
Optimization Design of the Process of Terminal Distribution of E-commerce Network under the Background of Big Data

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Abstract

This paper analyzes the process of terminal distribution of e-commerce network, and finds the problems in the terminal distribution of e-commerce network. Based on the big data analysis including the customer purchase behavior, the delivery time corresponding to different routes, the distribution efficiency of three kinds of end delivery methods, waiting time, customer satisfaction, etc., this article proposes recommendations for optimization of the distribution process.

Keywords

E-commerce network; big data; terminal distribution.

1. Introduction

Today, with the deepening of reform and opening up, the implementation of a series of important national strategies such as the “Belt and Road”, the living standards of Chinese people have rapidly improved. Statistics from the National Bureau of Statistics show that China's GDP in 2017 exceeded 80 trillion yuan, and annual per capita disposable income in urban areas was close to 37,000 yuan [1]. The growth of the national economy and the increase in the disposable income of the Chinese people are accompanied by the improvement of people's consumption level, the development of information technology, the improvement of the security and reliability of network information, and the gradual improvement of electronic payment systems and of terminal distribution networks. These have all promoted the development of the e-commerce industry. The convenience of online shopping and the price advantage of online sales have also promoted the development of e-commerce. As shown in Figure 1, the total retail sales of consumer goods in 2017 was 366.262 billion yuan, of which the total retail sales of online consumer goods was 7.1751 billion yuan, accounting for 19.6%; the total online retail sales of physical goods was 5.4806 billion yuan, accounting for 15% of the total retail sales of online consumer goods nationwide [1]. The online purchase of a large number of physical goods has brought about an increase in the quantity and variety of goods transported and a more distributed distribution of destinations, which have placed higher demands on the processing capability and efficiency of the terminals link of the e-commerce network.

In his book, *The Big Data Era*, published in August 2008, Victor Mel-Schoenberg first proposed the concept of big data that uses information technology to obtain all the data and analyze the data without using random sampling [2]. The development and maturity of technologies such as cloud computing, Internet technology, databases, and data mining make it possible to obtain a large amount of information related to terminals, such as purchasing habits, optimal routes in transportation, and to analyze and obtain an optimal solution. This article aims to study the current process of terminal distribution of e-commerce in China, and discuss the problems generated by it, then propose a process optimization solution based on the application of big data so as to improve the processing capacity

and efficiency of terminal distribution, thereby effectively saving enterprise costs and improving Customer satisfaction.



Figure 1 China's retail sales of social consumer goods in 2017

2. Literature review

With the development of information technology and the improvement of people's living standards, e-commerce represented by "online shopping" has developed rapidly, and many scholars have carried out corresponding research. In terms of the knowledge of the development current status and future development of express logistics and e-commerce: Wu Shuping and Yu Baoqin (2016) studied the coordinated development of e-commerce system and express logistics system [3]. They believe that the cooperation between e-commerce and express logistics in infrastructure construction is not high, and it is necessary to further improve the development of e-commerce and express delivery in technology research and infrastructure building. Moreover, Liu Yisheng and Li Honglei (2017) analyzed the impact of input factors on the output of express delivery industry based on the theory of industrial development [4]. The research shows that the capital investment of China's express delivery industry has a stronger positive relationship with the output of the express delivery industry than labor investment does. In order to increase the output of the express delivery industry, in addition to increasing incentives of workers, it is necessary to increase investment in capital.

