## Analysis of High-Quality Development of Logistics Efficiency Based on Low-Carbon Concepts

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Abstract: With economic globalization and the rapid development of various industries, logistics and transportation make a significant contribution to the economic life of countries around the world. However, due to the lack of a national unified market and the inefficiency of cross-transportation links, logistics costs are very high in China at this stage. At the same time, mankind's one-sided pursuit of economic value while ignoring the ecological value has led to environmental problems are becoming more and more prominent. Green logistics, as a new logistics model, plays an important role in the realization of low-carbon economy and sustainable development goals. It promotes the coordinated development of economy, society and environment by optimizing transportation routes and improving energy use efficiency. With the improvement of people's awareness of environmental protection and the concept of sustainable development, green logistics as the direction of the development of modern logistics industry and the inevitable trend will gradually be more widely used and promoted. This paper discusses the theoretical basis for the development of green logistics, the current status of research at home and abroad, thus contributing to the research and development of green logistics in a certain way.

## 1 INTRODUCTION

Amid the rapid advancement of commercial globalization and each stage of development, logistics and transportation have become an essential part of people's lives, and play a crucial role in the economic life of all countries in the world. In the context of China's "dual carbon" goals, the logistics industry with huge pollution and consumption needs to be completed by realizing the transformation of green logistics. The "Notice of the General Office of the State Council on Printing and Distributing the" 14th Five-Year Plan "Modern Logistics Development Plan" proposes a series of Specific measures to promote the development of green logistics, these measures have positive significance for reducing carbon emissions, improving environmental quality and promoting sustainable development. By carrying out standard implementation activities, promoting low-carbon technology and equipment, and creating green logistics hubs and parks, it can play a positive

role in promoting the development of the entire logistics industry in a green and low-carbon direction. At the same time, the active application of new energy and clean energy in transportation, warehousing, distribution and other links will also help reduce dependence on traditional energy and reduce environmental pollution. Measures for the development of green logistics is an indispensable part of the green economy. According to the guiding spirit of the "14th Five-Year Plan for National Economic and Social Development and the Outline of Long-term Goals for 2035", accelerating the development of green logistics is to promote sustainable development. An indispensable part of development, at the same time, due to the gradual rise of environmental barriers, green logistics is also an important part of adapting to the development of the world economy.

Lately, many academics have worked out valuable analysis on green logistics and logistics capability. In terms of low-carbon logistics, based on

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the Driving-Pressure-State-Impact-Response (DPSIR) model, Guo et al. analyzed the influencing factors and mechanism of railway green logistics from the aspects of driving force, pressure, state, impact and response, and put forward countermeasures for the development of railway green logistics (Guo et al., 2024), Hu and others innovatively proposed the "rail" urban green logistics system, based on the analysis of network nodes and channels, to improve the current urban environment and improve the efficiency of urban distribution through structure (Hu et al., 2023). Li and Hu analyzed and summarized the development status of green logistics in my country from three aspects. Green packaging, green warehousing and green transportation (Li and Hu, 2023). Han used the super-efficiency SBM model of unexpected output to measure and evaluate the efficiency of green logistics in the three northeastern provinces in the past ten years, and based on the results, put forward countermeasures including establishing and implementing a more complete regional logistics industry policy system and actively introducing foreign investment Suggestions to provide reference for the improvement of green logistics efficiency in other regions (Han, 2023). Shu used the factor analysis method to reduce the dimension of the inputoutput index, so as to build the low-carbon logistics efficiency evaluation index system in the eastern region, and studied the low-carbon logistics efficiency and influencing factors in the eastern region of my country (Shu, 2023). Li studied the development status and bottlenecks of Shanghai's logistics system, and put forward solutions (Li, 2022). Xue et al. took the data of 16 cities in Shandong Province as samples, used DEA and Malmquist index models to measure the efficiency of the logistics industry in 16 cities in Shandong Province, and used the qualitative comparative analysis method (QCA) to clarify the influencing factors and optimization paths of logistics efficiency in Shandong Province (Xue et al., 2024).

