WEP
Warwick Evans Publishing

Transactions on Economics, Business and Management Research
ISSN: 2960-1789, eISSN: 2960-2254 | Volume 17
WEPM 2026

Cost-Benefit Optimization of Packaging in the Green Transformation of E-commerce Logistics: A Case Study of JD.com

Peiqi Bai [1, *], Yatong Shi [2] and Jiaqi Wang [3]

[1] School of Management, Guangzhou University, Guangzhou, China

[2] School of Politics and Public Administration, Soochow University, Suzhou, China

[3] College of Grammar and Foreign Languages, Taiyuan University of Technology, Taiyuan, China

* Corresponding Author Email: 32265900009@e.gzhu.edu.cn

Abstract. The green transition of e-commerce logistics is a pivotal pathway to sustainable development. In practice, however, enterprises face the dual challenges of high initial investment and low short-term returns. Using JD Logistics as a case study, this research focuses on sustainable packaging to explore strategies for balancing environmental goals with cost–benefit considerations. The findings suggest that although green packaging requires substantial initial expenditure, enterprises can achieve both operational cost reduction and environmental performance enhancement in the medium to long term through standardization, scalability, and technological innovation. JD's "Green Stream Initiative", by promoting reusable packaging, optimizing packaging algorithms, and fostering industry-wide collaboration, has significantly improved resource utilization efficiency and reduced unit costs, thereby demonstrating the synergistic interaction between commercial viability and environmental responsibility. Building on this case, the study develops a cost–benefit analysis (CBA) framework for sustainable packaging and incorporates enterprise-level operational insights, offering a micro-level perspective and actionable pathways for the green transformation of the e-commerce logistics industry. Furthermore, it contributes to filling the empirical research gap in this field.

Keywords: E-commerce Logistics, Sustainable Packaging, JD Logistics, Green Stream Initiative, Cost–Benefit Analysis (CBA).

1. Introduction

The rapid expansion of China's e-commerce sector has driven unprecedented growth in the logistics industry. This boom, however, has been accompanied by escalating resource consumption and mounting environmental pressures. It is estimated that China's express delivery industry generates over 9 million tons of paper waste and approximately 1.8 million tons of plastic packaging waste annually. The life-cycle carbon emissions from these materials continue to rise, thereby creating a major bottleneck to sustainable development [1]. In particular, during the "last-mile" delivery stage, the heavy reliance on conventional fuel-powered vehicles and the uneven distribution density of orders result in per-unit carbon emissions more than 47% above the average level [1]. Issues such as excessive packaging, low recycling efficiency, and poor degradability not only cause resource inefficiency but also pose significant challenges to the achievement of China's "dual carbon" targets.

To address these pressing challenges, national policies have been promulgated to steer the industry toward a green transformation. The 2025 revision of the Provisional Regulations on Express Delivery Services, for example, explicitly highlights the direction of packaging reform, establishing a regulatory framework for mitigating environmental burdens. Nevertheless, the widespread adoption of sustainable packaging continues to encounter significant barriers. This transition typically requires substantial upfront capital outlays for procuring eco-friendly materials, establishing circular systems, and implementing technological upgrades, whereas the corresponding economic benefits are both deferred and uncertain. Evidencing this, the cost of paper-based composite materials generally exceeds that of plastic packaging by 25%, and biodegradable adhesive tapes command a price 3.7

Content from this work may be used under the terms of CC BY-NC 4.0 licence (https://creativecommons.org/licenses/by-nc/4.0/).
Published by Warwick Evans Publishing.

times higher than conventional alternatives, while also being susceptible to failure in low-temperature environments [2,3].

Moreover, the economic benefits of green packaging are not fully reflected in direct cost savings. Instead, the value lies primarily in life-cycle environmental benefits, consumer acceptance, and the long-term accumulation of brand equity. Research by Mondi Group shows that Generation Z consumers are willing to pay a premium of up to 5.7% of product value for sustainable packaging, revealing the potential for green packaging to translate into commercial value [4]. Yet such benefits are difficult to quantify in financial statements, leading many firms—under short-term profit orientation—to adopt a conservative stance. Even industry leaders such as JD Logistics, during the initial stage of its "Green Stream Initiative," suffered operational losses of up to 26% in its reusable packaging system, only achieving positive cash flow in the third fiscal year [5]. This structural tension—high short-term costs versus deferred long-term returns—remains the central challenge in advancing sustainable packaging.

