Research on Transportation Route Planning Method of Regional Logistics Network Based on Transfer Learning

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Abstract. China is in a period of rapid development of various modes of transportation, comprehensive transportation network is developing and improving rapidly, and the scope of regional logistics network transportation is also expanding. The comprehensive transportation system is the key direction of China's transportation development in the future. It is an important basis for the social and economic development and the improvement of residents' living standards, and is also the main functional element of logistics activities. Therefore, based on transfer learning, this paper designs a transportation path planning method for regional logistics network. Based on the construction of regional logistics network transportation path node and the determination of transportation path objective function, the optimal scheme of regional logistics network transportation path planning is selected. The experimental results show that: compared with the traditional transportation path planning method, this method can reduce the loss of transportation funds and time in logistics network to a greater extent.

Keywords: Regional logistics network · Logistics path planning · Migration learning · Path objective function · Optimal planning

1 Introduction

With the rapid growth of the overall scale and the rapid expansion of infrastructure in China's logistics industry, the problems of unscientific resource allocation and application, and imprecise design of operation process have exposed [1, 2], resulting in the low operation efficiency and high comprehensive cost of the traditional regional logistics network transportation path planning method, and the operation management mechanism and construction theory and method are difficult to meet the needs of the rapid development of the logistics industry [3]. The optimization of regional logistics network transportation path planning is to optimize the design of each link and element of logistics network, so as to improve the efficiency of the whole logistics network system. Therefore, the path optimization problem has its practical economic and academic significance, the effect of regional logistics network route optimization will directly

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determine the result of the whole logistics network optimization. Therefore, it is necessary to conduct in-depth research on the transportation route planning of the regional logistics network.

Reference [4] proposes a ship emergency logistics path planning method based on a two-layer ant colony optimization algorithm, establishes a ship emergency logistics path planning model, and then uses particle swarm optimization to quickly find a feasible solution set of ship emergency logistics paths. Take it as the initial information of ants, and finally search for the optimal route of ship emergency logistics based on the initial information, and conduct simulation test of ship emergency logistics route planning. Experimental results show that this method can accurately solve the problem of ship emergency logistics route planning, but the logistics network transportation cost is higher. Reference [5] proposed a port logistics distribution path planning method based on artificial fish swarm algorithm. According to the port logistics distribution path planning framework, the port demand point node expression form was designed, and path planning constraints were set. According to the constraint conditions combined with the VPR mathematical model, the construction of the distribution route planning model is completed. The artificial fish school algorithm is used to simulate the distribution process as a fish school foraging process, and the optimal travel direction and distance are selected to optimize the above-mentioned set path planning model. Experimental results show that this method has the problem of long time loss in logistics network transportation.

Aiming at the problems of traditional methods, a regional logistics network transportation route planning method based on migration learning is proposed. Based on transfer learning, this study explores the transportation path planning method of regional logistics network, optimizes the transportation path by means of data modeling, and focuses on solving the methods of reducing transportation time and cost on each transportation node, and improving the feasibility of the optimal path. From the strategic planning level of "network optimization" and the tactical planning level of "transportation service design", this paper puts forward the optimization theory and method to strengthen the coordination and coordination of regional logistics network transportation and improve the system operation efficiency. The experimental results show that the method in this paper effectively reduces the transportation cost and time of the regional logistics network, and its application performance is significantly better than traditional methods.

2 Design of Transportation Route Planning Method

Logistics network optimization is the design and optimization of all links and elements of the logistics network. Regional logistics route optimization is a key part of the overall optimization of regional logistics. Through specific analysis of the relevant theories and algorithm design of route optimization, the research finds solutions to regional logistics route optimization. The idea and method of the problem. Therefore, in view of the inability to select the optimal route in the traditional transportation route method and solve the high transportation cost, migration learning is used to optimize the transportation route method of the regional logistics network, and the collected data is analyzed by algorithm to realize the transportation route planning method design.