In terms of logistics efficiency, Zhang and others commented on the current situation of the entire logistics industry, including the evaluation methods and solutions for the efficiency of the logistics industry (Zhang, 2024). Li and Leng discussed the super-large-scale market, logistics efficiency and online consumption, and studied the role of city size in promoting household online consumption, which can improve the efficiency of logistics distribution (Li and Leng, 2023). Yang and others innovatively used the fuzzy set qualitative comparative analysis method (fsQCA) to explore the configuration role of each antecedent variable, studied to improve the highquality development efficiency of the logistics industry from a new perspective, and proposed a path to achieve high logistics efficiency (Yang et al., 2023).

Throughout the existing literature, the articles on low-carbon logistics and logistics efficiency mainly have the following shortcomings. In terms of solutions, most articles only explain from the surface and cannot dig out the reasons from the root. In the selection of objects, most articles prefer to choose a specific region as the research focus of logistics efficiency, but the analysis of the differences, improvement paths and internal mechanisms of logistics efficiency among various components in the region is often ignored. This issue has a great impact on academic research. This paper is based on the combination of green logistics and logistics efficiency literature to sort out and summarize the academic discussion on this topic.

### 2 CONNOTATION OF GREEN LOGISTICS

### 2.1 Concept of Logistics

At the beginning of the 20th century, American scholar Archie Shaw first defined the term "logistics" in the 1915 book "Some Problems in Market Circulation". He believes that the added value of logistics itself is realized with the transfer of time and space. After that, logistics gradually became a theory and began to develop in the West. After more than 30 years of changes, with the continuous development of the economy, the logistics theory in the West is also constantly innovating, especially the proposal of sustainable development, logistics began to be studied from the perspective of environmental protection and sustainable concepts.

Since the beginning of the last century, the concept of logistics has been created and developed through three stages. "Pre-logistics era", "logistics era" and "new logistics era" Logistics discipline has continuously advanced from the initial research on modal cost and modal rate in order to design an efficient transportation system to optimize transportation, storage, packaging, The sum of various logistics activities such as loading and unloading, processing logistics information, and then linking the mission and goals of the enterprise with the logistics system, coordinating the production, marketing and logistics of the enterprise. Since then, with the concept of full responsibility proposed, people began to pay attention to the role of logistics, and the economic contribution and social benefits of enterprises have also been taken into consideration. This stage is known as the subsequent development stage of the third stage.

### 2.2 **Proposal of Green Logistics**

In 1980s, the logistics industry in the continuous development of the process of social and environmental problems are becoming more and more serious, giving rise to air pollution, garbage pollution and other issues. In the early 1990s. Western scholars put forward the concept of green logistics, and soon received the great attention of all walks of life. In 1994, the famous logistics expert James -In 1994, James Cowper, a famous logistics expert, explored the great significance of developing green logistics on the basis of research on how to choose inventory strategy and transportation tools (Xiao and Zhou, 2005). Afterwards, the academic circles also began to study the way of green logistics. In 2001, China published "Logistics Terminology" (Wang Ping, 2001) on the definition of green logistics is as follows, to inhibit logistics in the logistics process of the environmental hazards caused by logistics at the same time, the realization of the purification of the material, so that the logistics resources can be fully applied. As the trend of economic globalization intensifies, green logistics has gradually become an important part of the new era of the economy and the supporting force, and a frenzy of research on green logistics has been set off at home and abroad, with many countries researching and exploring green logistics from different perspectives.

Some scholars have made different opinions on green logistics in various scenarios, for the definition of green logistics, the representative Jean-Paul Rodrigue, Brian Slack and Claude Comtois think that the environmentally friendly and environmentally compatible, efficient logistics system is green logistics (Slack et al., 2016). Wu and Dunn thought that green logistics is a system that is conducive to the protection of the environment. Dunn believed that green logistics is a logistics system that is conducive to the protection of the environment and environmentally responsible (Barysienė et al., 2015). Gonzalo and other scholars are more in-depth study of green packaging from the perspective of consumers and enterprises (Gonzalo et al., 2021).

### 2.3 Theory of Green Logistics

There are three theoretical foundations for green logistics. The first is the economic theory of sustainable development. Because of the need to bring economic value, the logistics process consumes a large amount of resources and energy, resulting in a waste of resources and pollution of the environment. On the other hand, sustainable development wants to have a constant flow of resources for people to use, so promoting sustainable development is the most important factor. Secondly, there is the theory of ecological economics, which takes the coordination of economic and ecological objectives as the ultimate goal to realize the common development of ecology and economy. The past development of the logistics industry has weakened the link between economic and environmental benefits, overemphasizing economic benefits and neglecting ecological benefits. Finally, there is the theory of ecological ethics, where people come out of their moral cultivation and realize that the interest of protecting the ecological environment is also to safeguard their own interests, and that the author must consider the obligations while enjoying the convenience. Due to the ethical theory, people are more likely to have more goodwill towards green enterprises, which enables them to gain competitive advantage through green logistics, thus promoting the development of green logistics.

