Intelligent Logistics Path Optimization and Real-Time Dispatching System Design Based on Big Data Analysis

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Abstract. The advancement of intelligent technology has brought the technological foundation for path optimization and real-time scheduling systems to the logistics industry, enabling more accurate and efficient order delivery. In order to further optimize the working conditions of intelligent logistics, this article proposes the technical tool of big data analysis. Moreover, this article also conducted a comparative experiment based on the method in this article and other mainstream methods at the end. In the comparative experiment on delivery time for users in a specific area, the average delivery time of the former was 10.82h, while the average delivery time of the latter was 14.81h. The obvious experimental gap fully reflects that big data analysis technology can well carry out intelligent logistics path optimization and real-time dispatch system design.

Keywords: Big Data Analysis, Intelligent Logistics, Route Optimization, Real-Time Scheduling, Order Allocation Model

1 Introduction

With the advancement of smart technology, the logistics industry has gradually evolved into smart logistics. Through technologies such as the Internet of Things and artificial intelligence, more efficient task allocation, company management and delivery vehicle control have been achieved. In order to further improve the work efficiency of intelligent logistics, this article proposes a big data analysis method.

This article begins with a comparison between smart logistics and traditional logistics, demonstrating the advantages of smart logistics as a progressive technology. This article then analyzes in detail the principles of path optimization and real-time dispatching systems in intelligent logistics, and uses big data analysis technology to establish a comprehensive and complete order allocation model to help intelligent logistics achieve more accurate and faster allocation work. Finally, this article conducts two

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comparative experiments to verify the effectiveness of this method from the perspectives of delivery time and customer satisfaction.

2 Related Work

In order to promote the development of the logistics industry, smart logistics based on smart technology has begun to have an impact on the industry. Bhargava A proposed that the Internet in today's era had deeply affected the demand and supply of materials, so it was crucial to establish low-cost and fast supply chain logistics [1]. Tran-Dang H proposed to realize "ubiquitous Internet" based on Internet of Things technology, thereby relying on this method to steadily obtain reliable and secure real-time data to help the operation of smart logistics [2]. Saglietto L believes that current smart logistics can be improved through the sharing economy [3]. The technical basis of smart logistics is actually path optimization and real-time scheduling systems. As Gul F pointed out, path planning can be used to solve the routing problems of aircraft in three dimensions: ground, air and even underwater [4]. Di Caprio D proposed to use a new ant colony algorithm to solve the shortest path problem of different types of fuzzy weights [5]. These studies have shown that intelligent logistics based on path optimization and real-time scheduling systems has the ability to accurately deliver orders. However, it is obvious that intelligent logistics is facing the current situation of market expansion, and there are still many problems that cannot be solved.

In order to meet this demand, this article believes that big data analysis technology can be tried. Negri E pointed out that the development of digital technology provided the possibility of collecting and analyzing large amounts of field data in real time [6]. Punia S K believes that with the continuous growth of big data, large amounts of data have gradually become the trigger for many changes in human lifestyles [7]. Kowarski K A proposed that automation technology should be used as much as possible to improve the efficiency and reproducibility of massive data acquisition [8]. Motamedi F proposed to use a random forest algorithm to accelerate big data analysis, thereby improving the prediction accuracy and interpretability of big data analysis systems [9]. Sun B proposed to use big data analysis technology in intelligent logistics to improve the problem of unbalanced and insufficient business development [10]. It is not difficult to see that big data analysis technology has the potential to be used in intelligent logistics, so this article will focus on this point.

3 Method

3.1 Advantages of Intelligence in the Logistics Industry

Song Y proposed to use intelligent technology to improve logistics efficiency under the current "Internet +" background [11]. Intelligent technologies in the logistics industry include emerging technologies such as the Internet of Things, artificial intelligence, and big data analysis. For example, Li HR built an intelligent Internet of Things system

based on Internet of Things technology [12]. Moreover, he also conducted a comparative analysis on the differences between smart logistics and traditional logistics.

