

THE IMPLEMENTATION PATHS AND EFFECTIVENESS ANALYSIS OF GREEN LOGISTICS: A CASE STUDY

HuiYing Wang, JiaYi Shi*, JingYun Shi, ZhongYi Tao
School of Accounting, Beijing Wuzi University, Beijing 101126, China.
Corresponding Author: JiaYi Shi, Email: shitongyue2023@163.com

Abstract: Against the backdrop of increasingly severe global environmental issues and the deepening advancement of the "Dual Carbon" goals, green logistics, as a crucial pathway to achieving sustainable development, has become an inevitable trend for the transformation of the logistics industry. Green logistics not only emphasizes reducing resource consumption and environmental pollution in logistics activities but also pursues the synergistic development of economic, social, and environmental benefits. In recent years, the Chinese government has intensively issued numerous green logistics policies, promoting the industry's green transformation across all segments, including packaging, transportation, warehousing, and informatization. Concurrently, a growing number of enterprises are actively exploring implementation pathways for green logistics. Through technological innovation, management optimization, and business model innovation, they aim to fulfill environmental responsibilities while enhancing operational efficiency. However, enterprises across different industries and of varying scales still face challenges in path selection, cost control, and technology application during their green logistics practices. Based on theories of sustainable development, stakeholder engagement, and green development, and by integrating literature review and typical case studies, this paper systematically explores the implementation pathways of green logistics and its associated environmental, economic, and social benefits. The findings are intended to provide theoretical reference and practical insights for the green transformation of China's logistics industry.

Keywords: Green logistics; Implementation pathways; Effect analysis; Sustainable development

1 INTRODUCTION

With the in-depth development of global industrialization and economic integration, logistics activities, as the artery connecting production and consumption, have become an indispensable core link in the modern economic system. However, while pursuing efficiency and speed, traditional logistics models are accompanied by a series of severe problems such as high energy consumption, high emissions, resource waste, and environmental pollution, posing significant challenges to the ecological environment and the sustainable development of society. Against this backdrop, the emerging concept of "green logistics" — which integrates the concepts of sustainable development, environmental ethics, and modern management science — has emerged. It emphasizes minimizing environmental pollution and reducing resource consumption throughout the entire logistics process. By leveraging advanced planning, technologies, and management methods, green logistics aims to optimize and upgrade the logistics system, ultimately building a new type of logistics model that not only promotes economic development but also coexists harmoniously with the environment.

Currently, addressing climate change has become a global consensus. China has put forward the "dual carbon" strategic goals: "striving to peak carbon dioxide emissions before 2030 and achieve carbon neutrality before 2060". This top-level national design has brought unprecedented transformation pressures and development opportunities to various industries, especially the logistics sector — one of the major sources of carbon emissions. In response to this strategy, China has intensively introduced a series of policies and regulations at both central and local levels in recent years to promote the greening of logistics. Covering multiple dimensions such as green packaging, adjustment of transportation structures, electrification of vehicles, and intelligent logistics parks, these measures have built an increasingly sound policy framework and action guidelines for the development of green logistics.

At the same time, driven by both market demands and social responsibilities, many leading enterprises have taken the lead in exploring and practicing green logistics. Ranging from manufacturing enterprises in the upstream of the supply chain to express delivery service providers in the downstream, these enterprises are actively practicing green concepts — either through energy-saving transformations in internal production processes and research and development of green products, or by optimizing transportation networks, promoting recyclable packaging, and adopting new energy vehicles. These practices have not only initially demonstrated environmental benefits but also sparked extensive discussions on their economic and social benefits. However, enterprises with different industry attributes and scales still face significant differences in aspects such as the selection of green logistics implementation paths, technology application, cost control, and benefit realization. They are also confronted with multiple challenges, including high transformation costs, insufficient technological reserves, and difficulties in full-chain collaboration. Therefore, systematically sorting out the theoretical basis of green logistics, in-depth analyzing its diverse implementation paths, and scientifically evaluating its implementation effects are of great theoretical and practical significance for guiding

more enterprises to effectively carry out green transformation and supporting the smooth realization of China's "dual carbon" goals.

Based on the Chinese context, this paper focuses on the core topic of "the implementation paths and effect analysis of green logistics". It will construct a theoretical framework based on the theory of sustainable development, stakeholder theory, and green development theory; systematically summarize the implementation paths and models of green logistics through a review of existing literature; select Liard Co., Ltd. and YTO Express Co., Ltd. as typical cases to conduct an in-depth comparative analysis of their green logistics practice paths and comprehensive effects; and on the basis of case studies, extract useful insights, prospect the direction and strategies for the high-quality development of green logistics in the future, so as to provide valuable references for the realization of a green, low-carbon, and sustainable logistics model.

2 THEORETICAL BASIS

2.1 Theory of Sustainable Development

The theory of sustainable development aims to guide the economic, social and environmental development of human society, ensuring that current needs are met without compromising the ability of future generations to meet their own needs. It adheres to the principles of fairness, sustainability and commonality, with the ultimate goal of achieving coordinated, fair, efficient and multi-dimensional development and ensuring the harmonious unity of the economic, social and environmental aspects. In March 1994, the State Council of China officially approved the "China 21st Century Agenda - White Paper on Population, Environment and Development in the 21st Century of China", which covers China's sustainable development strategy and action guidelines for population, economy, society, resources and environment in the 21st century. The realization path of green logistics should follow this concept. From an economic perspective, it can optimize resource allocation and maximize economic benefits; from a social perspective, it can reduce environmental pollution and waste of resources, and improve the quality of life of the public; from an environmental perspective, it can reduce resource consumption and waste emissions in the logistics process, which is conducive to mitigating the negative impact on the ecological environment during the development process. From a macro and long-term perspective, optimizing various aspects in the development process of green logistics can achieve efficient utilization of existing resources and effective protection of the ecological environment, improve the negative impacts such as excessive resource extraction and environmental pollution caused by packaging and decomposition in the development process of the logistics industry, further promote the mutual benefit and win-win situation between the logistics industry and green development, and bring sustainable development to the logistics industry and the social economy.

2.2 Stakeholder Theory

Stakeholder Theory, which originated in the 1960s, represents a pivotal framework in organizational management and business ethics. It posits that organizations must comprehensively consider and balance the interests of all stakeholders in their decision-making and operational processes, rather than focusing solely on shareholders. The core tenet of this theory is that an organization's success depends not only on shareholder satisfaction but equally on the fulfillment of all stakeholders' interests. According to Zhang H [1], the proposition of this theory aims to reinterpret and delineate the three fundamental challenges confronting shareholder capitalism—value creation, business ethics, and managerial mindset. In the practice of strategic management, the application of Stakeholder Theory encounters several challenges. The pathway to achieving green logistics is grounded in this theoretical framework. By analyzing the multitude of stakeholders involved in green logistics activities, the primary focus is directed toward three key groups: logistics enterprises, the government, and customers. Logistics enterprises, as the implementing entities of green logistics, can achieve a dual victory in economic and environmental benefits by reforming green logistics technologies and management methods. The government, acting as the guiding force for the development of green logistics, provides incentives—such as fiscal subsidies, tax incentives, and the enactment of relevant policies and regulations—to encourage logistics enterprises to actively engage in green logistics reforms. Meanwhile, customers, as the ultimate beneficiaries of green logistics, have expectations and demands that indirectly validate whether the development of logistics enterprises aligns with societal aspirations. Lan contends that green logistics is a green management activity process aimed at achieving customer satisfaction and societal development [2], connecting supply and demand to facilitate the efficient flow of green products and services. From a comprehensive analytical perspective, these three key actors not only promote the dissemination and practice of the green development concept but also advance the implementation of sustainable development theory.

2.3 Green Development Theory

Green development, a pioneering concept advocated by the United Nations Development Programme (UNDP) in 2002, is fundamentally centered on fostering harmonious coexistence between economic progress and ecological preservation. Hu Angang, recognized as a pioneering figure in China's green development movement, elucidates this innovative paradigm in his work "China's Innovative Green Development." He characterizes green development as a sustained investment in ecological systems—a new developmental model that transcends conventional sustainable development

frameworks. This approach is grounded in the triple integration of economic, social, and ecological dimensions, distinguished by its advocacy for rational low consumption, minimal emissions, and the preservation of ecological capital. According to Li [3], the ultimate objective of this developmental philosophy is to achieve harmonious coexistence between humans and nature, as well as among human societies. Establishing a green development framework necessitates, first, actively promoting the greening of industrial structures and accelerating the enhancement of green development standards across industries to realize the synergy between economic growth and environmental protection. Second, it requires championing low-carbon production methods to foster high-efficiency development within production systems. In synthesis, green development plays an indispensable role in advancing green logistics practices. It imposes distinct developmental requirements across multiple stakeholders—including consumers, enterprises within the logistics sector, and national governments—while providing robust theoretical foundations for greening the logistics industry.

3 LITERATURE REVIEW

3.1 Implementation Paths of Green Logistics

With the development of the economy, the degree of environmental degradation has deepened. As an integral part of economic activities, logistics activities also face environmental challenges. Establishing a green logistics system is an inevitable requirement for achieving sustainable development. Previous studies have indicated that there are four main paths to green logistics, specifically including improving policies and regulations, enhancing environmental awareness, upgrading the green level of facilities, and leveraging digitalization to drive development.