2.1 Construction of Transportation Path Node in Regional Logistics Network

Transfer learning is a machine learning method that uses a model for task development as an initial point and reuses it in another development model. In the computer vision tasks and natural language processing tasks of deep learning, it is a common method to use the pre-trained model as the starting point of the new model. Usually these pre-training models have consumed huge time resources and computing resources when developing neural networks, and transfer learning can transfer the acquired powerful skills to the related modeling process, thereby reducing time and resource consumption. For this reason, based on the transfer learning theory, the data collection process of the transportation route is shown in Fig. 1.

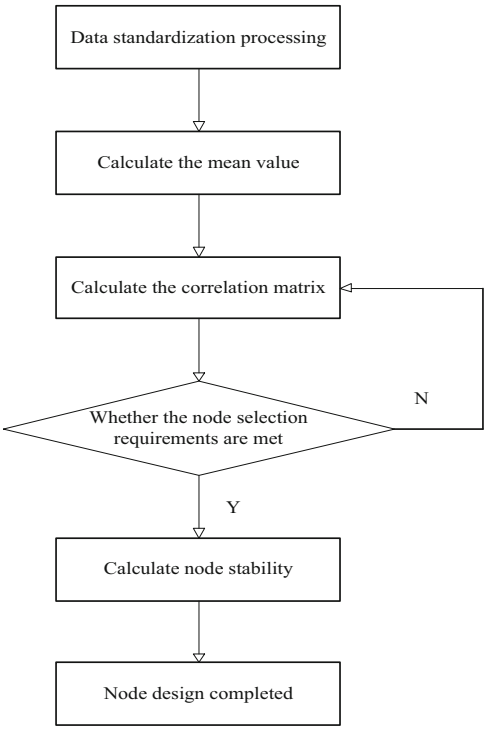


Fig. 1. Transportation path data acquisition process

The construction of logistics nodes in the regional logistics network based on migration learning is to screen multiple logistics nodes in regional logistics. The selection of logistics nodes is the focus of the construction of the entire logistics network. According to the construction ideas and principles, the final regional logistics node is selected by considering the method of transfer learning. The specific process is as follows:

First of all, the internal cause of regional logistics network is the internal structure of logistics network, namely point, line and surface. The essence of the screening of logistics nodes based on internal factors, especially the selection of regional hub logistics nodes, is to analyze, evolve and optimize the regional logistics network structure characteristics, especially in the regional logistics network structure relationship characteristics and regional logistics network optimization model; secondly, in the same region, due to the different economic development level and social and economic conditions of each region Similarly, the status of logistics nodes in regional logistics system is different. It is necessary to comprehensively consider these external factors affecting the selection of logistics node level.

The logistics nodes with different scales, functions, levels, and service scopes selected according to internal and external factors constitute a relatively distinct regional logistics node system. Screen different nodes and determine the specific tasks and scales by determining the layout of each node in the entire regional logistics network.

2.2 Determine the Objective Function of the Transportation Path

Based on the above transfer learning, the transport path planning model is constructed. Let the directed graph $G = (A, B)$ (edge weight $a \geq 0$), divide the node set A in the graph into two groups. The first group is the node set g with the shortest path calculated (there is only one source node in the initial A, i.e. the source point a_0 of the transportation path), and the second group is the node set A whose shortest path has not been determined. The nodes in the A set are moved out to g according to the increasing order of the shortest path length, that is, each shortest path is obtained, the nodes in the shortest path searched are moved from set A to g until all nodes of the graph are added to g, and the algorithm is finished. In the process of iterative operation, always maintain the principle that the shortest path length from source point a_0 to each node in g is not greater than the shortest path length from source point a_0 to any node in A. In addition, each node corresponds to a distance. The distance of the node in g is the shortest path length from j_0 to this node, and the distance of the node in A is only from g to this node. Only the nodes in g are intermediate nodes. The current shortest path length of, the specific application of the following formula to construct the data model:

The objective function considers the cost involved in the completion of the collection task, which is mainly composed of fixed investment cost, transportation cost, storage cost and handling cost [6].

