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Research on Bottleneck Constraints and Countermeasures of Green Logistics Development in China

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ABSTRACT

With the proposal of the "Dual Carbon" goals and the in-depth advancement of ecological civilization construction, green logistics has become an inevitable choice for the high-quality development of China's logistics industry. This paper adopts the normative analysis method to systematically sort out the policy background and practical significance of green logistics development in China, and deeply analyzes the main bottleneck constraints currently faced by green logistics development, including five major aspects: cost constraints, technical bottlenecks, standard deficiencies, imperfect policies, and weak awareness. Corresponding countermeasures and suggestions are proposed from five dimensions: government guidance, enterprise subjectivity, technological innovation, standard construction, and social co-governance. The research shows that the development of green logistics is a systematic project that requires coordinated efforts from the government, enterprises, industry associations, and consumers to jointly build an efficient, low-carbon, and circular green logistics system.

KEYWORDS

Green Logistics; Dual Carbon Goals; Bottleneck Constraints; Countermeasures and Suggestions; Sustainable Development

1. INTRODUCTION

1.1. Research Background

The logistics industry is a fundamental, strategic, and leading industry supporting the development of the national economy, and it is also a key area of energy consumption and carbon emissions. According to statistics, carbon emissions from China's logistics industry account for approximately 10% of the country's total carbon emissions, among which road transportation accounts for more than 85% of the logistics industry's carbon emissions. With the increasingly severe global climate change problem, green and low-carbon development has become a consensus among countries worldwide. In September 2020, China explicitly proposed the goal of "striving to peak carbon dioxide emissions before 2030 and achieve carbon neutrality before 2060", pointing out the direction for the comprehensive green transformation of China's economic and social development.

Against this background, green logistics, as an important gripper for the logistics industry to achieve carbon peak and carbon neutrality, has received unprecedented attention [1]. The National 14th Five-Year Plan for Modern Logistics Development clearly identifies "green and low-carbon" as an important principle for the development of the logistics industry [2], and proposes to accelerate the construction of a green and low-carbon logistics system, promote the adjustment of transportation structure, promote new energy vehicles, develop green packaging, and improve the reverse logistics

system. In recent years, the national and local governments have successively introduced a series of policies and measures to support the development of green logistics, and green logistics development has ushered in an important strategic opportunity period.

1.2. Research Significance

Developing green logistics is not only an objective requirement for achieving the "Dual Carbon" goals, but also an inherent need for the high-quality development of the logistics industry. From a macro perspective, developing green logistics helps reduce social logistics costs, decrease energy consumption and pollutant emissions, and promote the optimization and upgrading of industrial structure. From a micro perspective, developing green logistics helps enterprises reduce operating costs, enhance brand image, and strengthen market competitiveness.

However, the development of green logistics in China is still in its initial stage and faces many bottleneck constraints in practice, with unsatisfactory development effects. This paper systematically sorts out the main problems faced by China's green logistics development, deeply analyzes the causes of these problems, and proposes practical countermeasures and suggestions, which has important theoretical value and practical significance for promoting the healthy development of green logistics in China.

1.3. Research Methods and Framework

This paper adopts the normative analysis method and follows the research logic of "status quo analysis - problem diagnosis - cause analysis - countermeasure suggestions". Firstly, it elaborates on the policy background and practical significance of green logistics development in China. Then, it analyzes the bottleneck constraints faced by green logistics development from five aspects: cost, technology, standards, policies, and awareness. Finally, it proposes systematic countermeasures and suggestions from five dimensions: government, enterprises, technology, standards, and society.

2. POLICY EVOLUTION AND PRACTICAL SIGNIFICANCE OF GREEN LOGISTICS DEVELOPMENT IN CHINA

2.1. Policy Evolution of Green Logistics Development in China

The development of green logistics in China has roughly experienced three stages:

Stage 1 (2001-2012): Concept Introduction and Policy Embryonic Period. In 2001, China's national standard "Logistics Terms" first included "green logistics" in the logistics terminology system, marking the official introduction of the green logistics concept into China. In 2009, the State Council issued the "Adjustment and Revitalization Plan for the Logistics Industry", which first proposed the concept of "green logistics" in a national plan, emphasizing the need to vigorously develop green logistics and circular logistics. Policies in this stage were mainly focused on concept advocacy and macro guidance, lacking specific implementation details and supporting measures.