Liu concluded by analyzing the current status of green logistics in China that since the end of the 20th century [4], green logistics has gradually attracted attention from all sectors of society. The comprehensive greening of logistics is regarded as an inevitable trend in the development of China's logistics industry in the future. However, China's green logistics industry still remains at the conceptual stage to date, with a significant gap from practical implementation, and many issues remain to be resolved. The reasons for the stagnation of green logistics in China include the lack of green logistics awareness across the whole society, incomplete government policies and legal systems, backward infrastructure and information technology, a shortage of high-quality interdisciplinary talents, and insufficient attention to reverse logistics. As a cutting-edge environmental protection concept, green logistics needs to gain recognition and support from the entire society, which must start with the green transformation based on the current situation of China's logistics industry.

Xie and Wang argued that there are three paths for green transformation [5]. Firstly, improve government policies and relevant legal systems. For example, establish a competent authority in charge of logistics, formulate a comprehensive legal system for green logistics development, and use economic levers to encourage and guide the behaviors of logistics enterprises. Secondly, enhance the environmental awareness of consumers and enterprises. For instance, actively advocate green consumption, and encourage enterprises to emancipate their minds, break the traditional concept that "environmental protection is not economical", and establish a new concept of green logistics operation. Thirdly, upgrade the green level of infrastructure. This includes introducing advanced equipment, transforming existing logistics infrastructure to improve the level of mechanization, automation, and cleanliness; rationally planning the layout of logistics networks with cities as the core, and constructing modern logistics centers that integrate commodity flow, logistics, capital flow, and information flow; selecting appropriate transportation strategies, optimizing and integrating basic transportation tools such as trains, automobiles, ships, and aircraft, and implementing combined and consistent transportation; and actively introducing and independently developing advanced and applicable green logistics technologies.

In previous studies, some scholars have pointed out that in the current digital era, there is another important new path: the path of digital technology innovation leading the green and low-carbon transformation of the logistics industry. This path consists of three specific aspects: the capability enhancement path driven by basic research innovation, the technology upgrading path driven by core technology innovation, and the industrial joint development path driven by service system innovation. These three paths interact with and promote each other, jointly supporting the green development of the logistics industry [6].

3.2 Implementation of Green Logistics

Enterprises are the main entities for the development and implementation of green logistics [8]. The implementation forms of corporate green logistics can be divided into three categories: technology innovation-oriented, management improvement-oriented, and system constraint-oriented [7].

He put forward the view that based on the current development status of green logistics in China [9], the suitable promotion model should take the system constraint-oriented green logistics as the driving model, the management improvement-oriented as the foundation, and the technology innovation-oriented as the development strategy. Building on this, Liu drew on and compared the experience and characteristics of logistics systems in developed countries [10], and proposed three main implementation paths for the green logistics system: taking the legal and administrative means of the government as the leading force, using relevant economic means as the specific implementation method, and taking the Extended Producer Responsibility (EPR) system as the supplement. Focusing on China's leading implementation model, i.e., the system constraint-oriented green logistics model, it is believed that the formulation and

implementation approaches of the green logistics system are mainly reflected in three aspects: the legal and administrative means of the government and relevant organizations as the leading force (the relevant organizations here refer to formal and legal industry organizations or associations with certain international influence and official recognition, such as the Organization for Economic Co-operation and Development (OECD)); the economic means of the government and relevant organizations as the supplement; and the EPR system in the supply chain as the supplement.

Li argued that the leading role of the legal and administrative means of the government and relevant organizations is mainly reflected in the establishment and improvement of relevant laws [11], policies, rules, and regulations. The corresponding green logistics laws, policies, regulations, rules, and standards formulated by governments, enterprises, and various organizations of various countries not only have legal effect, but also serve as the fundamental basis and most basic principles of the green logistics system. With the economic means of the government and relevant organizations as the supplement, economic means are an extension and one of the specific implementation forms of legal and administrative means, aiming to exert both incentive and restrictive effects on economic entities through the use of relevant economic means.

The Extended Producer Responsibility (EPR) system in the supply chain. In the late 1980s of the 20th century, EPR was proposed as an emerging system, which clearly defines that after products are consumed, the main responsible entity for the waste recycling, recycling and reuse, and final disposal links should be the product manufacturers. The purpose of implementing this system is to minimize the environmental impact at all stages of the product life cycle.

Some scholars have concluded through research that on the surface, EPR emphasizes the green treatment and recycling at the end of the supply chain. However, in fact, manufacturers must bear part of the responsibilities for waste recycling, management, and recycling and reuse, or part of the costs of waste recycling and management. This will force manufacturers to carry out technological transformation at the source, implement green procurement, and conduct green design of products, so as to reduce the costs of reverse logistics for subsequent recycling and reuse [12].

4 CASE OVERVIEW

4.1 Current Development Status of Green Logistics

4.1.1 Policies

From 2021 to 2025, China has issued a number of green logistics regulations to advance the green transformation of the industry. In terms of packaging: It has standardized the packaging of parcels and express items, imposed strict control over excessive packaging, restricted the use of hazardous substances, and prohibited non-degradable adhesive tapes. In terms of transportation: It has promoted new energy logistics vehicles, adjusted the transportation structure, developed multimodal transport, and reduced logistics costs. In terms of logistics parks: It has supported the construction of green logistics parks, formulated relevant standards, and advanced digital, intelligent and green management. In terms of enterprises: It has guided e-commerce enterprises to tap into green consumption demand, promoted the green development of enterprises, and fully facilitated the logistics industry to achieve low-carbon, eco-friendly and efficient development, see Table 1.

Table 1 Summary of Major Green Logistics Policies (2021-2025)

Name	Year	Key Contents
Measures for the Management of Parcel and Express Packaging	2021	Aims to strengthen the management of green packaging for parcels and express items, ensure packaging quality, standardize packaging practices, conserve resources, and protect the environment. Applies to the use of packaging materials for domestic parcels/express items, packaging operations, and corresponding supervision and management.
Notice of the General Office of the Ministry of Commerce on Promoting the Green Development of E-commerce Enterprises	2021	Intends to support the green development of e-commerce services. Proposes measures such as guiding e-commerce platforms to explore green consumption demand, developing green design for product packaging, and building green brands to achieve tangible results in plastic pollution control.
Notice on Effectively Promoting the Popularization and Application of Standardized Logistics Turnover Boxes	2021	Calls for accelerating the green transformation of logistics packaging and striving to build a modern logistics system. Requires reducing the use of non-degradable plastic bags and disposable packaging boxes, strengthening R&D of recyclable and easy-to-recycle products, and effectively increasing the supply of green products.
Administrative Measures for the Demonstration Project of Urban Green Freight Distribution	2022	Standardizes the procedures for the demonstration project of urban green freight distribution. Encourages the promotion of new energy logistics vehicles and optimization of distribution networks. Requires cities participating in the project to complete system construction within 3 years and set assessment indicators such as the proportion of new energy vehicles.
14th Five-Year Plan for the Construction of a Modern Circulation System	2022	Emphasizes the development of green logistics and promotes the reduction and recycling of logistics packaging. Supports the construction of green logistics parks and the popularization of new energy transportation tools.
Opinions on Improving the Institutional Mechanisms and Policy Measures for the Green and Low-Carbon Transition of Energy	2022	Promotes the adjustment of energy structure in the transportation sector and supports the promotion and application of new energy logistics vehicles. Encourages logistics enterprises to use clean energy and reduce carbon emissions.

Name	Year	Key Contents
Work Plan for Promoting the Development of Multimodal Transport and Optimizing the Adjustment of Transportation Structure (2021-2025)	2022	Advances the adjustment of transportation structure (shifting freight from road to railway and waterway) to reduce carbon emissions from road freight. Encourages the development of multimodal transport to improve logistics efficiency and reduce energy consumption.
Name	Year	Key Contents
Green Transportation Standard System (2022)	2022	Formulates standards related to green logistics, covering fields such as new energy vehicles, green warehousing, and intelligent logistics. Drives the standardized and low-carbon development of the logistics industry.
Action Plan for Further Promoting the Green Transformation of Express Packaging	2023	Further advances the green transformation of express packaging and puts forward relevant action requirements for the greening, reduction, and recycling of express packaging.
Limits of Heavy Metals and Specific Substances in Express Packaging	2023	China's first mandatory national standard for express packaging. Sets strict limits on heavy metals (e.g., lead, mercury, cadmium) and specific substances in paper-based, plastic-based, and other types of express packaging. Prohibits the use of toxic and harmful materials and strengthens source control.
Opinions on Supporting Railway Transportation of New Energy Commercial Vehicles to Serve the Development of the New Energy Vehicle Industry	2023	Clarifies that railway transportation of new energy commercial vehicles shall not be managed as dangerous goods, reducing logistics costs. Promotes the leveraging of the green and low-carbon advantages of railway transportation to support the development of the new energy vehicle industry.
14th Five-Year Plan for Emergency Material Support	2023	Requires improving the capacity of green channels for emergency material transportation and promoting containerized storage and transportation. Encourages the application of high-tech distribution methods such as intelligent robots and drones.
Notice on Pilots for the Comprehensive Electrification of Vehicles in Public Sectors	2023	Requires that the proportion of new energy vehicles in postal express and urban logistics distribution reaches 80%. Supports the construction of intelligent charging infrastructure and explores new energy consumption models such as vehicle-grid integration.
Evaluation Indicators for Urban Green Freight Distribution	2023	This standard facilitates the comprehensive promotion of green logistics. Establishes an evaluation system for the development level of urban green freight distribution, covering 20 indicators including the utilization rate of standard pallets and the proportion of new energy vehicles in urban logistics distribution.
Opinions on Supporting Railway Transportation of New Energy Commercial Vehicles	2023	Relaxes restrictions on railway transportation of new energy vehicles. Establishes green channels for railway transportation and improves the multimodal transport system for new energy vehicles.
Action Plan for Effectively Reducing Logistics Costs Across Society	2024	Promotes the application of new energy logistics vehicles and researches zero-carbon technologies for medium- and heavy-duty trucks; supports the construction of logistics carbon emission accounting and platforms; advances the green recycling of logistics packaging; deepens the adjustment of transportation structure and promotes multimodal transport to increase the proportion of railway freight.
Service Specifications and Evaluation Indicators for Logistics Parks & General Technical Requirements for Digitalization of Logistics Parks	2024	These standards guide the intensive development of logistics parks. The updated versions improve the service and quality requirements for logistics parks, refine the intelligent and green management of equipment, and guide parks to enhance digital operation capabilities in 8 aspects. This aims to improve efficiency and services, and facilitate logistics integration and industrial chain linkage.
Waybill for Container Multimodal Transport	2024	This standard promotes the efficient connection of multimodal transport. It unifies the format, information items, and circulation requirements of container multimodal transport waybills, enabling convenience such as "one waybill for the entire journey". National standards for transport volume calculation and evaluation are also developed to help solve problems in the statistics and evaluation of multimodal transport.
Limits and Evaluation Indicators for Fuel Consumption of Light Commercial Vehicles & Limits for Fuel Consumption of Heavy Commercial Vehicles	2024	These standards update fuel consumption requirements based on factors such as the current status of vehicle fuel consumption, technology development trends, and new energy development expectations. They promote the improvement of energy efficiency of traditional vehicles (represented by logistics vehicles) and an increase in the proportion of new energy vehicles.
Requirements for Restricting Excessive Express Packaging & Guidelines for the Use of Recyclable Packaging for Parcels and Express Items	2024	Refine the criteria for judging excessive express packaging from three aspects: the adaptability of express packaging boxes, the number of packaging layers, and the usage of sealing tape. They continue to promote the greening, reduction, and recyclability of logistics packaging.
Guidelines for the Application of Transportation Clauses in International Trade Terms	2024	This national standard promotes the safety and convenience of international trade. It provides term codes and interpretations in line with international rules and puts forward application suggestions, helping to resolve issues such as unclear application of terms, responsibilities, and costs in international trade caused by differences in practices.
Decision of the State Council on Amending the Interim Regulations on Express Delivery	2025	Mandates a nationwide ban on non-degradable plastic tape in postal and express outlets and specifies penalties. Express enterprises are required to take responsibility for green packaging and are encouraged to use degradable materials. A new chapter

