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Research on the Site Selection Model of Express Service Outlets based on BP Neural Network

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Abstract: With the continuous development of the times, urban planning for the development of the logistics industry puts forward higher requirements, but also for the development of the express industry provides a more potential market, and how to efficiently carry out the site selection of express service outlets has become a difficult problem, so for the current market demand and the current situation. This paper combines the fuzzy comprehensive evaluation method, the establishment of a four-level comprehensive assessment system, the use of BP neural network training, the city express service outlets for scientific site selection and validation analysis, to get the region of the optimal location of each courier service outlets for the city courier service outlets to provide a scientific site selection program.

Keywords: BP Neural Network; Courier Service; Fuzzy Comprehensive Evaluation.

1. Introduction

In recent years, with the prosperous development of e-commerce, the courier industry is also in the rapid progress. In the face of the ever-expanding courier business, courier companies must meet the growing demand for express delivery through the construction of outlets. Now China's development of the courier industry has put forward the corresponding planning, the requirements of the domestic courier logistics system gradually towards the intelligent, efficient, convenient, green goal to development.

Courier service outlets as a place of express service, mainly for customers to provide self-pickup service, but also as an important transfer station for courier delivery of goods. The rapid growth in the number of courier service outlets at the same time also brings a lot of problems, such as courier companies invested in the early stage of the cost is too high, the customer to the courier service outlets to pick up the distance is unreasonable, the courier delivery distance, etc. Therefore, through the optimization of the location of express service outlets, can be a good solution to the problem of low distribution efficiency, to a certain extent, to reduce the expenditure of distribution costs.

There are many domestic and foreign studies on the location of express service outlets. Foreign scholars on express service outlets research, Wu [1] etal. (2015) considered the distribution of potential customers, constructed a site selection model to minimize the average distance between the customer and the express service point and maximize the community mobility of the self-pickup point as a multi-objective to study the location problem of express service outlets; Wang [2] etal. (2021) took the cost of outlets construction, transportation costs, customer satisfaction and the service efficiency of the end outlets as a Multi-objective, constructed to consider the network sharing, the end of the network service mode and capacity variable multi-level courier network site selection model for multi-level courier network site selection problem research.

In recent years, academics have obtained many important research results on the location of express or logistics outlets, resulting in a variety of excellent algorithms, such as more complex neural networks, simulated annealing algorithms, and genetic algorithms, ant colony algorithms, etc., has become an important method of courier service outlets location. In this paper, we will use the fuzzy neural network analysis method to establish the evaluation index of express service outlets by utilizing the influencing factors of site selection, and then train the neural network to get the optimal solution [3-5].

2. BP Neural Network Model

2.1. Principles of BP Neural Network Site Selection Evaluation Model

BP neural network is a multi-layer feed-forward neural network for error correction through error back propagation algorithm, and its most central feature is that the signal is forward propagated while the error is back propagated. In the forward propagation process, the input signal is processed layer by layer through the input layer and hidden layer, and when it comes to the output layer, if the result does not reach the desired requirements, it enters the reverse propagation process, which returns the error signal in the original way and modifies the weights of each layer.

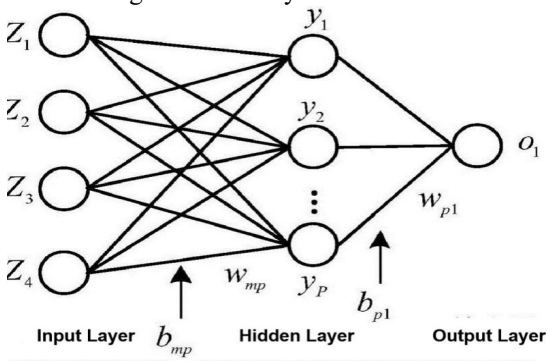

Figure 1. BP neural network structure

The BP neural network contains an input layer, a hidden layer and an output layer, in which the hidden layer can be more than one, in which the number of nodes in the input and output layers is fixed. Taking the data of express service

outlets of S Express Company in Xindu District, Chengdu City as an example, this paper adopts the BP neural network algorithm to evaluate the location of its express service outlets. The BP neural network model is shown in Figure 1.