### 2.4 Status of Green Logistics

The United States is one of the earliest countries in the world to develop logistics, so it also attaches great importance to the development of green logistics. First of all, the policy, the development of a series of laws and regulations, such as the Transportation Security Act, the Comprehensive Environmental Liability Compensation and Obligations Act, in order to reduce the waste of resources in the logistics and packaging process, and optimize the reverse logistics. By the end of the last century, the United States has basically completed the "Green Mark" requirements for the realization of bag logistics. This not only helps to reduce costs and revenues, but also helps to improve corporate image, consumer recognition, loyalty, so that enterprises can gain a competitive advantage. From a policy perspective, Japan has been leading the development of green logistics in the country. Many Japanese cities have specific transit centers and recycling centers, and through reinforcement, they oversee transportation, distribution, and scheduling in the city, thereby achieving the goal of reducing environmental

pollution and improving transportation efficiency. In addition, Japan has developed smart devices such as energy saving and emission reduction by improving transportation systems through electric power technology, cushioning material consumption for automated packaging systems to reduce packaging waste, and intelligent storage and sorting of objects by AUTSTORE robots. The Japanese logistics industry has been actively promoting modal shifts (from automobiles to rail and sea transportation with lower environmental loads), building operational systems for mainline transportation, establishing common distribution systems in metropolitan areas, and promoting energy-efficient driving to control pollution emissions.

Currently, China's green logistics development program is initially implemented, while the green development of logistics is not so rapid. According to the National Bureau of Statistics (NBS), "Statistical Bulletin of the National Economic and Social Development of the People's Republic of China in 2023", China's annual energy consumption is equivalent to 5.72 billion tons of standard coal, an increase of 5.7% compared to last year. Of this, coal and natural gas consumption grew by 5.6% and 7.2% respectively. Coal accounted for 55.3% of total energy consumption, while clean energy accounted for 26.4%. As can be seen from this, although the proportion of clean energy in China is increasing year by year, oil is still the main source of energy consumption. The State has been actively promoting the transformation of green logistics and encouraging enterprises to transform and optimize it, and up to now, China's exploration of the transformation of green logistics has also achieved stage-by-stage results.

In terms of providing a green port, Chongqing has already begun to layout. As a key region in China's western development and an important stop for the China-Europe liner. With the continuous promotion of green logistics construction, the shipping services of Chongqing port are also being optimized and upgraded, leading to the speedy progress of Chongqing's logistics industry and economy. However, the port area has not yet formed a green shipping service industry cluster, but the port area has not yet formed a green shipping service industry cluster, many supporting facilities are backward, and the logistics nodes are not well connected (Cui, 2024).

In terms of green parks, Wanwei Logistics Development Co., Ltd. has built China's first zerocarbon intelligent logistics demonstration park -Wanwei Shanghai Park, which is the first in the country in terms of the scale of cold storage, and advocates "Empowering Intelligent Carbon Neutrality with Technology". As of November 2022, its building area reaches more than 4.9 million square meters, and it has set up a rooftop distributed photovoltaic power plant in the pilot park to offset the carbon emissions in the park's operation through local renewable energy supply, successfully completing a zero-carbon logistics park (Gao, 2023).

### **3** DEVELOPMENT TRENDS AND CHALLENGEMENT

### **3.1** Globalization and Informatization

The continuous development of communication and information technology has facilitated economic globalization, and the rise of multinational corporations has pushed forward the change of global logistics and procurement mode. The popularization of e-commerce has accelerated the development of elogistics, providing consumers and enterprises with more efficient and convenient transaction methods. Through e-commerce platforms, consumers can achieve a global shopping experience, while enterprises can more quickly understand market demand and provide personalized services. The application of e-logistics technologies, such as online tracking, logistics scheduling and cargo inspection, further enhances the efficiency and controllability of the entire supply chain and promotes the development of global trade.

