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Simulation of Location Selection under Emergency Prevention and Control Based on Baumowalf Model

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Abstract

The post-epidemic era is a topic of concern to many people, and the emergency location of transit centers after the epidemic is also a field full of opportunities and challenges. This paper focuses on the emergency research of transport center simulation location based on Baumowalf model and transport problem under public health emergencies. Assuming that there is no capacity limit of the transit center, the existing Baumowalf model and the transit problem method are improved and innovated. Considering that the transit center does not participate in the selection in the case of emergency, the emergency factor is added to the transportation constraints, and the goal of minimizing logistics costs is met, and a single objective mixed integer programming model is established. Simulation in LINGO environment shows the effectiveness of the work in this paper.

Keywords: Emergency location, Baumowalf model, transport problem, LINGO simulation, Post-pandemic era

1. Introduction

In the wake of the COVID-19 outbreak, the global logistics industry has undergone profound changes. In China, due to the continuous outbreak of the epidemic and the strengthening of prevention and control measures, the location of transit centers has increasingly become the focus of academic and practical fields. Although the phenomenon of epidemic containment no longer appears under the current situation, this study is still of practical significance as a study on the location of transit centers for major public health emergencies. This paper will discuss the application of Baumorwalf model in the location of transit center under emergency prevention and control.

In this context, the Baumowalf model has become the core tool of research. Due to its comprehensive consideration of multiple factors, the model has gradually become an effective method to solve the problem of location of transit centers under epidemic prevention and control. Its advantage is that it can balance the needs of epidemic prevention and control and transport efficiency, and provide comprehensive location solutions for logistics enterprises.

Furthermore, integrating computer-related technologies such as Geographic Information Systems (GIS) and LINGO optimization algorithms enhances the efficacy of the Baumorwalf model. GIS facilitates spatial analysis and visualization, enabling better understanding of the geographical implications on transit center placement. Optimization algorithms, when applied to the Baumorwalf model, streamline decision-making processes by rapidly evaluating numerous potential locations against specified criteria, thus expediting the identification of optimal transit center sites.

2. Literature Review

2.1 Research status of emergency transit center site selection

This paper provides a literature review on the location of emergency transit centers based on Baumol-wolfe model and transit problems, aiming to summarize and analyze the current status, trend and key problems of emergency transit center location. Emergency location has always been a very important issue in the field of logistics, and its influence has been widely reflected in the social, scientific and economic fields. This literature review includes many aspects of emergency site selection, such as technology status, economic cost, method innovation, etc.

At present, the research on the location of emergency logistics distribution center can be roughly divided into two categories: one is the location model based on GIS technology, such as analytic hierarchy process, multi-index decision model; The second is the site selection method based on planning and experience, such as expert consultation method, case analysis method and so on. Using these research methods, many relevant papers have been published in this field. In this field, domestic and foreign scholars have achieved a wealth of research results.

Among them, in the emergency site selection under public health emergencies, Long et al.(2023) focused on the actual needs of cross-regional emergency resource allocation among multiple disaster-affected areas under public health emergencies. This paper proposes the site-allocation optimization problem of cross-regional dynamic collaborative emergency logistics considering patient transport, and constructs a two-stage optimal decision model, which is conducive to realizing resource collaborative allocation .[1]

Cheng et al.(2023) adopted the two-stage method to study the location of emergency logistics distribution center under different factors. This study considered several factors such as urgency of demand, rescue time and site selection cost to provide decision support for the actual location of emergency logistics center .[2]

Focusing on uncertain sudden disasters, Wang et al.(2023) built a model of maximum fairness and maximum comprehensive satisfaction, and provided a method of location selection of emergency logistics center under disaster conditions by considering different factors .[3]

Lv et al.(2023) studied the location problem of secondary distribution center with the site selection of first-level emergency logistics center as the starting point. Based on complex network theory and location advantage theory, specific schemes are provided for the layout of emergency logistics center.[4]

In his article, Duan (2023) used GIS to conduct a multi-factor comprehensive evaluation of the emergency shelter in Xiaodian Park of Taiyuan City. The research results include the evaluation of existing sites and suggestions for future site selection, and provide a reference example for the site selection evaluation and future construction of emergency shelter in parks .[5]

In his article, Lei et al.(2023) proposed that in the study, firstly, by considering passenger flow, network structure and surrounding resources, the vulnerability assessment index system of urban rail stations was established, the vulnerability was transformed into an index, and the grey correlation analysis method was used for calculation. Then, the work of building regional emergency rescue site location model is carried out to achieve the maximum coverage, the shortest rescue response time and the lowest construction cost. In the calculation of coverage level, the K-means clustering algorithm is used to classify the vulnerability of the sites. Finally, the validity of the proposed model is verified by the actual data of Xi 'an subway network. .[6]