Among them, the fixed investment cost, namely the fixed construction cost, is closely related to the geographical location and economic development level of the alternative nodes. For each node A, a fixed construction cost g_i will be generated, the fixed investment cost is as follows:

$$GT = \sum_{a \in A}^{n} g_a \times z_a \tag{1}$$

In the transportation process of collection, based on the above assumptions, since each node a has a certain damage probability p (the damage probability p conforms to the independent distribution [7]), and any node task with a transportation volume of t_i At the

beginning of the execution, it is impossible to know the status of each collection center due to the incomplete information. Therefore, each task sent from the demand point i must pass some different collection centers to meet the demand, so some Additional transportation distances increase transportation costs.

During the transportation of the tasks from demand point i, they will pass through the collection center in turn. If node a_i^1 is not damaged for the first time, then the task is completed and there is no need to visit other node centers. The probability is $(1-p)$. At this time, the transportation distance from demand point i to node center a_i^1 is d_i. Otherwise, the collection task from demand point i must continue to pass through other node centers in set A in order. From the node center a_i^1 to the node center a_i^{i-1}, there will be an additional transportation distance d_i, which will increase the transportation cost. At the same time, it also shows that the node center $\left\{a_i^1, a_i^2, \ldots, a_i^n\right\}$ previously visited will be damaged, and the probability of this situation will be p^{i-1}. at this time, the transportation distance from the demand point i to the node center a_i^i is $d_i + \sum_{i=2}^{i} p^{i-1}$, then the total transportation distance can be expressed as follows:

$$D = d_i + \sum_{i=2}^{n} p^{i-1} \times d_{ij} \tag{2}$$

Integrate the above two formulas to obtain the objective function of the transportation route planning result, and use this as the basis for the optimal route selection.

2.3 Selection of Optimal Scheme for Transportation Route Planning of Regional Logistics Network

Using the transportation path planning model constructed above as the basis of this route planning, the paper optimizes the transportation path of regional logistics network by means of transfer learning, and obtains the optimal path. Path planning is carried out from the source node [8, 9], simulation planning is carried out at the next node by using transfer learning, and the above process is repeated to obtain the optimal path.

Initially, let $i = 0$ and g contain only the source node a_0, that is, the distance between $g = \{a_0\}$ and a_0 is 0; A contains other nodes except a_0, that is: $A = \{A - a_0\}$. If node a_i in A has edge r_i, then the weight value between (a_i, a_k) is α (that is, the weight of edge e_i). If node a_k is not the adjacent node of the outgoing edge of node f_i, the weight of (a_i, a_k) is $+\infty$;

Select a node l with the smallest distance d_i from A, remove node l from A and add it to g, let $l = i$; take node a_i as the new intermediate point, update the a_k distance of the remaining nodes in J. If the distance from the source point a_0 to node a_k is shorter than the previous distance (without passing through vertex i), the distance value of node a_k is modified; the modified distance value is the distance of node a_i plus the weight of edge (a_i, a_k). Repeat the above steps until all nodes are included in R, and the path planning is finished.

In this design, part of the path selection operation is designed, and the specific process is as follows: The selection operation is to select individuals with higher fitness values from the population individuals in the previous step to ensure that the genetic algorithm approaches the optimal solution. In the selection operation, the greater the chromosome fitness value [10], the greater the probability of being selected, that is, the better feasible solution individual can get a greater survival probability.

In this design, during the selection operation, the more common roulette mechanism is adopted, the population size is R, the fitness f_i of all individuals is calculated separately, and the sum F_i of the fitness of all individuals is calculated, as shown below:

$$F_i = \sum_{i=1}^{R} f \tag{3}$$

The probability P_i of individual m being selected is calculated as follows:

$$P_i = f_i / F_i \tag{4}$$

Calculate the cumulative probability P_i of each point, then:

$$P_i = \sum_{i=1}^{R} P_n \tag{5}$$

Randomly generate a real number δ in the interval of [0, 1]. If $P_1 > \delta$, select individual 1, otherwise select individual q to make $P_{i-1} < \delta \leq P_i$. Repeat the above settings until the optimal route is reached. So far, the design of the regional logistics network transportation route planning method based on transfer learning is completed.

