Revolutionizing Logistics Supply Chain Management and Cost Control through Digital Marketing in the Era of Big Data and Internet of Things

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Abstract. Although China's logistics industry started late, it has developed rapidly, and the scale of the industry has been expanding in recent years, and breakthrough achievements have been made. However, there are still some problems in logistics development. Poor logistics infrastructure, insufficient coordination of various nodes in the supply chain, many shortcomings in the logistics model, and poor overall quality of logistics managers. The transportation cost management of logistics is also a major problem. The lack of planning of transportation routes, the high rate of empty goods, and the lack of effective use of existing resources have led to high transportation costs of logistics in China. In order to solve these problems, we have built a logistics supply chain management optimization model and transportation cost control model based on big data and Internet technology.

Keywords: big data, Internet of Things, logistics supply chain management, transportation cost; Digital Marketing in the Era
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1 INTRODUCTION

In 2022, the scale of China's logistics industry grew by 3.5% year-on-year, and the logistics demand is increasing, and the logistics industry is further developed. China's logistics supply chain started late, but the development is fast, and now China's logistics supply chain management has made initial achievements and built a perfect model. At present, the logistics supply chain commonly used by e-commerce enterprises includes enterprise open logistics mode, joint distribution logistics mode and third-party logistics mode, but these supply chain modes have their own advantages and disadvantages. Enterprise open logistics model enterprises set up their own warehouses, not only responsible for the parent company's logistics services, but also can provide logistics services to the

community. However, its disadvantage is high cost and requires managers with high logistics supply chain management ability. Joint distribution type logistics model over-relies on the distribution center, once the distribution center is paralyzed, the whole logistics system will collapse [15-26]. These logistics supply chain models and their market shares are shown in Table 1.

Logistics transportation cost in a broad sense is the sum of time resources, space resources and material resources occupied by the process of transporting objects, and this sum is often presented in the form of money. Although the ratio of logistics cost to GDP has gradually decreased in recent years, the ratio of logistics cost to GDP is still at a high level. At present, many logistics enterprises do not know enough about logistics costs, lack cost control professionals and do not have strict financial control, which leads to the high logistics costs in China remain high and at a high level for a long time [14-18]. In order to promote the further development of China's logistics industry, we must control logistics transportation costs, optimize the logistics transportation model, improve the economic efficiency of logistics enterprises, and promote the reduction of transportation costs in the logistics industry as well as the optimization of the logistics supply chain management model.

Type	*Aggregate percentage*
Enterprise open logistics model	*18.82%*
JIT type logistics model	*17.73%*
VMI type logistics model	*25.27%*
Joint distribution type logistics model	*16.09%*
Others	*22.09%*

Table 1: Logistics supply chain models of Chinese e-commerce enterprises and their market shares.