In their paper, Li et al.(2023) solved the model by using heuristic genetic algorithm and Python software, and combined with Supply Chain Guru? The optimization effect of the distribution of emergency rations supply network in Zhengzhou under different network damage rate was studied by using the software. By verifying the effectiveness and feasibility of the model and algorithm .[7]

Zhang et al.(2023) introduced an evaluation method for the location of emergency medical supplies storage, which combined analytic hierarchy process and fuzzy comprehensive evaluation model. The method includes using analytic hierarchy process to assign weight to qualitative indicators and introducing fuzzy comprehensive evaluation model to quantify these indicators. Through the evaluation of three alternative sites in Tianhe District of Guangzhou, it is concluded that Tianhe Park is the most suitable for emergency medical supplies storage in this region .[8]

In his paper, Niu(2021) mainly discussed the improvement of multi-objective planning model based on the logistics network from factory to transit center to customer in the case of major outbreaks. Based on the original model to maximize the emergency material satisfaction rate and minimize the rescue cost, the improved model considers the urgency of the demand point and the service radius of the transit center, taking into account fairness, economy and timeliness .[9]

Wang et al.(2023) proposed an emergency facility location model (RDGT-EFLP, EFLP) to provide a solution for emergency rescue of dangerous goods in railway accidents. Based on the ellipsoidal robust model, the robust control safety parameter Ω is introduced to evaluate the risk appetite of decision makers. The model limits the uncertainty of the range of requirements, the range of services, and the range of security parameters to deal with the situation where the time and location of an emergency are unknown. In order to solve the model, genetic algorithm is used and the actual data is abstracted. Finally, the feasibility and effectiveness of the model are verified by comprehensive analysis of the solution results under different maximum coverage conditions.[10]

Vahdani Behnam et al. (2022) proposed an emergency facility location model (RDGT-EFLP, EFLP) for emergency rescue involving dangerous goods in railway accidents. Based on the ellipsoidal robust model, the robust control security parameter Ω is introduced to evaluate the risk appetite of decision makers. The model limits the uncertainty of the range of requirements, the range of services, and the range of security parameters to deal with the situation where the time and location of an emergency are unknown. In order to solve the model, genetic algorithm is adopted and the actual data is abstracted. The feasibility and effectiveness of the model are verified by comprehensive analysis of the solution results under different maximum coverage conditions. It is critical to respond immediately to critical emergency relief necessities after a sudden disaster, including relief distribution and victim evacuation, to mitigate the impact of the disaster in the area concerned. In this paper, a dual objective optimization model for humanitarian regional logistics network planning is established, which considers the simultaneous decision of location allocation, reallocation, service sharing and vehicle routing of emergency facilities. For land and air routes, two types of closed and open vehicle routes are proposed. Due to the uncertainty of disasters, from demand and supply to various costs, a hybrid robust optimization method is proposed to overcome this challenge. Finally, the effectiveness of the proposed model and solution method in a real case study is investigated. The obtained results and rendering management insights reveal the applicability and effectiveness of the proposed model and solution method.[11]

In the study of heuristic model methods, Pei et al.(2023) considered the cost minimization model with the maximum capacity limit of reserve points. Heuristic simulated annealing algorithm and heuristic genetic algorithm are adopted to solve the problem, providing a solution for the emergency logistics location problem in a specific region .[12]

Li et al.(2020) used the Baumol-wolfe model to evaluate the total cost in the circulation process, and at the same time chose to build a cold chain storage center, and defined the upstream and downstream objects served by the center, the quantity of goods transferred and the direction of transportation .[13]

Wang(2019) attached the planning diagram of Baumowalf's location allocation scheme at the end of his article on future large-scale combat logistics supply by using Baumowalf's model, which made the results more clear and intuitive .[14]

Finally, based on the current situation of previous studies, we conclude that there are few studies considering major public health events, such as epidemic prevention and control and influenza transmission prevention and control, in the emergency location of transit centers. Therefore, in order to make up for the shortage of research in this field, attract more attention to such problems in the future and promote the research development of such problems, the theme of our research is realistic and necessary. Through in-depth research on the location of emergency prevention and control of transit centers under major public health events, the location model of emergency transit centers can be further improved, the effect of its practical application can be improved, and more reliable decision support can be provided for the logistics industry in the future when facing unknown challenges.

