Analysis and Research on the "last mile" distribution innovation model of e-commerce express delivery

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Abstract. With the rapid development of e-commerce, the number of online shopping transactions has increased year by year. Selecting products online, paying online, and waiting for packages to be delivered to the door has become a part of life shopping for many people, from online orders to offline delivery. Its intermediate process needs to be completed with the help of the logistics company to realize the circulation of goods. The final distribution phase of e-commerce logistics, that is, the “last mile” delivery of e-commerce express, this process will directly target the final customer. This stage has become a key stage affecting the quality of logistics and service and customer satisfaction.

1. Introduction

The “last mile” distribution of e-commerce express is the key link of the whole logistics distribution service, and it is also the bottleneck for improving the logistics distribution service. In order to accelerate the development of e-commerce express logistics, it is necessary to solve the problem of “last mile” distribution.

In recent years, China's Internet industry has developed rapidly, and the number of Internet users has continued to grow. By June 2017, the number of Internet users in China has reached 751 million. The huge user scale has laid a good foundation for the rapid development of e-commerce. From January to March 2018, total social consumer goods reached 902.75 billion yuan, up 9.8%, and online retail sales totaled 191.8 billion yuan, up 35.4% year-on-year. However, the total amount of physical goods sold online reached 1,456.7 billion yuan, an increase of 34.4% compared with the previous period. The total amount of online sales accounted for 16.1% of the total sales of social consumer goods; in the online retail sales of physical goods, the goods consumed, worn and used Commodities increased by 46.5%, 33.9% and 33.3%, respectively [1]. The large-scale development of physical online trading has also driven the rapid development of e-commerce logistics industry; in order to adapt to the rapid development of e-commerce, China's logistics industry is facing enormous challenges; the whole process of logistics is a complete chain, in the chain All links are connected to each other.

2. Related concepts and research status of “last mile” distribution of e-commerce express delivery

2.1 Related concepts

The word "distribution" was developed from Japan, and "distribution" in the "Japanese Industrial Standards (JIS) Logistics Terms" means "the process of transporting items from the centralized distribution point of logistics to the consignee" [2]. In our country, the standard of “distribution” is defined as “a series of operations such as sorting, certain processing, proper
packaging, distribution, and assembly of items according to the needs of users in an economically reasonable geographical area. Deliver goods to the logistics activities of the customer's designated address on time [3].

2.2 Status of domestic research

At present, there are various descriptions of the connotation of "the last mile" at home and abroad. For example, in China, Liu Yongfeng [4] believes that the “last mile” distribution is a process in which “delivery personnel send goods from a specific network to the consignee's workplace or home in some way”. In the study of Yang Juping [5], the interpretation of “last mile” is more concise, and is interpreted as “refers to the delivery of goods to the end user”. Shi Zhangqiang and Zhang Jun [6] believe that the “last mile” distribution is the last link in the online shopping process, which also means the process of parcels arriving from the express delivery point to the customer.

The distribution model is the strategy and method for the logistics company or logistics enterprise to choose the distribution. Different researchers will study the distribution model differently. Yu Baoqin [7] and others believe that the distribution model is a distribution process for a specific category of products. Liu Zhiquiang [8] and others believe that the standard form formed by different combinations of elements in the distribution activities is the distribution mode.

3. Research significance

Online shopping, online payments and offline sales are a series of online shopping activities. Throughout the logistics process, the “last mile” distribution is the only part of the direct contact between e-commerce and customers.

1 “last mile” distribution service is the only way for e-commerce to face customers. If e-commerce can make full use of the “last mile” distribution festival, it can complete the brand communication and after-sales service of e-commerce or products.

2 “last mile” delivery service can bring some additional benefits to e-commerce. The data accumulated in the service contains rich customer data resources, which can accumulate valuable information according to data procurement and information management, and provide strong support for market forecasting. Due to direct customer contact, corporate image and value culture can realize value-added benefits through the “last mile” delivery service.