In terms of the knowledge of e-commerce distribution networks, of problems with terminal distribution and of process optimization: Lin Tao and Xie Xiacheng (2017) elaborated on the elements and structure of the express network [5]. They clarified the classification and naming of the express network nodes, and displayed and analyzed the spatial layout of the main express delivery service stores and first level and second level nodes in Shanghai. Besides, Xu Hui and Pan Xuhua (2017) pointed out some problems in the express delivery industry during the analysis and research of China's express delivery industry [6]. It includes the way in which the courier companies use the "price war" to compete for market share of e-commerce; in order to cope with the sudden increase in service demand during the peak period of online shopping, each courier company needs to recruit employees in large quantities and quickly, etc. Due to these problems, the profit of express delivery enterprises is reduced, and the cost is increased, which causes the quality of express delivery services to be severely limited. Additionally, Yang Mengke and Zhou Xiaoguang (2015) proposed to establish an O2O e-commerce system based on intelligent courier cabinet [7]. In this way, we can use the intelligent express cabinet to carry out advertising, self-sales, releasing of product discount information and other activities to promote the coordinated development of e-commerce and express logistics in the end of the city distribution process. Also, Mei Ling and Shao Mingji (2018) took the Jingdong self-operated logistics as an example to optimize the delivery process of the express delivery business [8]. They propose multiple suggestions such as subdividing the delivery area that each courier is responsible for, determining the best delivery route and carrying out standard management to optimize the delivery process.

In terms of the knowledge of optimizing the terminal distribution process based on big data analysis: Yang Mengke and Zhou Xiaoguang (2015) proposed to establish a big data analysis system based on city express service in the process of the discussing how to construct the co-delivery mode of express delivery in the context of "Internet +" [7]. This hypothetical system analyzes a large amount of user data, making it easy for enterprises to use data for precise management. In addition, analysis of large amounts of user information can predict changes in behavior of community users and conduct business services based on them. Moreover, Xu Hui and Pan Xuhua (2017), in their article that aims to analyze and prospect China's express delivery industry, suggested to use the vast amount of customer information collected by express delivery companies to obtain specific information about customers' consumption preferences and shopping frequency, and then apply this information to extend the express industry chain——building business activities like supply chain finance and wealth management on both the upstream e-commerce platforms and downstream express companies [6].

It can be known from the existing literature that at present, China's express delivery industry still lacks capital investment like the investment on transportation equipment and infrastructure such as pick-up points and express deliver cabinets to meet the country's transportation and warehousing needs. There are still some unreasonable places in E-commerce network terminal distribution process, and terminal distribution process has problem of malign competition and of the system's inability to meet the huge change of demand. The analysis of customer demand, transportation route congestion, customer satisfaction, population distribution density and other data through big data analysis technology can help solve these problems and promote the smooth operation of the terminal distribution of the e-commerce network. This article will start with the research on the related processes of the terminal distribution of e-commerce networks in China, analyze the problems existing in the current process, and then combine the application of big data methods to propose the optimization of the terminal process of e-commerce networks.

3. Analysis of the status quo and problems of the terminal distribution of the e-commerce network process.

At present, the general process of the operation of e-commerce network in China from the purchase of goods by customers to the terminal distribution of e-commerce is as follows:

- (1) Consumers buy goods and place orders in online stores such as Amazon, Jingdong, Taobao, etc.
- (2) After receiving a certain number of orders, the online merchants of the online platform contact the courier company that cooperates with them to carry out the express delivery.
- (3) The courier company sent staff to pick up the goods and transport them to the nearest distribution center for collection and sorting, and transport the goods in the same direction to the downstream distribution center near the destination.
- (4) According to the recipient's delivery address and the recipient's schedule, the courier company staff chooses the appropriate time to deliver the shipment to the customers' doors, or send the shipment to the express deliver points or express delivery cabinets near the receiving address.

The online shopping process from the purchase of the customer to the delivery of the product to the customer is shown in Figure 2:

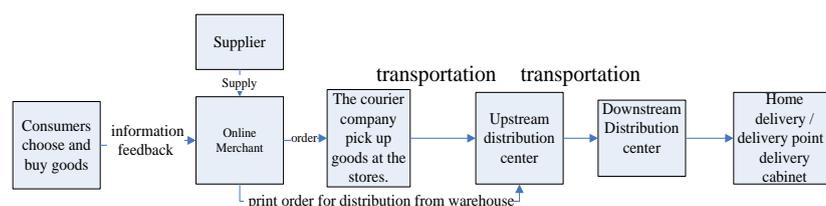


Figure 2 Customer online shopping process

In the choice of the way of terminal distribution, depending on the destination and the time of delivery, each courier chooses a different service [9]. Table 3 lists three traditional distribution methods and their advantages and disadvantages.