Table 1. The difference between smart logistics and traditional logistics

Difference	Intelligent logistics	Traditional logistics
Informationization degree	Real time collection, transmission, and processing of information.	Relying on manual operations and paper documents.
Supervise	Capable of real-time monitoring.	Lack of real-time monitoring.
Automation level	Introducing automation and robotics technology.	Mainly manual operation.
Approval rating	94.62%	5.38%

Table 1 shows the difference between smart logistics and traditional logistics. Yan H J took the quality of smart logistics web pages in Lanzhou Logistics Park as the discussion goal and pointed out that web orders, as a service provided by smart logistics, bring convenience to customers [13]. This article also conducted a questionnaire survey on a certain community to explore the residents' preferences for smart logistics and previous traditional logistics. In the end, 94.62% supported smart logistics, while only 5.38% supported traditional logistics.

3.2 Path Optimization and Real-Time Scheduling System Design

The most important thing in logistics is the transportation of goods, so Zhao HT proposed to use path optimization algorithm to realize scheduling work in vehicle-mounted heterogeneous networks [14]. In order to further optimize the vehicle path arrangement, Sun X Q proposed an improved genetic annealing algorithm [15].

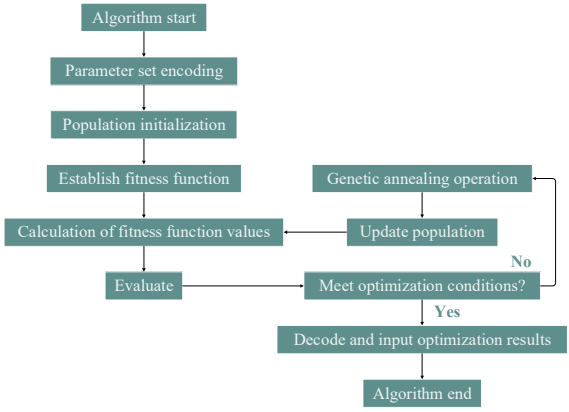

Fig. 1. Improved genetic annealing algorithm process

Figure 1 shows the process of improving the genetic annealing algorithm. This is also reflected in the study of Roger Lloret-Battlle, who proposes to use machine

learning to learn and master the algorithms for intelligent logistics sorting, so as to establish a more standardized and intelligent logistics system [16]. In order to maximize logistics efficiency and promptly correct some scheduling errors, real-time scheduling is extremely important. Ye H L proposed to use the improved ant colony algorithm to carry out smart logistics scheduling planning [17]. Let S be the starting point, E be the end point, L_{SE}, t_{SE} be the distance and time from the starting point to the end point respectively, n be the number of grids on the path from the starting point to the key point, and let m be the number of grids at the turning point, and ω is the angular velocity and l_n is the unit length of the grid, then the path cost function L_{km} of the basic ant colony algorithm is:

$$L_{km} = L_{SE} = n * l_n \tag{1}$$

The path cost function 1 of the improved ant colony algorithm is:

$$L_{km}' = t_{SE} = \frac{(n-1) * l_n}{v_s} + \frac{m * \pi}{2 * \omega} \tag{2}$$

3.3 Order Allocation Based on Big Data Analysis

With the further advancement of urban construction, market demand and the entire logistics scale system are constantly expanding. Therefore, Zhu X Q and Xu L R proposed that big data analysis technology can be used to solve the increasing needs of the logistics industry [18-19]. The specific way to solve this demand problem is to establish a huge customer database, and then rely on big data analysis technology to manage and distribute the order data of these customers. For this reason, Liu H designed an e-commerce logistics order allocation software based on big data [20].