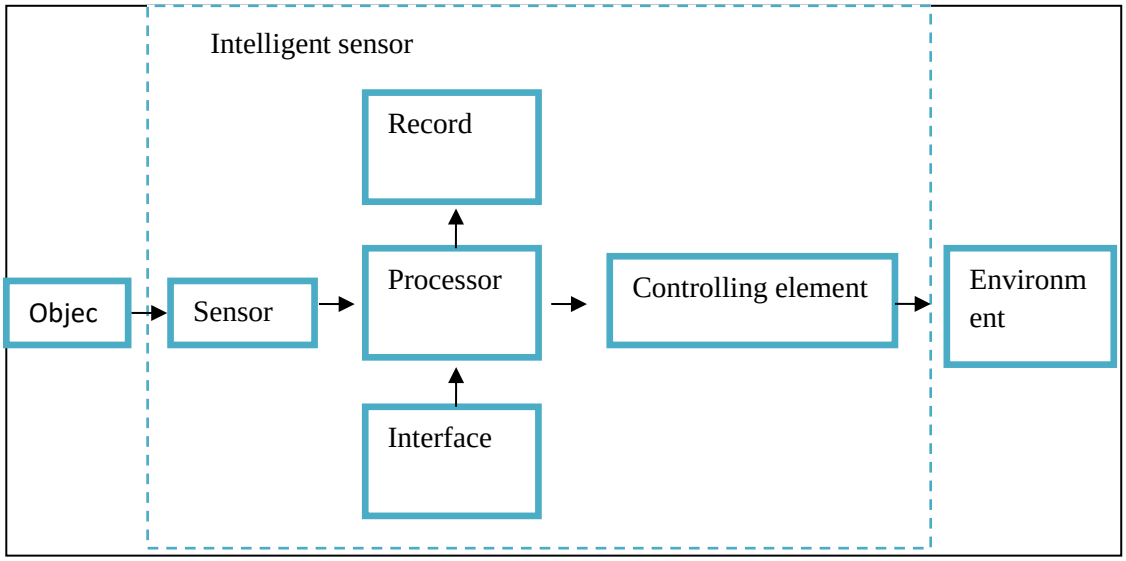

Figure 1: Application model of Big Data and Iot.

Although China's logistics industry has been developed, but due to the speed of development, in the process of development revealed much more. [19-17]. For example, the limitations of the traditional

"order" type supply chain management model, the limitations of the low timeliness of data management, the limitations of the traditional "order" type supply chain management model, the urgent need to improve product quality, and the lack of high-quality personnel in logistics supply chain management of e-commerce enterprises. The birth of big data and Internet of Things provides an opportunity to solve these problems. With the rapid development of information technology, big data and the Internet of Things came into being [21-22]. The two complement each other and serve as a prerequisite to promote the rapid development of information technology industry together. With the birth of IoT sensors, the amount of data in the information world has grown dramatically, and the large amount of data born from IoT sensors has accelerated the birth of big data. Big data technology mainly involves the collection, management, processing, and analysis of massive data, and is able to deal with massive data that is difficult to handle and solve by traditional methods. The Internet of Things (IoT) mainly includes the sensing part and the internal processing part, which breaks the limitation of information exchange of objects and constitutes a network of connected characters.The specific application model of big data and IoT is shown in Figure 1.

2 THE CURRENT SITUATION OF LOGISTICS SUPPLY CHAIN MANAGEMENT AND COST CONTROL

2.1 The Current Situation of Logistics Supply Chain Management

Logistics supply chain management is to build hardware system and software system in each link of logistics transportation, through the coordination of hardware system and software system, under the management of professionals, to achieve the orderly operation of logistics transportation, and can minimize the errors in the links of logistics supply chain. Logistics enterprises provide logistics services, and the services are passed through layers and finally handed over to users. Users then return to the logistics information flow. Logistics enterprises in this process real-time monitoring of logistics links to ensure that their logistics transport does not go wrong, and customers can also give feedback to the logistics supplier [23].The specific operation mode of logistics supply chain is shown in Figure 2.