Table 1 Traditional e-commerce terminal distribution methods and their advantages and disadvantages

Terminal distribution modes	Advantages	Disadvantages
Door-to-door delivery model	(1) Customers can get the goods without leaving the house, and the customer satisfaction is high. (2) Can be face-to-face acceptance, saving time for possible return operations [7]. (3) Can meet the needs of cash on delivery.	(1) It takes a lot of manpower. (2) The time conflict between the delivery personnel and the customer is difficult to reconcile, and the distribution efficiency is low. (3) Door-to-door delivery will lead to the disclosure of customer information, resulting in security risks.
Self-pick at express delivery point	(1) The distribution is simplified as a single delivery point service to the customer in the whole area, which reduces the transportation distance, saves the delivery time, and can meet the large distribution demand at a lower cost. (2) Customers can pick up the goods within a certain period of time, and the delivery personnel can also deliver the goods within a certain period of time. Both parties do not have to wait, saving time and cost and also improving the user experience. (3) There is no limit to the shape of the goods. (4) Acceptance operations can be performed and the time required for returning goods can be saved [7].	(1) Delivery point is far from customers on the edge of the area. (2) The initial construction cost is high, and the later operations will continue to generate costs. (3) Fluctuations in the number of shipments can result in additional costs for manual hire and dismissal. (4) The location of the delivery point and the placement of internal cargo will have an impact on service efficiency.
Self-pick at express delivery cabinets	(1) Provide goods distribution for the entire area, saving labor costs. (2) There is no time limit for customers to pick up the goods. (3) It is more convenient, it will not affect the time required for picking up the goods for the order in which the goods are stored.	(1) The construction cost in the early stage is relatively high. (2) Space is limited and there are limits to the shape and quantity of the items in stock. (3) It is far from the customer who lives on the edge of the area.

Since the express delivery point and the express delivery cabinet can serve a larger area and save labor costs, they are put into use in university campuses, residential areas and other places where online consumers are concentrated. The door-to-door delivery model is used more for the transportation of more expensive items and for special cases such as the need to transport items that need cash on delivery or items that is unusual large. If the goods delivered in the "door-to-door" delivery mode are not received, they will be directly transported back to the downstream distribution center for the next delivery or directly placed in the nearest delivery point or delivery cabinets waiting

for the recipient to pick up. If the goods temporarily stored in the express delivery point and the express delivery cabinets have not been collected for a long time or need to be returned, they will be returned to the merchants through the downstream distribution center and the upstream distribution center.

The process of terminal distribution of e-commerce is shown in Figure 3:

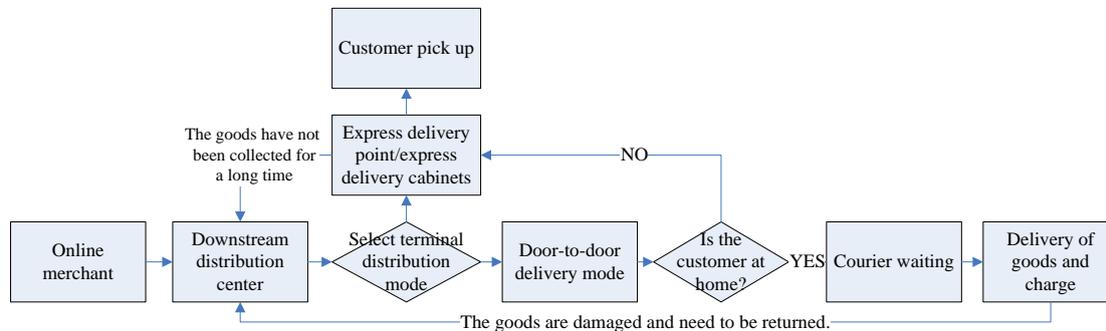


Figure 3 terminal distribution process of E-commerce

Among them, some problems in the whole process of online shopping and in the terminal distribution process of e-commerce are reflected in the following aspects:

(1) In terms of purchase: Most online merchants use past experience to determine when to stock up and how much goods should be purchased. Even some merchants have no or little predictions about the demand for goods, and the number of orders from online consumers is the sole basis for purchase--- How much goods a merchant purchases from an upstream supplier is determined by how many orders are placed by online consumers. Online merchants have great fluctuations in demand due to their own convenience and other characteristics. Take Tmall Mall as an example. in the “Double Eleven” shopping festival in 2017, the sales of Tmall Mall reached RMB 168.2 billion, resulting in a total of 1.38 billion parcels. Ordering strategies based on experience and demand forecasting for online consumer orders are clearly difficult to meet the volatility of online consumption. Inappropriate purchase strategies bring not only a significant increase in operating costs, but also lower customer satisfaction.