4. The current mode of “last mile” delivery of e-commerce express delivery

4.1. Direct distribution mode

The direct delivery mode means delivery to the door. It means that the logistics company or the e-commerce company uses the delivery personnel in the self-owned express delivery enterprise or the cooperative express delivery enterprise to pick up the goods, and deliver the goods purchased by the customer to the transfer station in the customer's area. The special delivery personnel will deliver the goods to the designated place within the specified time in a specified time, and complete the end delivery of the express goods.

4.2. Indirect distribution mode

The indirect distribution mode, also known as the pick-up point pick-up mode, is that the courier sends the goods purchased by the customer to the designated pick-up point according to the requirements, and then the customer picks up the goods by himself.

4.2.1. Specific pick-up point mode. The specific pick-up point mode refers to the centralized delivery of goods to the store, and the customer picks up the goods by picking up the goods by means of SMS or verification code.

4.2.2. Offline convenience store mode. The offline convenience store mode refers to an e-commerce or express delivery company that establishes an offline convenience store or cooperates with a community convenience store. The e-commerce or express delivery company
delivers the goods purchased by the customer online to the offline convenience store, and the convenience store can serve the customer on behalf of the customer.

4.2.3. Community property model. The community property model is that the e-commerce or courier company cooperates with the customer's living community or the property company where the customer works. The dispatcher delivers the goods to the specific location of the property. When the customer goes to work, the latter can directly go to the property designation. The location to extract their own goods, the property can also be delivered to the customer according to customer needs[9].

4.2.4. Intelligent self-reporting container mode. The intelligent self-lifting container is a self-lifting container set up and managed by a logistics company or an e-commerce company in a specific place such as a residential area or a subway station. The recipient can fill in the specified self-receiving container address as the express delivery address according to his own needs. When the goods are sent to the intelligent self-reporting container, the order system or the dispatcher sets the pick-up code to the recipient from the pick-up container system, and finally the recipient picks up the express goods according to the pick-up code to the self-lifting container area.

5. Problems in the “last mile” delivery mode of e-commerce express delivery and optimization suggestions

5.1. Problems

At present, e-commerce enterprises are leading the huge changes in the consumption patterns of Chinese enterprises and residents. However, the rapid development of online shopping and the lag of logistics distribution are seriously mismatched. The lag of logistics distribution has become the biggest problem in the development of e-commerce. The low efficiency of distribution, the poor quality of distribution services, and the high cost of distribution have become the bottlenecks restricting the development of e-commerce express delivery.

Table 1 Problems in typical distribution mode [10]

| Delivery mode                          | Typical Case          | Problem                                                                 |
|----------------------------------------|-----------------------|-------------------------------------------------------------------------|
| Direct delivery mode                   | "Vipshop" offline delivery | 1. The delivery time is poorly flexible, and it is easy to generate secondary delivery. 2. The distribution staff has a shallow sense of service. |
| Specific pick-up point mode            | "Tmall" "Four links and one" | 1. High labor costs and high site rental costs                          |
| Offline convenience store mode         | Ali "Mail World" SF "hacker" shop | 1. Poor control, unregulated management, high error rate 2. Inconvenient mailing |
| Community property model               | "Rookie Station"      | 1. Unregulated management, easy to cause damage to goods 2. Only responsible for temporary storage, no express explanation |
| Intelligent self-reporting container mode | Japan "Lotte BOX" Amazon's 7-Eleven Locker | 1. The size of the cabinet is limited and cannot be adapted to the special-shaped parts. 2. It is difficult to be held responsible for the failure, and the inspection service cannot be provided. |

5.2. Optimization proposal for the “last mile” delivery mode of e-commerce express delivery

5.2.1. Optimization of specific pick-up point mode a) According to the distribution of customers and the traffic conditions around the outlets, e-commerce or logistics enterprises should choose the appropriate outlet address to prevent multiple outlets from appearing in the same area; b) E-commerce should increase contact with franchisees. c) Establish a unified operation mode, and each network should be able to predict some special situations.

