THE METHOD OF WAREHOUSE LOCATION SELECTION BASED ON GIS AND REMOTE SENSING IMAGES

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ABSTRACT:

The traditional P-median selecting location model of logistics is based on the statistical static model. These traditional mathematical models often don't consider topography, transport conditions, slop etc. The distance between two nodes is often assumed for the straight line in this model, so the analytical result usually can not be used as a warehouse in actual applied. So the paper isn't only takes a catena supermarket warehouse as an example and adopts the geographical information system (GIS) technology, spatial analysis methods and remote sensing images to establish warehouse selection model of logistics distribution, but also improves P-median selecting location model. At the same time, the most suitable warehouse location is determined by multi-standards. The method mainly includes three processes: building networks, handling remote sensing and overlapping networks to remote images. Since the networks' distance is used in the model, the analysis result is more science and more close to reality. And the method can reduce blindness of choosing the warehouse location in catena manage, the customer is given some information of assistance decision.

1. INTRODUCTION

1.1 General Instructions

The warehouse location selection is a processing of selecting allocation center in economic region where there are some supply stations and the certain demand point. Generally, the warehouse location selection model follows some principles: adaptable principle, Coordinative principle, efficient principle and strategic principle [1].

The classical algorithm includes the center-of-gravity approach, the capacitated facility location problem model, the Baumol-Wolfe methods and the P-median selecting location model, in the warehouse location selection. The gravity of the physical system is looked as the best spot in the center-of-gravity approach. Its characteristics is simple computation is the main characteristic, but the accuracy of computation is low. So the result can only be referenced. The capacitated facility location problem model finds the optimal solution by revising the supply scope and moving the demand point for dropping cost in limited network scale situation. The complex computation process is the shortcoming of the model. For example, the optimal solution is showed in first resolving, but it can give the first resolving is the optimal solution, after the model must carry on all circulations. The non-linear problem can be solved in the network layout of Baumol-Wolfe methods and the linear plan is used in every iterating. The optimal plan can been found under some specific constraints. But there are two flaws of the model, the one is that the optimal plan cannot be guaranteed in every conditions, the other is that the constant investment isn't showed in the model. In order to avoid the above limitation, the method of integrating GIS with remote photo is used in the article.

2. THE WAREHOUSE LOCATION SELECTION MODE

The network analysis is the major step to realize the warehouse location selection model. The network analysis model and the algorithm should be established according to the demand.

2.1 The P-median Selecting Location Model

The location assignment problem of P-median can be indicated as following: the number supply stations of P is selected to sever for the n demand points in the sum supply stations number of m, in order to the expense of distances, or time, or cost is least. Supposition i is the demand points, w_i is the demand quantity of i, d_{ij} is the distance of from the supply station j to the demand point i. The formula is:

$$\min \left(\sum_{i=1}^{n} \sum_{j=1}^{m} \omega_i \cdot \alpha_{ij} \cdot d_{ij} \right) \tag{1}$$

And

$$\sum_{j=1}^{m} \alpha_{ij} = 1, \quad i = 1, 2, \cdots, n \tag{2}$$

$$\sum_{j=1}^{m} \left(\prod_{i=1}^{m} \alpha_{ij} \right) = P, \quad P \leqslant m \leqslant n \tag{3}$$

Among them, a_{ij} is the distribution coefficient, if the demand point i is severed by the supply station j, its value is 1, otherwise its value is 0. The formula is following:

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$$\alpha_{ij} = \begin{cases} 1, & i \text{ is severed by } j \\ 0, & others \end{cases}$$

(4)

The above two constraint formulas can guarantee that every demand point can only receive the service from a supply station and that the sum number of supply stations is P.

It can be seen from the above model that the factor is unitary in the model. But many factors are involved in actual location selection. So the p- median algorithm is improved by adding other factors in the article. At the same time, the all factors are also allocated weights.