In this paper, the research mainly through the collection of the various factors affecting the location of express service outlets in Chengdu City, as the input information of the input layer, after the BP neural network algorithm training, the output of the final evaluation results of the preparation of the location. The basic process is shown in Figure 2.

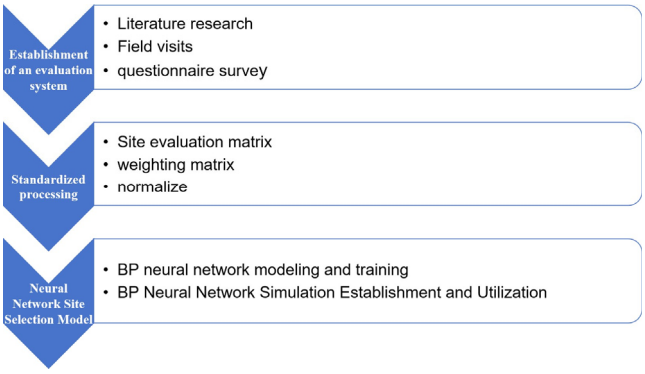

Figure 2. BP Neural Network Site Selection Principle Flowchart

2.2. Express Service Network Site Selection System based on Fuzzy Comprehensive Evaluation Analysis

Table 1. Fuzzy Comprehensive Evaluation Indicator Factor Set

Number	Level 1 indicators	Level 2 indicators
Site selection influences	Transportation	Road Facilities
		Transportation distance
		Traffic accessibility
		Transportation conditions
	Geographic conditions	Geographic complexity of the radiation area
		Topography around the outlets
	Social conditions	Influence of consumer demand
		Competitor pressure
		Residents' values
		Population density
	Cost conditions	Logistics cost of goods received and sent
		Logistics personnel costs
		Outlet land cost
		Outlet Operation Costs
		Cost-effectiveness

A lot of factors affecting the location of express service outlets, both qualitative and quantitative indicators, usually can be attributed to cost factors, geographical factors and transportation factors, social factors, four aspects. On the basis of the research to organize and summarize the data, combined with the documents of the relevant departments of urban planning and construction, to get the courier service outlets center location assessment model, that is, the fuzzy comprehensive evaluation index factor set, see Table 1.

And in the research process of the various influencing factors using access to courier service outlets map information, distribution of questionnaires, courier service personnel interviews, expert ratings and other methods to ensure that the research data is not affected by the subjective consciousness of the individual personnel, so as to make it more objective. The final formation of courier service outlets site selection evaluation matrix, the evaluation matrix and weight matrix

3. BP Neural Network Model

3.1. BP Neural Network Parameters Setting

The evaluation results obtained from fuzzy hierarchical analysis are taken as the signal input in the neural network, and the number of network layers is determined to be 4 according to the actual application, the implied layer is 3, and the number of neurons in the output layer is 1. The data of the first 20 logistics service outlets are taken as the input of the training samples, and the activation function of the implied layer is set to "tansig", the activation function of the output layer is set to "purelin", the training function is set to gradient descent function, the number of training times is set to 1000, and the result of the evaluation results is set as the target value for training simulation. The data of the first 20 logistics service outlets are used as training samples, the activation function of the hidden layer is set to "tansig", the activation function of the output layer is set to "purelin", the training function is set to gradient descent function, the number of training times is set to 1,000, and the result of the evaluation result is set to be the target value, so as to carry out training simulation.

3.2. BP Neural Network Learning Training and Result Validation

This paper takes 25 express service outlets of S Company in Xindu District, Chengdu City, as the research object, collects data through field visits and questionnaires, and evaluates the location of 25 express service outlets in Xindu District, Chengdu City, based on the fuzzy comprehensive evaluation analysis method, and obtains the final comprehensive evaluation results.