(2) In terms of the choice of transportation route during transportation: Whether it's a large online store that ships directly from its own warehouse or a smaller online seller that delivers the goods through a courier company, there is no shortage of options of transportation route in transportation process. There are now several ways to choose the shortest path to transport. However, the shortest path study in the simpler static transport line model has been unable to meet the needs of various traffic conditions that are constantly changing in reality. Unexpected situations such as traffic jams, road repairs, and natural disasters occur in large-scale long-distance transportation, which affects the efficiency of terminal distribution of e-commerce networks. Longer transit times are not only not conducive to meeting the timeliness of logistics, but also cause safety problems such as driver fatigue driving during transportation, as well as increased fuel consumption and tolls during transportation. In addition, there may be problems such as deterioration of fresh and perishable products.

(3) In terms of transportation space utilization: According to the literature and information, China's current logistics and transportation equipment is still in a state of short supply. In the face of the huge demand for express shipments, large trucks used for long-distance transportation and short-haul vehicles connected between upstream suppliers, downstream consumers and their respective distribution centers cannot fully meet the transportation needs. It is less efficient to load a variety of express shipments by means of a traditional self-organizing placement by the porter. In order to solve the problem of mismatch between the supply and transportation requirements of transportation vehicles, in addition to increasing the number of vehicles, the rational use of the internal space of transportation vehicles is also an important means.

(4) Longer waiting times are usually required when delivering to your door: In the existing e-commerce network terminal distribution process, when dealing with the “last mile” problem of

express delivery, the goods are delivered to each household directly. Even if there are steps to contact the customer by phone, it usually happens when the customer is found to be out of the home or when the courier is about to arrive at the designated shipping address. Lack of communication with customers can lead to problems such as repeated delivery. Even if the shipment is sent to a nearby express delivery cabinet or saved from a delivery point, it will still waste a lot of delivery time and the human resources required for terminal distribution.

(5) Fixed storage time of the express delivery point and express delivery cabinet: At present, in the terminal distribution process of e-commerce network, the use of delivery cabinets and delivery point can avoid the complicated route of delivering the shipments to the customers' homes and can therefore save a lot of manpower, financial resources and the time and effort required by the courier to find a specific customer location. A large number of stagnant shipments often appear in the delivery cabinets and delivery point. The current processing method is that each courier company stipulates the storage time by itself. If it is overdue, they will charge a certain fee. If the stagnant time is long, the shipment will be returned to the merchant. The length of time that the courier company will help with the deposit and the amount of the overdue fee will be related to the customer's satisfaction and to the number of shipments that need to be processed from the delivery point or delivery cabinet. This length of time should be handled with optimized regulations and programs.

(6) In terms of the security of door-to-door delivery service [10]: In the door-to-door service, the courier is required to deliver the courier to the customer's home. The privacy exposure of the customer's home address and the difference in the quality of the courier will bring hidden dangers to the customer's life and property safety. The protection and evaluation of customer safety and the favorable supervision and evaluation of courier behavior are also the links that need to be considered in the terminal distribution process of the e-commerce network.

