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A Study on the More Effective Delivery System Combined with the Ethical Value of Customers

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Abstract. In recent years, with the expansion of the e-commerce market and the improvement of customer requirements and service levels, express operators have fallen into a shortage of truck drivers. The operator's distribution channel optimization reaches its limit, and an e-commerce system assisted by customers is needed. Through SDGs and other goals, people pay more attention to social problems. Thus, customers are highly likely to cooperate. However, the indicators of e-commerce operators' contribution to social issues have not been established yet. Operators have set different goals, and customers can not compare various operators. What impact will it bring to the logistics industry with the cooperation of consumers with high environmental awareness? Therefore, the purpose of this study is "logistics operators set common goals related to social issues, and consumers can also evaluate logistics operators" and "logistics operators propose customer cooperative e-commerce to achieve this goal and test its effectiveness." As a method to achieve these purposes, "adopting the concept definition of ethical e-commerce and making evaluation indicators," "establishing a system for calculating the latest excess load when new orders arrive," and "inspired by China's logistics, what SDGs goals can logistics operators achieve with the help of consumers" are introduced.

Keywords. Cost Modeling, Analysis and Engineering, Decision Support Tools and Methods, Logistics, ESG, SDGs, E-commerce, Effective Logistics, Future Logistics, Energy Saving, Earth Protection, Scare Resource

Introduction

Nowadays, one of the significant challenges Japanese logistics faces is the lack of logistics drivers. Reiko (2021) [1] mentioned that there will be a 35% gap between the demand and supply of logistics drivers in Japan in 2030. With the expansion of the E-commerce market, the time zone designation service, and the spread of one-to-two-day delivery services, the demand has increased both in total volume and service quality. And the qualitative and quantitative increase in these needs is expected to continue. On the other hand, the number of truck drivers who deal with logistics has not increased significantly due to the poor working environment of long-term heavy labor and low wages, which resulted in a severe labor shortage. The shortage of last-mile drivers has been a worldwide challenge, primarily when people relied on E-commerce for daily life after the spread of COVID-19. In 2021, the global retail e-commerce sales were about

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4.9 trillion U.S. dollars. This figure is expected to grow by 50% in 2025 and reach about $7.4 trillion. [2]

As a measure against the shortage of drivers, logistics companies have been trying hard to make the working environment wealthy, efficient, and healthy. From the perspective of logistic companies' sensitive and competitive pricing strategies, it's hard to raise the delivery fee for higher drivers' salaries simply. From the standpoint of higher delivery efficiency, various companies have been engaged in improving the delivery route decision system. Still, the situation has not significantly improved in the redelivery rate exceeding 10%. [3] There is a limit to the efficiency improvement conducted one-sidedly by logistic companies. Hence, on the other side—customer cooperation is needed for optimization.

Due to the severe coronavirus disease, the world energy-related carbon dioxide emission increased by 6% to 36.3 billion tons, the highest level in history. [4] In 2018, transportation caused 82.6 billion tons, accounting for about 26% of global carbon dioxide emissions. [5] And the logistics industry, as a part of it, has a unshirkable responsibility. The delivery services selected by customers randomly may unintentionally bring both carbon emissions and longer working time, which is against their will if they know more. At this time, we can imagine that if we can provide information to the environmentally conscious consumers and get their support, it will bring great help to the global SGDs goal, both for the environment and for the drivers.

China has been proved to be one of the countries with the highest utilization rate of e-commerce. Therefore, China's logistics companies have contributed a lot to the goal of SDGs. Consequently, I will learn from China's logistics models, such as Cainiao and express cabinets, and advocate a new model brought by consumers with environmental awareness. For example, logistics companies can display carbon emission information to consumers before delivery and let them choose whether to deliver on-site or put it in the express cabinet. In this way, people who are not in a hurry can use environmentally friendly and convenient methods such as express cabinets.

1. Literature Review

A study on the derivation of delivery orders belongs to the vehicle routing problem (VRP). VRP has been extensively studied, and various reality constraints have been considered. [6] As for the research on the time zone designation, Koike [7] concentrated on the problem that the number of daily delivery increases significantly immediately after the sales promotion event of the e-commerce sellers, and the change in the customer behavior and the leveling off the daily delivery quantity by the point assessment are studied. In addition, Matsuda [8] aims at leveling off the daily delivery quantity by recommending the time zone specification to customers, plus taking the delivery capacity of each time zone specification and the past preference record of customers into consideration. Although there is research to change the time zone specification of customers, there is no paper that arranges a sequential delivery plan by VRP and changes the customer behavior based on the result.

