



Design and Implementation of the Algorithm of E-commerce Logistics Cabinet Location Based on Big Data

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ABSTRACT

With the rapid rise of emerging industries such as Internet big data and mobile e-commerce, the express service industry has slowly grown up. Behind the constant changes in the express service industry, the industry's own disadvantages have gradually begun to appear, and the end distribution link of express logistics is also facing severe challenges. The logistics cabinet is also about to emerge under the background of this new era, and it will definitely become an important key point to solve the current plight of our country's express industry logistics terminal distribution. By studying reasonable and scientific express logistics cabinet placement management methods and models, it can solve the current terminal distribution difficulties and management problems in the development of our country's express logistics industry, reform traditional express delivery service methods, improve logistics services, and improve express delivery companies. The economic benefits of the company have very important reference value. This article aims to study the design and implementation of the location selection algorithm for e-commerce logistics cabinets based on big data. First, it analyzes the difficulties faced by logistics distribution, explains the importance of logistics cabinets in solving the difficulties of express end distribution, and elaborates the choice of express delivery logistics cabinets. Then, through extensive research on the service radius problem in service public facilities, the model of the location of the logistics cabinet is defined and the model is analyzed. Finally, the logistics cabinet location algorithm is applied to the logistics cabinet placement process. The research results show that the average daily utilization rate of the logistics cabinet in a stable state is more than 80%, which can provide a better user experience and maintain a certain elastic growth. Space has excellent economic benefits.

Keywords: *Big Data, E-commerce, Logistics Cabinet Location, Location Algorithm*

1. INTRODUCTION

Riding on the east wind of e-commerce development, our country's logistics industry has been able to grow rapidly [4][7]. However, our country's logistics industry is still in a critical period of transition from traditional business models to informatized services. Only when the entire logistics network is informatized and intelligently upgraded can the concept of "smart logistics" be truly realized [1].

The rapid growth of the logistics industry has gradually become a key sunrise industry in contemporary our country, but at the same time as it continues to grow and develop, the difficulties that the logistics service industry needs to face in the

distribution link have further emerged [2][5]. In recent years, our country's transportation and logistics service industry has actively developed various aspects of technology such as the construction of Yuncang and other trunk transportation networks, and applied them in daily management; at the same time, the logistics industry is also mainly engaged in warehousing. The overall layout and trunk line infrastructure have been improved in many aspects, and considerable benefits have been achieved. However, with the rapid growth of logistics service volume, this also makes logistics companies begin to pay attention to the difficulties faced by logistics terminal distribution [3][10].

This article mainly analyzes the difficulties faced by the logistics distribution field, the main factors affecting the location of logistics cabinets, and the principles of

logistics cabinet location selection, and explores a set of problematic research models suitable for logistics cabinet placement and location selection. Combining with the actual situation of the current target area, the model is constructed and empirical research is carried out, which provides a decision-making basis and support for the current issue of logistics cabinet placement and location selection in our country.

2. PROPOSED METHOD

2.1. Difficulties Faced by Logistics Distribution

2.1.1. Difficult to enter the city

At present, most of the distribution outlets of chain stores, supermarkets and various distribution service centers are generally there to store and receive goods directly during the day, and their geographic location and other places are generally due to their location. In other words, it is a place with relatively high traffic pressure or an important area. It is also very likely that it is because they lack the basic supporting facilities, space and environmental conditions and sufficient personnel resources required to realize and accept these goods. Trucks cannot be emergency parking and transportation loading and unloading in accordance with the requirements of the specification, which may greatly reduce the efficiency of logistics and transportation of enterprises, and some enterprises may also produce illegal activities such as pass rent-seeking. At the same time, some cities and places in central areas of the country have also introduced some preferential transportation policies such as limited time, a few hours, or limited roads for large freight vehicles. Many large freight vehicles have to choose to take risks on their own or make detours, able to reach the destination of material distribution [6].

2.1.2. Difficult to dock

Since the 21st century, the per capita demand for express delivery has increased, and the economic growth of the express service industry has also become very rapid. However, due to the implementation of the policy of restricted truck transportation in major cities, some companies have to choose to use minivans. Modified vehicles and electric tricycles, and other more flexible vehicles, distribute the logistics of large cities by mixing people and goods. However, these transportation vehicles are all standard trucks, which are used as logistics distribution and transportation tools, not only their work efficiency is relatively low, but also easy to cause safety hazards.