on "express packaging" is added, requiring compliance with national standards and prevention of excessive packaging to achieve full-chain supervision.

4.1.2 Current development status of the industry

(i) Inception Time

The concept of green logistics emerged in the early 1990s. Against this backdrop, China began to introduce the concept of green logistics, with relatively few related practices at that time. In 2013, enterprises such as SF Express started independent R&D of eco-friendly packaging. In 2014, the State Council issued the Medium- and Long-Term Plan for the Development of the Logistics Industry (2014-2020), which explicitly proposed to vigorously develop green logistics for the first time, marking the start of the systematic development of green logistics in China.

(ii) Positive Progress

State-owned enterprises (SOEs) usually have stronger capital strength and resource integration capabilities, and have achieved outstanding performance in the construction of green logistics infrastructure—for example, investing in the construction of green and smart logistics parks equipped with advanced environmental protection facilities and intelligent equipment. Moreover, SOEs play a leading role in implementing the national green development policies and actively promote the adjustment of transportation structures. At the same time, relying on their scale advantages and industry influence, SOEs are more likely to cooperate with upstream and downstream enterprises as well as government departments to build a green logistics industrial chain.

Some private enterprises have quickly engaged in the green logistics field with flexible market strategies, and their scale has been continuously expanding. Meanwhile, they actively apply new technologies: for instance, optimizing transportation routes through intelligent logistics dispatching platforms and realizing cargo monitoring with the Internet of Things (IoT). In terms of green practices, private enterprises are also active—adopting new energy vehicles for transportation and promoting reusable eco-friendly packaging materials, among other measures, see Table 2.

Table 2 Examples of the Development Status of Green Logistics in Chinese Enterprises

Enterprise Name	Enterprise Type	Progress in Green Logistics
Shanxi Construction Investment Group	State-owned Enterprise (SOE)	It has built a smart logistics park, which introduced the first "fluorine + carbon dioxide" cascade refrigeration system in the province, with equipment from world-leading brands. Relying on the smart data center, the park realizes real-time online collaboration among personnel, vehicles, cargo, and warehouses. The temperature of the entire cold chain logistics chain is controllable and the process is visible, which has improved the park's safety management and control as well as logistics operation efficiency.
Shanxi Coking Coal Group	State-owned Enterprise (SOE)	It promotes the adjustment of transportation structure. By optimizing the transportation structure, it vigorously promotes the application of clean energy vehicles, and advances the "truck-to-rail", "truck-to-waterway" and "bulk-to-container" transformation for the transportation of bulk materials and medium-to-long-distance cargo, so as to build a multimodal transport logistics system. At present, the proportion of clean transportation vehicles of Shanxi Coking Coal Group has reached more than 42%, and the proportion of railway freight volume for coal transportation over 500 kilometers has reached more than 95%.
China COSCO Shipping Group, Sinopec Chemical Sales Co. Ltd.	State-owned Enterprise (SOE)	They have built a green logistics industrial chain. COSCO Shipping Energy and Sinopec Chemical Sales Co., Ltd. signed a strategic cooperation agreement to jointly promote the application of green energy and the construction of an industrial ecosystem, covering links such as scientific research, trade, and consumption application. They share resources, unblock the value chain of hydrogen energy application, deepen cooperation in the transportation of liquid chemicals, liquefied gas, and green energy, and jointly build an interconnected and efficient energy and chemical distribution network.
Hangzhou Subang Logistics	Private Enterprise	With the support of Hangzhou Transfar Highway Port Platform, it implements road-rail intermodal transport and optimizes transportation routes through an intelligent logistics dispatching platform. Taking the Hangzhou-Liuzhou route as an example, in the first quarter of 2024, its transportation volume increased by 300 tons and costs decreased by 13%.
ZTO Express Co., Ltd.	Private Enterprise	ZTO Express uses degradable stone-plastic eco-friendly boxes, which feature high durability, water resistance, moisture resistance, and reusability, making them suitable for packaging products such as laundry detergent, fresh fruits, and vegetables. At present, more than 5 million such stone-plastic boxes have been put into use.

(iii) Challenges Faced

State-owned enterprises (SOEs) have a large number of internal departments, which may lead to relatively complex decision-making processes. This can result in slower response speeds when adapting to market changes, applying emerging green technologies, and advancing projects. Additionally, despite their sufficient capital, SOEs still face the issue of high transformation costs.

Private enterprises vary greatly in scale and strength. Small private enterprises, constrained by capital and technology, face significant difficulties in green transformation. They are unable to bear costs such as the purchase of new energy vehicles and the research and development of green packaging, leading to uneven development levels. Moreover, due to fierce talent competition in the industry, private enterprises have relatively weak capabilities in attracting and retaining

professional talents, resulting in a talent shortage. Furthermore, driven by market competition, private enterprises generally prioritize short-term economic benefits and have insufficient awareness of the long-term value of green logistics.

4.2 Introduction to Case Enterprises

The implementation of green logistics has increasingly gained attention from major enterprises, becoming a prominent feature in the development of the logistics and various other industries. As environmental awareness deepens and the concept of sustainable development spreads widely, enterprises have gradually recognized that green logistics is not only a reflection of fulfilling social responsibilities but also a key initiative to enhance their competitiveness and achieve long-term development.

Major enterprises have successively incorporated green logistics into their strategic planning, actively promoting the green transformation of logistics links through measures such as adopting environmentally friendly packaging materials, optimizing transportation routes to reduce carbon emissions, and promoting new energy logistics vehicles. These initiatives not only help reduce operational costs but also enhance brand image and win consumer favor. Meanwhile, the implementation of green logistics has promoted collaborative cooperation among upstream and downstream enterprises in the supply chain, jointly building a green and low-carbon logistics ecosystem. Looking ahead, with continuous technological progress and policy guidance, green logistics has been put into application by major enterprises. Below, this article will introduce two different enterprises in different industries and their distinct approaches to implementing green logistics, aiming to demonstrate the progress of Chinese enterprises in green logistics, see Table 3.

Table 3 Green Logistics Development Paths of Two Enterprises

	Leyard Optoelectronic Co., Ltd. (300296.SZ)	YTO Express Co., Ltd. (600233.SH)
Industry	Supply chain enterprise	Logistics enterprise
Green logistics implementation time	2016	2022
Milestone for starting green logistics	Formulated the "Green Supply Chain Construction Implementation Plan"	Delivered and put into use 200 new energy light trucks
Core concept	Adopted a circular production chain development approach consisting of "green design + green procurement + green production + green logistics + green sales + green recycling" to build Leyard's green supply chain system	Achieved through recyclable packaging, new energy transportation capacity, intelligent sorting, and digital carbon management, etc.
Echnology research	1. The world's first common cathode technology energy-saving LED display, which supplies power to the red, blue, and green chips separately, achieving lower power consumption and reducing power waste. 2. Most Micro LED large screens adopt full flip-chip technology, which avoids the blocking of light by electrodes and maximizes the light-emitting area and light-emitting efficiency of the chips	1. Using green recyclable express boxes for receiving and sending parcels. 2. New energy box trucks and light trucks. 3. Combining photovoltaic power generation with automated sorting, and continuously deploying automated sorting equipment. 4. Promoting the application of robotic arms, flap machines, flexible sorting, and unmanned end bag pulling.
Actual Implementation Effects	1. PetroChina Transportation Dispatch Command Center 2. PetroChina Port Dispatch Command Center 3. CNOOC Research Institute	1. The number of corrugated cartons put into use exceeds 60 million, and roughly statistics show that the number of parcels using recyclable express packaging has exceeded 200 million so far. 2. During the Hangzhou Asian Games, 110 new energy box trucks were introduced. 3. More than 70 unmanned vehicles have been put into use in over ten regions, and the maximum daily delivery volume of each vehicle can reach 2,000 orders.