2.2 Improving P-median Algorithm

The warehouse location selection need consider main factors [1]: the natural environment factor including meteorology, geology, hydrology, topography and so on; the business environment factor including demand layout, logistical expenses and so on; the infrastructure condition including traffic, public facility and so on. The five factors including terrain, area of warehouse, rent, distance and land type are selected in the article.

So the above five factors is used in the improving P-median algorithm. Among the algorithm, the slope is used to replace the terrain for quantitative calculation. But the value of slop is far litter than the one of other factors. So the standardized processing is carried on to avoiding the phenomenon that the small number is eaten. At the same time, the weights of all factors are given by reciprocal rank method [3]. The formula is:

$$\min[\sum_{i=1}^{m}(w_i^1 S_i + w_i^2 C_i + w_i^3 A_i + w_i^4 D_i + w_i^5 L_i)] \quad (5)$$

Among it, m is the number of the candidate warehouse;

w^1、w^2、w^3、w^4、w^5 are the weight of slop, rent, area, land type and distance respectively. The all factors is ordered by sort or decent, the most important factor is given the value 1, the more important factor is given the value 2, the value of other factors is analogy with the two values, the most unimportant factors is given the value 5. Then the weight formula of all factors is following:

$$W_j = \frac{1/r_j}{\sum(1/r_j)} \quad （6）$$

Among it, W_j is the weight; r_j is the sequential number of factor j in series. The numerator of the above equation is the reciprocal of sequential number, the denominator is the sum of all reciprocals.

S_i is the slope of the number i candidate warehouse; C_i is the rent of of the number i candidate warehouse; A_i is the area of of the number i candidate warehouse; D_i is the land type of the number i candidate warehouse; the sum of short distances from

the candidate warehouse i to all the all demand points, L_i is computed as following:

$$Li = \sum_{j=1}^{n} l_{ij} \quad （7）$$

Among it, n is the number of demand points; l is the short distance from the candidate warehouse i to the demand point j .

3. PROCESSING OF ESTABLISHING MODEL.

3.1 Hypothesis

There are the following suppositions in the model calculation:
(1) The good of every demand points can be transported in one time, and the velocity is not change.
(2) The one demand point is only served by one warehouse.
(3) The cost is related the length from the warehouse to the demand point, the transport condition does not be considered.

3.2 Processing of Establishing Model

(1) Integrating datum. Integrating the GIS with remote photo is the premise of selecting the warehouse location, since some factors come from GIS and other factors need the remote photo to auxiliary analysis. Remote photo is rectified and reinforced by the same information from GIS and Remote photo.

(2) Processing datum. The spatial entity need be digitized by GIS to selecting the warehouse location. The conflict between GIS and remote photo need be resolved in the digitized process. But some entities, including road, candidate warehouse, the position and attribute of demand points, need be renewed in GIS database by remote photo. Through the new GIS database, the network can be established by the weight of segment's length in first; Secondly, the slop factor is gained by slop map that can be set up by TIN; Thirdly, the area of warehouse can be given by the digital map; Finally, the rent and land type is obtained from GIS attribute information.

(3) Calculating the distance from the candidate warehouse j to the demand point i. the short-path of network is used to replace the straight distance.

(4) Deciding weight. The weight is allocated by formula 6. Then the weight of distance is 0.438, the weight of warehouse area is 0.219, the weight of rent is 0.146, the weight of land type is 0.109, the weight of slop is 0.088.

(5) Standard processing. The land type is calculated by value in five factors. For computing the land type, the value 1 is given to the land used for military, administration, education and commerce; The value 0.5 is given to the land used for medical severce, harbours and industry; The value 0 is given to warehouse land. Since the value of distance and area factors is far bigger than the value of slop and land type, the standard processing should be carried on.

(6) Calculation and visualization. The warehouse location is calculated by formula 5, so the result is showed.

4. THE PRACTICAL EXAMPLE

After the remote photo is reinforced in the ERADS software, the remote photo is overlaid by vector datum in the ARCGIS software. The short-path factor is resolved by exploitation in VBA. The weight of the geometry network is the length of segments in Figure 1.The short-path and the line from the candidate warehouse 5 to the all demand points are showed in figure 1.