2. Evolution and Practice of the Cost-Benefit of Green Packaging

The green transformation of e-commerce logistics can be seen as centered on packaging innovation, which appears to represent a fundamental rebalancing of costs and benefits [6]. While traditional linear packaging models may offer low initial costs, they are often accompanied by significant environmental externalities and long-term resource risks. In contrast, green packaging seeks to create a closed-loop system of "production - use - recycling - reuse," thereby internalizing some external costs as upfront investments [7]. This approach potentially aims to achieve superior long-term benefits through economies of scale, technological empowerment, and value reconstruction. The following sections will, therefore, explore the cost structure of green packaging and its potential pathways to benefit realization [8].

2.1. Cost Structure of Green Packaging: the Interplay between Short-Term Investment and Long-term Returns

The adoption of green packaging tends to involve more than a simple substitution of materials. It can be viewed as a systematic endeavor that requires coordinated efforts in research and development, manufacturing, logistics, and the redesign of reverse supply chains. Typically, the cost structure is characterized by high initial fixed costs and lower long-term variable costs. This structure can often present challenges for enterprises focused on short-term financial performance goals.

2.1.1. Initial Cost Pressure: The Upfront Investment for Green Transformation.

The case of JD's "Qingliu Box" serves to illustrate the typical initial cost composition. A significant portion of the cost is likely attributable to research and design, which can be considered a sunk cost. To achieve goals such as lightweighting, durability, and recyclability, it is reported that JD invested heavily in independent Research and Development (R&D). For instance, the box's unique lock design, which eliminates tape, and its polypropylene material are thought to have contributed to improved environmental performance, but also to higher upfront R&D expenses [9].

Furthermore, material and manufacturing costs are generally observed to constitute direct financial pressure. The unit price for recyclable plastics is often considerably higher than for traditional corrugated paper. This observation is supported by case studies on reusable food delivery packaging in China, which suggest that the initial costs of reusable systems are usually higher than those of disposable systems, largely due to greater complexity in materials and production [7]. To fund such capital expenditure, the use of green financial instruments, such as green asset-backed securities, appears to have been necessary, indicating the substantial scale of the initial investment [10].

Finally, the establishment of system-wide infrastructure is generally considered indispensable. A nationwide reverse logistics network is widely regarded as the foundation for a circular system like the Qingliu Box, necessitating recycling points, sorting centers, and cleaning facilities. It could be

argued that the primary challenge in implementing sustainable packaging lies in establishing this robust reverse logistics infrastructure, which demands substantial capital investment and intricate operational coordination, thereby acting as a potential barrier to systemic transformation.

2.1.2. Long-Term Cost Advantage: Cost Amortization through Economies of Scale.

Despite the high initial investment, the cost advantage of reusable packaging may not be derived from direct per-unit comparison, but rather from economies of scale and cost amortization over multiple cycles. According to JD's "2022 ESG Report," each Qingliu Box can reportedly be reused an average of 50 times or more. This data point seems to fundamentally alter the economic model.

Research by Camps-Posino, utilizing lifecycle assessment and cost analysis, suggests that with sufficient cycles, reusable packaging can begin to demonstrate advantages over disposable systems in terms of global warming potential and total cost, which appears consistent with JD's experience [7]. Additionally, significant implicit cost savings are suggested by JD's report, which indicates a reduction of over 550,000 tons of disposable packaging materials in 2022 through such initiatives. This potentially avoids substantial future cash outflows, thereby locking in long-term savings from a supply chain perspective. More broadly, sustainable packaging is often thought to create long-term economic value by reducing waste, lowering disposal costs, and mitigating potential environmental fines. Thus, the cost structure of green packaging seems to be defined by high short-term investment but potential long-term advantage, forming the foundation for benefit realization.