Stage 2 (2013-2020): System Construction and Policy Refinement Period. In 2014, the "Medium and Long-term Plan for Logistics Industry Development (2014-2020)" listed "Green Logistics Engineering" as one of the seven key projects, proposing to promote green transportation, green warehousing, and green packaging. In 2016, the "13th Five-Year Plan for Modern Logistics Industry Development" further refined the specific tasks and measures for green logistics development. During this stage, the green logistics policy system was gradually improved, and targeted support policies and incentive measures began to emerge.

Stage 3 (2021-Present): Dual Carbon Leadership and Policy Deepening Period. After the proposal of the "Dual Carbon" goals, green logistics policies entered an accelerated deepening period. In 2022,

the "14th Five-Year Plan for Modern Logistics Development" identified "green and low-carbon" as one of the five principles for logistics industry development, proposing to build a green and low-carbon logistics system. The national and local governments have successively introduced a series of specific policies such as new energy vehicle promotion, diesel truck elimination, and green packaging promotion. Policies in this stage pay more attention to implementation and effect assessment, with significantly enhanced operability.

2.2. Practical Significance of Developing Green Logistics

First, developing green logistics is an important support for achieving the "Dual Carbon" goals [3]. The logistics industry is an important source of carbon emissions. Promoting the green transformation of logistics and reducing the energy consumption and carbon emissions of logistics activities play an irreplaceable role in achieving the carbon peak and carbon neutrality goals [4]. According to estimates, a 10% reduction in carbon emissions from the logistics industry can drive a reduction of approximately 1 percentage point in national carbon emissions.

Second, developing green logistics is an inevitable choice for the high-quality development of the logistics industry [5]. The traditional logistics model is characterized by high investment, high consumption, and high emissions, with extensive development patterns and low resource utilization efficiency. Green logistics emphasizes the efficient utilization and recycling of resources. By optimizing transportation organization, promoting energy-saving technologies, and developing joint distribution, it can significantly improve logistics efficiency, reduce logistics costs, and realize the connotative development of the logistics industry.

Third, developing green logistics is an effective way to enhance enterprise competitiveness. With the enhancement of consumers' environmental awareness and the popularization of green consumption concepts, green has become an important source of competitiveness for enterprises. Implementing a green logistics strategy not only reduces energy costs and environmental costs for enterprises, but also enhances brand image, wins consumer recognition and trust, and occupies a favorable position in market competition.

Fourth, developing green logistics is an objective requirement for participating in international competition. Green barriers have become important barriers in international trade. Developed countries and regions such as the European Union have successively introduced green trade policies such as the Carbon Border Adjustment Mechanism. Developing green logistics and improving the green level of logistics links helps Chinese enterprises break through green trade barriers and enhance international competitiveness [6].

3. BOTTLENECK CONSTRAINTS FACED BY GREEN LOGISTICS DEVELOPMENT IN CHINA

3.1. Cost Constraints: Insufficient Economic Incentives for Green Transformation

The primary bottleneck faced by green logistics development is the cost issue. Compared with traditional logistics, green logistics often requires higher upfront investment, while the corresponding cost savings and revenue returns are long-term and uncertain, resulting in enterprises lacking endogenous motivation for green transformation.

This is specifically manifested in three aspects: First, high upfront investment costs. The purchase cost of new energy logistics vehicles is 30%-50% higher than that of traditional fuel vehicles, the cost of green packaging materials is 20%-40% higher than that of ordinary packaging materials, and the investment in intelligent warehousing equipment and energy-saving equipment is also very large. Second, high operation and maintenance costs. The charging infrastructure for new energy vehicles is imperfect, with long charging times and short cruising ranges, affecting operational efficiency; the

recycling and recycling system for green packaging is imperfect, resulting in high recycling costs. Third, lack of cost-sharing mechanism. The environmental benefits generated by green logistics have positive externalities, but the corresponding costs are mainly borne by logistics enterprises. There is a lack of effective cost compensation and incentive mechanisms, leading to the phenomenon of "whoever goes green suffers".

3.2. Technical Bottlenecks: Lagging R&D and Application of Green Technologies

Technology is the core support for green logistics development. However, the current R&D and application of green logistics technologies in China are still relatively lagging, making it difficult to meet the needs of green logistics development.