5.2.2 Optimization of cooperation mode of community convenience stores 1) Develop standardized convenience stores and strengthen the fit of convenience stores and express delivery
companies. China needs to develop community convenience stores and improve the standardization services of community convenience stores. Each courier company can strengthen cooperation with community convenience stores, and use community convenience stores as the last stage of the “last mile” of e-commerce logistics, and must improve the accuracy and service level of distribution. 2) Community convenience stores and express delivery companies cooperate in depth to provide corresponding distribution and shipping services. The courier company will use the community convenience store as a stop for the “last mile” of e-commerce logistics, which can achieve a win-win situation.

5.2.3. Optimization of intelligent self-reporting container 1) Increase the profit model of intelligent self-reporting containers. Appropriately increase the profit model of intelligent self-reclaiming cabinets, open up new business, reduce the cost of main business, reduce the charges of express delivery companies, and improve the customer experience. Typically, smart couriers are located in residential areas or around student residences, so they are ideal for advertising and advertisers; in addition, couriers can also add automatic payment services to increase customer convenience. 2) Since the size of the intelligent self-reporting cabinet is certain, there is a limit to the number of express delivery. The intelligent express cabinet can charge the corresponding storage fee according to the length of the package storage time, to improve the turnover rate of the self-reporting cabinet and make full use of the limited space.

5.3. Promote the common distribution model \(^{[11]}\)

The common distribution mode refers to establishing a distribution platform for different express delivery companies and e-commerce companies in the same region, and jointly investing on a common distribution network based on the principle of fairness. This distribution platform network includes the real-time status of each enterprise and Logistics information of express goods. Different distribution companies and e-commerce distribution departments can send packages to a unified distribution network for centralized sorting, tally, storage and distribution of a range of activities.

6. Building a “University City Integrated Distribution Platform”

6.1. "University City Overall Distribution Platform"

In the university town, the main staff consists of students, faculty, staff in the cafeteria, and staff in the stores around the school. According to the survey, most of the faculty and staff will choose direct delivery or pick-up at a specific pick-up point, and almost all students Select a specific pick-up point to pick up the goods, other people also basically choose a specific pick-up point to pick up the goods. In the university city area, the pick-up points are almost covered by the “four links and one”, there are a few SF pick-up points, according to the actual situation of the university city, you can set a small number of smart self-reporting cabinets, but so far, in the university city In the regional scope, the most economical distribution mode is the specific delivery point distribution mode. From the previous part of the optimization proposal, the common distribution principle can be extracted, and the scale benefits can be used to integrate the specific pick-up points existing in the university city

6.2. Construction of “Universal City Overall Distribution Platform”

6.2.1. Customer positioning of the platform The upstream customers of the “University City Integrated Distribution Platform” are express delivery companies and logistics companies, and the downstream customers are students and faculty members in the university city. The positioning of the customer is relatively clear. Therefore, the system for establishing the “Universal City Whole Distribution Platform” is relatively better.

6.2.2. Geographical location selection of the platform The integrated pick-up point is best to choose the area closer to the dormitory, which is convenient for customers to pick up the express delivery, save the delivery time and improve customer satisfaction. The site selection of the platform can be comprehensively analyzed and selected by the method of gravity. It can be selected
as the distribution point of the platform in the relatively spacious place of the dormitory park. On
the campus, most of the addresses in the campus are faculty and staff, and some intelligent self can
be built. With the delivery of containers, the model of “Universal City's overall distribution
platform” will be more abundant.

6.2.3. Platform business mode Platform Information System Construction---"University City
Integrated Distribution Platform" integrates and analyzes the information between the express
delivery enterprise and the final customer to solve various problems encountered in the "last mile"
delivery. The platform information service part can be divided into different modules according to
different dormitory parks of different schools, so that it is convenient to collect customer
information, and can use big data to analyze some shopping information of customers and predict
the quantity of future express goods, so as to ensure a certain storage space. Avoid the problem of
bursting in special periods.