2.2. Benefit Realization Path: Synergy between Environmental Value and Commercial Value

2.2.1. Direct Benefits: Monetizable Economic and Environmental Gains.

The most direct benefit is likely to be operational cost savings achieved through reuse and material reduction. Perhaps more importantly, there is growing potential for the monetization of environmental benefits. Against the backdrop of rising carbon emission trading prices in China, JD's Qingliu Initiative is reported to have cumulatively reduced carbon emissions by over 500,000 tons, which could gradually be regarded as a potential "carbon asset." This aligns with the view, as discussed by Cristóbal in the context of compostable packaging, that monetizing environmental externalities is probably key to advancing the circular economy and revealing the true value of sustainable choices [8].

2.2.2. Indirect Benefits: Building Brand Equity and Enhancing Supply Chain Resilience.

Green packaging is often considered a demonstrable proof of corporate environmental responsibility, which can potentially enhance brand image and brand affinity. Studies, such as those by Wandosell, suggest that consumers generally hold positive attitudes toward eco-friendly packaging and are often willing to pay a slight premium. For companies, the adoption of green packaging could therefore be an effective strategy to communicate brand values and achieve competitive differentiation. JD's alignment of its brand with sustainability through the "Qingliu Initiative" can be viewed as an example of catering to this growing wave of green consumption [11].

Secondly, green packaging practices can serve to manage policy compliance risks and secure incentives. Given increasingly stringent global regulations on plastic pollution, JD's early-stage investments not only mitigate risks associated with future bans or regulations but also potentially position the company as a benchmark in government-led green transformation initiatives.

Finally, these practices are likely to strengthen supply chain collaboration and ecosystem leadership. The success of initiatives like the Qingliu Initiative is often dependent on deep collaboration with various stakeholders. As the implementation of sustainable packaging generally requires close supply chain coordination, leading enterprises can enhance their influence and create extended strategic value by spearheading such efforts.

3. JD.com Case: A Practical Paradigm for Optimizing the Cost-effectiveness of Green Packaging

Due to the majority of research being based on policy or industry macro perspectives, quantitative optimization analysis relying on empirical data from enterprises is relatively scarce. Therefore, this article will focus on the effective practices of JD.com and combine a cost-benefit analysis model to deeply analyze its transformation and optimization path for green packaging.

In June 2017, JD Logistics, in collaboration with nine major brand merchants, jointly initiated the Qingliu Plan, a joint action for the green supply chain. They introduced a new type of green packaging model called "Qingliu Box" to promote the green development of the logistics industry from multiple aspects, such as reducing packaging volume, innovating and applying green logistics technology, and energy conservation and emission reduction. Since the launch of this plan, JD has built a green packaging system focused on three major directions: circular packaging, technology-driven packaging reduction, and policy-market collaboration. Its practice not only verified the cost logic of "Short-term investment-Long-term return", but also formed a collaborative benefit path of "environmental value-business value" [12,13]. The following analysis is conducted from the perspective of specific practices and cost-benefit quantification [14].

3.1. Circular Packaging System: Reducing Unit Costs through Large-scale Application

Taking "Qingliu Box" as the core carrier, JD.com establishes a full life-cycle recycling model of "production-use-recycling", addressing the industry pain point of "high initial cost" through large-scale application. On the production side, JD.com collaborates with suppliers to use high-strength PP recycled materials. The following table compares Qingliu Boxes with traditional disposable paper boxes:

On the user side, the standardized size of Qingliu Box is 30cm×20cm×15cm, which is compatible with JD's "Asia No.1" intelligent warehouse automated sorting equipment. Its loading rate is 15% higher than that of traditional paper boxes, allowing for the transportation of 300 more parcels per trip and reducing unit transportation costs by 8%. On the recycling side, dedicated recycling bins are set up in 12,000 express delivery outlets nationwide. JD also introduces a mechanism of "returning Qingliu Boxes and getting 5 JD Points". In 2024, the recycling rate of the boxes reached 78%, an increase of 38% compared to the initial stage.

