

# Fourth-Party Logistics Environmental Compliance Management

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Fourth-party logistics, as an integrator of the supply chain, has made some explorations in sustainability. To ensure the sustainability of the supply chain, a fourth-party logistics company (4PL) is more willing to cooperate with a green third-party logistics company (3PL). The 4PL leverages the combined capabilities of the 3PL and management consulting, to provide solutions, while the 3PL focuses on operational issues, such as implementation and execution.

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## 1. Introduction

The supply chain accounts for more than 90% of the environmental impact of most consumer goods companies, according to McKinsey & Company <sup>[1]</sup>. Therefore, with the development of industry, the supply chain is the primary cause, for most companies, of their environmental impact <sup>[2][3]</sup>. The transportation industry has a great impact on global air and water pollution, accounting for about 28% of global greenhouse gas emissions <sup>[4]</sup>. To achieve sustainability in the logistics area, the concept of green logistics has been proposed. Green logistics refers to a set of sustainable policies and measures aimed at reducing environmental impact <sup>[5]</sup>. Reducing the impact of logistics and transportation is at the heart of green logistics.

Fourth-party logistics, as an integrator of the supply chain, has made some explorations in sustainability. To ensure the sustainability of the supply chain, a fourth-party logistics company (4PL) is more willing to cooperate with a green third-party logistics company (3PL) <sup>[6]</sup>. The 4PL leverages the combined capabilities of the 3PL and management consulting, to provide solutions, while the 3PL focuses on operational issues, such as implementation and execution. For example, Cainiao Network, founded by Alibaba in 2013, is a 4PL, and connects a network of logistics partners, warehouses, and merchants, by creating a logistics information platform. In 2016, Cainiao Network joined with 32 logistics partners to launch a “Go Green Campaign” to explore ways to mitigate the environmental impact of the logistics industry, aiming to reduce carbon emissions by 3.62 million tons by 2020, while replacing 50 percent of e-commerce packaging with biodegradable materials <sup>[7]</sup>.

Green logistics is primarily concerned with environmental protection, and involves all attempts to reduce the ecological impact of regional and global supply chains <sup>[8][9]</sup>. Thus, green logistics seeks changes in all processes, from product design to transportation types and routes. Periodic environmental audits are the critical enablers for successfully achieving this transformation <sup>[10][11]</sup>. For example, PwC provides audit services for non-financial information, including carbon footprint and environmental information, in Corporate Social Responsibility reports <sup>[12]</sup>. The audit of sustainability covers the entire supply chain <sup>[13]</sup>, and the process includes analysis of current production systems, data analysis and reporting, and determining the best alternative.

Investment in logistics is an incentive instrument to improve sustainability <sup>[14]</sup>. Logistics investment refers to the allocation of capital through infrastructure, operations (transportation modes and equipment), and human resources (labor, management, etc.), to increase integration with supply chains, make better use of transportation assets, and improve the efficiency of freight distribution <sup>[15]</sup>. Therefore, the 4PL can invest in infrastructure, such as process automation or more efficient handling equipment, that can enable the 3PL to deploy resources more effectively <sup>[16]</sup>. For example, the Cainiao Green Foundation, formed by Cainiao Network with six leading logistics providers in China, invested about \$40 million toward sustainability initiatives <sup>[4]</sup>. Li & Fung Logistics has invested heavily in “efficient equipment, technologies, systems and vehicular fleets” to improve sustainable logistics <sup>[17]</sup>.

The level of logistics compliance with environmental regulations also depends on the efforts made by the 3PL, including improvements to the logistics process, investment in the logistics and delivery system, and training of delivery personnel.

Furthermore, the 4PL's investment efforts and the 3PL's efforts may interact and jointly affect the level of logistics compliance with environmental regulations. For example, the 4PL may provide education and training on environmental management to the 3PL's employees, and such efforts made by the 4PL will complement the 3PL's efforts to improve its compliance level, because the skills acquired enable the 3PL to deploy resources more efficiently. Therefore, the 4PL's investment improves the probability of the 3PL's efforts to pass the audit being successful.

To improve the level of compliance level with environmental regulations, researchers investigated the investment and pricing strategies of the 4PL compared to the 3PL, and analyzed the effect of the logistics audit level, and the 4PL's commitment to the level of investment, on the choice of strategies. Researchers considered a logistics service supply chain, in which the 4PL deputed the delivery task of the client to a 3PL by a wholesale price contract. The 3PL decided whether to make efforts, while the 4PL chose whether the investment level was high or low, and determined the wholesale price. The 4PL set the efforts standards that the 3PL should comply with, and audited the 3PL's actual efforts during the delivery process after entering a contract <sup>[18]</sup>. The 3PL's not making efforts would lead to the logistics not complying with environmental regulations, and the not-complying would be recognized by the public, resulting in the 4PL suffering from a cost in loss of public goodwill. The 4PL might not commit (base case) or might commit its investment level: in the case of non-commitment, the 3PL and the 4PL would move simultaneously in their respective efforts, while in the case of commitment, the 4PL's efforts could be known before the 3PL decided.