5 CASE ANALYSIS

5.1 Comparison of Implementation Paths

5.1.1 Analysis of implementation paths of case enterprises

To study the implementation paths of green logistics in China and find the most effective operation mode at present, this paper gradually refines and compares the implementation paths of Leyard and YTO Express, and discusses the advantages and disadvantages of different implementation paths. Based on their own resource endowments, business scales, and policy environments, different enterprises have adopted differentiated green logistics strategies to provide references for the green transformation of the industry and help the logistics industry achieve the coordinated development of economic benefits and environmental benefits, see Table 4.

Table 4 Implementation Path of Leyard Optoelectronic Co., Ltd

	Implementation Path	Core Technology
Factory Workshop	The fresh air system is used to meet the high environmental requirements of the automated production workshop, including the control of dust and the precision of the workshop's temperature and humidity.	Fresh Air System: Using natural air to cool the environment, which is expected to save 3,000 kWh of electricity per month.
	The air compressor room operates more energy-efficiently, saving approximately 131,000 kWh of electricity annually. It not only extends the service life of the air compressors but also reduces the number of loading and unloading cycles of the air compressors, lowering energy consumption during operation.	Intelligent Air Compressor Control System: Automatically adjusting the number of operating air compressors according to the actual air consumption.
Product Manufacturing	Using low-temperature lead-free solder paste instead of leaded solder paste, which can save about 129,000 kWh of electricity every year.	Low-temperature lead-free solder paste realizes low-temperature soldering through special alloy components. Its core principle is to reduce the melting point to meet the soldering requirements of heat-sensitive components.
LED Display	The application of common cathode drive technology has achieved significant progress in the power consumption, packaging, and heat dissipation of the unit. Compared with traditional chips, the power consumption is reduced by 50%.	Common Cathode Drive Technology: Using different voltages to drive the red, blue, and green three-primary-color LEDs.

With the deepening of the operation of Leyard's internal management system, the enterprise has implemented green logistics in various systems such as R&D, production, and supply chain. In terms of products, as early as 2015, Leyard developed the world's first common cathode technology energy-saving LED display. Judging from the recent actions of this LED display leader, Leyard has not only realized a green supply chain in production and achieved "green manufacturing" but also launched green and energy-saving products. In practical applications, it has assisted energy enterprises on many occasions. Leyard has been moving forward on the path of building green factories. Through the fresh air system and the energy-efficient operation of the air compressor room, it has saved a large amount of electricity and reduced energy consumption during operation. Therefore, the company has achieved a number of energy conservation and emission reduction goals, promoting the high-end, intelligent, and green development of the LED display industry, see Table 5.

Table 5 Green Logistics Implementation Path of YTO Express

	Implementation Path	Core Technology
Packaging	Recyclable packaging boxes adopt honeycomb panel composite materials. YTO recycles and reuses corrugated cartons and uses recyclable express packaging.	The core technology of honeycomb panel composite materials lies in its bionic honeycomb structure design and multi-layer material composite process, which achieves the unity of light weight and high strength. Meanwhile, in terms of environmental protection, this material is superior to 30mm natural stone.
Distribution	The King Kong Intelligent Management System is used to monitor the operation status of transportation tools in real-time, and the transportation capacity allocation of more than 2,000 trunk lines across the country is optimized by machines.	The collaborative operation of unmanned aerial vehicle (UAV) distribution and unmanned warehouses has increased the parcel sorting efficiency by 40% compared with the manual mode and reduced energy consumption by 28%.
Transportation	New energy box trucks and light trucks have become an important part of YTO's transportation fleet.	The technology of new energy box trucks mainly includes the "three-electric system" (battery, motor, electronic control), lightweight design, intelligent management system, and environmental adaptability technology.
Data Platform Construction	Construction The digital carbon footprint management system is an important support for its green development. This system covers the entire life cycle of each parcel and collects real-time carbon emission data in three categories: fuel consumption, electricity consumption, and packaging. It ranks the carbon emissions of YTO's collection and transportation in various regions on an annual and monthly basis. Moreover, the "carbon footprint" can be detailed to the carbon emission changes caused by different packaging used for a single parcel.	Based on the system data, YTO can optimize transportation routes, adjust vehicle deployment plans, and select more environmentally friendly packaging methods to further reduce carbon emissions in the transportation link.

With the rapid development of modern logistics, YTO Express is gradually transforming from an enterprise in the experimental stage of green logistics to a benchmark enterprise in the implementation of green logistics. It integrates the green concept into all links of enterprise operation and continues to innovate in packaging, distribution, transportation, and data platform construction. In terms of packaging, it reuses a large number of recycled corrugated cartons to reduce

waste; in green transportation, it uses new energy box trucks, light trucks, UAV distribution, and unmanned warehouse models, advocating the joint development of green energy and intelligent driving. The "technology cost reduction - green value-added - social win-win" model explored by YTO Express may become a model for China's logistics industry to cope with the global carbon neutrality challenge. The development of green logistics in China is not only reflected in the transportation industry but also achieves achievements in the transportation manufacturing industry.

5.1.2 Comparison of implementation paths of case enterprises

From the above case enterprises, it can be seen that both enterprises have conducted technical research on their respective key projects, starting from key technical points and overcoming technical difficulties to lay the foundation for the future development of green logistics. The difference lies in that the two enterprises are respectively engaged in the supply chain industry, logistics and transportation industry, and automobile manufacturing industry. Leyard's technical focus is on the greening of the production environment in factories and energy-saving lighting systems. The fresh air system and the operation of the air compressor room have significantly reduced electricity consumption. The three-color LED large screen it launched uses products to reduce power consumption, and many leading enterprises such as PetroChina have used this large screen. YTO Express focuses more on optimizing packaging, distribution routes, and distribution tools. YTO focuses on improving logistics distribution, using UAVs, new energy box trucks, and light trucks for distribution, which reduces labor consumption while supporting green distribution. The cooperative partners in the implementation path of green logistics are also different. Leyard has built its own green logistics system and formed a green supply chain with suppliers. YTO Express cooperates with automobile manufacturers and packaging manufacturers to develop and purchase new energy vehicles and recyclable packaging.

The common points are that Leyard's factory proficiently purchases green electricity and uses new energy as raw materials to reduce environmental pollution. Both enterprises have realized green and recyclable packaging. For example, the recyclable packaging boxes used by YTO Express and the lightweight packaging of Leyard's LED products have reduced the waste of disposable packaging. In terms of coordinated development, both enterprises have actively responded to the national "dual carbon" policy (carbon peaking and carbon neutrality) with their partners, promoting green logistics to reach a wide range of consumers and the whole world. These common points indicate that the realization of green logistics depends on the digitalization of green logistics, process optimization, and ecological coordination. Its essence is to achieve a win-win situation between the environment and the economy through technological innovation and resource integration.

5.2 Analysis of Implementation Effects

5.2.1 Analysis of environmental benefits

(i) Leyard Co., Ltd.

Leyard has established green supply chain management (GSCM) as one of its pivotal overarching strategic frameworks. Dating back to 2018 and earlier, the company's social responsibility reports alluded to environmental initiatives—particularly in energy conservation and emission mitigation—while optimizing logistical and warehousing operations, albeit without explicitly coining the term "green logistics." A significant milestone was reached in Leyard's 2019 Social Responsibility Report, where the company articulated its GSCM philosophy and implementation in a systematic and explicit manner. The report introduced the objective of "forging a green supply chain," incorporating environmental criteria for supplier selection, promotion of green procurement, and enhancement of internal logistical and warehousing systems to reduce energy consumption and emissions. This delineated the systematic inception of Leyard's green logistics paradigm. Subsequently, in the 2020–2024 Environmental, Social, and Governance (ESG) and Social Responsibility Report, Leyard provided a longitudinal analysis of resource consumption and emission metrics from 2020 to 2024, based on historical energy usage data, as delineated in Table 6 below.

Table 6 Temporal Evolution of Resource Utilization Patterns at Leyard Co., Ltd. (2020–2024)

energy utilization	2020	2021	2022	2023	2024
Electricity consumption (kWh)	5484832	14104534	32491625	47420563	56998890
Gasoline consumption (liters)	24373.45	45864.62	36233.14	37379.31	29840.60
Natural gas consumption (square meters)	173021	180764.1	179302.4	166416.4	151008.0

Data presented in this analysis are sourced and systematically compiled from Leyard Co., Ltd.'s "Leyard 2022–2024 Environmental, Social, and Governance (ESG) and Social Responsibility Report."

The analysis reveals a profound decoupling phenomenon between economic expansion and environmental impact during this five-year period. Electricity consumption surged nearly tenfold from 5.48 million kWh in 2020 to 57 million kWh in 2024, reflecting the corporation's rapid operational scaling. However, the environmental implications of this exponential growth are fundamentally contingent upon the generation mix of the grid infrastructure, with potentially substantial embedded carbon emissions should the electricity originate predominantly from fossil fuel sources, particularly coal. Contrasting this pattern, gasoline consumption demonstrated remarkable optimization. After increasing from 24,400 liters in 2020 to 37,400 liters in 2023, it registered a significant 20.2% year-on-year reduction to 29,800 liters in 2024. This achievement is particularly noteworthy considering the manifold increase in business activity, as

indirectly indicated by the electricity consumption metric. The 2024 consumption level even fell below that of 2021, representing an absolute reduction in consumption and thereby preventing substantial emissions of greenhouse gases and tailpipe pollutants. Concurrently, natural gas utilization displayed a consistent downward trajectory, declining from the 2021 peak of 181,000 cubic meters to 151,000 cubic meters in 2024—a 16.6% reduction from the maximum consumption level. This establishes another case of absolute emission reduction achieved alongside business expansion. The collective data strongly indicates that Leyard's green development strategy transcends simplistic energy reduction. Instead, it exemplifies a sophisticated approach focused on structural optimization of energy portfolios and enhanced energy efficiency, successfully achieving a critical decoupling of economic growth from environmental degradation.