4. Optimize process design using big data method

By using information technology to capture all data and analyze it, big data technology has been widely used in various fields of people's work and production. After learning the various ways of using big data analysis technology in practice through relevant literature, this paper proposes feasible improvement schemes for various problems in the terminal distribution of the e-commerce network based on big data analysis so that the terminal distribution process of the e-commerce can be optimized. The specific links to improve the existing processes using the big data approach are as follows:

(1) Apply big data technology to determine purchase time and purchase quantity

E-commerce activities are different from traditional mass-produced commercial production. In e-commerce activities, consumers tend to be fragmented, and the products they produce are diversified to meet the individual needs of customers; the life cycle of new products is shortened; new varieties of products are also emerging rapidly. All of the above put forward requirements for the prediction of demand and the control of inventory. Figure 4 shows the improvement of the customer purchase process using big data. As can be seen from the figure, using big data to analyze the click frequency and click time of the product keywords of online shopping customers in the computer input method can help to get key information like customer's "customary time for online shopping" and "the variety and quantity of goods that customers tend to purchase". An analysis of the spending habits of the online shop customers within a certain time span can help online merchants to make accurate demand forecast. Adjusting marketing tools and purchasing strategies based on such demand forecasting can greatly reduce inventory and facilitate online merchants to balance the inventory cost and the fixed cost of purchase to accurately make optimal decisions.

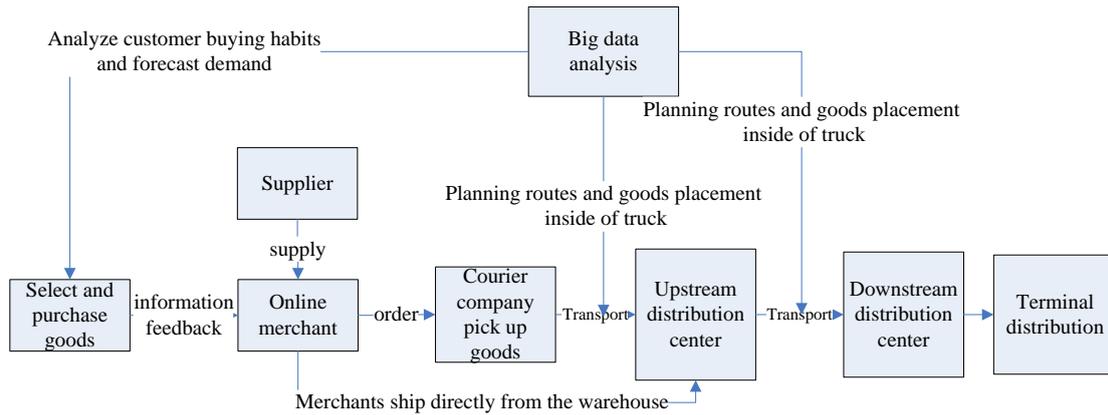


Figure 4: Using big data to improve the purchase process

(2) Use big data to help choose the transportation route

The road conditions in the terminal distribution process of the e-commerce network are complicated, and the urban roads are often in a state of being built, congested, which negatively affect the traffic. You can use big data technology to calculate important data of each transportation route in the city like the average travel speed, the waiting time of traffic lights, the feasibility of the passage of freight vehicles, and the time required for the freight vehicles to distribute the unit distance for all the traffic routes from the start point to the end point, to help choose the optimal transportation route.

(3) Applying big data technology to the design of express delivery cabinets and transport vehicles

The diversity of express shipments in the terminal distribution of the e-commerce network causes the specifications between the express and the express to vary greatly. In order to make reasonable use of the volume of the warehouse in the intelligent delivery cabinet and the transporting vehicle, and to make the order of the goods to be easy and straightforward to take, the goods can be arranged according to the order of delivery of the goods during the stocking. Place the first delivered item on top and place the item delivered later under it. Simulate a variety of placement methods in a computer with this placement order as a constraint to place the goods in the most reasonable way. Using a simulation like this, with long-term data statistics, it is possible to analyze the size and number of the most suitable bins and the size of the truck compartment for manufacturing. In addition, big data analysis based on the time taken for a large number of customers to pick up goods can help decision makers determine the appropriate fees to be charged for overdue storage. The improvement of terminal distribution process of the e-commerce based on big data is shown in Figure 5.

