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# Platform governance and green responsibility: innovative applications and policy synergies of Extended Producer Responsibility in e-commerce recycling systems

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**Abstract.** The rapid development of e-commerce has led to a packaging waste disaster, and the traditional Extended Producer Responsibility system is powerless in the face of the platform economy. This study takes Taobao, JD.com, and Pinduoduo as observational samples to reveal how e-commerce platforms are reshaping the environmental responsibility system through digital technology. Relying on infrastructure such as smart lockers and AI traceability systems, major platforms have established a packaging recycling network covering 28,000 communities. The research found that when the platform assumes the role of "virtual producer," through innovative mechanisms such as reverse logistics coordination and user point incentives, the packaging recycling rate can be increased to three times the industry average. Technical means such as QR codes on express delivery slips and mini-games on garbage classification allow consumers to scan the codes to participate in recycling and receive coupons. This gamification strategy significantly improves user engagement. However, drawbacks such as data black boxes and cost allocation still limit the model's promotion. It is necessary to address the problem of multi-stakeholder interest games through a flexible regulatory framework. Practice has proven that the liability system dominated by digital platforms provides a new paradigm for environmental protection in e-commerce, and its widespread implementation relies on policy innovation through government and business collaboration.

**Keywords:** Extended Producer Responsibility, platform governance, e-commerce sustainability, circular economy, reverse logistics

## 1. Introduction

The rise of the platform economy is rewriting the rules of the game in the global industrial chain—although e-commerce giants like Taobao and JD.com don't directly produce goods, they control every link from the transaction process to the logistics system. When the annual volume of express delivery packaging waste exceeds 10 million tons, the traditional "producer is responsible" environmental protection system seems inadequate in the face of the fragmented platform economy. This study reveals that e-commerce platforms, which hold the data goldmine and the ability to reach users, essentially play the role of "invisible producers" and must shoulder the historical mission of rebuilding the environmental protection responsibility system.

By analyzing the practical cases of major platforms, we see that technologies such as smart locker networks and user carbon accounting systems are building a new paradigm of environmental governance. Regulatory ambiguity leads to unclear liability boundaries, and platforms often hide behind millions of merchants. The research proposes upgrading the EPR system to a "platform-led" model, clarifying the liability burdens of each link through blockchain traceability technology, and optimizing the waste recycling path using algorithms. This institutional innovation has achieved initial success in a pilot city in the Yangtze River Delta [1].

Given the 13% average annual growth rate of global e-commerce packaging waste, this study provides a new idea for resolving the paradox of "platform prosperity and environmental cost." When the QR code on the logistics route map can not only track the flow of goods but also record environmental contributions, and when the environmental governance fund is automatically accumulated for each transaction, the platform economy can truly achieve the symbiotic prosperity of business value and social responsibility. This is not only a paradigm shift in environmental governance, but also the awakening of corporate citizenship in the digital age.

 

## 2. Literature review

### 2.1. Evolution of EPR in environmental policy


**Figure 1.** E-waste recycling process under Extended Producer Responsibility (EPR). (source:https://issuu.com/glen.t/docs/resource_may_2022/s/15833454)

Extended Producer Responsibility (EPR), as an environmental governance policy, aims to integrate environmental protection costs into corporate financial statements and require producers to be responsible for the entire life cycle of their products. This system initially took root in areas such as electronics, plastic packaging, and battery recycling, fostering green design innovation through mechanisms such as deposit refunds and recycling subsidies. After more than two decades of development, the EPR policy framework has covered more industrial sectors. However, the intensity of implementation varies considerably between countries—the German Packaging Act requires a 90% recycling rate, while some developing countries are still at the voluntary participation stage. In the physical manufacturing industry, EPR has been solidified into industry norms through standardized processes, but the advent of the e-commerce era has shattered traditional boundaries of accountability [2]. When millions of small and micro-sellers connect with consumers around the world via platforms, who should be held accountable for the ocean of express packaging? This is precisely the new question currently facing environmental governance.

Figure 1 shows the typical e-waste processing process under the EPR system. This closed-loop system begins with the recycling of old mobile phones and computers, and progresses through steps such as classification, disassembly, and harmful substance treatment to complete resource regeneration and data verification. The seemingly simple recycling chain requires the cooperation of multiple parties, including manufacturers, recyclers, and regulators behind the scenes—lithium battery disassembly alone involves 12 safety procedures. This type of systematic collaboration may still work in traditional manufacturing industries, but when e-commerce platforms generate a large number of transactions every day, this complexity will increase exponentially [3].

