Research on Decision-making Method of Logistics Distribution Vehicle Scheduling Based on Artificial Intelligence Platform

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Abstract: The prosperity of e-commerce has promoted the vigorous development of the logistics and distribution industry, and the problem of logistics vehicle scheduling has become increasingly prominent. To this end, the issue of vehicle scheduling in logistics distribution has become the focus of attention in the logistics industry. Based on this, based on the artificial intelligence platform, the paper establishes the management framework of the logistics distribution vehicle scheduling decision system, and determines the specific business process and operation mode according to the dynamic and responsible nature of the dispatched tasks. At the same time, the paper uses the hybrid intelligent algorithm mathematical model to optimize the vehicle scheduling problem in the logistics distribution center. The experimental results show that the proposed method can coordinate the vehicle transportation path and vehicle loading.

1. Introduction

At present, modern logistics has become the third important source for enterprises to create profits in addition to reducing material consumption and increasing labor productivity. It is also an important way for enterprises to reduce operating costs and improve product market competitiveness. As the terminal of the logistics system, distribution plays a very important role in meeting the needs of logistics customers, and is the key to the profit increase of logistics enterprises. Nowadays, traditional manual operation and simple computer processing no longer meet the increasing demands of the society for logistics distribution business and distribution network [1]. Only by combining the advantages of both human and computer, the logistics distribution information platform is speeded up and intelligent. In order to achieve efficient and high-quality distribution services, and to improve logistics economic benefits, achieve scientific and reduce logistics costs, research on intelligent information systems for logistics distribution is very meaningful. Based on a series of problems such as unreasonable resource utilization, high operating cost and poor service quality in manual logistics distribution vehicle scheduling, in order to improve the efficiency and resource utilization of logistics distribution enterprises, this paper uses hybrid intelligent algorithm. Mathematical model, with the help of powerful system computing functions in the artificial intelligence platform, to realize the visualization effect of data processing, optimize and dispatch logistics and distribution vehicles.

2. Artificial intelligence platform business process and framework

2.1 Management framework of the distribution center vehicle dispatching system

The distribution center vehicle dispatching system is a sub-function module in the artificial intelligence distribution platform. Its main function is that the distribution center generates a distribution task based on the cooperation between the enterprises in the artificial intelligence distribution platform, and generates the vehicle quickly and intelligently. A scheduling scheme to organize and control the process of vehicle delivery. The overall structure of the distribution center vehicle scheduling system management framework is shown in the figure [2-3].

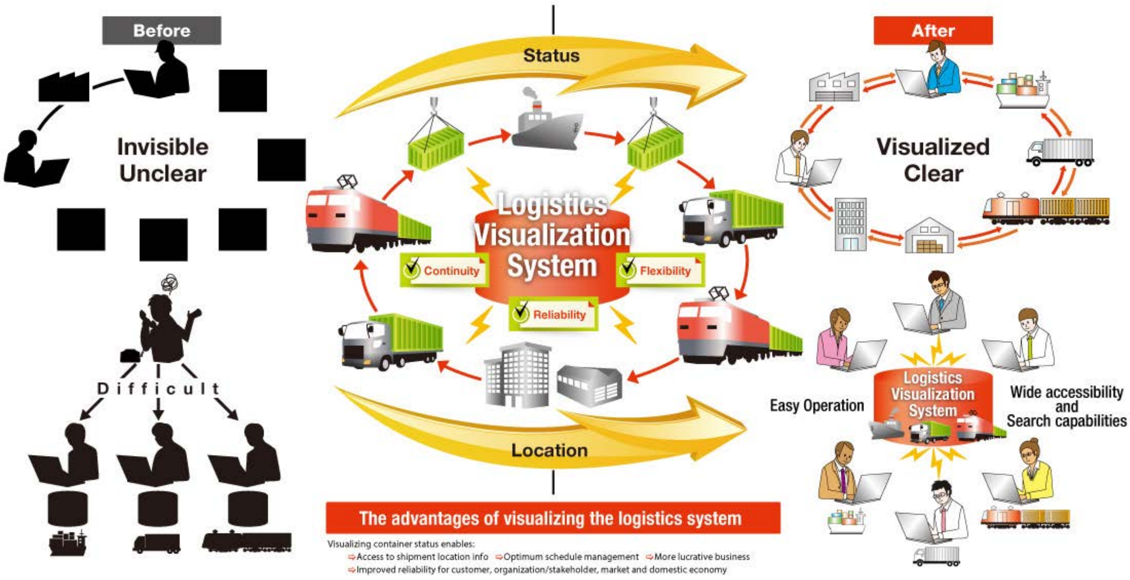

Figure 1. Structure of the management framework of the distribution center vehicle dispatching system