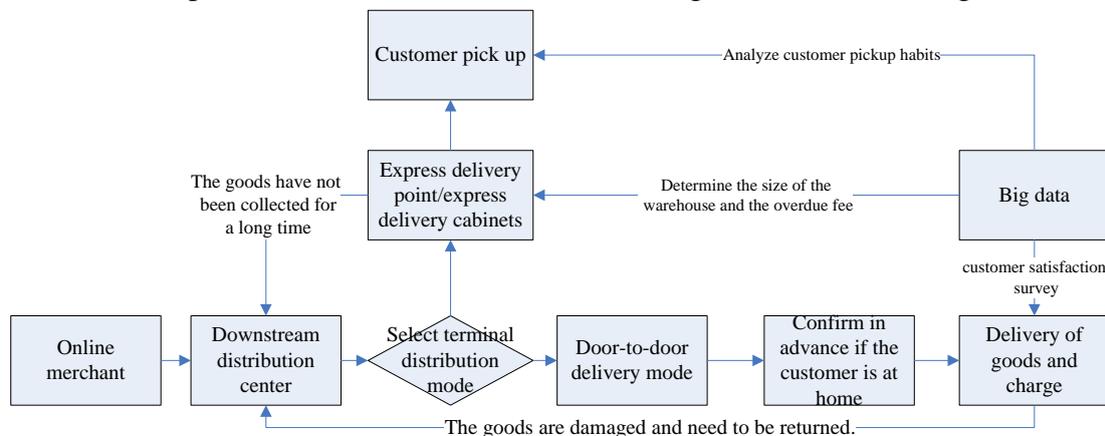


Figure 5: Improvement of terminal distribution process of the e-commerce based on big data

(4) Matching of idle transportation space of vehicles based on big data technology

In order to alleviate the shortage of vehicle and the shortage of human resources for cargo operations for cargo transportation in the face of huge logistics and transportation needs, it is recommended to

introduce and standardize the means of carrying cargo in the idle cargo space of passenger vehicles. At present, most of the passenger vehicles' warehouses are underutilized. Since passenger vehicles have many train times, sufficient capacity and a wide range of operating routes, it is very common for carrier to use passenger vehicles to carry goods for long-distance transportation. Carrying goods can not only use idle transportation resources, but also bring extra income to passenger drivers, and can also reduce the cost of express delivery companies transporting goods. This is an advanced model that is environmentally friendly. It promotes efficient use of social resources, and helps to smooth the integration of all links of logistics. However, it is difficult to supervise this carrying activity carried out by the individuals like the driver or the merchant who is entrusted to transport. The legality of the goods that is carried by passenger vehicles is not guaranteed, and the transportation of prohibited items also brings challenges to the safety of passengers and the supervision of government departments. Because the passenger car is loaded with cargo, the phenomenon that the passenger car is not full of people but is still overweight is very common, which also increases the potential safety hazard. Based on the above advantages and disadvantages of using passenger cars to carry goods, this paper believes that the mode of carrying goods by passenger vehicles should be used in the end of the e-commerce network. This mode can help solve short-distance express delivery problems such as terminal distribution in the city, so as to alleviate the pressure of insufficient delivery capacity at the end of the city e-commerce network and traffic problems in the city. In this model, the courier company cooperates with the car rental company or the 'hitchhiking' project of the large online car rental management platform. The bus driver picks up the goods that have already been examined from the nearby distribution center and then delivers them to the express delivery point or express delivery cabinet in the same direction as the passenger destination. In terms of supervision, the supervision mode of co-operation between the courier company and various types of commercial companies such as DiDi companies and Shenzhou companies substitute the traditional supervisory mode of private transactions between passenger drivers and carriers. Such regulation helps multiple platforms to be responsible for the safety of passengers, the legality and safety of goods. In addition, the route of goods distribution is only between the distribution center and the express delivery point or express delivery cabinet near the passenger destination. This makes it easy to use big data analytics and artificial intelligence to match cargo orders with passenger vehicles that meet space and route requirements.

In this model, big data analysis technology mainly focuses on analyzing passenger flow of 'hitchhike', the time of the peak and trough of the passenger flow, vehicle free cargo space, customer satisfaction before and after cargo loading, and cost and incomes changes before and after cargo loading and so on. These analyses help to determine which passengers need to carry the cargo and what kind of cargo is transported through which line to achieve the lowest manpower, fuel consumption, and time cost. Different passenger vehicles' routes mentioned above can be determined by factors such as the vehicle's starting points, destinations, transportation time, and available cargo space. The type of goods carried can be determined by factors such as the starting point, destination, shape and weight of the goods.