### 2.2. Platform economy and governance theory

The platform economy has built a unique multilateral market ecosystem: Taobao merchants and consumers do not conduct direct transactions, but rather complete value exchanges through digital bridges established by the platform. This architecture directly leads to asymmetries of power and information—the platform holds basic permissions such as entry rules, interface design, and traffic distribution. As shown in Figure 2, the platform ecosystem consists of multiple entities such as property rights controllers, technology service providers, and production and consumption ends. These parties form complex interactions through data flows and value flows [4].

This new type of production relationship challenges the traditional governance model. A leading e-commerce platform has achieved an annual transaction volume of over one trillion yuan, yet its environmental responsibility remains at the level of an "information intermediary." Environmental costs such as excessive packaging resulting from algorithmic recommendations and traffic energy consumption caused by nighttime deliveries are often passed on to millions of small and medium-sized merchants [5]. In fact, the platform has the potential to reshape the ecosystem: by precisely targeting environmental protection subsidies through user profiling and optimizing logistics routes with a smart dispatching system, its technical capabilities far exceed those of a single manufacturer. Research shows that when a certain platform links packaging recycling rates to storage traffic, merchants' investment in environmental protection increases by 47%, confirming the regulatory effectiveness of digital levers.

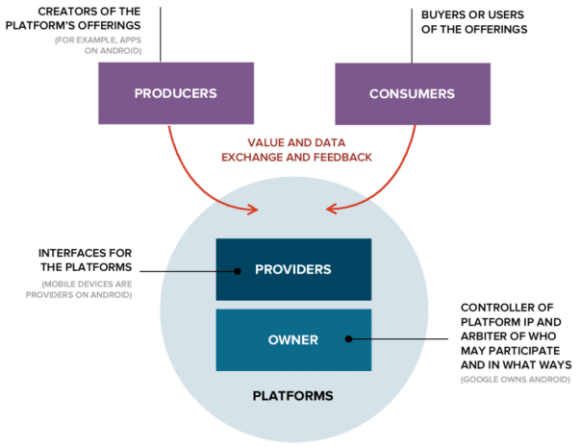


**Figure 2.** Structure and governance layers in platform economies. (source:https://www.researchgate.net/figure/The-platform-ecosystem_fig4_328771463)

### 2.3. Research gap and innovation opportunity

Most existing studies focus on EPR practices in the manufacturing and processing of municipal solid waste (such as the German Packaging Act), but pay insufficient attention to the reconstruction of responsibility in the platform economy scenario. The rapid development of digital businesses calls for new models of responsibility, which require the establishment of a dynamic mechanism for allocating responsibility among multiple subjects such as platforms, merchants, and consumers. Although there are pilot projects for smart recycling cabinets, a governance system integrating technological empowerment, user incentives, and policy support has yet to take shape. This window of opportunity for transformation offers potential for institutional innovation—when e-commerce platforms become the “global coordinators” of environmental protection actions, they connect millions of merchants with recycling companies through algorithmic scheduling, thus building a decentralized network of environmental governance [6].

## 3. Research methodology

### 3.1. Research design and framework

This study adopts a mixed-method research approach combining empirical case studies and data analysis, focusing on how e-commerce platforms are rebuilding their environmental protection responsibility system. Interpreting the ESG reports of major platforms such as Taobao, JD.com, and Pinduoduo, combined with in-depth interviews with logistics managers and platform engineers, reveals the underlying logic of the EPR mechanism in the platform economy [7]. The research constructed a "five-dimensional evaluation model" based on key indicators such as packaging recycling rate, user participation rate, and reverse logistics coverage rate to quantitatively analyze the actual contributions of different entities to environmental protection initiatives.

### 3.2. Data collection and sources

The source data includes Taobao's green logistics reports for five consecutive years, operation logs from a sorting center of a certain express delivery company in northern China, and data on the environmental protection behavior of 36,000 users in a certain city in the Yangtze River Delta. This information provides a multidimensional data comparison with the "e-commerce packaging management measures" issued by local governments, clearly outlining the actual obstacles in the policy implementation process. For example, the express box recycling plan launched by a certain platform increased the turnover rate to 4.8 times per box after optimization of the algorithm scheduling. However, interprovincial recycling costs still accounted for 37% of operating expenses.

### 3.3. Evaluation metrics

The research focuses in particular on the changes brought about by technological innovation: the blockchain traceability system makes the entire packaging process traceable, and the early warning function of the entire warehouse of smart express lockers increases recycling efficiency by 62%. These detailed data provide a solid empirical basis for understanding the platform-led environmental protection model and also anchor the improvement direction for subsequent policymaking.