The customer submits the distribution requirements to the artificial intelligence distribution platform through the computer and other equipment, and the combination optimization function module of the artificial intelligence distribution platform realizes the matching of the user distribution requirements with the resources of the distribution center, and the customer's demand and the equipment of the distribution center. The resource information is transmitted to the intelligent dispatching system. After the system processes, the results are fed back to the customer and the distribution center, so that the customer can track the cargo situation at any time and the distribution center can organize the distribution activities efficiently. The specificity of the distribution center vehicle dispatching system the process is shown in the figure.

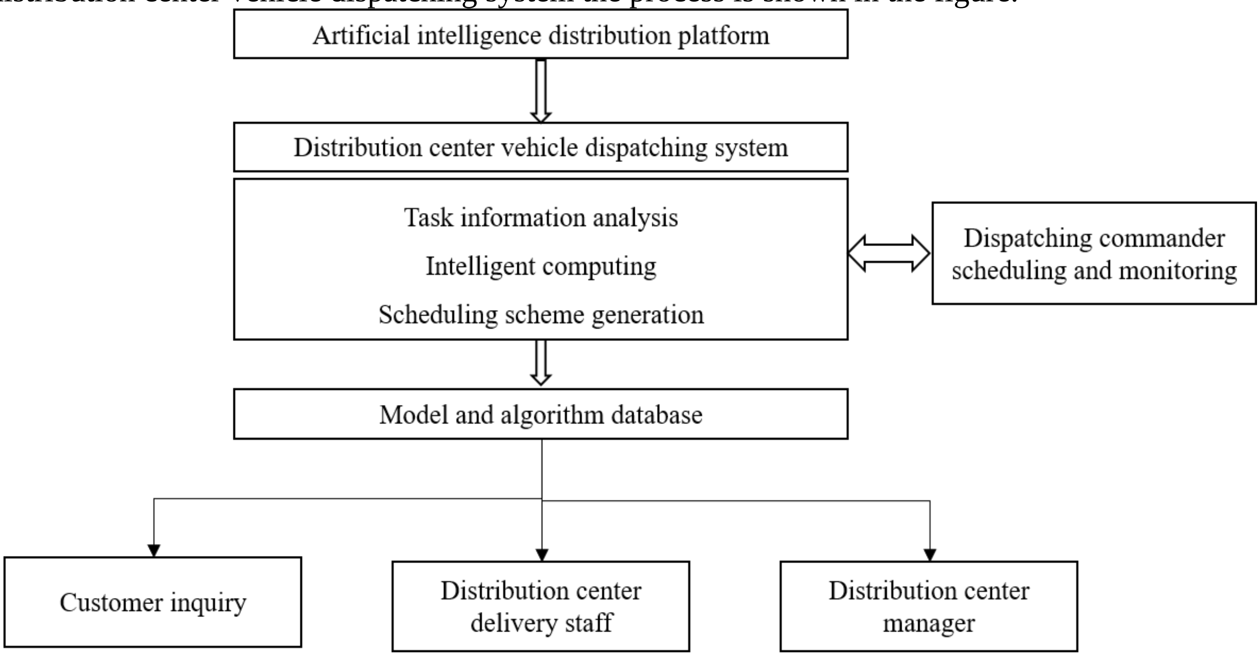

Figure 2. System information delivery process

2.2 Vehicle dispatching process

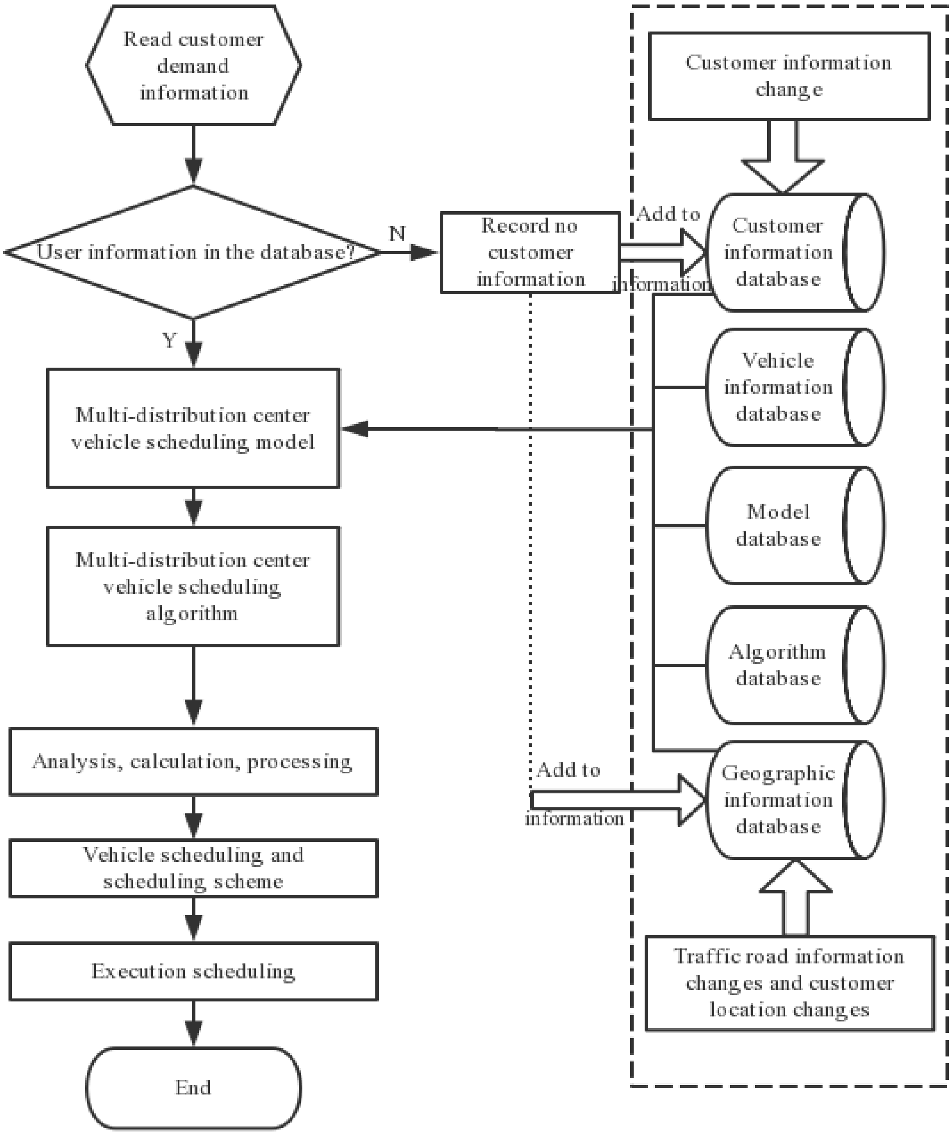

Figure 3. System operation process

The distribution center vehicle dispatching system first obtains the customer's demand information through the cloud distribution platform, determines the customer's type and whether it is known. In order to ensure the high efficiency of the delivery, it must ensure that the customer information is updated at regular intervals. The shorter the time interval, the better; then, according to the various databases in the system, the distribution tasks are analyzed to select the appropriate vehicle scheduling model and solving algorithm. After analysis, calculation and processing, the specific scheme of vehicle scheduling is generated and passed through the vehicle. The dispatch center communicates to the driver of the delivery vehicle in the distribution center to deliver the goods required by the customer in a timely and accurate manner according to the detailed distribution plan and route. The main business process is shown in the fig.3.