2.1.3. Difficulty in cooperation

At present, in most of the large and medium-sized cities in rural areas and regions in our country, the value-added business operation mode of logistics companies is still relatively simple, but according to the needs of their own enterprises, they provide services according to the needs of customers within their business scope (Such as distribution, warehousing, transportation, etc.), there are few value-added businesses, and there is a lack of innovation in profit models [8][9]. At the same time, due to the lack of in-depth communication and cooperation between enterprises and other customers, and between enterprises and other companies, they cannot share and communicate information and resources with each other, and cannot establish long-term and reliable cooperative relations with others, which seriously reduces the company.

2.2. Factors Affecting the Location of Logistics Cabinets

2.2.1. Social environmental factors

Social environmental factors mainly include economic development level, population size, shopping habits, income status, age composition, etc. Generally speaking, there are more online shopping in areas or business districts with a relatively high level of economic development than areas or business areas with a low level of economic development: the number of people is the basis for market growth, and the greater the number, the operational benefits that may be brought about Higher. At the same time, a person's shopping preferences can also affect the use of logistics cabinets. Although the development of e-commerce in today's society is in full swing, it does not prevent some people from having a soft spot for supermarkets and retail stores; and consumers' household income status can also restrict consumer behavior, and the age composition of consumer groups will also show different enthusiasm for online shopping.

2.2.2. Economic benefit factors

Economic benefits include construction costs, facility utilization, logistics and distribution, development potential, etc. As we all know, the construction of the logistics cabinet is to consolidate the original customers and open up new markets for the company to bring higher economic benefits. Therefore, the economic benefits brought by logistics cabinets are undoubtedly an important consideration for the success of its construction. Generally speaking, as a one-time hardware facility, a certain production cost will be incurred during the launch and operation of the logistics cabinet. On the premise of pursuing the maximum

economic benefits, reasonable cost control is also a key issue that the company must consider. Once the construction of the logistics cabinet is completed, its facility utilization is an intuitive manifestation of its economic benefits, and the distribution cost from the logistics distribution center to the location of the logistics cabinet is also an important factor affecting the final economic benefits. In addition, the development potential of the location where the logistics cabinet is located will have an inevitable impact on future economic benefits.

2.2.3. Environmental factors of infrastructure construction

Generally speaking, the infrastructure environment includes traffic conditions, infrastructure integrity, and usable area. Among them, the traffic condition is another key factor that affects the success of the location of the logistics cabinet. The accessibility and convenience of traffic will directly affect user behavior and logistics costs. The completeness of infrastructure includes not only road facilities but also the provision of basic service functions such as power supply and network in the area. These will not only directly affect the operation of logistics cabinets, but also affect the lives of nearby residents. At the same time, the usable area will have the most direct impact on the construction of the logistics cabinet and the capacity setting.

2.2.4. Government policy factors

In our country, the government policy of a region not only plans the blueprint for the development of the city, but also plays a certain guiding role in the development of enterprises. The policy factors we generally refer to include factors such as current policy implementation and long-term development planning goals.

2.3. The Location Principle of Logistics Cabinet

2.3.1. Location target of logistics cabinet

(1) Meet customer needs: In the layout of the logistics cabinet, we should first consider the needs of customers. While being able to solve customer needs, we must also fully consider the acceptance of customers. We need to be able to enable our customers to find and use logistics cabinets. This inevitably needs to select a solution to cover all customers in the target area, and on this basis, go as much as possible to the closest customer; at the same time, according to the single specification of the logistics cabinet and its overall size and other factors, it is required Make a reasonable design so that the customer's operation process when receiving the logistics cabinet express is smooth, attract

customers and cultivate their usage habits by receiving the logistics cabinet express in a reasonable way.

(2) Meet the economic benefits: The business goal of an enterprise is to obtain certain economic benefits in the production and business activities of the enterprise within a certain period of time. As a new type of product, the logistics cabinet needs to create certain social and economic benefits for the enterprise itself to maintain its long-term and healthy survival and development. Therefore, we need to target the target location and the level of socio-economic development of the location when the logistics enterprise launches. Based on comprehensive considerations, generally speaking, areas with relatively high population densities have relatively high economic and social activities and production costs, so priority can be given to choosing such areas under the conditions and premises that other economic conditions can be met.