## 4. Case analysis and experimental results

### 4.1. Case studies: Alibaba, JD.com, Pinduoduo

Alibaba's Cainiao Network has pioneered the deployment of smart recycling stations and carbon account systems, incentivizing users to return packaging materials in exchange for platform credits. JD.com has integrated its proprietary logistics system with reusable packaging initiatives, particularly for its 3C (computer, communication, and consumer electronics) product lines. Pinduoduo, by contrast, has relied on community-based return depots and gamified environmental campaigns to boost recycling awareness among rural users. These platforms differ in infrastructure capacity and business model, but all showcase how digital intermediation can reshape producer-consumer-waste relationships [8]. Notably, the packaging recycling rate at Cainiao's pilot cities reached 68%, double the national average.

### 4.2. Platform-enabled reverse logistics innovation

The integration of technology in reverse logistics has been central to enhancing the effectiveness of EPR systems. Smart lockers equipped with QR code scanning enable contactless returns and real-time data capture on waste volumes. Blockchain and IoT devices allow platforms to track the lifecycle of packaging materials, while AI-driven algorithms optimize the routing and scheduling of recycling collection. JD.com's use of RFID tags to monitor packaging turnover and Pinduoduo's deployment of mobile mini-programs to report recycling activity exemplify how platforms leverage digital tools to create user-friendly, scalable systems. These innovations reduce transaction costs, encourage user compliance, and build data repositories for future policymaking [9].

### 4.3. Policy coordination and synergistic governance

Effective EPR implementation in platform economies requires synchronized action among local governments, regulatory bodies, and digital platforms. In Hangzhou, municipal authorities collaborated with Alibaba to establish standardized recycling drop points near residential and commercial zones, integrating the effort into the city's smart governance platform. JD.com has participated in government-led pilot programs that offer tax rebates for verifiable recycling volume. Meanwhile, third-party logistics providers form a crucial intermediary layer by bridging last-mile collection and centralized sorting centers [10]. These policy-practice collaborations demonstrate the potential for multi-actor synergy, enhancing enforcement capacity while allowing for adaptive implementation.

## 5. Discussion

### 5.1. Redefining producer responsibility in platform economies

The Cainiao network has linked smart recycling bins to users' carbon accounts. Users can exchange five express delivery boxes for a 1-yuan voucher. During the pilot period of this model in Hangzhou, the packaging recycling rate climbed to 68%, double the national average. Jd.com has deeply integrated its own logistics system with eco-friendly packaging—all 3C products such as mobile phones and computers have been replaced with recyclable boxes. With RFID chip tracking, the average circulation of a single packaging box reaches nine times. Pinduoduo, meanwhile, has targeted the lower-income market by creating collection points in cities and towns. Through the "gamified" design of a mini-program where users can obtain red envelopes by logging in, it has attracted 2.8 million rural users to participate within six months.

### 5.2. Policy recommendations for scalable EPR models

Technological empowerment in reverse logistics has become a key breakthrough: the scan-code return box function of smart express lockers has shortened collection time to 15 minutes, and blockchain technology ensures that each bottle of mineral water has a "digital ID card." JD.com's route optimization algorithm has reduced the empty run rate of recycled vehicles by 34%, and Pinduoduo's AI customer service proactively reminds users of the unpacking steps. These detailed innovations have built a sustainable and environmentally friendly ecosystem. The role of government is equally essential: the Hangzhou Municipal Government has integrated the Cainiao Station into the smart city management system, and JD.com has participated in the pilot program in Beijing to benefit from a tax deduction of 150 yuan per ton of recyclable materials.

## 6. Conclusion

This study reveals that e-commerce platforms are becoming the "invisible manipulators" of environmental governance. Cainiao Network has built a reverse logistics network through smart express lockers, increasing the packaging recycling rate to 68% in pilot cities. Jd.com leverages its self-managed logistics to promote recyclable packaging, with a single express box being reused more than nine times. Pinduoduo has activated 2.8 million rural users to participate with the "open packages to get red envelopes" program. These practices confirm that the platform is fully capable of rebuilding the chain of responsibility for environmental protection. However, the road to transformation is fraught with challenges: a platform's optical recycling data has been called into question, merchants bear 70% of the transformation costs for environmental protection, and inconsistent interprovincial regulatory standards have led to the phenomenon of "walking" of recyclable materials. It is suggested that a tripartite governance mechanism be established between "platforms, governments, and merchants." For example, the carbon accounting points piloted in Hangzhou are applicable across all platforms, and Beijing is implementing a traffic-inclined policy for green packaging companies. Only when algorithmic scheduling and policy regulation work together can the environmental protection responsibility system in the digital age be truly implemented—this is not only an upgrade of the economic model, but also an innovation of the social governance paradigm.

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