2.2 Heuristic algorithm thinking of Baumol-wolfe model

The Baumol-wolfe model used in the background examples in this paper can solve problems that linear programming cannot solve in the above models: The heuristic algorithms of the Baumol-wolfe model play a key role in solving some practical problems that linear programming cannot solve. In specific situations, such as resource constraints or complex situations such as fixed costs and management costs, heuristic algorithms are used to solve problems. The Baumol-wolfe model is suitable for dealing with multi-factors and complex constraints, and can be used in the location of transit centers.

Overall, its advantages are:

(1) Heuristic algorithm to deal with complex problems:

Heuristic algorithms solve problems that linear programming cannot cover, making the model more general and applicable to a variety of practical situations.

(2) Applicable to practical decision-making:

The comprehensiveness and practicability of the model make it a powerful tool for practical logistics and emergency management decision-making.

Using this model, the advantages and disadvantages of potential transshipment centers can be evaluated more comprehensively and accurately, and the quality of location decision can be improved.

2.3 Transport Problem Solution

Application of single objective mixed integer programming model:

A single objective mixed integer programming model is used to determine the number and optimal location of transshipment centers, taking into account various potential factors such as distance and cost. Through model output, an efficient transport network is established to minimize logistics costs and improve transport efficiency.

Introduction of emergency factors:

Emergency factors are added to the model to cope with sudden major emergency events. The factor can be adjusted according to the urgency and impact of the event. By flexibly adjusting the emergency factors, the optimal location of the transit center in an emergency can be realized to ensure the rapid response and distribution of emergency materials.

In summary, its advantages are:

(1) Comprehensively consider multiple factors:

In order to improve the comprehensiveness and adaptability of the model, several factors such as distance and cost can be comprehensively considered in the location of the transshipment center.

(2) Enhanced practicality of emergency factors:

The introduction of emergency factors can make the model more practical, and can flexibly deal with sudden major emergency events to ensure the disaster resistance of the system.

3 Baumol-wolfe Model Building

3.1 Problem description

Baumol-wolfe model is also called multi-node single-variety location model, that is, only one product is considered in the model. The model assumes that a single product with m resource points is shipped to customers in n regions through distribution centers selected from the candidate set or directly. The problem is how to select a number of locations from the set of s candidate locations as logistics facility nodes, so that the total logistics cost (or transportation cost) is minimized when the same product is delivered to several customers from a number of known resource points through these selected facility nodes. There may also be products shipped directly from the factory to a customer point in the model.

3.2 Model building

Record S_i-- supply of products from factory i;

D_k-- Customer k's product demand

x_{ij}- Volume of goods from Plant i to alternative facility node j;

y_{jk}- The volume of goods from alternate facility node j to customer k;

Z_{ik}-- The quantity of goods purchased directly by customer k from factory i;

U_j-- Decision variable of whether alternative facility node j is selected (0-1 variable);

c_{ij}-- Purchase cost per unit of goods purchased from factory i by alternative facility node j;

d_{jk}-- Purchase cost of unit goods supplied by alternative facility node j to customer k;

e_{ik}- Direct distribution cost of goods purchased directly from factory i;

w_j- Alternative facility node j variable cost per unit of goods passing through volume (such as warehouse management or processing cost, etc., related to scale), that is, storage cost rate;

v_j-- Infrastructure investment costs after alternative facility node j is selected (fixed costs, costs unrelated to scale).

Assuming F is the total cost of the location layout scheme, the mathematical model of the node layout of multi-node single-variety logistics facilities can be written as follows:

$$\min F = \sum_{i=1}^{m}\sum_{j=1}^{s} c_{ij}x_{ij} + \sum_{j=1}^{s}\sum_{k=1}^{n} d_{jk}\, y_{jk} + \sum_{i=1}^{m}\sum_{k=1}^{s} e_{ik}z_{ik} + \sum_{j=1}^{s} \left(v_j U_j + w_j \sum_{i=1}^{m} x_{ij}\right) \tag{1}$$

$$\text{s.t.} \sum_{j=1}^{s} x_{ij} + \sum_{k=1}^{n} z_{ik} \le S_i\,, i = 1,2,\cdots,m \tag{2}$$

$$\sum_{j=1}^{s} y_{jk} + \sum_{k=1}^{m} z_{ik} \ge D_k\,, k = 1,2,\cdots,n \tag{3}$$

$$\sum_{i=1}^{m} x_{ij} = \sum_{k=1}^{n} y_{jk}\,, j = 1,2,\cdots,s \tag{4}$$

$$\sum_{i=1}^{m} x_{ij} - MU_j \le 0, j = 1,2,\cdots,s \tag{5}$$

4 The Study of Emergence FA in Location Selection Based on Baumol-wolfe Model

4.1 Asking questions

Ask a question,

Origin: A1 Shantou (250) A2 Yiwu (200)

Distribution Center: D1 Hefei D2 Wuhan D3 Hangzhou D4 Shijiazhuang D5 Tianjin

Customer: B1 Beijing (80) B2 Shanghai (70) B3 Guangzhou (75)

B4 Shenzhen (40) B5 Zhengzhou (50) B6 Nanjing (25)

B7 Jinan (30) B8 Harbin (40)

The data in the above questions refer to the supply and demand of origin and customers respectively. Based on the above conditions, we need to select one or more distribution centers to optimize the location to achieve the shortest transportation cost. At the same time, considering the factors of epidemic prevention, we only assume that five distribution centers may be affected by epidemics.