(ii) YTO Express Group Co., Ltd.

YTO Express Group Co., Ltd. has publicly disclosed its corporate social responsibility (CSR) reports for eight consecutive years since 2016, demonstrating its commitment to Environmental, Social, and Governance (ESG) transparency. Against the backdrop of green logistics emerging as an industry trend, the company revised and registered its "Courier Packaging Operation Standards" in 2022 to refine management protocols and fulfill environmental responsibilities. This commitment was further underscored by the release of its inaugural "2024 Sustainability Report" in 2024. Proactively advancing energy conservation and emission reduction, YTO has instituted internal policies such as the "Notice on Implementing Seven Energy-Saving and Consumption-Reducing Measures Across the Network's Centers" and the "YTO Energy Conservation and Consumption Reduction Management System and Standards." These establish a comprehensive energy consumption control responsibility system and inspection mechanism. A key initiative involves enhancing the operational efficiency of its centers to improve overall energy utilization efficiency. The various measures adopted by YTO Express Group Co., Ltd. in its green development endeavors from 2020 to 2024 collectively illustrate its dedicated efforts toward sustainable development, as detailed in Table 7 below.

Table 7 Core Indicators of Circular Economy Practices and Green Operations (2020-2024)

Year 2020	Year 2021	Year 2022	Year 2023	Year 2024
The corporation has deployed approximately 6.9 million reusable transit sacks across its network, achieving an impressive cumulative utilization of 65.28 million cycles. At the operational hub level, the adoption rate of these reusable sacks exceeds 95%, demonstrating systematic implementation. Furthermore, the company has comprehensively transitioned to packaging tape with a width of 45mm or less, which now accounts for over 99.9% of all sealing operations. A significant 70.9% of e-commerce parcels shipped through its network are dispatched without secondary packaging, effectively reducing material consumption. Supporting this circular logistics framework, the company has established over 5,000 collection points equipped with dedicated recycling boxes throughout its service areas. Notably, within designated pilot regions, the deployment rate of such recycling facilities has reached 100%, creating a comprehensive infrastructure for packaging recovery and reuse. These metrics collectively illustrate a holistic, system-wide	The company has achieved near-universal adoption of electronic waybills, with an implementation rate exceeding 99.9%, while single-layer shipping labels now constitute over 95% of total usage. Its innovative reusable packaging systems utilize fully recyclable and biodegradable materials, featuring unique interlocking designs that eliminate the need for adhesives or sealing tapes. These containers demonstrate exceptional performance characteristics including water resistance, thermal stability, compression strength, and shock absorption, while maintaining 100% recyclability—with damaged units being regenerated into new packaging. Concurrently, through strategic optimization of packaging designs by eliminating excessive color saturation, the corporation has reduced ink coverage by one-third while achieving a 10% decrease in manufacturing defect rates. This streamlined approach yields	By the conclusion of 2022, the corporation had achieved a remarkable 93% adoption rate for standardized packaging materials across its network, while standardized packaging procedures reached 92% implementation. The company has procured and deployed tens of thousands of reusable delivery boxes, alongside facilitating the recovery and reuse of 22.08 million corrugated cartons throughout its operational network. Concurrently, the implementation rate of single-layer electronic waybills attained 92%, with 92% of e-commerce parcels across the network dispatched without additional packaging. The total deployment of reusable transit bags reached 18.37 million units, achieving a utilization rate exceeding 96% at distribution centers. These validated performance metrics systematically demonstrate the company's	The proportion of e-commerce parcels dispatched without secondary packaging has reached 90%, while the volume of mail and express deliveries utilizing reusable packaging solutions has surpassed 200 million. The system-wide recovery and reuse of corrugated cartons has exceeded 60 million units, complemented by the cumulative deployment of over 26 million reusable transit bags achieving a 99% utilization rate across distribution centers. These validated metrics demonstrate systematic integration of circular economy principles within	In 2024, YTO Express achieved comprehensive adoption of streamlined packaging tape across its distribution centers, reaching 100% implementation. This initiative yielded a substantial reduction in plastic film usage by 372,970 square meters, equivalent to approximately 9.4 metric tons annually. Furthermore, the corporation introduced compact packaging labels while eliminating bag-stitching procedures, consequently reducing paper consumption by nearly 50%. Concurrently, through systematic equipment enhancements and operational optimizations, the monthly replacement rate of cardboard boxes due to damage demonstrated significant improvement—declining from 662,400 to 550,200 units. These operational enhancements have yielded both environmental benefits and measurable efficiency gains across the network.

Year 2020	Year 2021	Year 2022	Year 2023	Year 2024
commitment to operational sustainability and the advancement of a circular economy paradigm within the logistics sector.	measurable economic benefits, generating a marginal cost saving of 0.012 RMB per unit, thereby validating the commercial viability of its sustainable packaging initiatives.	comprehensive transition toward standardized operational frameworks and circular economy principles within its logistics ecosystem.	logistics operations.	

Data Source: The empirical analysis draws upon systematically compiled disclosures from YTO Express Co., Ltd.'s Corporate Social Responsibility Report (2020-2020), supplemented by subsequent data from the 2024 Sustainability Report.

5.2.2 Appraisal of economic performance

(i) Cost of Revenue

Table 8 Temporal Evolution of Operational Cost Structure: Leyard Optoelectronic Co., Ltd. (2016-2024)

Year	2016	2017	2018	2019	2020	2021	2022	2023	2024
Operating Costs (billion)	29.96	38.51	47.17	59.62	61.54	78.98	74.38	70.76	68.91

Data sourced from the Income Statement of Leyard Optoelectronic Co., Ltd.

Business Expansion (2016-2021): During this period, the Cost of Revenue demonstrated a substantial upward trajectory, escalating from CNY 2.996 billion to a historic zenith of CNY 7.898 billion. This trend aligns with conventional commercial dynamics, where dimensional expansion in operations necessitates proportional increases in production, distribution, and logistical expenditures, see Table 8.

Strategic Transformation and Cost Inflection (2021-2024): This critical juncture witnessed a paradigm shift in cost structure. Contrary to the previous expansionary pattern, the Cost of Revenue retreated from its 2021 peak of CNY 7.898 billion, registering three consecutive annual contractions and settling at CNY 6.891 billion by 2024—representing an aggregate reduction of CNY 1.007 billion. This reversal signifies a fundamental strategic realignment toward operational efficiency and structural optimization.

Table 9 Trend Analysis in Cost of Revenue: YTO Express Group Co., Ltd. (2020-2024)

Year	2020	2021	2022	2023	2024
Operating Costs (billion)	32.98	42.82	49.01	53.32	64.41

Data Sources: The underlying financial data are systematically curated and extracted from the Consolidated Income Statements of YTO Express Group Co., Ltd. (YTO Express Co., Ltd.) spanning the fiscal years 2020 to 2024.

The Cost of Revenue demonstrated a substantial ascent from CNY 3.298 billion in 2020 to CNY 6.441 billion in 2024, representing a near two-fold expansion (approximating 95% growth) over the quinquennial period, see Table 9. This trajectory closely corresponds with China's era of exponential express delivery volume expansion. The absolute cost escalation is directly attributable to the dramatic scaling of operational throughput, where increased parcel volumes necessitated commensurate increases in transportation, sorting operations, labor, and material inputs.

Notably, this analysis suggests that in the absence of concurrent green logistics initiatives and operational efficiency enhancements, the magnitude of cost inflation would likely have been substantially more pronounced. The observed cost trajectory thereby implicitly reflects the mitigating role of sustainable development strategies within the corporation's expansion paradigm.

(ii) Selling Expenses

Table 10 Trajectory of Selling Expenses: Leyard Optoelectronic Co., Ltd. (2014-2024)

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Selling Expenses (ten thousand yuan)	14,634.9	203,65.6	394,75.9	49,388.7	59,817.3	70,017.5	65,390.2	73,436.8	82,723.4	80,603.8	79,092.9
	3	2	9	1	8	5	0	6	2	3	3

Data Sources: The dataset is curated from Leyard Optoelectronic Co., Ltd.'s Financial Final Accounts Reports (also referenced as Annual Financial Statements)

Pre-transition Period (2014-2019): During this expansionary phase, selling expenses exhibited rapid growth alongside business scale enlargement. The absolute expenditure remained at a relatively modest level, yet demonstrated exceptionally high growth rates—a characteristic pattern of corporate infancy and rapid expansion phases, necessitating sustained investment in sales resources for market penetration and brand establishment, see Table 10.

Strategic Inflection Point and Efficacy Realization (2020-2024): This period witnessed effective cost containment and optimization. The growth trajectory of selling expenses manifested a distinct plateau with marginal regression: commencing in 2020, the growth rate decelerated substantially, culminating in two consecutive years of absolute

reduction in 2023-2024, declining from CNY 8.27 million in 2022 to CNY 7.90 million in 2024. Notably, this financial optimization coincides temporally with Leyard's systematic implementation of green supply chain initiatives and sustainable production methodologies (commencing circa 2018-2019 with tangible outcomes emerging post-2020). The empirical evidence reveals a fundamental transformation in Leyard's selling expense architecture following its green transition—evolving from an initial "scale-driven high-growth paradigm" to an "efficiency-driven stabilization model." This metamorphosis demonstrates the economic dividends generated through green brand empowerment, validating the strategic synergy between environmental stewardship and financial performance optimization.