From the perspective of cost-benefit quantification, it is clear to calculate the particular cost. The initial production cost of the green flow box is 28 yuan per box, and its reuse frequency is 50 times per box. In contrast, the initial production cost of the traditional disposable box is 1.2 yuan per box, and its reuse frequency is 15-20 times per box. Based on the annual deployment of 1 million Qingliu boxes, the total initial production cost, combined with the cost of recycling and transportation, and the amortized cost of dedicated stacking equipment (1.2 yuan/box), after deducting government subsidies (2 yuan/box), the total life cycle cost per box is 67.2 yuan, and the unit usage cost is only 1.34 yuan/time, which is very close to the cost level of disposable paper boxes at 1.2 yuan/time.

$$Totalcost=28\times 1million+0.8\times 50\times 1million+1.2\times 1million-2\times 1million$$

$$=6.72billionyuan \quad (1)$$

$$\text{Cost per unit of use} = 67.2\div 1\text{ million}=67.2\text{ yuan} \quad (2)$$

$$\text{Unit cost} = 67.2\div 1\text{ million}\div 50\approx 1.34\text{yuan/number} \quad (3)$$

If replaced with disposable paper boxes, 500 million parcels for 50 reuses would consume 600 million yuan worth of paper boxes. Although the total cost of Qingliu boxes is 672 million yuan, considering carbon emission reduction and brand benefits, its net present value (NPV) turns positive in the third year, verifying the reduction effect of scale on unit cost.

3.2. Tchnology-driven Packaging Reduction: Enhancing Operational Efficiency through Algorithm Optimization

JD.com reduces hidden costs from two dimensions: “reducing quantity at the source” and “improving efficiency” through intelligent algorithms and material technology innovation. In the packaging design phase, it develops an “intelligent packaging matching system” which automatically recommends the smallest suitable packaging based on the volume of the product. For example, the packaging gap for 3C products reduces from 5cm to 2cm, the use of cushioning bubble wrap reduces by 60%, and the material cost per package reduces by 0.3 yuan. In the warehousing and transportation phase, by combining the “BeiDou navigation + dynamic path planning” system, green packaging packages are preferentially matched with orders in the same region, resulting in an 8% reduction in transportation mileage and a 0.02t CO_2e reduction in carbon emissions per delivery.

The iteration of material technology further magnifies benefits. JD.com, in collaboration with the Chinese Academy of Sciences, develops starch-based cushioning particles to replace traditional EPS foam. The material cost reduces from 2.5 yuan/kg to 1.8 yuan/kg, with a degradation rate exceeding 90%, avoiding the incineration cost of 0.5 yuan/kg. After replacing 50mm traditional tape with 30mm slimmed-down tape, the length of a single roll extends from 100m to 150m, reducing tape consumption by 1,200t and saving costs by 2.4 million yuan in 2023. Data shows that, driven by technology, the average cost per piece of JD.com's green packaging parcels decreases by 28% compared to 2021. Consumer satisfaction with “no excessive packaging” increases from 4.2 to 4.7, indirectly driving a 0.5% increase in repurchase rate and correspondingly generating an additional revenue of 125 million yuan.

3.3. Policy and Market: Building A Green Transformation Ecosystem

Through policy engagement and industry chain collaboration, JD.com reduces transformation resistance and amplifies comprehensive value [15]. JD.com actively applied for “Special Subsidies for Green Logistics” and received a cumulative subsidy of 120 million yuan from 2022 to 2024, accounting for 15% of the total investment in green packaging. It participated in the national carbon market trading and achieved carbon revenue of 6 million yuan from the emission reduction of 120,000 tons of CO_2e in 2023. At the same time, it obtained income tax relief of 3 million yuan per year with the qualification of “National Green Supply Chain Demonstration Enterprise”. On the market side, JD.com signed the “Joint Declaration on Green Packaging” with 500 brand merchants such as Procter & Gamble and Unilever. In 2023, it jointly purchased 8,000 tons of green packaging, with procurement costs reduced by 12% compared to individual procurement. Through the “Green Footprint” logo and science popularization column on the APP, it enhanced consumer awareness, with 82% of users indicating that they “prefer to choose green packaging merchants”, driving a 35% increase in sales of green products on the platform.

It is noteworthy that, based on the practice of the “Green Stream Plan”, JD.com, in collaboration with the China Federation of Logistics and Purchasing, released the ‘General Technical Requirements for E-commerce Recyclable Packaging’, which standardizes material standards and recycling processes. This initiative aims to increase the utilization rate of recyclable packaging in domestic e-commerce from 10% to 25% by 2024, marking a breakthrough from corporate practice to industry standards. It provides a replicable ecological paradigm for optimizing the cost-effectiveness of green packaging.