(3) Meet the coordinated development: Although the logistics cabinet may be said to be a brand-new logistics distribution service model, it still must play an important functional role in the system. Therefore, in its setting, we still need to fully consider how to achieve the same area. Various distribution service facilities such as distribution centers, distribution centers and temporary collection and delivery stations within the distribution center coordinate and develop together, and play a role together.

2.3.2. Basis for location of logistics cabinet

(1) In line with the overall urban planning: The logistics cabinet is a kind of equipment that can be used by the public. It needs to conform to the overall plan of a city, that is, it needs to be set up according to the total economic volume and population of a city, so as to meet the population of a city to the greatest extent.

(2) Comprehensive consideration of regional demand and distribution differences: Due to the large differences in the development of express delivery economy in different areas of the city, there are also large differences in the demand for express delivery in different areas of the city. The demand is large, and the demand for express delivery is relatively small in areas relatively far from the urban area and relatively small population density. Therefore, the setting of the logistics cabinet is to make specific decisions based on the different needs of customers in different regions to ensure that each customer's pick-up path can be evenly distributed.

(3) Consider traffic conditions: In the daily operation of logistics cabinets, generally speaking, we will find that many express items are transported from a logistics center to a self-pickup cabinet called express delivery. That is to say, there are still many pickers who go every day. The express mail is picked up there, and the traffic

volume of vehicles and staff near the logistics cabinet is relatively large. Therefore, it is necessary to ensure that the surrounding area can have a more convenient transportation environment as much as possible, and to ensure the safety of express delivery and collection.

3. EXPERIMENTS

3.1. Establishment of the Logistics Cabinet Location Model

In a given logistics cabinet network $g(v, a)$, the direct influence factors on service quality are fully considered, based on the maximization of the total coverage of the global radius of the logistics cabinet service and the maximization of the benefit of location selection. Double goals, seeking the best understanding among them, the results of the constructed model are as follows:

Objective function:

$$(P_1) \max \sum_{i \in I} \sum_{j \in J} w_i f(r_{ij}) x_{ij} \quad (1)$$

Restrictions:

$$\sum_{j \in J} x_{ij} = 1; \forall i \in I \quad (2)$$

$$\sum_{j \in J} y_j = p \quad (3)$$

$$\sum_{j \in J} x_{ij} \leq w_i \quad (4)$$

In the problem P_1 , the objective function (1) is used to describe the maximum coverage of the service radius of the target location and the maximum benefit of the target location; Restrictive conditions (2) the code description indicates that all required locations of each logistics cabinet must consist of only the facilities or locations owned by one logistics cabinet to provide services to other places. By default, when all the required locations are contained or covered by the service areas of other multiple logistics cabinets, select a location or the nearest logistics cabinet to directly receive services from other places; the constraint condition (3) code is used to ensure that there are p logistics cabinet equipment points; the constraint condition (4) represents to ensure that the service volume provided by each logistics cabinet equipment point for each requirement point is not lower than its actual requirement.

3.2. Model Analysis

The location model constructed as described above is a mixed integer programming model, in which the method of solving the problem is the np-hard problem. With the increase in the number and scope of the problems or the expansion of the constraints, the importance and complexity of the required understanding of the model will gradually become an exponential growth. Therefore, in solving the model in

actual applications, most people will choose to use heuristic algorithms to design and solve the model in a targeted manner. Therefore, this article specially researches and designs based on the sub-gradient algorithm and Lagrangian relaxation.

4. DISCUSSION

The logistics cabinet is the core function of the logistics platform. It has always been committed to providing various businesses such as specialized logistics collection and item storage for the majority of owners and customers, and providing a centralized and high-efficiency for the majority of express companies and e-commerce platform customers. The logistics cabinet platform mainly includes three functional modules: (1) the logistics cabinet information system; (2) the express app that provides delivery services; (3) the client app that provides pickup services.