Table 11 Trajectory of Selling Expenses: YTO Express Co., Ltd. (2020-2024)

Year	2020	2021	2022	2023	2024
Selling Expenses (ten thousand yuan)	10,029.97	14,055.62	22,770.72	18,185.14	21,981.06

Data Sources: The dataset is systematically curated from YTO Express Co., Ltd.'s Financial Final Accounts Reports (also referenced as Annual Financial Statements)

Phase of Intensified Competition and Strategic Investment (2020-2022): This period witnessed a pronounced upsurge in selling expenses, culminating in a cyclical peak during 2022. This trajectory reflects the industry's fierce competition for market share, characterized by protracted price wars and aggressive marketing campaigns, see Table 11. Consequently, selling expenses—encompassing subsidies, advertising, and channel incentives—demonstrated significant upward rigidity.

Phase of Efficacy Realization and Strategic Recalibration (2023-2024): The marked contraction observed in 2023 represents a pivotal inflection point, signaling either proactive or reactive modifications to the corporation's market approach with substantially enhanced expenditure control. The moderate resurgence in 2024 does not indicate regression to previous extensive patterns but rather suggests strategic recalibration within a new operational paradigm—with absolute expenditure remaining below the 2022 zenith. This pattern likely reflects controlled, efficiency-driven investments rather than undisciplined spending.

The dataset illuminates a critical "investment-recalibration-efficiency enhancement" cycle, wherein the economic dividends of green development gradually materialize. The green development strategy has facilitated structural optimization of YTO Express's selling expenses, enabling a paradigm shift from "extensive subsidy-driven customer acquisition" to "sophisticated brand value-driven growth." This transformation has ultimately elevated sales efficiency and fiscal discipline, demonstrating how environmental strategy can catalyze commercial excellence.

(iii) Inventory Turnover Ratio

Table 12 Structural Transition in Inventory Turnover Dynamics: Leyard Optoelectronic Co., Ltd. (2014-2024)

Year	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Inventory Turnover (times)	2.13	1.54	1.73	1.51	1.30	1.42	1.33	2.00	1.64	1.65	1.76

Data Sources: Financial data systematically compiled from Leyard Optoelectronic Co., Ltd.'s Annual Financial Statements (2014-2024).

Leyard's inventory turnover ratio demonstrated a distinct "decline-trough-rebound-steady improvement" trajectory over the decade, closely aligned with the corporation's developmental phases and green strategy implementation.

Efficiency Downturn Phase (2014-2020): The inventory turnover ratio experienced a systematic decline from 2.13 times in 2014 to a historical low of 1.33 times in 2020. This period coincided with rapid business expansion and increasing product portfolio complexity, necessitating substantial raw material and finished goods inventories to meet market demand. Consequently, elevated inventory levels contributed to diminished capital turnover efficiency, see Table 12.

Green Transformation and Efficiency Inflection (2021): The year 2021 marked a critical reversal, with the ratio surging remarkably to 2.00 times—a greater than 50% year-on-year improvement and a multi-year peak. This pivotal transition corresponds temporally with the corporation's systematic implementation of green supply chain management, positioning green development strategy as the fundamental catalyst for this operational transformation.

Efficiency Consolidation and Sustained Optimization Phase (2022-2024): Although the ratio moderated from its 2021 peak, subsequent readings of 1.64, 1.65, and 1.76 times established a stabilized operational plateau significantly superior to the 2017-2020 efficiency trough (averaging approximately 1.40 times). This consolidation pattern demonstrates the institutionalization of efficiency gains rather than temporary fluctuation, indicating the establishment of a sustainable operational paradigm.

Note: YTO Express Co., Ltd. has not publicly disclosed inventory turnover metrics in its official reporting.

5.2.3 Analysis of social benefits

(i) Leyard Optoelectronic Co., Ltd.

Table 13 Table of Leyard's Annual Social Benefit Dimensions, Specific Achievements and Manifestations

Dimension of Social Benefits	Specific Achievements and Contents	Time	Manifestation of Social Benefits
------------------------------	------------------------------------	------	----------------------------------

Enhancement of Brand Value	It ranked 352nd on the list of "China's Top 500 Most Valuable Brands" with a brand value of 28.965 billion yuan, and has topped the list of brand value in the LED display industry for many consecutive years.	2025	As a key link in the green supply chain, green logistics helps enterprises establish a sustainable development image, strengthen market recognition, and drive their brand value to maintain a leading position in the industry.
Official Green Qualification Certification	Leyard Optoelectronic has been included in the list of "Green Supply Chain" enterprises by the Ministry of Industry and Information Technology of the People's Republic of China; Leyard TV Technology Co., Ltd. and Shenzhen Leyard have been included in the list of "Green Factory" enterprises by the Ministry of Industry and Information Technology of the People's Republic of China.	2021	It demonstrates the standardization and advancement of the enterprise's green logistics and supply chain management, making it a benchmark for the industry's green development and guiding upstream and downstream enterprises in the industry to practice green operations.
Low-Carbon and Carbon Neutrality Certification	It has obtained the Low-Carbon Product Supplier Certificate and Product Carbon Label Evaluation Certificate (the first in the industry) issued by the China Electronic Energy Conservation Association, and has been authorized as a "Carbon Neutrality Commitment Demonstration Unit".	2022	Green logistics facilitates the low-carbonization of the entire product life cycle, gains recognition from authoritative institutions, strengthens enterprises' ability to fulfill carbon neutrality commitments, and enhances society's trust in enterprises' low-carbon contributions.
Recognition of ESG Practices	It has been selected into lists such as "2023 China's Top 100 Listed Companies in ESG" and "Case Studies of China's Top 100 Leading Listed Companies in ESG".	2023	Green logistics is an important component of ESG practices. Its relevant achievements have been selected into authoritative case lists, which reflects the enterprise's outstanding performance in fulfilling social responsibilities and provides a reference for the industry's ESG development.
Positive Media Exposure	It has attracted a relatively high frequency of positive media coverage due to its green qualification certifications, outstanding ESG performance, and leading position as an industry benchmark.		Through positive media communication, the social influence of green logistics and the enterprise's sustainable development concept is expanded, driving more enterprises to pay attention to and practice green logistics.
Establishment of Environmental Management System	In accordance with the standards of GB/T19001-2016/ISO9001:2015, IDT "Quality Management System Requirements", GJB9001C-2017, GB/T24001-2016/ISO14001:2015, IDT "Environmental Management System Requirements with Guidance for Use", and QC080000:2017 "Hazardous Substance Process Management System", an environmental management system has been established. This system is clearly formulated in the "Comprehensive Management Manual" to promote the continuous improvement of environmental management capabilities.	2024	In January 2024, the Beijing Leyard Public Welfare Foundation was jointly funded and established by Leyard Optoelectronic Co., Ltd. and Chairman Li Jun, with a registered capital of RMB 10 million (in words: Ten Million Yuan Only). Relying on its own advantages, the foundation will coordinate and integrate resources to carry out public welfare projects, and promote the work in fields such as student assistance and rural revitalization in a systematic and efficient manner.
Contributions to Public Welfare	On June 11, 2014, Leyard donated 11 million yuan to jointly establish the "Siyuan·Fanxing Education Fund" with the China Siyuan Project Poverty Alleviation Foundation. The fund aims to help students who are at risk of dropping out of school due to family poverty or major misfortunes, focus on addressing the difficulty of accessing education for poor primary and middle school students, and provide them with the opportunity to "change their destiny through knowledge".	2015	It leverages the enterprise's technological advantages to donate smart classrooms and improve teaching conditions, expands students' horizons through summer camp study tours, and sets up awards to motivate rural teachers. Meanwhile, it adopts models such as "enterprise matching donations + social collaboration" to drive more forces to pay attention to education public welfare, effectively promote educational equity, and convey the opportunity of "changing destiny through knowledge".
Operational Environmental Management	At the end of 2016, the company invited a third party to conduct testing for the waste gas monitoring project of the LED Application Industrial Park. The factory newly installed centralized waste gas treatment equipment for process waste gas emissions, and the equipment has significantly improved the industrial waste gas emission situation.	2016	It not only proactively fulfills the enterprise's environmental protection responsibilities, reduces the pollution of industrial waste gas to the surrounding air environment through technical means, and contributes to the improvement of regional ecological environment quality; but also effectively safeguards the living environment and physical health of residents around the industrial park, reduces the impact of waste gas emissions on public life. At the same time, it sets a responsible