In the following article, I will first define what is ethical e-commerce. Then I do the literature review of China's logistics model and its applications. After that, I will introduce a new load calculation method and path planning when adding new orders to existing orders. After calculation, the increased load is then visualized and presented to consumers to choose the delivery time according to their ethical value and availability in

the next step. Using the carbon emission visualization system, the company can involve the consumers' ethical value as the strength in contributing to lower carbon emissions and a better working environment for drivers.

2. Conceptual definition and evaluation indices of ethical e-commerce

Recently, e-commerce business operators who actively tackle social issues related to SDGs have become ethical e-commerce business operators. However, there is no systematic indicator of the e-commerce level. In this paper, we defined the ethical value of logistics by conducting an ethical consumption survey. An index to evaluate the degree of the e-commerce operators at 100 points was determined, as shown in Figure 1. As a result, consumers can compare the ethical level of e-commerce business operators. Each e-commerce business operator can also grasp the company's position in the market and decide on the goal. This essay will focus on the green parts and study how consumers can achieve SDGs goals with enterprises.

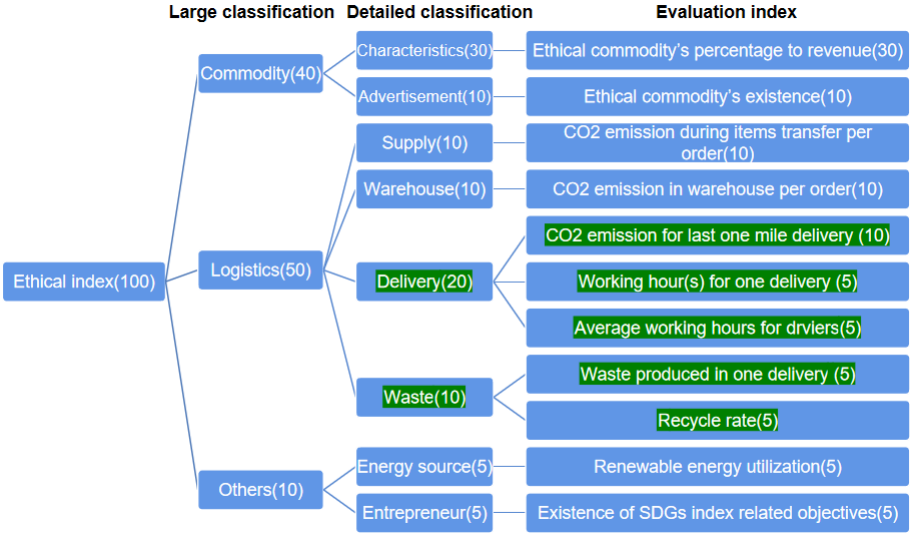

Figure 1. An evaluation index of the ethical e-commerce for logistics companies.

3. Inspiration from the last mile solution of China Logistics

According to Forbes, in 2019, the average number of express packages received by each person in Beijing and Shanghai reached 70, compared with 21 parcels in the United States. What's more, China remains the most substantial influence on the market, with 63.5 billion packages shipped in 2019 and an increase of 26 percent in parcel volume year-over-year. Although there is no shortage of labor force in the logistics industry in China, China's methods are still worth learning from some countries, especially in solving the problems of the environment and labor force. The two leading solutions for the last mile of logistics in China are Cainiao stations (Figure 2) and express storage cabinets (Figure 3). When logistics consumers have more environmentally friendly

choices, and some choose these environmentally friendly ways, it will undoubtedly contribute to the logistics industry and the global environment.