4. Conclusion

Against the backdrop of China’s green transition in e-commerce logistics, the tension between environmental burden and economic costs in the packaging stage has become increasingly prominent. This study focuses on the cost–benefit optimization of sustainable packaging and develops a multi-dimensional cost–benefit analysis (CBA) framework covering the entire lifecycle of packaging production, usage, and recycling. Taking JD Logistics’ “Green Stream Initiative” as an empirical case, the paper systematically examines its practical pathways in three areas: circular packaging

systems, technology-driven source reduction, and policy coordination mechanisms. The findings indicate that although sustainable packaging initially entails high capital investment and operating costs, enterprises can progressively achieve unit cost reduction and operational efficiency gains as technologies mature, economies of scale take effect, and institutional environments improve. Consequently, firms can attain a synergy between environmental benefits and commercial value. This research not only enriches the literature on the cost–benefit analysis of green logistics from a micro-level perspective but also provides a replicable paradigm for other e-commerce platforms pursuing sustainable transformation.

Based on these findings, the study recommends that e-commerce enterprises should strengthen R&D in sustainable packaging technologies and algorithm optimization to improve material utilization and delivery efficiency. At the same time, they should promote the standardization and scaling-up of circular packaging systems to offset initial costs. In addition, firms are encouraged to actively participate in policy pilots and industry standard-setting, thereby fostering a multi-stakeholder collaborative green ecosystem. For policymakers, measures such as fiscal incentives, tax reductions, and data-sharing mechanisms are advised to lower the barriers to green transition and enhance corporate participation. Future research could incorporate quantitative modeling to more precisely evaluate the environmental benefits, brand value, and shifts in consumer behavior associated with sustainable packaging. Comparative studies across multiple platforms could also be conducted to assess the adaptability and scalability of different green transition pathways.

Authors Contribution

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

References

[1] Pahwa, A., Jaller, M.: A cost-based comparative analysis of different last-mile strategies for e-commerce delivery. Transportation Research Part E: Logistics and Transportation Review 164, 102-178 (2022).

[2] Yue, R., Xu, X., Li, Z., Bai, Q.: Reusable packaging adoption in e-commerce markets with green consumers: an evolutionary game analysis. Journal of Retailing and Consumer Services 81, 103-181 (2024).

[3] Kang, Z., Gao, X., Liu, Y.: Research on the design of recyclable express boxes. Logistics Engineering and Management 42 (8), 12-19 (2020).

[4] International Paper Board Industry Group: Five trends in e-commerce packaging. International Paper Board Industry 66 (1), 56-59 (2023).

[5] Wang, R., Zhu, C., Luo, S.: SWOT analysis of reverse logistics enterprises in express packaging: a case study of JD Logistics. China Packaging 44 (3), 11-13 (2024).

[6] Asim, Z., et al.: Significance of sustainable packaging: a case-study from a supply chain perspective. Applied System Innovation 5 (6), 11-17 (2022).

[7] Camps-Posino, L., et al.: Potential climate benefits of reusable packaging in food delivery services. A Chinese case study. Science of The Total Environment 794, 148-157 (2021).

[8] Cristóbal, J., et al.: Management practices for compostable plastic packaging waste: impacts, challenges and recommendations. Waste Management 170, 166-176 (2023).

[9] JD.com: JD.com 2022 environmental, social and governance report (2022).

[10] JD.com: JD.com 2023 environmental, social and governance report (2023).

[11] Wandosell, G., et al.: Green packaging from consumer and business perspectives. Sustainability 13 (3), 13-56 (2021).

[12] Du, P.: Environmental cost accounting and benefit analysis under the green logistics and distribution model. China Storage & Transportation 12 (5), 45-46 (2025).

[13] Meng, F.: Discussion on enterprise procurement logistics cost control based on low-carbon supply chain. China Logistics and Procurement 10 (16), 71-72 (2023).

[14] Sun, H.: Cost control and benefit analysis in logistics and transportation management. China Logistics and Procurement 22 (23), 101-102 (2024).

[15] Kuang, X., Xiao, J.: Commentary on Elinor Ostrom's public governance thought. Contemporary Finance and Economics (11), 5-11 (2009).