For this problem, we first adopt the Baumol-wolfe model to solve, which can not only take into account transportation costs, but also variable costs and fixed costs. Logistics distribution center is an important part of the logistics system, and its location is an important issue in logistics planning. Select the best one or more of the five distribution centers to achieve the goal.

Distribution center is engaged in the equipment of goods, its main cargo collection, processing, selection, distribution and other functions, in addition, the distribution center also organizes the delivery of users, to achieve a high level of sales and supply services. Distribution center is an important part of logistics, its upstream is the manufacturer, the downstream is the customer, and it plays a hub role in the whole logistics system network. Choosing a reasonable distribution center is quite necessary for a logistics enterprise. A reasonable distribution center can make the logistics system operate effectively, provide the basis and premise for the enterprise to carry out normal logistics activities, and help the enterprise to complete the distribution process in the entire logistics system with minimal transportation cost, so that logistics is no longer a simple transportation or transfer, but a distribution with optimal routes. At the same time, the reasonable choice of distribution center can bring customers faster and more convenient transportation services, reduce the transportation cost of enterprises, improve the operating profit of enterprises, improve the operation efficiency of enterprises, expand the scale of warehousing and distribution services in the future and even expand the brand effect of enterprises. Our case involves selecting the best distribution center among 5 locations, and the location problem of multiple distribution centers can be solved using the Baumol-wolfe model.

4.2 Establishing model conditions

The distance between cities is measured by a map as the main consideration for transport costs between the two places, and the following conditions are obtained. These are shown in Tables 1 to 3.

Table 1 Unit transportation cost and supply from the production base to the distribution center candidate

		D1	D2	D3	D4	D5	supply
A1		9.52	8.33	8.45	16.54	17.57	250
A2		3.86	5.78	1.18	10.82	11.13	200

Table 2 Distribution center candidate location storage costs

Candidate site	D1	D2	D3	D4	D5
Storage cost	$300G_1^p$	$300G_2^p$	$500G_3^p$	$400G_4^p$	$200G_5^p$

Table 3 Average unit distribution costs from distribution center candidate locations to distribution centers

	B1	B2	B3	B4	B5	B6	B7	B8
D1	9.13	4.5	10.34	10.68	4.77	1.49	5.57	17.53
D2	10.51	6.92	8.25	8.86	4.78	4.74	7.29	20.43
D3	11.28	1.65	10.46	10.56	7.92	2.51	7.54	18.11
D4	2.65	9.94	16.56	17.28	3.67	7.69	2.74	13.13
D5	1.12	9.51	18.12	18.53	5.54	7.95	2.57	10.69
Quantity demanded	80	70	75	40	50	25	30	40

4.3 Add emergency factors

We assume that the first distribution center, the Hefei distribution center, has the epidemic, so we assign the unit freight of the two factories to the Hefei transit center and the unit freight of the Hefei transit center to the eight destinations as 99.These are shown in Tables 4 to 6.

Table 4 Unit transportation cost and supply from production base to distribution center candidate location

		D1	D2	D3	D4	D5	supply
A1		99	8.33	8.45	16.54	17.57	250
A2		99	5.78	1.18	10.82	11.13	200

Table 5 Distribution center candidate location storage costs

Candidate site	D1	D2	D3	D4	D5
Storage cost	$300G_1^p$	$300G_2^p$	$500G_3^p$	$400G_4^p$	$200G_5^p$

Table 6 Average distribution cost per distribution center candidate to each distribution center

	B1	B2	B3	B4	B5	B6	B7	B8
D1	99	99	99	99	99	99	99	99
D2	10.51	6.92	8.25	8.86	4.78	4.74	7.29	20.43
D3	11.28	1.65	10.46	10.56	7.92	2.51	7.54	18.11
D4	2.65	9.94	16.56	17.28	3.67	7.69	2.74	13.13
D5	1.12	9.51	18.12	18.53	5.54	7.95	2.57	10.69
Quantity demanded	80	70	75	40	50	25	30	40

4.4 Calculation and modeling

(1) Find the initial solution

According to Table 4 and Table 6, the minimum transportation cost $C_{ik}^{0}$from the production base to each sales place is calculated and the candidate place is selected.As shown in Table 7.

