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Research on the Path of Creating Green Supply Chain for E-commerce Platform Enterprises - Taking Cainiao Network as an Example

[1]Zhang Mengjin and [1]Liu Meilin,
[1,2]Beijing Wuzi University, Beijing, China

Abstract: In the process of the rapid development of the global e-commerce industry, environmental problems such as carbon emissions in the logistics sector and packaging waste pollution have become increasingly prominent. The construction of a green supply chain has become the core path for e-commerce logistics platforms to achieve transformation. This paper takes Cainiao Network as a specific research object, carries out a systematic analysis of its green supply chain practices, constructs a three-dimensional creation framework of "top-level management-strategy implementation-information disclosure", and refines a reproducible methodology, providing practical references for the green transformation of the e-commerce logistics industry. The study finds that enterprises can effectively balance environmental responsibilities and commercial value by setting quantitative strategic goals, carrying out technological innovation across the entire chain, and constructing an ecological collaboration mechanism, promoting the low-carbon and circular development of e-commerce logistics.

Keywords*: Green Supply Chain; Cainiao Network; E-commerce Logistics; Carbon Emission Reduction; Sustainable Development*

I. THE URGENCY OF GREEN TRANSFORMATION IN E-COMMERCE LOGISTICS

A. The Dual Game between Industry Development and Environmental Crisis

In recent years, global e-commerce has shown explosive growth under the dual promotion of the digital wave and consumption upgrading. Statista data shows that the global e-commerce scale is expected to reach 8,034 billion US dollars in 2027, while data from the Ministry of Commerce of China shows that the total online retail sales in China reached 15.4 trillion yuan in 2023, an increase of 11% year on year. While the prosperity of the e-commerce industry drives economic growth, it also brings severe environmental challenges. It is estimated that carbon dioxide emissions from e-commerce logistics transportation links will increase by 32% in 2030 compared with 2019, and the contradiction between the high energy consumption and high pollution of the traditional logistics model and the sustainable development goal is increasingly acute.

Taking trunk transportation as an example, a 30-ton fuel truck consumes about 38 liters of fuel per 100 kilometers, with a carbon emission of nearly 100 kilograms. There are more than one million trunk vehicles for e-commerce logistics in the country, and the annual carbon emissions are equivalent to the annual carbon emissions of a city with a population of 20 million. The problem of packaging waste is more shocking: China's express delivery industry consumes enough tape every year to circle the earth's equator 420 times, and the number of cartons used exceeds 10 billion, of which only 15% are effectively recycled, and the rest are disposed of by landfilling or incineration, causing serious soil and air pollution.

B. The Simultaneous Resonance of Policy Drivers and Corporate Responsibilities

At the policy level, China's "Double Carbon" strategy and documents such as the *"14th Five-Year Plan for the Development of Circular Economy"* clearly require the logistics industry to promote green and low-carbon transformation. In 2021, the Ministry of Transport and other seven departments jointly issued the *"Opinions on Doing a Good Job in Protecting the Lawful Rights and Interests of Express Delivery Personnel Groups"*, incorporating green logistics into the industry governance system; in 2023, the State Post Bureau put forward the specific goal of "obtaining obvious results in the green transformation of express packaging by 2025", requiring e-commerce logistics enterprises to achieve breakthroughs in packaging reduction, circulation, and degradability.

Cainiao Network, as a leading e-commerce logistics platform in China, has industry demonstration significance in the construction of a green supply chain. The platform was established in 2013 and currently covers more than 300 cities across the country, 联动 (cooperates with) more than 1,700 logistics partners, and processes an average of more than 100 million orders per day. Its supply chain greening practices have important reference value for the entire e-commerce logistics industry.

II. THEORETICAL BASIS AND REALISTIC CHALLENGES OF GREEN SUPPLY CHAIN IN E-COMMERCE LOGISTICS

A. Core Characteristics of Green Supply Chain

Cainiao Network's "Sky Network + Ground Network + Human Network" system includes more than 2,000 warehousing nodes and 500,000 terminal distribution stations, forming a huge physical network. This scale effect amplifies the environmental impact of each link in the supply chain - the lighting and temperature control systems in the warehousing link alone consume as much electricity annually as 100,000 households, while the exhaust emissions from terminal distribution vehicles directly affect urban air quality.