Cainiao station is a combination of express temporary storage point and store. Generally, individuals apply to the logistics company for joining and pay a certain deposit and joining fee. And the only initial equipment to be purchased is the goods rack and the computer with a code scanning gun. Cainiao station is generally located in each community as a temporary storage point for express delivery. Next, I will analyze the feasibility of this system from the perspective of three direct stakeholders. First, for the delivery personnel in the last kilometer, the Cainiao station can help them keep these express and wait for consumers to pick up the express, thus eliminating the cost, time, personnel, and other elements of the direct delivery express to customers. Still, the express delivery personnel must pay a small amount of money to the Cainiao station according to the number of express packages. Second, consumers who are intended to receive a package can pick up the express when they have time, which avoids the trouble of being busy and having no time to pick up the express, and there is no need to pay for the express. When necessary, consumers can pay the amount to let the Cainiao station deliver goods, express delivery, or return and exchange goods for E-commerce. Third, for the holders of Cainiao stations, other than the service fees from the delivery staff, they can also use the massive flow of people to start a second business, such as opening a supermarket, furniture store, or community group purchase. This model has been vigorously promoted in China. Perhaps one day, Japanese convenience stores will cooperate with logistics companies and become a good network.

Figure 2. The appearance of Cainiao station in China [9].

The express cabinets are placed in each community by the express company. Firstly, the courier places the packages in the express cabinet and uploads the corresponding tracking code to the e-commerce platform, and then the e-commerce platform informs consumers of the pick-up password. In this process, the delivery courier does not need to pay the amount fee, and the consumer takes the parts free within 24 hours. If they do not take the parts within 24 hours, they need to charge a certain fee. In this way, it not only saves the delivery time, personnel, and cost for the delivery personnel, but also provides convenience for the customers who are busy and have no time to pick up the packages, and avoids the trouble of redistribution caused by the time difference between consumers and the delivery staff. Especially when COVID-19 failed to get effective control in recent two years, the courier cabinet avoided direct contact between people, and the courier cabinet has become the main means of conveying goods in Beijing's 2022 Winter Olympic Games for participants.

Figure 3. Express cabinets in China [10].

4. A delivery load calculation system when new order appears

Section 4 will state a new load calculation method and path planning when adding new orders to existing orders. The increased load is then visualized and presented to consumers to choose the delivery time according to their ethical value and availability in the next step.

As far as we know, adding an urgent new order in the case of an existing distribution path will significantly change the distribution path, cause a considerable cost increase to the logistics company, and emit more carbon dioxide into the air. Especially when the distribution driver needs to return for delivery or the new order is not on the original distribution path. Therefore, we need a system that can calculate the old distribution cost and the new distribution cost.

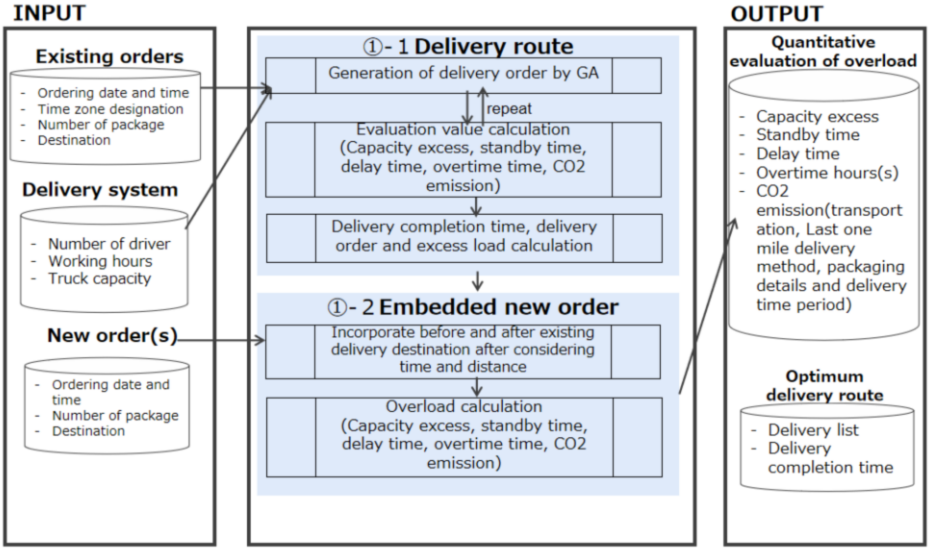

Figure 4. An overview of a new delivery load calculation system.

4.1. Overall view of the system

Figure 4 shows an overall image of a calculation system when a new order is added. The system calculates existing delivery orders, delivery systems, and new orders as input data. After that, it calculates the extra delivery load of the existing order by the new order and outputs an optimal delivery plan with a new order.