3 Experimental Analysis

In order to verify the feasibility of the regional logistics network transportation route planning method based on transfer learning, the following experiments are designed.

3.1 Experimental Environment Setting

In the experiment, 100 sampling points of different experimental paths are randomly set in the regional logistics network of a city to form a whole set of sampling points. The distribution of some of the sampling points is shown in Fig. 2.

In Fig. 2, each digital node represents the nodes passed by the regional logistics network transportation process. The migration learning-based regional logistics network transportation path planning method and traditional path planning method designed in the article are used to carry out the experimental path samples set above. Transportation planning.

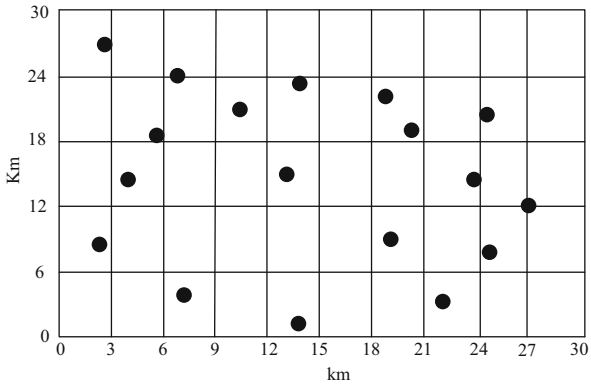


Fig. 2. Sample node setting points of experimental path

3.2 Experimental Process Setting

Under the same road conditions, using the same type of vehicles for regional logistics transportation, the average cost of vehicles per kilometer is 25 yuan, and 10 experiments are carried out. After the completion of the experiment, the cost and time of two different methods of vehicles were compared for statistics. Due to the different transport capacity of the three different transportation routes, in the regional logistics network, the transit capacity of different transport modes of nodes is also different, and the corresponding cost and time consumption of transportation modes among different nodes are generated, as shown in Table 1.

Table 1. Time and cost of unit transfer between different modes of transportation

Cost/yuan (time/h)	Rail transport	Road transport	Waterway transportation
Rail transport	0(0)	6(5.0)	8(10.0)
Road transport	6(5.0)	0(0)	12(15.0)
Waterway transportation	8(10.0)	12(15.0)	0(0)

3.3 Analysis of Results

According to the experimental process set above, the method set in the text and the traditional method data are counted in the form of a table. The specific results are shown in Table 2.

It can be seen intuitively from Table 2 that compared to the traditional path planning method, the regional logistics network transportation path planning method designed in this paper consumes less time and cost.

Table 2. Data analysis of experimental results

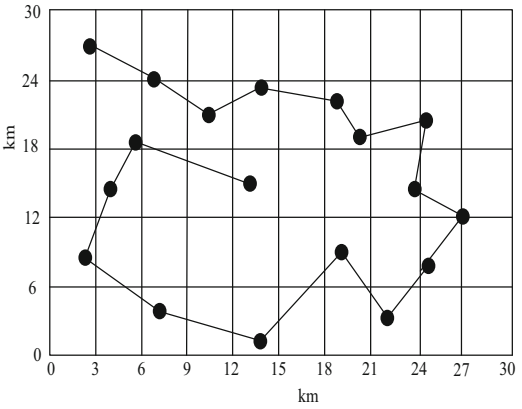
	The method of this paper		Traditional method 1		Traditional method 2	
Experimental project	Cost/yuan	Time/h	Cost/yuan	Time/h	Cost/yuan	Time/h
1	5400	5.12	5931	6.13	5400	5.04
2	5369	5.13	6010	6.03	5369	5.13
3	5421	5.02	5946	6.23	5421	5.02
4	5412	5.16	5972	6.07	5931	5.16
5	5389	5.01	5940	6.09	6010	5.24
6	5412	5.01	5945	6.03	5946	5.01
7	5436	5.04	5987	6.13	5931	5.04
8	5378	5.13	5936	6.24	5378	5.13
9	5401	5.18	5899	6.15	5971	5.04
10	5412	5.06	5976	6.07	5412	5.06

The optimal solution of the path calculated by different methods is shown in Fig. 3. It needs to go through the following nodes to make it consume the least resources to complete the transportation between nodes.