Has received high recognition from the guild	In 2017, the Group was awarded the title of "Top 100 Enterprises in China's Electronic Information Industry" and "Top 10 Enterprises in Beijing" by the China Electronic Information Industry Federation.	2017	example for the same industry in the coordinated development of industrial production and ecological protection, and promotes the formation of an industry atmosphere that values environmental protection and compliant production. Leyard takes enhancing human audio-visual enjoyment as its mission, relies on the integration of culture and technology as the strategic support for development, and focuses on urban landscape lighting (smart cities) and cultural tourism as its key priorities. It works hand in hand with governments at all levels to jointly build happy cities.
Accelerate and intensify R&D and innovation	With LED small-pitch displays as the leading product, the company will intensify the R&D of cutting-edge technologies and product innovation in intelligent display, realize full coverage of intelligent display in terms of products, industries, regions and solutions, expand production capacity, improve quality, and comprehensively enhance product competitiveness and market share.	2018	Leyard ranks first in the world in terms of LED display market share, among which it also ranks first globally in the LED small-pitch TV market share. This reflects Leyard's strong dominance in the industry.
Participation in major national-level events	Leyard Group provided a variety of display products and display systems with a total area of 14,000 square meters for the National Day 70th Anniversary Celebration and Gala Activities, including the "Square Red Ribbon LED Display Screen", the 0.9mm fine-pitch display screen for the military parade command center, the display products for the parade floats, the 1,400-square-meter ultra-high-definition carbon fiber screen for the evening party in the Great Hall of the People, the 5,400-square-meter giant mesh screen for the gala evening, the display screens for 7 "firework trees" (each with an area of 2,200 square meters), and the display components of 3,290 handheld light and shadow screens.	2019	Strengthen the nation and boost industries, act as a responsible Chinese brand, voice China to the world, and highlight the reputation of Chinese enterprises.
Enrich the people's cultural and sports activities	From 2000 to 2021, Leyard·Jinlixiang has provided services for the Spring Festival Gala (CCTV) for 21 consecutive years, witnessing the evolution of stage art. In addition to the CCTV Spring Festival Gala, Leyard·Dehuo Technology has long served the radio and television industry and also provided technical solutions for many local TV stations. In 2021, it offered technical support and guarantees for the Spring Festival Galas of multiple TV stations, including Anhui Satellite TV and Guangxi Satellite TV.	2020	Leyard's display products and visual effect service systems integrate cutting-edge technological means, break through the presentation form of traditional stage space, and cooperate with technologies such as panoramic free-view shooting, combined with photography control, special shooting and real-time virtual rendering production, bringing a powerful audio-visual shock experience to the audience.

(ii) YTO Express Co., Ltd.

Table 14 Table of Social Benefit Dimensions, Achievements and Manifestations of YTO Express Co., Ltd. (2016-2024)

Social Benefit Dimension	Specific Achievements and Content	Time	Manifestation of Social Benefits
Improve logistics infrastructure	By the end of 2016, the company had built 62 self-operated hub transfer centers nationwide, with 2,593 franchisees and 37,713 terminal outlets. Its courier service network covered 31 provinces, autonomous regions and municipalities directly under the Central Government across the country, basically achieving full coverage in cities at or above the prefecture level and a coverage rate of 96.10% in cities at or above the county level. Additionally, it had an air fleet of 5 aircraft. At the same time, the company had successively launched dedicated courier services to Hong Kong region, Macao region, Taiwan region, Southeast Asia, Central Asia, Europe, the Americas, Australia, South Korea and Japan, enabling express deliveries to reach major overseas markets.	2016	The overseas dedicated courier services launched by the company, covering Hong Kong region, Macao region, Taiwan region, Southeast Asia, Central Asia, Europe and other regions, have built a logistics bridge between the domestic and overseas markets. On the one hand, they provide convenient and low-cost logistics options for the export of products from domestic enterprises (especially small, medium and micro enterprises), helping them expand overseas markets and enhance international competitiveness. On the other hand, they also offer logistics support for overseas goods to enter the Chinese market, enrich domestic consumption choices, and at the same time promote economic and cultural exchanges between China and foreign countries. This contributes to the deepening of China's opening-up pattern, and in particular plays a positive role in promoting trade facilitation in neighboring regions such as Southeast Asia and Central Asia.
Industry Influence and Honors	In 2017, the company was rated as a Grade 5A Logistics Enterprise and an "Internet + Key Credit Certified Enterprise", and won the "2017 China Express Annual Development Award". It was listed among the Top 500 Private Enterprises in China in 2017 and ranked among the Top 100 Private Enterprise Service Providers in China in 2017.	2017	Set a benchmark for the logistics industry and promote the standardization and high-quality development of the industry; strengthen market credit construction and optimize the consumption and business environment; demonstrate the strength of private enterprises and drive industrial synergy and economic growth; consolidate confidence in social development and contribute to regional and industry brand building.
Improve customer satisfaction	In 2018, the company adopted a variety of measures to focus on improving timeliness and service quality. The achievement rate of express delivery timeliness increased steadily, while customer complaints decreased significantly. From January to December 2018, the company's average effective complaint rate was 2.70 per million, which was 3.02 per million lower than that in 2017, with a decrease rate of 52.86%.	2018	Protect consumers' rights and interests and enhance the experience of services related to people's livelihood; lead the service upgrading of the logistics industry and promote the industry's transformation from "quantity" to "quality"; empower upstream and downstream industries and reduce social operating costs; save social resources and improve the overall efficiency of the logistics system.
Technology-driven Efficiency Enhancement	In 2019, the company also continued to establish and improve a grid-based and diversified terminal service system. Relying on advanced information tools, it implemented an early warning system for express delivery delays, while strengthening the development of diversified delivery terminals, increasing the proportion of express items stored in warehouses and lockers, gradually raising the frequency of express deliveries, and improving delivery timeliness. By the end of 2019, the company's full-link express delay rate had dropped significantly, with the total express delivery duration decreasing by nearly 10%, and the effectiveness of refined management and control was remarkable.	2019	Optimize the experience of logistics related to people's livelihood and meet the diversified needs of last-mile delivery; promote technology empowerment in the logistics industry and lead the digital transformation of last-mile services; alleviate the pressure of urban last-mile logistics and contribute to the optimization of urban governance; enhance the emergency response capacity of social logistics and ensure the stability of material circulation.

Social Benefit Dimension	Specific Achievements and Content	Time	Manifestation of Social Benefits
Expand the coverage of logistics and transportation in towns and townships	By the end of 2020, the company's courier service network had covered 31 provinces, autonomous regions and municipalities directly under the Central Government across the country. It had basically achieved full coverage in cities at or above the prefecture level, with a coverage rate of 97.33% in cities at or above the county level. Meanwhile, the courier service network in towns, townships and village groups continued to be further expanded and deepened.	2020	Promote the balance of urban and rural logistics and narrow the regional gap in services; empower the development of rural industries and expand channels for improving people's livelihood and increasing income; support the upgrading of people's livelihood consumption and enhance the quality of residents' lives; contribute to regional economic coordination and improve the social logistics system.
Comprehensive Digital Transformation	In 2021, the company adhered to the guidance of technology. Relying on advanced technologies such as big data, cloud computing, and artificial intelligence, it gave full play to the advantages of its talents and teams, rapidly iterated and developed systems, and promoted the all-round penetration of digital transformation in business operations, functional management, market expansion and other aspects.	2021	Lead the digital transformation of the logistics industry and promote the upgrading of the industry's overall efficiency; optimize the service experience of logistics related to people's livelihood and enhance the accuracy and certainty of services; optimize the allocation of social resources and contribute to green, low-carbon and efficient utilization; empower the collaborative innovation of the industrial chain and support the high-quality development of the real economy; drive the cultivation of talents in technology and logistics and facilitate the optimization of the social talent structure.
Build a Differentiated Product System	In 2022, the company gradually built a differentiated product and service system consisting of "universal services, Yuanzhunda (a customized standard delivery service), and high-end time-sensitive products". Meanwhile, it explored and innovated marketing models to stimulate the vitality of marketing, accurately meet customers' increasingly diverse needs for express products and services, and promote in-depth market expansion.	2022	Adapt to diverse people's livelihood needs and achieve "inclusive + personalized" coverage of logistics services; promote product upgrading in the express delivery industry and optimize the industry's competitive ecosystem; empower the segmented needs of the industrial chain and support the precise development of the real economy; activate the consumption vitality of the logistics market and promote market fairness and in-depth expansion.
Focus on Refined Management and Control to Reduce Costs	Continue to enhance the standardization level of on-site loading, strengthen the daily management and control of single-vehicle loading, and constantly improve the incentive mechanism for trunk transportation loading. As a result, the number of shipments loaded per vehicle has further increased. By the end of the reporting period, the number of shipments loaded per vehicle of the company had increased by more than 19% compared with the beginning of the period. In 2023, the company's transportation cost per shipment was RMB 0.46, a decrease of RMB 0.05 compared with the same period last year, representing a decline rate of 9.67%.	2023	Reduce the total cost of social logistics and help the real economy cut costs and increase efficiency; promote the development of green and low-carbon logistics and contribute to the achievement of the "dual carbon" goals; standardize the industry standards for trunk transportation and advance the refined operation of the industry; enhance the resilience of the social logistics network and ensure the circulation of people's livelihood and emergency materials.
Strengthen the construction of the central intelligent quality control system	By the end of the reporting period, the company's express loss rate had decreased by more than 47% year-on-year. Meanwhile, the company accurately analyzed customers' delivery preferences, implemented on-demand delivery to improve the delivery fulfillment rate, and continuously strengthened the assessment and management of false sign-offs to ensure the safe delivery of express items. By the end of the reporting period, the company's false sign-off rate had decreased by nearly 28% year-on-year.	2024	Fortify the defense line for protecting consumers' rights and interests and enhance the sense of security in services related to people's livelihood; promote the standardization of services in the logistics industry and lead the quality upgrading of last-mile services; improve the convenience of people's daily lives and adapt to diversified parcel-receiving scenarios; strengthen the social trust foundation in logistics and support the stable development of consumption and trade.