4.1. Core module of logistics cabinet location

(1) Functional module design: The logistics cabinet information system is the carrier of Fengchao's logistics cabinet informatization and intelligent services. The main functions are logistics cabinet location selection, logistics cabinet supervision and logistics cabinet data analysis, etc. And the core modules related to the logistics cabinet location algorithm are shown in Figure 1:

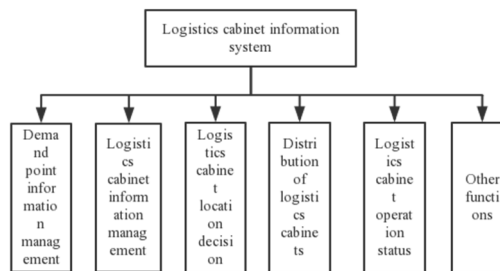


Figure 1. Schematic diagram of core function modules

(2) Core module design: The logistics cabinet location decision module is the core function realization part of the logistics cabinet location algorithm. It is based on Matlab for algorithm modeling, and then implements background calls through Java, and finally displays the processing results on the page through Jsp. The processing flow is shown in Figure 2:

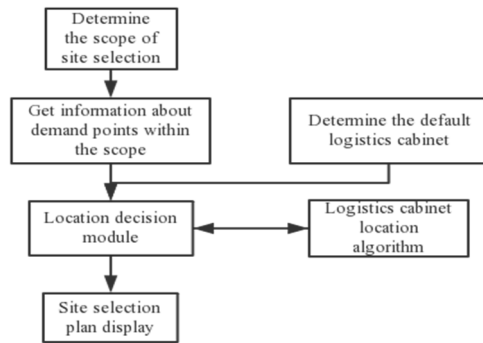


Figure 2. Site selection module decision processing flow

4.2. APP side

(1) The courier enters the recipient's phone number, waybill number (can scan the code), courier company, select cabinet, cabinet number, etc., and send the express message for dispatch.

(2) When the courier submits the express delivery service, the user receives a corresponding message reminder. The user only needs to find the corresponding logistics cabinet to scan and pick up the shipment.

(3) Analysis of utilization rate: Through the statistical analysis of the operational data of logistics cabinets in a certain area from September 2020 to March 2021, the utilization rate of logistics cabinets changes, as shown in Table 1:

Table 1. Changes in utilization

	Utilization rate
202009	51%
202010	63%
202011	81.50%
202012	85%
202101	83%
202102	82%
202103	82.50%

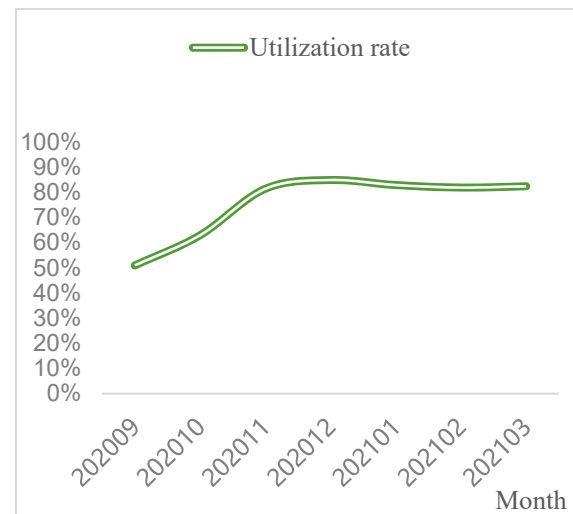


Figure 3. Changes in utilization

It can be seen from Figure 3 that the utilization rate of logistics cabinets was low at the initial stage of launch. As time changes, the location of logistics cabinets has gradually become known to users and the express industry, and the utilization rate has also increased significantly, and then gradually stabilized. At the same time, statistical analysis shows that the average daily utilization rate of logistics cabinets in this area is above 80% in a stable state, which can provide a better user experience, while maintaining a certain amount of flexible growth space, and has excellent economic benefits.

5. CONCLUSIONS

The widespread popularity of big data has promoted the rapid development of our country's Internet e-commerce, but the current environment and pressure of our country's logistics distribution have severely restricted the survival and development of other logistics companies in our country in the Internet distribution process, and directly affected users' delivery services. At the same time, the deployment of an intelligent logistics cabinet has gradually developed into a technology and mainstream solution that people need to accept and adopt to open up the difficult situation. However, the delivery of logistics cabinets is a one-time delivery, which is difficult to change. Therefore, only scientific and reasonable site selection and investigation and research on logistics companies' stores can truly achieve the effect of saving time and effective use of human resources, and improving user satisfaction.

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