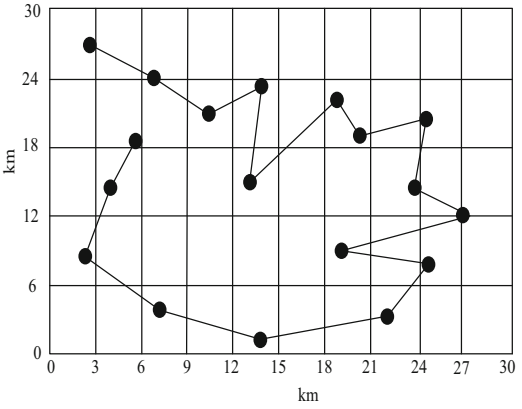
Analyzing Fig. 3, it can be seen that the traditional route planning method has the phenomenon of line duplication during the vehicle transportation process, so that it consumes more time and cost and causes a waste of resources. Therefore, the transportation route planning method designed in the article is better than the traditional method. The distribution route diagram designed in this paper conforms to the distribution habits. In a small area, within the limitation of the loading capacity of the logistics vehicle, a logistics vehicle is used for delivery. Considering the overall scope, in a relatively remote area, the use of an electric logistics vehicle for overall distribution to customers in a region has proved that it is reasonable and effective to use migration learning to solve the logistics vehicle distribution path planning problem.

In order to further verify the effectiveness of the method in this paper, considering the various influencing factors in the logistics transportation path, using the stability of the planning method as an experimental indicator, comparing the path stability obtained by different methods of planning, the results are shown in Fig. 4.

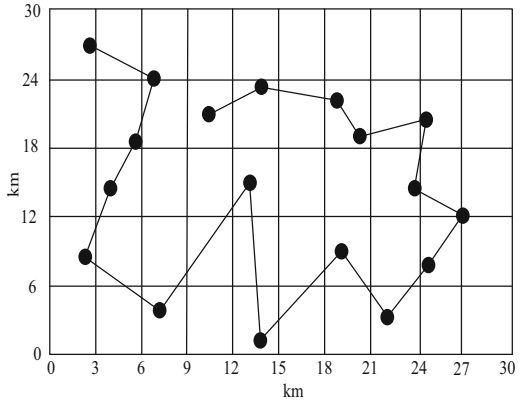
The analysis of Fig. 4 shows that the stability coefficient of logistics transportation path under this method is significantly higher than that of traditional methods, which indicates that this method can reduce the influence of interference factors on path planning, thus improving the effectiveness of this method.



(A) Design method in the text



(b) Traditional method 1



(b) Traditional method 2

Fig. 3. Experimental results of path planning

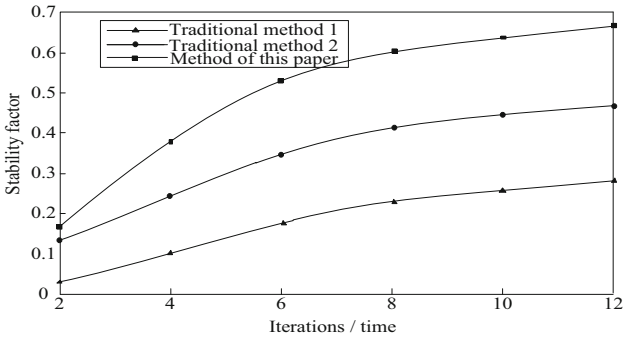


Fig. 4. Comparison of path planning stability

4 Conclusion

In the traditional transportation route selection process, due to the uncontrollability of the road information, the vehicle can not choose the optimal path in the transportation process, which increases the transportation cost to a certain extent. In order to reduce the cost of time and money, regional logistics network transportation adopts transfer learning as the basis of transportation path planning to carry out path planning. Through the above experimental results, we can see that the results of the transportation path planning in this paper are better than the traditional methods. We should vigorously promote the transportation path planning method in the future regional logistics network, so as to better reduce the various costs of regional logistics network transportation and improve economic benefits.

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