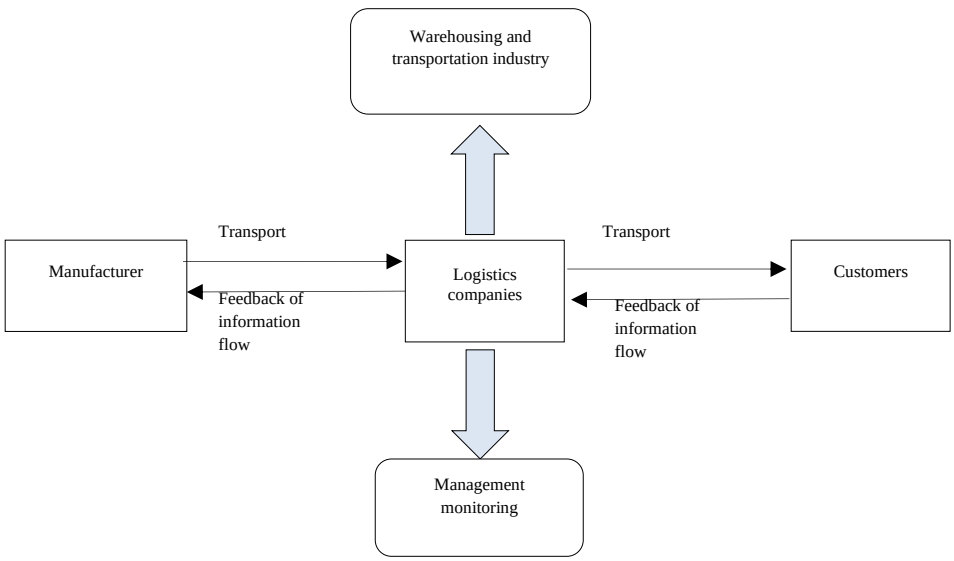

Figure 2: Logistics supply chain link diagram.

China's logistics supply chain is composed of several links, the main body of the circuit are suppliers, manufacturers, distributors, users, etc. Logistics involves multiple links, the transportation process is complex, and the chain management is difficult. At present, China's logistics supply chain management mainly has the following problems [10].

First, the logistics infrastructure is poor, the infrastructure of logistics is closely related to the level of logistics and transportation, poor infrastructure will have a great possibility to cause poor services provided by the logistics supply chain [16].

Secondly, the coordination of each node of the supply chain is not enough, which leads to frequent errors in logistics transportation and reduces the level of logistics management.

Third, there are many shortcomings in the logistics model, resulting in the poor quality of our logistics and transportation products [8].

Fifth, the level of enterprise informatization is not enough. Logistics supply chain management is ultimately the management of data, and the management of data is closely related to the level of information technology of enterprises. A high level of information technology will bring high data processing efficiency, thus improving the operation level of the enterprise logistics supply chain and improving the transportation level of enterprise logistics. The management of logistics data involves many links of information collection, transmission, processing, handling, storage, analysis and use, etc. A mistake in one link may cause a mistake in all the remaining links. Therefore, the perfect degree of data management mode is a major factor that restricts the development of logistics supply chain management mode. In the process of logistics and transportation, the amount of data generated by various activities is huge, such as supplier supply information, order processing, customer demand information, etc. In the traditional "order" logistics supply chain management mode, the huge amount of data generated by each link will directly affect the turnaround time of items in each link, thus indirectly affecting the efficiency of logistics. The correctness of data processing is also a major factor that hinders the development of logistics supply chain management mode. Correctness is the premise of efficient data processing, and correct data can ensure the correct processing of orders [7].

2.2 Status of Logistics Cost Control

Table 2 is the latest composition of China's logistics costs in 2022 as a percentage of the specific data shown in Table 2, China's logistics costs are mainly composed of the following five parts, which are warehouse management costs, order processing costs, transportation costs, system usage costs, and manpower costs, of which transportation costs account for the highest percentage [5].

Logistics Costs	*Proportion*
Warehouse management costs	*14%*
Order processing costs	*16%*
Shipping costs	*55.8%*
System usage costs	*4.2%*
Labor Costs	*10%*

Table 2: Composition of logistics costs in China.

Transportation cost is the highest part of logistics cost. According to the survey, China's logistics and transportation costs are nearly 50% higher than those of the western developed countries, so the control of logistics and transportation costs is the key to reduce the total cost of logistics in China[11].Logistics transportation cost is the sum of the cost of objects from one location to another. In this process, the wages of transportation personnel, fuel costs, and toll fees, are the most