Figure 1. Inquiry of shortest path

The possible warehouse is digitalized, but rivers, houses green space are not considered in remote photo. Generally, the position of candidate warehouse is not right on the road network. So the entrance of warehouse is judged by remote photo, the entrance is right on the road network. the position of warehouse is replaced by the position of corresponding entrance. And the short-path can be calculated on the road network.

The detailed information of five candidate warehouses is showed in table 1. So standard processing is introduced by table 1.

Order	Slop (°)	Distance (km)	Warehouse area (m^2)	Rent (yuan/ m^2/d)	Land type
1	7	13.376	827	0.52	0.5
2	3	18.989	2225	0.45	0
3	3	8.014	2602	1	1
4	10	18.268	1683	0.6	0.5
5	4	9.104	556	0.36	0.5

Table 1. Information of four warehouses

When user rents warehouse, he often gives some conditions. Such as the slop is about 3 degree, the sum distance is about 15km, the rent is 0.5 yuan/ m^2/d, the area is about 1200 m^2 and so on. Then the value that is given by user is looked as standard value, the absolute value of the difference between the every data in table 1 and the corresponding standard value. The result is table 2.

Order	Slop (°)	Distance (km)	Warehouse area (m^2)	Rent (yuan/ m^2/d)	Land type
1	4	1.624	373	0.02	0.5
2	0	3.989	1025	0.05	0
3	0	6.986	1402	0.5	1
4	7	3.268	483	0.1	0.5
5	1	5.896	644	0.14	0.5

Table 2. The absolute value of the difference

The standard processing is carried on, the result is table 3.

Order	Slop	Distance	Warehouse area	Rent	Land type
1	0.571	0.232	0.266	0.04	0.5
2	0	0.571	0.731	0.1	0
3	0	1	1	1	1
4	1	0.468	0.345	0.2	0.5
5	0.143	0.844	0.460	0.28	0.5

Table 3. Standardization of data

The synthesis evaluation result of five candidate warehouses is 0.270458, 0424787, 0.912, 0.452239, 0.578376. The result can be showed by figure 2. The best warehouse location is the candidate warehouse 1 on left-top of figure 2. The short-path is also showed by red line in figure 2. The different colours of the candidate warehouse express the suitable level.
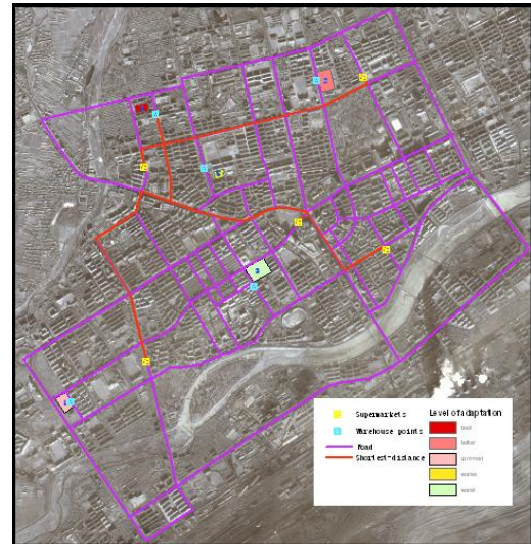

Figure 2. Calculating result

5. CONCLUSION

The warehouse location selection model is established by GIS and remote photo. The best warehouse location is decided by five factors. Through test, the analysis result of model can satisfy the essential requirement of selecting location, the analysis warehouse location is not probably on square, park, waters and so on. The distance that is calculated by road

network is more real than the straight line. At the same time, many factors are used in the warehouse location selection.

For the research result, other problems may be more thorough approach. (1) The short-path is replaced by the optimal path in model. (2) If the economic factor is used in model according to the actual need, the economic efficiency will be showed in the result. With the development of digitized and information management, the plan of warehouse location selection will become better and better through integrating GIS with remote.

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