Carbon footprint data shows that carbon emissions from logistics transportation, warehousing, and packaging links account for 51% of total supply chain emissions, of which the transportation link accounts for 35%. In trunk transportation, a traditional fuel heavy truck can emit more than 100 tons of carbon annually, while non-degradable materials such as plastic tape and foam fillers in the packaging link account for 16% of the carbon footprint in their production and disposal

processes. During e-commerce promotion periods, such as Double 11, 618 and other nodes, the daily amount of packaging waste can reach three times that of daily, causing a sharp increase in short-term environmental load. During Double 11 in 2023, the national express packaging waste exceeded 1 million tons, of which only 10% was professionally recycled.

As a digital logistics platform, Cainiao Network's technical facilities such as intelligent scheduling systems and big data centers consume huge amounts of electricity. Data in 2021 showed that its data center carbon emissions accounted for 23% of total supply chain emissions, and with the widespread application of AI technology, the computing power demand of the intelligent scheduling system doubles every 18 months, and the energy consumption of data centers is growing exponentially. In 2023, the power consumption of Cainiao Network's data centers increased by 25% year on year, and green technology upgrading is imminent.

B. Multidimensional Challenges in Green Supply Chain Construction

Interest Game of Multiple Subjects: Small and medium-sized packaging enterprises face the pressure of high R&D costs for environmental protection materials, and the cost of biodegradable materials is 30% higher than that of traditional plastics; among logistics enterprises, the purchase cost of new energy vehicles is 40%-60% higher than that of fuel vehicles, which is difficult for small and medium-sized logistics companies to bear; consumers have insufficient awareness of green packaging, low willingness to cooperate in recycling, and there is a contradiction between the requirement for distribution timeliness and green distribution.

Data Management Dilemma: The carbon footprint data of packaging materials is scattered, and there is a lack of a unified accounting standard; the data formats of logistics carriers are not uniform, resulting in errors between carbon emission reduction data and actual monitoring values; data such as packaging recycling volume at the consumer end are difficult to collect in real time, and the error rate of traditional manual statistics is high.

Balance between Environmental Protection and Profit: The R&D of green technologies and facility upgrades require huge funds. For example, the investment in the replacement of new energy vehicles and supporting facilities has a payback period of 8-10 years, which far exceeds the average return on investment required by the industry.

III. PRACTICAL EXPLORATION OF CAINIAO NETWORK'S GREEN SUPPLY CHAIN

A. Development History and Strategic Evolution

Initial Stage (2013-2017): Construct the "Sky Network, Ground Network, Human Network". The Sky Network relies on Alibaba's big data to build an intelligent logistics scheduling system, and the order processing efficiency is 40% higher than the traditional model; the Ground Network builds modern warehousing centers in core cities across the country, and the energy consumption per unit of warehousing is 25% lower than that of traditional warehouses; the Human Network integrates express delivery personnel to achieve digital management of terminal distribution.

Strategic Upgrade (2018-2022): Upgraded to the "One Horizontal and Two Vertical" strategy. The "One Horizontal" builds digital infrastructure for the logistics industry, and the "Two Verticals" promote the construction of intelligent logistics supply chain solutions and a global logistics network. Among them, the Southeast Asia cross-border 专线 (special line) shortens the transportation distance by 15% and reduces carbon emissions by 20%.

Green Transformation (2023 to the present): Incorporate the green supply chain into the core strategy, release the *"Green Logistics White Paper"*, clarify the goal of "50% carbon emission reduction by 2030", and the green technology investment in 2023 accounts for 35% of the R&D expenses, forming a gradient R&D system.

B. Full-chain Green Practice Model

Technical Level: Independently develop core technologies such as intelligent path algorithms and green packaging materials. In 2023, the number of green technology patent applications reached 580. The intelligent path algorithm shortens the average driving distance of distribution vehicles by 15%, and reduces carbon emissions by about 120,000 tons in 2023.

Ecological Level: Integrate 500 packaging enterprises and 800 logistics carriers through the "Cainiao Green Alliance", establish a green credit system, and the average green business proportion of alliance members increased by 20% in 2023, promoting the green transformation of small and medium-sized partners.