important costs, accounting for 22.6%, 34.5%, and 22.9% respectively. With the rapid development of China's logistics industry, the scale of logistics has grown rapidly, and the growth of freight volume has led to a gradual increase in China's logistics costs. China's logistics costs remain high mainly for the following reasons, first of all, the logistics transport empty rate is high, according to incomplete statistics, China's logistics transport vehicle full rate of only 60%, while the full rate of Western developed countries can be as high as 90%. And this data is only the statistics of one-way logistics empty rate. In the return trip, the logistics of the empty rate is even higher. Logistics empty cars caused a waste of human, material and financial resources, resulting in high logistics transportation costs. Secondly, the choice of transport mode is unreasonable. China has up to 60% of the logistics transport choice of road transport. China's logistics staff in logistics transportation, no strict accounting of logistics costs, most cases are just choosing the most convenient road. This leads to blindness in the selection of logistics routes in China, which cannot achieve the optimal cost of logistics transportation. And most enterprises concentrate on road transport, it will cause road congestion, from increasing the time cost of transportation, and from the other hand, increase the total cost of logistics transportation [24].

3 MODEL CONSTRUCTION

In order to solve the problems of logistics management and transportation cost control in China, we have built a logistics supply chain management optimization model and transportation cost control model based on big data and Internet technology. By optimizing the logistics management process and planning the logistics transportation process, we can significantly improve the overall coordination level of logistics and improve the efficiency and effectiveness of logistics transportation. After verifying the model constructed by this king. It has certain practical significance [2].

3.1 Optimization of Logistics Supply Chain Management Model Based on Big Data and Internet of Things

3.1.1 Two supply chain management models

China's logistics supply chain management model is in a backward state, and one of the main problems is that the informatization of supply chain management is not high, the efficiency of information processing is low, and the error rate of information is high. In order to solve these problems, we have built an optimization model of logistics supply chain management based on big data and Internet of Things technology. The optimization is carried out on the basis of lean supply chain of general enterprises and responsive supply chain of recent enterprises [9].

3.1.2 Supply chain operation of general enterprises

Lean supply chain is a model in which general enterprises provide services and products at lower prices than their potential competitors by reducing production costs, transportation costs, and management costs in order to gain a competitive advantage. Lean supply chain is generally applicable to small enterprises, which generally do not make high profits, do not have a strong industrial operation model, and can only operate in the market by virtue of lower prices. In the internal operation, this supply chain integrates the strategic objectives, management system, and management team of the enterprise, and integrates the supply chain within the bed sheet, so that through the analysis and processing of logistics and information flow, it can provide users with lower-cost services or products within the time specified by users as much as possible. Lean supply chain reduces the total cost of logistics through route planning, warehouse location, and transportation cost control in the logistics and transportation process, and provides users with relatively high-quality services [6].

3.1.3 Supply chain of enterprises in the window of opportunity

Agile supply chain improves its market rate by providing users with fast and high-quality services. Compared with the lean supply chain of general enterprises, the components of agile supply chain change more rapidly [13].

3.1.4 Optimization of logistics supply chain management model based on big data and IOT technology

In order to facilitate the construction of the model, this paper simplifies the operation model of the supply chain, there exists a logistics service provider, whose upstream faces N product suppliers and its downstream multiple customers. The specific model is shown in Figure 3.

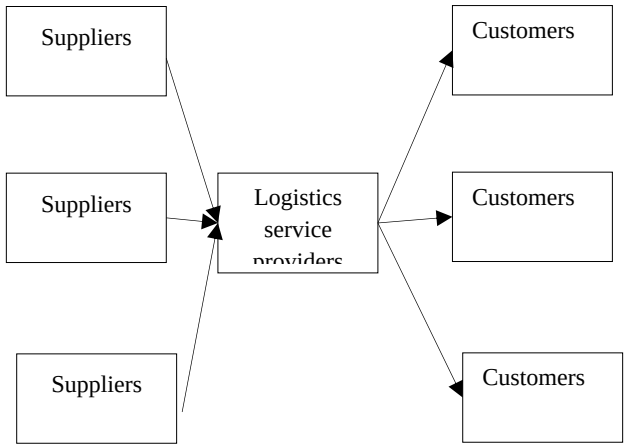

Figure 3: The operation model of the simplified supply chain.