3. Vehicle scheduling decision model construction

3.1 Vehicle scheduling optimization objectives

The vehicle scheduling problem is to select a certain target as the optimization target under the condition of satisfying certain constraints, and realize the total distribution cost (generalized distribution cost, such as delivery time, total cost, vehicle required, etc.) is optimal [4]. The total distribution cost is generally expressed as the minimum total cost, that is, the sum of the expenses of the vehicle to complete the delivery task is the smallest, such as the vehicle enabled fixed fee, the vehicle running cost, the vehicle waiting fee, the vehicle service fee, the vehicle penalty fee, etc.; The number of vehicles required is the minimum total number of vehicles required to complete all delivery tasks; the minimum total distance is the minimum total length of the vehicle path for completing all delivery tasks; the minimum service time is the minimum total delivery time for all delivery tasks, and the delivery time generally includes the vehicle travel time, Waiting time, service time and delay time.

3.2 Scheduling decision model

The method of quantitatively studying logistics distribution costs by establishing mathematical models can be summarized into three categories: vehicle flow model, material flow model and set coverage model. Considering the starting point when modeling, most models can be seen as deformations and combinations of these three models. The vehicle flow model is generally used when the fixed cost of a vehicle is higher than the driving cost. The vehicle scheduling problem used in this paper is the vehicle flow model.

The mathematical model of logistics distribution vehicle scheduling problem can be described as: the vehicle is issued by the distribution center, and each customer is delivered according to time or other requirements. After the vehicle completes the delivery, the vehicle returns to the distribution center, and each customer can only be carried out by one vehicle. Service and service only once, it is required to optimize the vehicle travel path under the constraints (such as load constraints, time constraints, mileage constraints, etc.), so that the optimization objectives (cost, distance, number of vehicles, etc.) for completing the distribution are minimized. The mathematical model of logistics vehicle scheduling problem is the target planning model. Its structural characteristics are generally divided into the constraints related to the number of vehicles, vehicle models, load, constraints related to the distribution loop, variable value setting, constraints related to the time window, and others. Constraint.

(1) Vehicle scheduling model with load constraints

The vehicle scheduling problem can be divided into non-full-load vehicle scheduling problems and full-load vehicle scheduling problems according to the loading task situation. The problem of non-full-load vehicle scheduling requires that each customer's demand is less than the vehicle's load, and one car can deliver goods to one or more customers at the same time. Most of the time, a task can't just fill the entire car, which often results in a low vehicle loading rate. In the full-load vehicle scheduling problem, the customer demand is not less than the vehicle's load, and each task needs to be loaded at full load [5]. The delivery process requires multiple vehicles to be fully loaded, and there is a situation where the last vehicle is not fully loaded. At present, the research on vehicle scheduling problems is mainly based on non-full-load vehicle scheduling problems. The decision variable expression is as follows:

$$x_{ijk} = \begin{cases} 1; \textit{Vehicle k is driven by customer i to customer j} \\ 0; \textit{other} \end{cases}$$
$$y_{ik} = \begin{cases} 1; \textit{Customer i's delivery task is completed by vehicle k} \\ 0; \textit{other} \end{cases} \tag{1}$$

The following is a vehicle scheduling model for non-full-load vehicle scheduling problems.

$$\begin{aligned}
&\min z=Fm+\sum_{i}^{n}\sum_{j}^{n}\sum_{k}^{m}c_{ijk}d_{ij}x_{ijk}\\
&s.t:\\
&\sum_{i=1}^{n}y_{ik}q_i\le Q,\quad \sum_{i=1}^{n}y_{ik}=1,\quad \sum_{i=1}^{n}\sum_{i=1}^{n}x_{ijk}d_{ij}\le L_k,\quad i=1,\dots,n;j=1,\dots,n;k=1,\dots,m\\
&\sum_{k=1}^{m}y_{ko}=m,\quad \sum_{i=1}^{n}x_{ijk}=y_{kj},\quad \sum_{j=1}^{n}x_{ijk}=y_{ik},\quad i=1,\dots,n;j=1,\dots,n;k=1,\dots,m\\
&x_{ijk}*\left(1-x_{ijk}\right)=0,\quad y_{ik}*\left(1-y_{ik}\right)=0
\end{aligned}\tag{2}$$

Where: F is the fixed cost of the vehicle, m is the number of vehicles, c_{ijk} is the unit mileage cost, d_{ij} is the distance from customer *i* to customer *j*, q_i is the customer demand, Q is the vehicle load, L_k is the maximum travel distance of the vehicle; The conditions are load constraint, demand customer corresponding to a vehicle completion task constraint, vehicle maximum travel distance constraint, each customer can get the vehicle's delivery task constraint, the relationship between the two variables, the decision variable is 0-1 constraint.