5. Summary and prospect

This paper combines the study of literature and data and the study of online shopping process of customers and of the terminal distribution process of the e-commerce network, to describe the problems in some aspects of the process and the reasons for the problems. These problematic links include the decision of online merchants' purchase quantity and purchase time, the choice of transportation route during the distribution process, the use of transportation vehicle space, the selection of the terminal delivery process, and the security of the door-to-door mode. According to the problems in these processes, the paper proposes: (1) Using big data technology to help online merchants determine the ordering quantity and ordering time; (2) Using big data technology to help select transportation routes; (3) Using big data technology to help optimize the design of the vehicle space and the specifications of the cabinet; (4) Using big data technology to help determine the order

of storage of goods in the vehicle; (5) Using big data technology to help the courier company and the passenger car company cooperate in the terminal distribution process of e-commerce network. In this way, the e-commerce network end distribution process can be operated more smoothly.

China's e-commerce network end-of-sale distribution process is relatively smooth, and it is a high level in the world. In the future, China's e-commerce network distribution will rely more on big data, cloud computing, artificial intelligence and other technical applications, making the connection of each link more compact and smooth [11]. In terms of the choice of the terminal distribution mode, in addition to some special circumstances, China's e-commerce network end distribution mode will focus on using express delivery point and express delivery cabinet, and upgrade the return services and cash on delivery services of express delivery cabinets. In the development of the entire express delivery industry, China will increase capital investment in logistics equipment and facilities, and use some new technologies and equipment to more effectively integrate and utilize customer resources, improve service quality, and further develop.

References

- [1] Chinese National Bureau of Statistics. China Statistical Yearbook [M]. Beijing: China Statistics Press, 2017.
- [2] Viktor Mayer-Schönberger, Kenneth Cukier. Big Data: A Revolution That Will Transform How We Live, Work, and Think [M]. London: Hodder Export, 2013.
- [3] Wu Shuping, Yu Baoqin. Research on the Cooperative Development Path of E-commerce and Express Logistics[J]. Management Review, 2016, 28(7): 93-100.
- [4] Liu Yisheng, Li Honglei. Empirical Research on the Development of China's Express Industry from the Perspective of Industrial Development[J]. Journal of Capital University of Economics and Business, 2017, 19(1): 66-73.
- [5] Lin Tao, Xie Xiacheng. Elements, Structure of Express Network and Spatial Layout of Shanghai Nodes[J]. Journal of Transportation Research, 2017, 3(5): 39-49.
- [6] Xu Hui, Pan Xuhua. Analysis and Prospect of China's Express Industry——Based on Comparative Analysis of Chinese and American Express Delivery Enterprises[J]. Observing and Commentary, 2017(12): 14-16.
- [7] Yang Mengke, Zhou Xiaoguang. Construction of Cooperative Delivery Mode of Express Terminal in the Background of “Internet +”[J]. Journal of Beijing University of Posts and Telecommunications(Social Sciences Edition), 2015, 17(6): 45-50.
- [8] Mei Ling, Shao Mingji. Optimization Design of Express Delivery Business Process——Taking JINGDONG Self-operated Logistics as an Example[J]. Circulation Economy, 2018 (1): 107-109.
- [9] Lu Huanhuan, Pei Shaoqing. Analysis of “last mile” distribution problem based on common distribution e-commerce[J]. Logistics Science and Technology, 2013(10): 117.
- [10] Zhang Huiyun, Shang Xin. Analysis of the Last Kilometer Distribution Mode of Express Delivery Industry——Taking the CAI NIAO and HIVE BOX as Examples[J]. Logistics Technology, 2015, 34 (22): 48-51.
- [11] Zhou Hongbo. Cloud Computing: Technology, Applications, Standards and Business Models [M]. Beijing: Publishing House of Electronics Industry, 2011: 18-23.