First, insufficient breakthroughs in key technologies. In key core technologies such as high-efficiency energy-saving engines, lightweight materials, power batteries, and hydrogen fuel cells, China still has a large gap compared with international advanced levels. Core components rely on imports, resulting in high technical costs. Second, low penetration rate of technology application. Although some green logistics technologies are mature, their penetration rate in the industry is still low due to high costs and insufficient awareness. For example, new energy logistics vehicles account for less than 20% of urban distribution vehicles, and recyclable packaging is used in less than 10% of e-commerce express deliveries. Third, insufficient integration of digital technologies. Digital technologies such as big data, artificial intelligence, and the Internet of Things are not deeply applied in green logistics. Functions such as accurate carbon emission accounting, intelligent logistics path optimization, and full-process transportation visualization have not been fully realized, and the role of technology in enabling green development has not been fully exerted.

3.3. Standard Deficiencies: Imperfect Green Logistics Standard System

Standards are an important foundation for green logistics development. However, the current green logistics standard system in China is still imperfect, making it difficult to effectively support green logistics development.

First, incomplete standard system. Existing standards mainly focus on basic standards such as terminology and classification, while standards in key areas such as green logistics operation specifications, evaluation indicators, certification systems, and carbon emission accounting are seriously insufficient, lacking a unified, standardized, and operable standard system. Second, inconsistency between standards. Standards formulated by different departments and industries overlap or even conflict with each other, lacking overall coordination, leaving enterprises at a loss. Third, weak standard enforcement. Most existing standards are recommended standards, with few mandatory standards. There is a lack of effective supervision and assessment mechanisms, resulting in greatly reduced standard implementation effects. Fourth, low degree of standard internationalization. China's green logistics standards are not sufficiently aligned with international standards, making it difficult to adapt to the needs of international green trade development.

3.4. Imperfect Policies: Inadequate Institutional Guarantee System

Although the state has introduced a series of policies to support green logistics development, the policy system is still imperfect, and the pertinence, coordination, and operability of policies need to be improved.

First, policy fragmentation. Green logistics-related policies are scattered across multiple departments such as development and reform, transportation, commerce, and environmental protection, lacking overall coordination. There is a lack of effective connection between policies, making it difficult to form policy synergy. Second, insufficient incentive policies. Existing policies are mainly restrictive policies, with few incentive policies. The intensity of fiscal subsidies, tax incentives, and financial

support for enterprise green transformation is insufficient, and the precision and effectiveness of policies need to be improved. Third, imperfect supervision mechanism. Environmental supervision of logistics activities is inadequate, with low illegal costs. As a result, some enterprises prefer to pay fines rather than invest in green transformation, highlighting the phenomenon of "bad money driving out good money". Fourth, inadequate infrastructure support. Infrastructure construction such as charging and swapping facilities for new energy vehicles, urban joint distribution centers, and green logistics parks lags behind, making it difficult to meet the needs of green logistics development.

3.5. Weak Awareness: Green Development Concepts Not Yet Deeply Rooted

The development of green logistics requires the participation of the whole society. However, the current understanding of green logistics by all sectors of society still needs to be improved.

First, weak green awareness of enterprises. Most logistics enterprises still adhere to the traditional development concept of "valuing efficiency over environmental protection". They have insufficient understanding of the importance of green logistics, lack initiative and consciousness for green transformation, and often passively respond to policy requirements rather than actively implementing green strategies. Second, insufficient green consumption awareness of consumers. When choosing logistics services, consumers pay more attention to price and timeliness, and consider fewer green and environmental factors. They lack willingness to pay for green logistics, making it difficult to form effective market demand pull. Third, lack of strong social atmosphere. The promotion and popularization of green logistics are insufficient. The public's awareness and recognition of green logistics are not high, and a good atmosphere for the whole society to participate in green logistics development has not yet been formed.

4. COUNTERMEASURES AND SUGGESTIONS FOR PROMOTING GREEN LOGISTICS DEVELOPMENT IN CHINA

4.1. Strengthen Government Guidance and Improve Policy Support System

The government plays an important guiding and promoting role in green logistics development. It is necessary to strengthen top-level design, improve the policy system, and create a good institutional environment for green logistics development.