Project	*Customer satisfaction*	*Goods intact degree*	*Supplier delivery speed*	*Logistics transportation time*	*Transportation costs*	*Total cost*
Before using the model	*88%*	*86%*	*95%*	*87%*	*87%*	*96%*
After using the model	*92%*	*95%*	*99%*	*88%*	*89%*	*97%*

Table 3: Supply chain management data.

Step 1: By analyzing the dynamics of product supply, logistics transportation, and product sales in the logistics supply chain, we propose a dynamic model of supply chain operation. The specific

$$M_{s+1}^{q}$$

formula is shown in (1). The specific formula is shown in (1). represents the supplier 's supply at the time of s, V_{j}^{s} represents the customer 's demand at the time of j, and U_{j}^{q} represents the maximum supply capacity of the logistics provider at the time of j. These three variables are all high-dimensional vectors [28].

$$M_{s+1}^{q} = M_{j}^{q} + U_{j}^{q} - V_{j}^{q} \tag{1}$$

Step 2: For logistics providers, the dynamic model of logistics supply is shown in Formulas (2), (3). For logistics providers, there are two factors that determine logistics supply. One is the capacity of the warehouse. Second, the speed of logistics processing.

$$H_{j} = f\ (V_{j}^{s}, V_{j}^{p}) \tag{2}$$

$$X_{j+1}^{s} = X_{j}^{s} + P_{j} - V_{j}^{p} \tag{3}$$

Step 3: Build customer supply model, all customers as a whole, the specific model is shown in Formula (4).

$$X_{j+1}^{l} = X_{j}^{l} + V_{j}^{p} - d_{j}^{h} \tag{4}$$

Step 4: Build a specific operation model, first determine the longest life cycle of the operation mode, through the calculation as shown in Formula (5), and then determine the shortest life cycle of the operation mode, the calculation formula as shown in (6).

$$A_{j+1}^{s} = w_{2}(A_{j}^{s}, A_{jp}^{s}, A_{pm}^{s}, A_{p}^{s}) \tag{5}$$

$$B_{j+1}^{s} = w_{1}(A_{j}^{s}, A_{jp}^{s}, A_{pm}^{s}, A_{p}^{s}) \tag{6}$$

Step 5: Determine the time of the model operation, and combine the shortest life cycle and the longest life cycle. The details are shown in Formula (7).

$$TTL = [B_{j+1}^{s}, A_{j+1}^{s}] \tag{7}$$

In order to verify the reliability of the above model, we worked with a company to let them use our management model to finally get management-related data as shown in Table 3. The indicators were evaluated using a percentage system. It can be seen from Table 3 that after adopting the model, the company's indicators have improved, which proves the effectiveness of this model to a certain extent.

3.2 Transportation Cost Control Model of Logistics Supply Chain Based on Big Data and Internet of Things

3.2.1 Model ideas

The reason for the high cost of logistics transportation in China is that many logistics providers lack a reasonable analysis model in cost planning. On the other hand, there are many modes of transportation in China, such as road transportation, waterway transportation, air transportation

and railway transportation. However, most logistics companies prefer road transportation, resulting in increased transportation pressure and road congestion, which affects the efficiency of logistics. In order to solve this problem, we use the terminal of the big 5-point network to collect data, collect data from the terminal of the Internet of things, use big data analysis to process these data, extract feature vectors, plan, and finally get the best model of transportation [3].