4.2. Delivery route planning

A genetic algorithm (genetic algorithm: GA) was used in this research. The optimization problem solved by GA is (1), and it is the sum of the five items as the objective function Palldriver is known as (2). These five indices consist of items relating to the last one-mile delivery in the evaluation index defined in Figure 2 and items relating to the restriction conditions of delivery. All five indices were calculated to be in dollars.

The following five indices are described. Luggage excess penalty is an index that considers the hassle of docking when the load exceeds the truck's capacity. The standby penalty is an index relating to the situation of waiting until the time zone designation when arriving earlier than the time specification of the customer. The delay penalty is an index of the situation when delivery is entirely after the customer's time zone specification. The CO2 emission penalty is an index of CO2 emission in delivery. The overtime penalty is imposed when the driver is forced to work overtime since there are too many delivery orders.

$$\min P_{alldriver} \tag{1}$$

$$P_{\text{alldriver}} = \sum_{k} \{P_{cap}(k) + P_{wait}(k) + P_{delay}(k) + P_{overtime}(k) + P_{CO2}(k)\} \tag{2}$$

- $P_{cap}(k)$: Luggage excess penalty [dollar]
- $P_{wait}(k)$: Standby penalty [dollar]
- $P_{delay}(k)$: Delay penalty [dollar]
- $P_{overtime}(k)$: Overtime penalty [dollar]
- $P_{CO2}(k)$: CO2 emission penalty [dollar]

4.3. Initial solution generation method

It is expected to calculate an efficient solution in a short time. As for the existing research, a study decides the delivery order using GA by clustering a customer near the geographical distance, but in this case, the time zone designation is not considered. At this time, it is possible to search for a solution that does not satisfy the order of the time zone designation and is inefficient. This paper proposes an initial solution generation method that satisfies the order of time bands. To be more specific, clustering delivery tasks into different time zone specifications, then drivers are allocated in the order of time zone designation. An outline of the method is shown in Figure 5.

4.4. Delivery load calculation by incorporating new orders

In the integration of the new orders shown in Figure 4, the increasing amount of delivery load the proposal delivery order by the new order is outputted based on the delivery order of the existing order, which is the output data of 3.2 and the delivery completion schedule time. A more specific flow will be: Initially, we acquire a customer list scheduled to be completed by delivering a new order and obtaining five customers who are close to a new customer. Next, a new customer is built before and after the delivery order of the five customers, and the 4.2 evaluation function calculates the delivery load. The delivery load by the new order is calculated from the difference between the delivery order of the existing order and the minimum of the ten delivery loads.

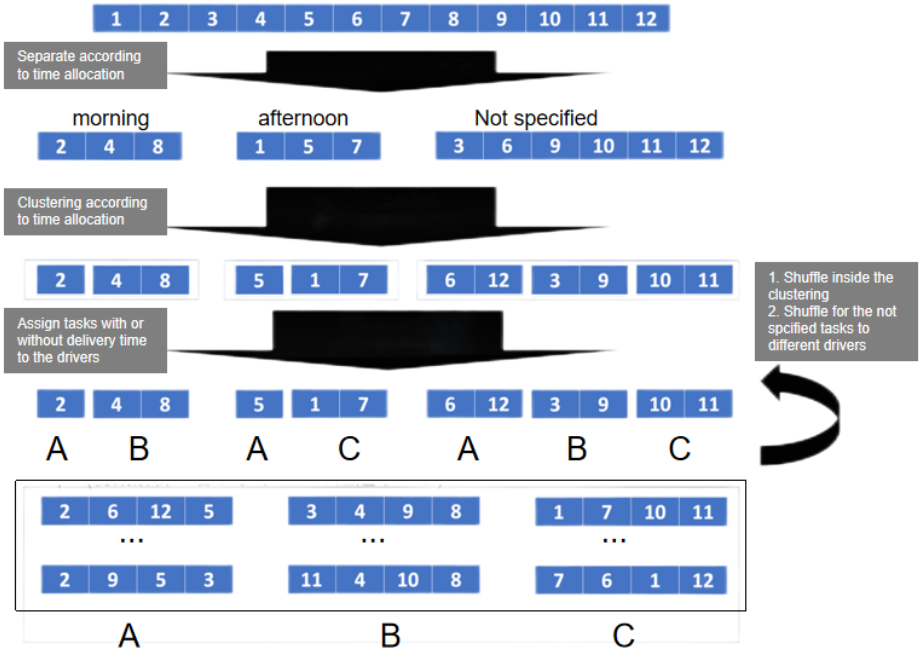

Figure 5. The flow of the initial solution generation method.