# 3.2 Stereoscopic and Networked Infrastructure

In 2020, the introduction of the National Comprehensive Stereo Transportation Network Planning Outline marked a new stage in China's transportation infrastructure construction. The plan outlines the future development strategy for an integrated land, sea, and air transportation network to elevate the quality of logistics services, and the future logistics infrastructure in China will show the characteristics of networked and three-dimensional development. Specifically, the future development of logistics infrastructure will reflect the following characteristics.

First, the network coverage is wider. The scale of the comprehensive transportation line network will proceed to build up and the volume of transportation lines will rise day by day. The transportation conditions of border crossings, ports, industrial parks, rural areas and other important nodes will be significantly improved, and the blockages and bottlenecks of the relevant transportation routes will be gradually eliminated.

Second, higher operational efficiency. The construction of new infrastructure and the application of information technology will promote the development of various modes of transportation in the direction of intelligence. At the same time, the reform and innovation of the comprehensive management system will enhance the efficiency of coordinated operation between various modes of transportation.

# 3.3 Specialization and Refinement of Service Model

With the adjustment of the structure of logistics demand, the pattern of the service industry will also be transformed. Various specialized logistics works, such as e-commerce strategy, cold chain strategy and threatened goods logistics, will develop. China recently released the original five-year plan in specialized strategy, "14th Five-Year Plan" (Ma, 2024) Cold Chain Logistics Development Plan, indicating the importance of specialized logistics. Enterprises will integrate resources and utilize high technology in order to fight for traditional logistics market share in the face of fierce competition. In the future, the scale of supply of refined and high-quality logistics services, such as instant direct delivery, time-limited delivery and personalized delivery, will also continue to increase.

### 3.4 Challenge of Logistics Efficiency

In modern years, the proportion of total social logistics cost to GDP is still very high. According to the data jointly released by various departments, it can be seen that in 2023, China's full communal strategy costs will be 12.1 trillion yuan, an increase of 9.2% year-on-year; the ratio of total social logistics costs to GDP will be 14.6%. However, it is still much higher than the level of 8% to 9% in developed countries.

### 3.4.1 Logistics Systematic Not Strong

There are some problems in China's logistics industry, such as the overall and comprehensive nature is not strong enough, the transportation structure is not reasonable enough, and the degree of networking and organization is low. This has led to the decentralized development of the logistics system, weak supporting and compatibility of infrastructure, and weak end-to-end network. In terms of the logistics network, there are imperfections in the network consisting of trunk lines, feeder lines, terminals, as well as logistics hubs, parks, centres, distribution centres, and terminal outlets, and there are weak points between each link. At the same time, the physical infrastructure, information network and operation network have not yet formed a complete. The ratio between public logistics infrastructure, socialized logistics infrastructure and enterpriseowned logistics infrastructure is also unreasonable.

## 3.4.2 Shortage of Logistics Infrastructure Structure

The level of China's logistics industry does have some challenges, such as relative lagging behind, low proportion of modernized facilities, and insufficient facilities such as modern warehousing and multimodal transshipment. The comprehensive transportation network is required to optimize the layout, and the logistics park system has yet to be established. In addition, there is a lack of complementarity between different logistics infrastructures, making it difficult to connect them effectively. These problems require systematic and comprehensive solutions to promote the modernization of logistics infrastructure.

### 3.4.3 Third-Party Logistics Management

First of all, supply chain management includes multiple links and participants, and each participant has a blind spot in the understanding of information, leading to information asymmetry from time to time. Therefore, it is difficult for third-party logistics enterprises to obtain the real situation of each enterprise and cannot make accurate decisions. Secondly, the service quality of third-party logistics enterprises is difficult to guarantee under the highdemand market, and there are cases of cargo loss and delivery delay from time to time. And some thirdparty logistics innovation ability is weak, lack of advanced logistics management system means, thus the competitiveness of enterprises. affecting Excessive logistics costs are also a more serious problem. Third-party logistics enterprises need to maintain a large number of warehouses and workers, and these costs will be added to the cost of services. Finally, in today's rapidly changing information technology, network security issues are of great concern, the loss of plagiarism that occurs in the transport process, will have an impact on the credibility of the enterprise.