3.2.2 Model construction

The logistics transportation cost system is set as S, and its various influencing factors are Si. The total cost can be expressed as Formula (8), where S_n represents the cost of each factor in the logistics transportation system, including fuel costs, tolls, labor costs, vehicle loss costs and many other factors.

$$S=\left(S_1,S_2,S_3,...S_n\right) \tag{8}$$

Construct an adjacency matrix A, assuming that the distance between P and Q is L, and the adjacency matrix A describes the relationship between the various cost elements consumed during this distance. As shown in Formula (9), there are two values, when the correlation coefficient is 0, a_{ij} = 0, when the correlation coefficient is not 0, a_{ij} = 1.

$$A=[a_{ij}] \tag{9}$$

IoT sensors can collect massive data and quickly return the data to the back-end processor [11, 23]. Big data can process and analyze the data, and can mine the hidden patterns and contents in the data. Figure 2 Logistics supply chain link diagram through the Internet of Things sensors to collect massive data, the data about transportation costs are extracted, the correctness analysis and feature description of the data are carried out, the feature vectors are extracted, and then the big data analysis is used to judge the correlation between the feature vectors. The correlation can be analyzed by a variety of analysis methods. After obtaining the correlation of each group of variables, experts in the logistics industry are invited to audit the results, and the results of the audit waiting are constructed into an adjacency matrix. For the sake of simplicity, this article only cites a simple four-dimensional matrix B. It seems that b_1 represents fuel costs, b_2 represents transit costs, and b_3 represents the unit price of fuel. The details are shown in Formula (10) [4].

$$B=\begin{bmatrix}1 & 0 & 1\\ 0 & 1 & 0\\ 1 & 0 & 1\end{bmatrix} \tag{10}$$

Then the adjacency matrix is calculated, and the formula is shown in Formula (11) [1].

$$(A\cap I)^{\mathrm{n}}\neq(A\cap I)^{2\mathrm{n}}=(A\cap I)^{4\mathrm{n}},4\mathrm{m}\leq\mathrm{n}\text{-}1 \tag{11}$$

Finally, according to the reachability matrix, the elements are divided into the underlying element R, the priority set A, and the reachable set B, as shown in Formulas (12)-(14) [12].

$$A(\mathrm{s_i})=\{\mathrm{s_i}\mid \mathrm{s_i}\in S,m_{ij}=1\} \tag{12}$$

$$B(s_i) = \{s_i \mid s_i \in S, m_{ij} = 1\} \tag{13}$$

$$R(s_i) = \{s_i \mid s_i \in S \text{且} A(s_i) \cap B(s_i) = A(s_i)\} \tag{14}$$

4 VERIFICATION OF THE THEORETICAL MODEL

In order to verify the availability of the model, we selected a logistics company in A city as the survey object. This company is on the verge of bankruptcy due to improper operation. The team negotiates with the enterprise to enable the enterprise to refer to the model proposed in this paper during the nine-month operation process from January 2022 to October 2022 to optimize the logistics supply chain model and control the logistics transportation cost. The team monitors the operation of the company for nine months [27].

4.1 Verification of Logistics Supply Chain Model Optimization

Due to the complexity of the logistics and transportation situation of this enterprise, the model constructed in this paper cannot be thoroughly used. After some consultations, on the basis of the existing model of the enterprise, the core idea of the model constructed in this paper is used to modify. In these nine months, the indicators of team monitoring mainly include customer satisfaction, cargo transportation quality, cargo transportation cycle, vehicle empty rate and total logistics transportation cost [25].

It can be seen from Figure 4 that customer satisfaction has risen slowly in these nine months, and the quality of cargo transportation has shown a trend of slow decline and then rapid rise. Considering that the enterprise has just used the new logistics transportation model and there is a certain trial period in various operations, we can approximately regard the trend of cargo transportation quality as rising.

It can be seen from Table 4 that the proportion of empty vehicles has changed from 66.9 % to 15 %, which has been improved in terms of green vehicles. The total cost of logistics transportation has dropped by 20 %, which can help enterprises obtain more economic benefits.

4.2 Verification of Logistics Transportation Cost Control Model

In chapter 4.1, it has been proved that the logistics supply chain management model constructed in this paper has a certain effect on reducing the total logistics cost, but the logistics transportation cost is only a part of the total logistics transportation cost. We must verify the logistics transportation cost control model.