4.5. The additional options that customers can choose to achieve SDGs goals.

Consumers can choose to place the express delivery in the express cabinet, nearby storage points (such as Cainiao station), convenience stores, and home delivery according to their availability and environmental awareness. As shown in Figure 6, in addition to the distribution problems stated above that can be coordinated by environmentally conscious consumers, consumers can also participate in the following environmental protection measures. It shows a specially designed mobile App page that can be used by express companies in the future, which visualizes the carbon emissions generated during transportation to consumers and makes SDGs further with their cooperation. First, in addition to choosing trucks, consumers can also choose airplanes that consume more energy and deliver faster or choose ships and trains as alternatives. Second, saving on packaging, such as whether they need secondary packaging, protective

fillers (such as ice or Expandable Polystyrene), paper receipts, and whether the goods need to be packaged separately. Third, the fees converted from the period with busy business, insufficient staffing, or traffic jam will be visualized and listed for consumers. For example, the fees will be reduced when there are sufficient workforce and no traffic jams. If the express company can clearly state the environmental protection measures and corresponding expenses that these consumers can cooperate with, and if some environmentally conscious consumers are willing to cooperate, it will bring significant environmental protection to the logistics industry.

Similarly, as shown in Figure 7, consumers can also return recyclable materials, such as boxes and fillers, to the courier and obtain corresponding discount coupons when receiving or sending express next time. It increases the stickiness of consumers to the same express company and reduces carbon emissions and resource waste.

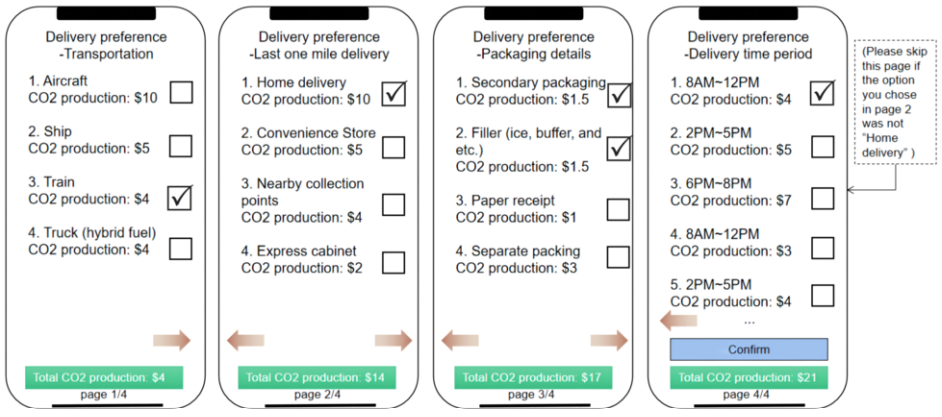

Figure 6. A mobile page displays carbon emission costs according to customers' ethical value.

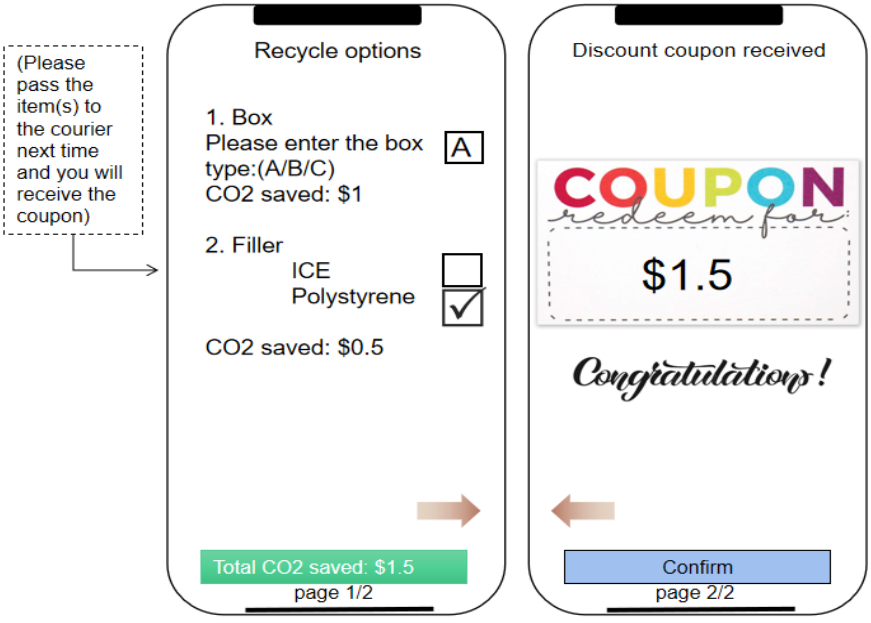

Figure 7. A mobile page display that transfer the carbon dioxide saved to the coupon.