(2) Vehicle scheduling model with time constraints

The time constraint problem can be divided into three types: hard time window constraint, soft time window constraint and mixed time window constraint. The hard time window constraint model gives a large penalty M value for the inability to arrive within the specified time, thereby reducing its fitness value; the soft time window constraint model is for the delivery that cannot be delivered within the specified time. Penalty, the penalty value depends on the difference between the arrival time and the specified time; the mixed time window model is for the segmentation process that cannot be delivered within the specified time, and the soft time window problem is processed within the acceptable time range, which is more acceptable. The time range is handled by hard time window problems [6].

Hard time window problem penalty function setting: The vehicle must arrive within $[e_i,l_i]$ time, otherwise it will be given a larger penalty value M. The following is a vehicle scheduling model with hard time window constraints:

$$\min z=Fm+\sum_{i}^{n}\sum_{j}^{n}\sum_{k}^{m}c_{ijk}d_{ij}x_{ijk}+M\sum_{i}^{n}\left(\left(\max\left(e_i-s_i\right),0\right)+\max\left(s_i-l_i\right),0\right)\tag{3}$$

Need to add time window constraint equation:

$$\begin{aligned}
&t_i+T_i+t_{ij}+\left(1-x_{ijk}\right)T\le t_j\\
&e_i\le t_i\le l_i, i=1,\dots,n
\end{aligned}\tag{4}$$

Among them: t_i is the time when the delivery vehicle arrives at the customer *i*, T_i is the time taken to load and unload the goods at the customer *i*, t_{ij} is the time taken by the vehicle from *i* to *j*, and T is a constant large enough.

(3) Vehicle scheduling model with mileage constraints

A realistic source of mileage constraints is the vehicle tank volume limit. There is also an economic explanation: the vehicle will charge a fuel surcharge after driving a certain mileage. Its mathematical model has been explained in (2).

(4) Vehicle scheduling model with minimum carbon emission constraints

The vehicle's carbon emissions are calculated by the effective work of the vehicle's engine, as follows:

$$\min c\sum_{r\in R}\sum_{(i,j)\in Arc}\left(a_{ij}d_{ij}\omega z_{ijr}+a_{ij}f_{ijr}d_{ij}\sum_{k\in N}z_{0kr}+d_{ij}\beta v^2 z_{ijr}\right) \tag{5}$$

Indicates that the sum of carbon emissions from all vehicles $r\in R$ effective work in a planning cycle is the smallest; where factor c is the carbon footprint of the engine work (unit: J); $a_{ij}d_{ij}\omega z_{ijr}+a_{ij}f_{ijr}d_{ij}\sum_{k\in N}z_{0kr}$ is the weight of the vehicle carrying the path $(i,j)\in Arc$ The energy demand required for ω and load f_{ijr} is the value of the effective work required by the engine; $d_{ij}\beta v^2 z_{ijr}$ is the energy requirement for the corresponding speed v on the corresponding path.

4. Conclusion

With the development of the domestic modern logistics distribution industry, China's logistics industry faces many challenges, but also brings many opportunities for development. Many enterprises have begun to attach importance to the information management of enterprises and the resulting profit value. The intelligent, informational and visual management of logistics, distribution and transportation will surely become the focus of most logistics companies. By creating a logistics and distribution center artificial intelligence platform and combining vehicle scheduling intelligent algorithms, the paper links the cargo owners and logistics companies and individual owners of different spaces and time, which increases the intelligence and informational of logistics and distribution, greatly reducing the traditional mode. Transaction costs such as time consumption and labor consumption facilitate the cooperation between companies, reduce waste of resources, idle vehicles, etc. It is believed that with the further improvement and development of the platform, it will play a positive role in reducing the cost of logistics and distribution in China.

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