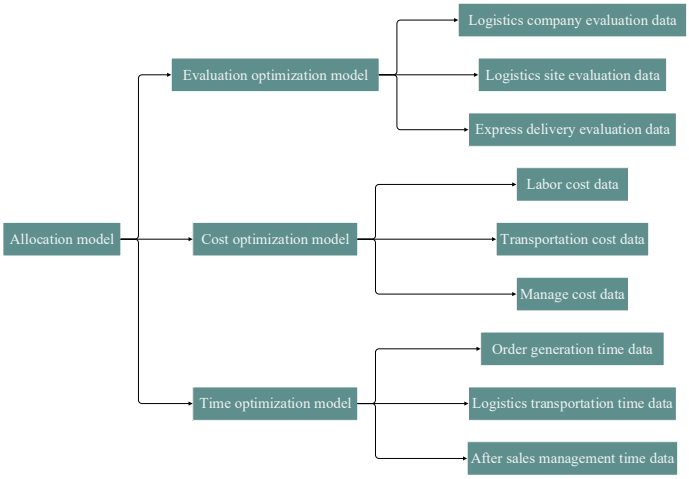

Fig. 2. Order allocation model based on big data analysis

Figure 2 shows the order allocation model based on big data analysis. In this model, there are three sub models. These three sub models are evaluation optimization model,

cost optimization model, and time optimization model. Due to the diversity of data sources, the information sources for evaluation optimization, cost optimization and time optimization are different, so necessary data pre-processing is also required to combine these complete data and make the next decision.

4 Results and Discussion

4.1 Customer Satisfaction Comparison Experiment

The specific experiment method is that this article will select a certain logistics system to conduct two stages of testing before and after. The first stage is set as the control group, which adopts a more basic and conventional intelligent logistics system. The second stage is the experimental group, for which the complete order allocation model is loaded. The logistics systems in these two stages perform several distribution tasks respectively, and finally collect customer satisfaction receipts from these target customers.

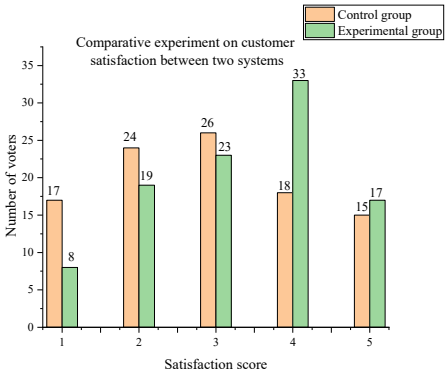

Fig. 3. Customer satisfaction comparison experiment

The results of the customer satisfaction comparison experiment are shown in Figure 3. This article sets five customer satisfaction rating indexes from 1 to 5 in the survey response to reflect the customer's degree of satisfaction with the delivery work. There are more votes in the high scoring range of the experimental group. This fully demonstrates that logistics systems based on big data analysis can indeed bring a better experience to customers.

4.2 Delivery Time Comparison Experiment

Men F proposed to use planning robots based on the Internet of Things to realize the design of intelligent logistics systems [21]. In order to further verify whether this method is innovative, this article will compare it with this method. The specific method is to use two sets of logistics systems, one of which uses the method in this article as the experimental group, and the other uses this method as the control group. Then the two

systems are ordered to issue 50 delivery instructions each within the designated area (the distance between the delivery targets is not large), and their respective delivery completion times are calculated.

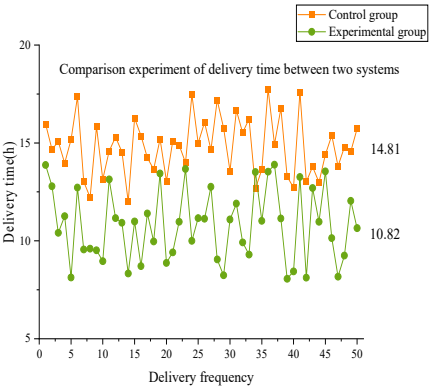

Fig. 4. Delivery time comparison experiment

The results of the delivery time comparison experiment are shown in Figure 4. It can be seen that the delivery time curve of the experimental group basically hovers at the lower end of the control group, and the specific average delivery time performance gap is also obvious. The average delivery time of the experimental group was 10.82h, while the average delivery time of the control group was 14.81h.

5 Conclusion

The core idea of this article is to compare intelligent logistics with traditional logistics to derive the technical foundation that makes intelligent logistics advantageous, that is, a path optimization and real-time dispatching system that can accurately provide short routes, and then use big data analysis technology to establish an order allocation model to further improve the efficiency of smart logistics. However, this article also has some shortcomings, that is, in the experiment, there are errors caused by other variables. In general, the continuous development of intelligent technology will radiate many modern industries, and the logistics industry is one of them. This will further boost the Internet economy and help future market development.

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