## **| 2. Sustainability Supply Chain Management**

From the early 2000s, sustainable operations management developed as an area that incorporates environmental and social issues into the supply chain management framework <sup>[19]</sup>. The environment, society, and economics are the triple-bottom-line dimensions of sustainability <sup>[20]</sup>. In regard to 4PL operations management, Qian, et al. <sup>[6]</sup>, studied a 4PL employing multi-attribute reverse auctions to purchase logistics services from green 3PLs. Qorri, et al. <sup>[21]</sup>, developed a new approach to assessing the environmental, social, and economic sustainability of the entire supply chain. Compared to reverse logistics or closed-loop supply chains, there are fewer operations research methodologies and analytic approaches for forward sustainability supply chain management in the published research <sup>[22][23]</sup>. Niu and Mu <sup>[17]</sup> considered an original equipment manufacturer and a logistics service provider's preferred outsourcing structures, by incorporating the logistics service provider's sustainable efforts and the competition with the manufacturer. Using the environment impact index defined by Krass, et al. <sup>[24]</sup>, and by Choi and Chiu <sup>[25]</sup>, Niu, et al. <sup>[26]</sup>, investigated how environmental sustainability in a logistics service supply chain, consisting of short-distance and long-distance logistics service providers, deteriorated when a Physical Internet-enabled operational model was adopted. For suppliers to follow sustainable practices, firms can invest in activities that help raise awareness and improve the sustainability practices of the suppliers, enabling them to deliver goods, in compliance with all regulatory requirements, on time <sup>[27]</sup>. Christmann <sup>[28]</sup> considered that firms investing in environmental management practices evolve complementary abilities that enable them to outperform in other fields of competitiveness. Sodhi and Tang <sup>[29]</sup> examined the effect of partnerships and stress on corporate investments in socially sustainable practices.

## **| 3. Audits in the Supply Chain**

Morais, et al., performed audits in the food industry to evaluate the energy consumption of the equipment, and presented several measures and best practices for the improvement of energy efficiency <sup>[30]</sup>. In the literature on responsible supply chain management, Chen and Lee <sup>[16]</sup> found that when the supplier has responsibility risk, the buyer uses the process audit to identify penitential problems to reduce the sourcing risks. Caro, et al. <sup>[31]</sup>, compared three types of audit mechanisms of buyers, including the buyers conducting their respective audits, buyers conducting audits jointly, and each buyer conducting audits independently and sharing their audit reports. Plambeck and Taylor <sup>[32]</sup> explored the phenomenon of the supplier's evasion of a buyer's audit, which is caused by the supplier's hiding effort when the supplier has caused major harm to workers or to the environment. Process audits were also used to improve the supply and quality of agents. Nikoofal and Gümüş <sup>[33]</sup> examined the effectiveness of auditing the hidden actions of the supplier, in regard to the buyer, when the supplier was privately aware of the supply risk. Nikoofal and Gümüş <sup>[18]</sup> characterized the value of output- and action-based incentive mechanisms adopted by manufacturers to control the quality of suppliers when privately informed of the risk of failure.

## **| 4. Logistics Service Supply Chain Management**

Logistics service demand management is critical to service supply chain management, as it significantly influences customer demand <sup>[34]</sup>. De and Singh <sup>[35]</sup> examined the impact of different channel leadership strategies to promote proper

decision making on prices and logistics service quality in the fresh agri-product supply chain in the post-COVID-19 era. Zhang, et al. [36], investigated the attractiveness and effectiveness of the 4PL-driven and private lending-driven financing models when a capital-constrained 3PL seeks credit loans. Wu, et al. [37], considered that product survival rate and freshness level are functions of the level of logistics service, and examined the decisions of distributors and logistics service providers under different channel power structures with unit pricing contracts. To motivate 3PL providers to invest in developing their IT capabilities, Gong, et al. [38], studied the impact of IT investment on 3PL providers, in terms of supply chain profitability, under four logistics outsourcing contract structures. So [39] examined the impact of using time guarantees on price and time competition for service firms, and found that the monopoly situation was significantly different from the competition situation. Additionally, in their research of logistics service supply chain coordination, Huang, et al. [40], considered a fourth-party logistics company deputing a third-party logistics company with tasks received from clients: to address possible risks in the delivery process, different quality-based delivery contracts were proposed, to stimulate the 3PL to exert their best efforts. Liu, et al. [41], explored the supply chain coordination issues between a functional logistics service provider and a logistics service integrator, arising from the Belt and Road Initiative, and investigated the effects of the cost-sharing contract on the determinations for a mass-customized logistics services supply chain. Liu, et al. [42], examined scenarios in which the logistics service integrator and the functional logistics service provider had altruistic preferences; they proposed an ex-post payment contract and revenue sharing + franchise fee contract to coordinate the system. Liu, et al. [43], examined the quality game between a logistics service integrator and a functional logistics service provider in the presence of multi-period-oriented cooperation.

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