First, strengthen overall planning. Incorporate green logistics into the overall national economic and social development plan, formulate a special development plan for green logistics, and clarify the goals, tasks, and paths for green logistics development. Establish a cross-departmental coordination mechanism to strengthen policy coordination among departments such as development and reform, transportation, commerce, and environmental protection, forming a joint force to promote green logistics development.

Second, increase policy incentives. Increase financial investment in green logistics, establish special funds for green logistics development, and provide subsidies for new energy vehicle purchases, green packaging promotion, and energy-saving technology transformation. Implement and improve relevant tax preferential policies for green logistics, granting corporate income tax and value-added tax reductions to green logistics enterprises. Innovate green financial products to provide financing support such as low-interest loans and green bonds for green logistics projects.

Third, improve the supervision mechanism. Establish and improve the green logistics supervision system, strengthen environmental supervision of logistics activities, increase penalties for illegal pollution discharge, and raise illegal costs. Establish a green logistics evaluation and assessment mechanism, incorporate green development indicators into the assessment system of logistics enterprises and local governments, and strengthen assessment constraints.

Fourth, strengthen infrastructure construction. Accelerate the construction of charging and swapping facilities for new energy vehicles, and build a moderately advanced and rationally distributed charging infrastructure network. Promote the construction of urban green logistics parks and joint distribution centers, and improve the urban distribution node network. Strengthen the construction of green transportation infrastructure such as railways and waterways to provide support for transportation structure adjustment.

4.2. Highlight Enterprise Subjectivity and Stimulate Endogenous Motivation for Green Transformation

Enterprises are the main subjects of green logistics development. It is necessary to give full play to the role of the market mechanism and stimulate the endogenous motivation of enterprises for green transformation.

First, guide enterprises to establish green development concepts. Strengthen publicity and guidance for enterprises, help them fully understand the significance and economic value of green logistics, and integrate green development concepts into enterprise development strategies. Encourage enterprises to formulate green logistics development plans and clarify the goals and paths for green transformation.

Second, promote enterprises to implement green operations. Guide enterprises to optimize transportation organization models, vigorously develop joint distribution, centralized distribution, and night distribution, improve vehicle loading rates, and reduce empty driving. Encourage enterprises to use new energy and clean energy vehicles and phase out high-emission old vehicles. Promote green warehousing and apply energy-saving technologies such as energy-saving lighting and intelligent temperature control. Promote green packaging, use degradable and recyclable packaging materials, and reduce excessive packaging.

Third, improve enterprise green governance. Encourage enterprises to establish a green logistics management system and set up special green management institutions and personnel. Guide enterprises to carry out carbon emission accounting, establish carbon emission ledgers, and formulate carbon emission reduction targets and action plans. Encourage enterprises to release green logistics social responsibility reports and actively accept social supervision.

Fourth, cultivate leading green logistics enterprises. Support large logistics enterprises to play a demonstrative and leading role, take the lead in implementing green transformation, and form replicable and popularizable experience models. Encourage leading enterprises to drive small and medium-sized enterprises in the industrial chain to jointly implement green transformation and build green supply chains.

4.3. Promote Technological Innovation and Strengthen Scientific and Technological Support for Green Development

Technological innovation is the core driving force for green logistics development. It is necessary to increase the R&D and application of green logistics technologies and empower green logistics development with scientific and technological innovation.

First, strengthen R&D of key core technologies. Increase investment in R&D of key green logistics technologies, support joint research by universities, research institutes, and enterprises, focus on breaking through key core technologies such as high-efficiency energy-saving power technology, lightweight technology, power battery technology, and carbon capture and utilization technology, and reduce technical costs.

Second, accelerate the promotion and application of mature technologies. Establish a green logistics technology promotion catalog and increase the promotion of mature and applicable technologies.

Encourage enterprises to apply mature technologies such as new energy vehicles, energy-saving equipment, and recyclable packaging. Establish green logistics technology demonstration bases to play a demonstrative and leading role.

Third, deepen the integrated application of digital technologies. Accelerate the application of digital technologies in green logistics, use big data and artificial intelligence to optimize logistics path planning and improve transportation efficiency. Use Internet of Things technology to realize full-process visualization of logistics and real-time monitoring of carbon emissions. Use blockchain technology to establish a green logistics traceability system, enabling traceability of green credit.