Data Level: Build a carbon footprint management platform. In 2023, the data collection coverage rate reached 85%, and real-time tracking of carbon emission data in all links of the supply chain provides data support for the optimization of emission reduction strategies.

IV. THREE-DIMENSIONAL CREATION PATH OF GREEN SUPPLY CHAIN

(1) Top-Level Management: Strategic and Organizational Guarantee System

Scientific Goal System Design: Adopt a three-layer system of "long-term vision + medium-term goals + annual indicators". The long-term vision is to achieve a 50% carbon emission reduction in the entire supply chain by 2030; the medium-term goals (2025) are the proportion of new energy vehicles in stock reaching 50%, the usage rate of green packaging reaching 90%, etc.; the annual indicators (2024) are a carbon emission reduction of 1.2 million tons, etc., and establish a "goal-resource-assessment" linkage mechanism.

Construction of a Systematic Management System: Deeply apply the PDCA cycle mechanism, formulate the *"Three-Year Action Plan for Green Logistics"* in the planning stage, and subdivide special tasks; promote implementation through the "Cainiao Green Alliance" in the implementation stage; rely on the carbon footprint tracking system to generate performance reports in the inspection stage; optimize strategies according to inspection results in the adjustment stage.

(2) Strategy Implementation: Full-chain Green Innovation

Optimization of Transportation Links: The sub-warehouse layout analyzes consumption data through machine learning, and the new regional warehouses shorten the average distribution distance of goods. In 2023, it reduced trunk transportation mileage by 1.2 billion kilometers and reduced carbon emissions by about 36,000 tons; iterated the "Hummingbird Intelligent Scheduling System V4.0", introduced a reinforcement learning model, and reduced carbon emissions by 150,000 tons through route optimization in 2023; jointly developed exclusive electric distribution vehicles with

vehicle enterprises. As of 2023, more than 60,000 vehicles have been put into use, covering 250 cities across the country, and the energy consumption per order is 40% lower than that of traditional fuel vehicles; built 5,000 "photovoltaic-storage-charging" integrated stations, launched a "rent-to-purchase" plan, and drove 200 small and medium-sized logistics enterprises to complete the new energy transformation.

V. CONCLUSIONS AND OUTLOOK

A. Research Conclusions

Cainiao Network's green supply chain practice shows that enterprises can systematically promote green transformation through a closed-loop system of "top-level strategy-full-chain execution-data feedback". The qualitative and quantitative target system needs to be matched with the PDCA management cycle and a professional organizational structure to form an institutional guarantee for strategy implementation; technological breakthroughs can simultaneously improve efficiency and reduce carbon emissions, proving that greening and commercialization can develop synergistically; through the green rating system and capacity building, promote partners to form a green alliance and break the "prisoner's dilemma" of supply chain collaboration; the carbon footprint tracking system and disclosure mechanism not only provide data support for internal optimization but also enhance public trust through transparency.

B. Industry Insights

Small and medium-sized e-commerce platforms can focus on core links to avoid "large and comprehensive" investments; large platforms can learn from the "technology + ecology" dual-drive model to build green supply chain barriers. Green technology investment needs to pay attention to ROI calculation to form a 良性循环 (良性循环). Enterprises can actively apply for policy projects to obtain subsidies and tax incentives to reduce transformation costs.

C. Future Outlook

Cainiao Network has launched a pilot project for hydrogen fuel cell heavy trucks, which is expected to be applied on a large scale in trunk transportation scenarios in 2025; introduce large model technology to achieve real-time prediction and dynamic optimization of supply chain carbon footprints; cooperate with scientific research institutions to develop packaging materials based on agricultural waste, and plan to reduce costs by 40% compared with traditional plastics by 2026; launch a full-process carbon footprint on-chain platform, with the goal of covering 80% of core suppliers by 2025; jointly formulate the *"E-commerce Logistics Green Supply Chain Standard"* to promote the standardized transformation of the industry; rely on the "Belt and Road Initiative" to export China's green logistics solutions, offset cross-border logistics carbon emissions by purchasing overseas renewable energy projects, and achieve "net zero emission" cross-border distribution.

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