We divide the logistics transportation cost into the transportation cost from the cargo provider to the logistics company, and the transportation cost from the logistics company to the user, the calculated project transit cost, fuel cost, labor cost, processing cost and other costs. The transit cost is m, the fuel cost is n, the labor cost is e, the processing cost is s, and the other cost is q. Therefore, the transportation cost of bicycle cargo can be expressed as m + n + e + s + q [20].

It can be seen from Figure 5 that the logistics transportation cost is 21.05 % lower than before. This result proves that the logistics transportation cost can be significantly reduced by rationally planning the route, selecting the appropriate mode of transportation, and increasing the full load rate of the vehicle.

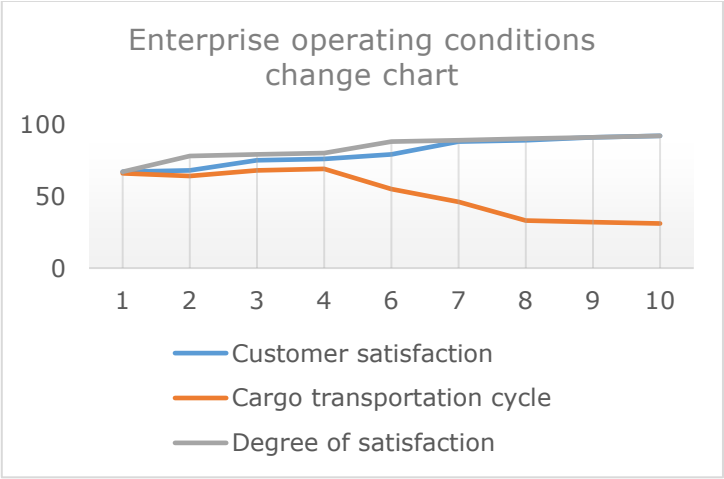

Figure 4: Changes in business conditions.

Project	*Before*	*After*
Empty rate	*66.90%*	*15%*
Total transportation cost (bicycle)	*1209*	*967*

Table 4: Comparison of empty car rate and total cost.

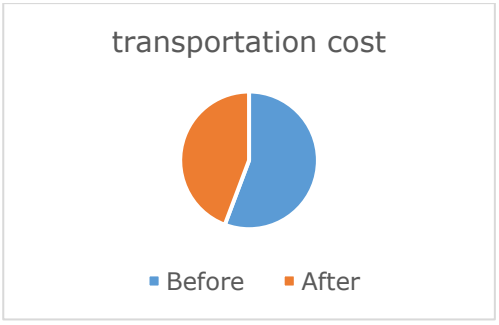

Figure 5: Cost comparison of bicycle freight transportation.

4.3 Meaning

The model constructed in this paper is used in specific logistics transportation practice. On the one hand, it verifies the practical significance of the code model. On the other hand, it also finds some shortcomings in the implementation process of the model, so as to further improve the model.

5 CONCLUSION

China's logistics infrastructure is poor, the coordination of each node of the supply chain is not enough, the logistics model has many shortcomings, and the overall quality of logistics management personnel is not high. The transportation cost management of logistics is also a big problem. The lack of planning of transportation routes, the high rate of empty goods, and the lack of effective use of existing resources have led to the high transportation cost of logistics in China. In order to solve these problems, we build a logistics supply chain management optimization model and a transportation cost control model based on big data and Internet technology. By optimizing the logistics management process and planning the logistics transportation process, it can significantly improve the overall coordination level of logistics and improve the efficiency and efficiency of logistics transportation. The model constructed in this paper is verified. It has certain practical significance. Digital marketing channels, such as social media platforms, websites, and online advertisements, can be used to raise awareness about the benefits and significance of implementing the logistics optimization and transportation cost control models. Educational content, success stories, and case studies can be shared to demonstrate the positive impact of these models on logistics efficiency and cost reduction.

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