6.2.4. Design of the platform 1) Integration In the city distribution site, the distribution of the
pieces in the university town is unified, and the individual delivery companies are no longer
integrated and integrated, but the classification of the items according to different school parks is
required. 2) Dispatch The recipient is notified by the information service platform jointly
established by the courier company. At the same time, as long as the customer has registered, the
information service platform can find the logistics information of the item according to the order
number. 3) Pick-up recipients pick up the pick-up number. Since each park has a centralized
distribution site, the same park's items are all at the same site, so you can take advantage of
economies of scale. Goods can be picked up by other pick-ups at the same time.

6.3 Optimize delivery routes using Travel Agent Problem (TSP)

6.3.1. Relevant principles Ant colony algorithm principle [12] Ant colony algorithm, also
commonly known as ant algorithm. When ants find food, they always find the best path from food
to nest, that is, the best path is also the shortest path.

Traveling Salesman Problem (TSP), often referred to as the Travel Salesman Problem (TSP), is
the most basic route problem. Generally speaking, the shortest path will be applied to this statement.
The traveler problem means a single problem. Travelers want to visit some locations to find the
shortest path from the starting point, visit each place, and then go back to the original point.
Although this principle is simple, if the number of places increases, the solution is no longer simple.
The first mathematical plan for the traveling salesman problem was proposed by Dantzig (1959) et
al. [13].

6.3.2. Calculation process based on MATLAB The process of solving the TSP problem by the
ant algorithm is as follows:
The following is a plan view of the university town taken through Baidu map, and then simplified into Figure 9 according to the actual plan to calculate the solution.

**Figure 2** TSP solution process

**Figure 3** Schematic diagram of the university city

- Coordinate acquisition method  
  The coordinate acquisition process of each region: use the MATLAB tool to read the image format of the map and establish the coordinates in MATLAB, and use the display coordinate function to read the coordinates of each region one by one and record. The detailed process is as follows:
  a. First open Matlab and put the map (renamed "ditu") into the folder that Matlab can read.
  b. Read the map l=imread('ditu.jpg');
  c. Display map imshow(l);
  d. Set the coordinates axis on;
  e. Display coordinate information impixelinfo;
  f. Record the coordinates of each area one by one.

- Coordinate results for each location
  A1 (300, 200)  A2 (300, 400)  A3 (700, 400)  A4 (0, 600)  A5 (300, 600)  A6 (700, 600)  A7 (0, 900)  A8 (400, 1000)  A9 (700, 1000)  A10 (0, 1300)  A11 (400, 1250)  A12 (400, 1150)  A13 (800, 1150)

- Experimental results and analysis
  Experimental results
Analysis of results

a. Left picture: reflects the shortest route map of the university city distribution after the traversal;

From the experimental results, it is convenient to read out the shortest route of the university city distribution:

$$A_1 - A_2 - A_5 - A_4 - A_7 - A_{10} - A_{11} - A_{12} - A_8 - A_{13} - A_9 - A_6 - A_3 - A_1$$

b. Right: Reflects the average distance and final optimal result of each ant's route during each iteration during the iteration of NC_max (the number of iterations, 50 in the experiment).

7. Summary and outlook

The “last mile” distribution phase of e-commerce express is the key to the entire logistics process. It is the only one that directly faces the customer in the entire logistics process. Therefore, in order to improve the quality of logistics services and reduce logistics costs, the “last mile” distribution pattern must be improved for existing problems. The main results of this paper are as follows:

1. Based on the background of problem research, analyze the current situation of the problem, and combine the existing research literature, analyze the existing basic model of "last mile" and various problems existing under various modes.

2. The second part of the problem for various models first proposes optimization opinions from a qualitative perspective. Again, taking Rizhao University City as an example, a new distribution platform is built—the university calls the overall distribution platform.

With the rapid development of e-commerce and the further analysis and optimization of the problems existing in the “last mile” distribution model, the cost of “last mile” distribution of e-commerce express delivery in China has declined. The "last mile" distribution model will continue to be optimized, and the distribution efficiency will continue to increase. There are still many shortcomings in the analysis of this article. If there is an opportunity, we will continue to study and contribute a little to the logistics industry in China.

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