### 3.4.4 Logistics Informatization and Intelligence Lagging Behind

There are still some challenges in China's logistics industry in terms of informatization and intelligence. At present, the overall planning capacity needs to be improved, the construction of logistics informatization is relatively slow, industry standards and norms are not sound enough, and there is a relative shortage of information professionals. In addition, the integrated development and sharing of information resources is not sufficient and the updating speed is slow. The overall application level is low, especially the informationisation level of small and medium-sized logistics enterprises performs poorly, the application of advanced technology is limited, and the integration of informationisation with the work and manufacture links of companies are lacking.

#### 3.4.5 Lack of Connection with Other Industries

The linkage between the logistics industry and the manufacturing industry, agriculture, commerce and trade, and e-commerce still exists to a certain extent. At present, logistics is slow, costly, the channels are not smooth enough, and the mode is relatively outdated, which seriously restricts the manufacturing industry to realize the process of changing from big to strong, solving the problems of agriculture, and promoting the sustainable development of commerce and trade services and e-commerce. Structural contradictions in supply and demand between industries at different levels are prominent, and the application of information technology platforms and technologies in linking the logistics industry with related industries is lagging behind, failing to bring into sufficient play the facilitating effect on the linked development of industries.

### **4** CONCLUSION

Under the "dual-carbon" goal, the logistics industry also needs to emphasize energy savings and emission reductions and promote green development. The key to the development of a low-carbon economy lies in the reduction of greenhouse gas emissions. At present, countries around the world are actively taking measures to reduce the emission of carbon dioxide and other greenhouse gases, such as strengthening energy management, optimizing the energy structure, and promoting clean energy. In China, the

Government promotes the development of a lowcarbon economy through the enactment of policies, like encouraging energy conservation and clean production, and promoting new energy vehicles. The development of a low-carbon economy can reduce greenhouse gas emissions. Compared with the traditional economy, the low-carbon economy is more efficient and smarter, which can enhance the capability of resource utilization, cut down efficiency consumption and waste emissions, and is also conducive to promoting scientific and technological innovation and improving product quality. With the continuous development of low-carbon economy, green logistics has also become an important link. Green logistics aims to reduce emissions and achieve sustainable development, environmental protection, sustainable as the guide, to achieve the whole process of logistics green, low-carbon, environmentally friendly. The rise of green logistics can not only decrease energy consumption and waste emissions, but also improve logistics efficiency and service quality, and bring more economic benefits and social benefits for enterprises.

At present, people's understanding of green logistics is not deep enough, through community publicity, article pushing and other ways to let the public have a deeper understanding of green logistics, and gradually form a green consumer concept. At the same time on the existing logistics system policy to supplement and improve environmental protection, the establishment of green logistics to make the efficient development of the structure, the development of green logistics in the policy. Investment in the establishment of green logisticsrelated infrastructure, the development of a unified management system, due to the fact that there are now fewer environmentally friendly logistics equipment, many of which are independent and difficult to be compatible, which makes it difficult to make changes to the overall planning of logistics from a macroscopic point of view, but also leads to a waste of resources. Unified standards will help integrate sustainable development into all aspects of green logistics, green logistics cooperation and exchanges between enterprises can also learn from each other's successful experience in the implementation of green logistics facilities to accelerate the improvement of the use of technology.

The rise of green logistics is also inseparable from the talent, strengthen the green logistics theory research and talent training, in the university have opened a green logistics management program, to provide various levels of education and training, because of the green logistics is a cross-specialty disciplines, the need for cooperation between colleges, but also need to enterprises and schools and scientific research departments to cooperate, the theory of the combination of education and practical research, the development of green logistics, technology and management of composite specialties, to supplement the talent gap, the establishment of green logistics facilities to use the technology to improve. As a systematic project involving multiple sectors, disciplines and subjects, its development will not be accomplished overnight.

For the existing green logistics infrastructure, it is necessary to integrate and raise the skill of its value. It is necessary to fully utilize the government's and associations' functions, use policy guidance to raise the environmental protection concept of the whole society, and break the independence of regions, departments and industries in the past. People will pay attention to the mutual cooperation between schools and enterprises, and constantly fill the talent gap in the industry, not only to cultivate their own urgently needed logistics talents, but also to further enhance the quality of in-service logistics personnel. With the joint participation of the government, enterprises and consumers, the author will accelerate the realization of a logistics system that meets the low-carbon requirements strategy of the new era, which not only has ecological and environmental protection value, but also brings better economic value.

### AUTHORS CONTRIBUTION

All the authors contributed equally and their names were listed in alphabetical order.

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