5.3 Analysis of Differences in Implementation Effects

5.3.1 Corporate positioning

The two enterprises have different positioning and belong to different industries. Leyard Optoelectronic Co., Ltd. is a supply chain enterprise, while YTO Express Co., Ltd. is a logistics enterprise. Their different industry affiliations lead to varying focuses in green logistics practices. As a supply chain enterprise, Leyard's green logistics efforts are part of

its overall green supply chain management, see Table 13-14. Its core lies in controlling resource consumption and pollutant emissions in its own production processes. As a logistics and transportation enterprise, YTO's green logistics focuses on greening its core business operations themselves, which directly relates to its service processes and cost structure.

5.3.2 Transformation methods

According to the above data analysis: Leyard (2020–2024): The consumption of gasoline and natural gas first increased and then decreased, with gasoline consumption showing a significantly larger decline. Electricity consumption, however, continued to rise. This indicates that Leyard, while controlling overall energy consumption, reduced traditional energy use and shifted to clean energy, upgrading its energy structure. YTO (2020–2024): The usage of recyclable transfer bags, the recycling rate of corrugated cartons, and the proportion of e-commerce packages without secondary packaging all increased. At the same time, tape sealing, paper consumption, and plastic film usage decreased. This shows that YTO, while reducing packaging material use, improved the secondary utilization of packaging and enhanced resource efficiency.

5.3.3 Implementation paths

Both enterprises use digital technology to improve the efficiency of green logistics implementation, as well as transportation and warehousing efficiency. However, their implementation paths differ due to their distinct positioning. Leyard: It mainly applies technology in the production link. By developing more energy-efficient products and improving production processes, it directly reduces material and electricity consumption per unit of product. The core of its path is to indirectly achieve green logistics goals through energy-saving production and environmentally friendly technologies. YTO: It adopts multiple targeted measures: Promotes lightweight and recyclable green packaging to reduce packaging waste. Uses intelligent management systems (e.g., King Kong Intelligent Management System) in smart distribution to optimize capacity allocation for trunk routes and improve efficiency. Adopts collaborative operations between drones and unmanned warehouses to significantly enhance sorting efficiency and reduce energy consumption. Implements clean transportation by using new energy box trucks and light trucks on a large scale to reduce carbon emissions in the transportation link. Builds a digital carbon footprint management system for data-driven management, which monitors and analyzes carbon emissions throughout the entire life cycle of packages in real time. This data is used to optimize routes, vehicle deployment, and packaging methods to achieve precise emission reduction. The core of YTO's path is data-driven management, which runs through all links (packaging, transportation, distribution) to achieve systematic carbon reduction.

5.3.4 Financial analysis

Operating Costs YTO: Its operating costs grew steadily from 3.298 billion yuan in 2020 to 6.441 billion yuan in 2024, nearly doubling. This strongly reflects the rapid expansion of its business scale, and the cost-saving effects of green logistics have been offset by the growth in business volume. Leyard: After peaking at 7.898 billion yuan in 2021, its operating costs decreased for three consecutive years to 6.891 billion yuan. This indicates that with a relatively stable scale, Leyard reduced costs through green improvements in internal management and production links. Sales Expenses Leyard: It has a large scale of sales expenses, as it requires continuous investment in marketing activities such as brand building, customer relationship maintenance, and exhibition participation. Positioning "green and energy-saving" as a product selling point helps enhance its brand image and support its high-end market positioning, and such green marketing investments are included in sales expenses. YTO: Its sales expenses are small in scale but show fluctuating growth. The express delivery industry faces fierce price competition, so its marketing efforts focus more on competing for market share. Its green logistics initiatives (e.g., the "Box Recycling Program") are mostly corporate social responsibility campaigns, which have a relatively limited impact on consumer choices. Therefore, the proportion of sales expenses directly invested in "green" themes is not high.

5.3.5 Social collaboration

(i) Brand Value

Leyard: As a leading enterprise in the LED screen manufacturing industry, it has high brand value in the industry, which reflects its market position and technological strength. Its green logistics efforts have helped it obtain national-level certifications, such as "Green Supply Chain," "Green Factory," and the industry's first "Carbon Label." These honors and qualifications are important components of its brand value, helping to consolidate its image as an industry benchmark and enhance customer trust. In short, Leyard's green logistics has increased its brand reputation. YTO: As a courier service provider, its brand value is directly linked to its network scale, service experience, and public reputation. Its green logistics optimizes operating costs during transportation and is also used as a service product to improve user satisfaction. YTO's green path enriches its brand connotation through environmental initiatives and efficiency improvements, attracts customers, and ultimately contributes to the growth of its brand value.

(ii) Marketing Methods

Both companies conduct public welfare marketing through participating in charitable activities to indirectly convey brand value and increase consumers' trust and positive perception of their brands. Beyond this, their targeted methods differ: Leyard: It conducts conference marketing by participating in major national-level conferences. Leveraging the influence and exposure of these conferences, it enhances both its brand image as a "green enterprise" and its market competitiveness. YTO: It launches campaigns such as "Energy Conservation and Environmental Protection, YTO Actions," prints environmental protection stickers for its employees to create an environmental protection atmosphere, and builds a differentiated product system while exploring innovative marketing models to stimulate marketing vitality and accurately meet customers' increasingly diverse needs for express products and services. Additionally, it promotes

green logistics concepts to users through social media and other channels to raise users' environmental awareness and participation.

(iii) Public Affairs

YTO: It helps local governments build infrastructure (e.g., photovoltaic power generation projects, new energy vehicles), reduces environmental pollution, and promotes industrial upgrading toward green development. These efforts demonstrate its corporate social responsibility and environmental awareness, enhance its corporate image, and lay the foundation for the development of green logistics in China. Leyard: It uses technological means to reduce environmental pollution in surrounding areas, improve the ecological environment quality, and enhance the living environment and health of nearby residents. These actions reflect its corporate social responsibility and environmental awareness, deepen consumers' impression of its green brand, and improve consumer satisfaction.

6 CONCLUSION

This study focuses on the implementation pathways and effects of green logistics. By integrating theoretical foundations, literature review, case comparisons, and effectiveness analysis, it delves into the current state of green logistics development in China and its realization paths to examine both the economic and social benefits.

Research indicates that green logistics, grounded in sustainability theory, stakeholder theory, and green development theory, emphasizes the integration of economic efficiency, social responsibility, and environmental protection within logistics activities. A comparative case study of Liade Co., Ltd. and YTO Express Group reveals that despite operating in different sectors, both companies have effectively reduced energy consumption and enhanced environmental performance through measures such as green packaging, clean energy transportation, and intelligent digital systems. This demonstrates the significant effectiveness of green logistics in energy saving and emission reduction.

In terms of implementation outcomes, green logistics not only yields substantial environmental benefits—such as reducing pollution emissions, optimizing the energy mix, and saving energy consumption—but also exhibits dual advantages in economic benefits through cost reduction and operational efficiency improvements. From a social benefit perspective, green logistics drives enterprises to design green products and optimize industrial chain structures, thereby enhancing the brand value of green logistics companies, promoting the establishment of industry standards, and raising public environmental awareness. Currently, China's green logistics has made positive progress in terms of policy support and corporate practices. However, challenges remain, including difficulties in breaking through entrenched industrial patterns towards fully industrialized green logistics, as well as insufficient funding and technical capabilities among SMEs to support related research. The future should focus on strengthening policy coordination, increasing support for technological research and development, and fostering collaborative cooperation across the entire supply chain through government-enterprise partnerships to achieve high-quality development of green logistics.

In conclusion, green logistics is not only an inevitable choice for addressing environmental pressures but also a crucial pathway for the logistics industry to achieve sustainable development. Through multi-stakeholder collaboration and technological empowerment, green logistics will play an increasingly critical role in the context of the "Dual Carbon" goals.

COMPETING INTERESTS

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

FUNDING

This paper is supported by the 2025 College Student Innovation and Entrepreneurship Training Project of Beijing Wuzi University (Project Number: 202501040J022).

REFERENCES

- [1] Zhang H. Strategic research on green logistics development in the mechanical manufacturing industry from the perspective of value co-creation: Taking Company C as an example. *China University of Mining and Technology*, 2025, 7. DOI: 10.27623/d.cnki.gzkyu.2024.001850.
- [2] Lan Q X. Research on the development of green logistics systems based on circular economy. *Journal of Business Economics and Management*, 2007(07): 29-34.
- [3] Li L. Research on the coordinated development of green logistics and green economy in the Yangtze river economic belt and its influencing factors. *Anhui University of Science and Technology*, 2025, 4. DOI: 10.26918/d.cnki.ghngc.2024.001105.
- [4] Liu B Y. A brief analysis of green logistics and its implementation paths. *Market Modernization*, 2007(34): 112-114.
- [5] Xie S X, Wang W F. Green logistics paths: Strategic choices for green transformation of logistics. *China Business and Market*, 2010, 24(05): 15-18.
- [6] Wang X H, Xie X. Mechanisms and paths of digital technology innovation leading the green and low-carbon transformation of the logistics industry: A case study of JD Logistics. *Research on Economics and Management*, 2024, 45(05): 21-40.

- [7] Wu H J, Dunn S C. Environmentally responsible logistics systems. *International Journal of Physical Distribution and Logistics Management*, 1995, 25(2): 20-38.
- [8] Xu J. An analysis of green logistics theory and its development paths. *Science & Technology Information*, 2010(34): 770-771.
- [9] He H. Research on the implementation types and effects of green logistics. *Logistics Technology*, 2009, 28(02): 11-13.
- [10] Liu Y J. Exploration and reflection on China's green logistics system from a comparative perspective. *China Business and Trade*, 2012(31): 165-166.
- [11] Li X X. Institutional analysis and reference of green logistics development in developed countries. *Ecological Economy*, 2009(07): 128-130.
- [12] Weng X G, Jiang X. The development status of green logistics in Japan and its enlightenment. *China Business and Market*, 2011, 25(01): 16-20.