Fourth, improve the technological innovation service system. Establish a green logistics technology innovation platform to provide enterprises with services such as technical consultation, testing and certification, and achievement transformation. Strengthen the training of green logistics talents to provide talent support for technological innovation.

4.4. Accelerate Standard Construction and Build a Unified and Standardized Standard System

Standards are an important foundation for green logistics development. It is necessary to accelerate the establishment and improvement of the green logistics standard system and give full play to the normative and leading role of standards.

First, improve the standard system framework. Formulate guidelines for the construction of the green logistics standard system, and build a complete standard system covering basic standards, technical standards, management standards, service standards, and evaluation standards. Focus on accelerating the formulation of key standards such as green logistics carbon emission accounting, green packaging, green transportation, green warehousing, and green service evaluation.

Second, strengthen overall coordination of standards. Establish a green logistics standard coordination mechanism to coordinate the standard formulation work of various departments and industries, avoiding overlapping and conflicting standards. Strengthen the coordination and matching of national standards, industry standards, local standards, and group standards to form a multi-level standard system.

Third, strengthen standard implementation and enforcement. Increase standard publicity and training to improve enterprises' awareness and implementation ability of standards. Establish a standard implementation supervision mechanism and strengthen supervision and inspection of standard implementation. Incorporate standard implementation into the enterprise credit evaluation system to strengthen standard constraints.

Fourth, promote standard internationalization. Actively participate in the formulation of international green logistics standards and promote the alignment of Chinese standards with international standards. Learn from international advanced standards to improve the internationalization level of Chinese standards. Promote Chinese standards to "go global" and enhance China's voice in international standard formulation.

4.5. Promote Social Co-governance and Create a Good Atmosphere for Green Development

Green logistics development requires the participation of the whole society. It is necessary to build a social co-governance pattern with the coordination of the government, enterprises, industry associations, and consumers.

First, give play to the role of industry associations. Support logistics industry associations to play a bridging role, strengthen industry self-discipline, and formulate industry green development conventions. Encourage industry associations to carry out green logistics training, consultation, and

evaluation services to promote advanced experience and practices. Support industry associations to carry out industry green development evaluation and release industry green development reports.

Second, cultivate green consumption concepts. Strengthen green consumption publicity and education to improve consumers' environmental awareness and green consumption concepts. Guide consumers to prioritize green logistics services when choosing logistics services and pay a reasonable premium for green logistics. Encourage e-commerce platforms to set up green logistics zones to guide consumers to choose green delivery.

Third, strengthen publicity and guidance. Make full use of various media to increase the publicity of green logistics, popularize green logistics knowledge, publicize advanced green logistics models, and create a good atmosphere for the whole society to care about, support, and participate in green logistics development. Carry out green logistics public welfare activities to improve public awareness and recognition of green logistics.

Fourth, encourage public participation in supervision. Establish a green logistics social supervision mechanism, unblock public supervision channels, and encourage the public to report environmental pollution behaviors in logistics activities. Give play to the role of news media in public opinion supervision and expose logistics enterprises that seriously pollute the environment.

5. CONCLUSION

Green logistics is an important support for achieving the "Dual Carbon" goals and an inevitable choice for the high-quality development of the logistics industry. Currently, the development of green logistics in China faces multiple bottleneck constraints such as cost constraints, technical bottlenecks, standard deficiencies, imperfect policies, and weak awareness, and green transformation has a long way to go.

Promoting green logistics development is a systematic project that requires coordinated efforts from multiple parties. The government should strengthen top-level design, improve the policy support system, and play a guiding role; enterprises should highlight their subject status, actively implement green transformation, and stimulate endogenous motivation; technological innovation should be strengthened to provide scientific and technological support for green logistics development; standard construction should be accelerated to build a unified and standardized standard system; social co-governance should be promoted to create a good atmosphere for the whole society to participate.

With the in-depth implementation of the "Dual Carbon" strategy and the continuous improvement of the policy system, green logistics development in China will surely usher in a broader space. Through the joint efforts of the government, enterprises, and the whole society, we will surely be able to build an efficient, low-carbon, and circular green logistics system and make important contributions to achieving the carbon peak and carbon neutrality goals and promoting high-quality economic and social development.

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