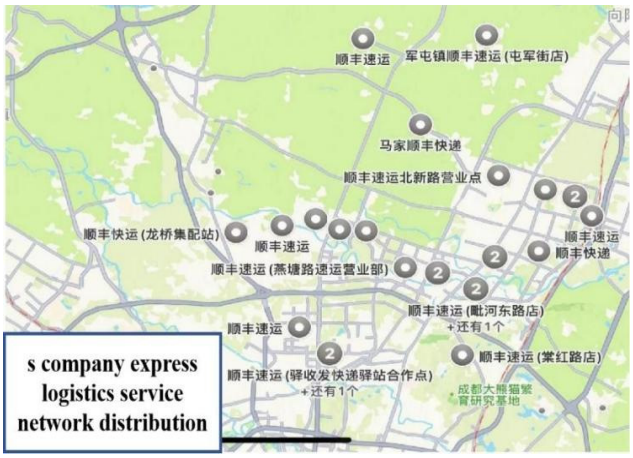

Figure 3. S Company Express Service Outlets Distribution Map

Table 2 shows the final comprehensive evaluation results based on the fuzzy comprehensive evaluation analysis method for the site selection assessment of 25 express service outlets in Xindu District, Chengdu City.

Table 2. Fuzzy integrated evaluation results

No	Transportation conditions	Geographical conditions	Cost conditions	Social conditions	Evaluation results
1	83.35	61.56	86.59	88.77	81.98
2	75.60	85.80	67.66	89.55	78.80
3	85.85	80.05	61.69	88.24	77.74
4	89.89	84.20	79.05	88.32	84.96
5	88.22	77.50	86.38	78.12	82.87
6	82.04	92.21	84.38	78.58	83.65
7	80.45	81.29	73.34	85.27	79.68
8	87.93	87.63	77.50	76.16	81.24
9	87.87	78.06	85.52	76.44	82.15
10	82.01	77.20	91.20	82.56	84.24
11	93.81	72.09	87.51	79.73	83.94
12	82.07	79.22	85.28	94.92	86.18
13	72.59	93.08	81.71	76.54	80.30
14	85.43	99.21	99.29	86.98	92.78
15	73.49	88.74	83.53	83.92	82.37
16	76.53	85.00	87.94	75.53	81.43
17	72.79	84.06	87.48	89.26	84.13
18	75.92	88.08	91.41	88.30	86.53
19	74.63	80.14	70.76	78.89	75.58
20	34.95	89.28	84.71	87.29	75.31
21	72.50	78.52	98.96	79.21	83.93
22	89.84	90.38	87.20	90.79	89.36
23	76.51	84.38	92.74	86.04	85.79
24	90.79	87.11	87.54	75.88	84.91
25	74.43	72.20	69.96	85.60	75.72

The BP neural network algorithm program was run in MATLAB 2021 environment, and the optimal results were obtained by actually running 562 times, which took 0.05 seconds. The training results are basically the same as those analyzed based on fuzzy comprehensive evaluation. The network error sum of squares is 0.01 when the number of training times is 512, which is in line with the error allowance of 0.01.

4. Conclusion

For the courier service network location problems, previous studies often use fuzzy comprehensive evaluation method, AHP hierarchical analysis method and fuzzy sorting method combined with the hierarchical method. But the fuzzy comprehensive evaluation methods such as subordinate function weights determined by a certain degree of subjectivity, so its scope of application has certain limitations. The BP algorithm can evaluate the advantages and disadvantages of different programs more objectively, so this paper synthesizes the fuzzy method into the input value of the BP algorithm, which can take into account the advantages of the two algorithms to a certain extent and expand the scope of application. Through the analysis of the case, it is clearly shown that the BP neural network can make an objective and accurate evaluation of the alternative programs, reduce the influence of human factors, and is an effective method to solve the problem of selecting the location of express service outlets.

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