5. Case study

The data is generated from a part of the joint research project with an EC company and is based on actual logistics data provided by the company. The case study was carried out using actual data from this company. The delivery area was part of Setagaya in Japan. The delivery system was formed by four drivers divided into two teams, working in the morning and afternoon, respectively. The load calculation currency is the dollars. In the following section, we will use the cost calculation formula in Section 4 and try to determine the theoretical improvement rate by customer cooperation.

In this case study, we compare a customer-cooperation model in which all customers choose the time zone with the smallest delivery load to a model without customer corporation. A non-customer-cooperation model selects the time zone specification without paying particular attention to the delivery load, just like the current delivery model. The results are shown in Table 1. When a customer cooperates, the delivery load of 328 US dollars can be saved compared to the usual case without consideration of delivery load, which was a 64% improvement. Especially the most considerable improvement can be seen in the delay penalty. Table 2 shows the difference in the number of orders and delay penalty for each time zone with customer cooperation. When there is no customer cooperation, the order is concentrated in the time zone designation at 8-12 o'clock and 19-21 o'clock. The delay time is greatly increased without meeting the designated time of the order in that time zone. On the contrary, in the customer cooperation model, the overload delivery time zone's delivery task flows to the more spare time zone, such as the 14-16 o'clock time zone. As for the delivery system, it is considered that the 14-16 time zone is the time zone with the most vacancy to input other tasks by these four drivers. Since the vacancy to input tasks in the 14-16 time zone designation number is the largest, the delivery model approached a more optimum model by the customer's cooperation, proving the feasibility of an optimized model for delivery by taking advantage of the ethical values of customers.

Table 1. Comparison of delivery load with and without customer cooperation for one day.

	Without customer corporation (dollars)	**With customer corporation (dollars)**	**Extent of improvemnet (dollars)**	**Rate of improvement**
Capacity excess penalty	0	0	0	NAN
Standby penalty	74.94	61.32	13.60	18%
Delay penalty	331.05	41.51	289.54	87%
CO2 emission penalty	65.46	67.46	-2.00	-3%
Overtime penalty	36.61	10.75	25.86	71%
Total	508.06	181.05	327.01	64%

Table 2. Comparison of delivery time and delivery load in various time zones.

Designated time zone		**8-12**	**14-16**	**16-18**	**18-20**	**20-22**
Number of orders	Without customer corporation	55	15	12	21	27
	With customer corporation	42	30	20	22	16
	Difference	13	-15	-8	-1	11
Delay penalty(dollars)	Without customer corporation	338.35	0	0	8.32	98.44
	With customer corporation	49.71	0	0	0.00	6.11
	Improvement	288.64	0	0	8.32	92.33

6. Conclusion

This paper involves a transdisciplinary nature, mainly involving System Engineering, Environmental science, and logistics. Moreover, this paper was inspired by the solution to China's last one-mile problem, uses consumers' ethical values and awareness of environmental protection, and forms a set of cooperation systems with express companies' carbon emission visualization systems. Specifically, consumers can choose the delivery time, transportation methods, express packaging methods, and pick-up methods. In the case study, five cost factors from the formula in section 4 were used to evaluate the effect of the ethical values of customers. In the future, a fully developed model involving more factors that customers can jointly consider will be used, which is expected to have a more significant impact on the environment and customers' e-commerce experience.

Today, with the rising awareness of environmental protection, the continuous growth of e-commerce usage, and the shortage of logistics labor force, a visualization system of carbon emission coordinated by consumers will become a breakthrough and solve the above problems to a certain extent. When the awareness of environmental protection in the future is deeply rooted in the people's hearts, this system will significantly help global carbon neutralization and bring a healthier and more beautiful growth environment to our next generation.

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