Table 7 The minimum transportation cost from the production base to each place of sale

	B1	B2	B3	B4	B5	B6	B7	B8
A1	(D5)18.62	(D3)10.1	(D2)16.58	(D2)17.19	(D2)13.11	(D3)10.96	(D2)15.62	(D5)26.56
A2	(D5)12.25	(D3)2.83	(D3)11.64	(D3)11.74	(D3)9.1	(D3)3.69	(D3)8.72	(D3)19.29

After the initial calculation, it is found that the distribution center D1 and D4 are no longer considered, and the initial solution is obtained. As shown in Table 8.

Table 8 Initial solution

	B1	B2	B3	B4	B5	B6	B7	B8	supply
A1	(D5)45		(D2)75		(D2)50			(D3)80	250
A2	(D5)35	(D3)70		(D3)40		(D3)25	(D3)30		200
Quantity demanded	80	70	75	40	50	25	30	80	

(2) Find the second solution

According to the results of the initial solution, the throughput of each candidate location of the distribution center can be summarized and then further calculated c_{ik}^{1}. Storage rates at transit centers are calculated by the formula $w_j=\frac{\mu_j}{2\sqrt{G_j}}$. The results are shown in Table 9.

Table 9 Distribution center candidate site throughput 1 and storage Rate1

Candidate site	D1	D2	D3	D4	D5
Handling capacity	0	125	175	0	80
Storage rate	M	17.89	18.9	M	16.77

Then, according to the calculated storage rate, the minimum transportation cost is obtained by adding up the unit transportation cost c_{ik}^{1}, and the second solution is obtained. These are shown in Tables 10 to 11.

Table 10 Minimum transportation cost C_{ik}^{1} from production base to each sales place

	B1	B2	B3	B4	B5	B6	B7	B8
A1	(D5)35.46	(D3)29	(D3)38.81	(D2)35.08	(D2)31	(D3)29.86	(D2)33.51	(D5)45.03
A2	(D5)29.02	(D3)21.73	(D3)30.54	(D3)30.64	(D3)28	(D3)22.59	(D3)27.62	(D3)38.19

Table 11 Second solution

	B1	B2	B3	B4	B5	B6	B7	B8	supply
A1	(D5)80				(D2)50	(D3)10	(D2)30	(D5)80	250
A2		(D3)70	(D3)75	(D3)40		(D3)15			200
Quantity demanded	80	70	75	40	50	25	30	80	

Continue the iterative calculation, these are shown in Tables 12 to 18.

Table 12 Distribution center candidate throughput 2 and storage rates 2

Candidate site	D1	D2	D3	D4	D5
Handling capacity	0	80	210	0	160
Storage rate	M	22.36	17.25	M	11.86

Table 13 Minimum transportation costs C_{ik}^{2} from the production base to each place of sale

	B1	B2	B3	B4	B5	B6	B7	B8
A1	(D5)30.55	(D3)27.35	(D3)36.16	(D3)36.26	(D3)33.62	(D3)28.21	(D5)32	(D5)40.12
A2	(D5)24.11	(D3)20.08	(D3)28.89	(D3)28.93	(D3)26.35	(D3)20.94	(D5)25.56	(D5)33.68

Table 14 Third solution

	B1	B2	B3	B4	B5	B6	B7	B8	supply
A1	(D5)80		(D3)60				(D5)30	(D5)80	250
A2		(D3)70	(D3)15	(D3)40	(D3)50	(D3)25			200
Quantity demanded	80	70	75	40	50	25	30	80	

Table 15 Distribution center candidate throughput 3 and storage rates3

Candidate site	D1	D2	D3	D4	D5
Handling capacity	0	0	260	0	190
Storage rate	M	M	15.5	M	10.88

Table 16 Minimum transportation costsC_{ik}^{3} from the production base to each place of sale

	B1	B2	B3	B4	B5	B6	B7	B8
A1	(D5)29.57	(D3)25.6	(D3)34.41	(D3)34.51	(D3)31.87	(D3)26.46	(D5)31.02	(D5)39.14
A2	(D5)23.13	(D3)18.33	(D3)27.14	(D3)27.18	(D3)24.6	(D3)19.19	(D5)24.58	(D5)32.7

Table 17 Fourth solution

	B1	B2	B3	B4	B5	B6	B7	B8	supply
A1	(D5)80		(D3)60				(D5)30	(D5)80	250
A2		(D3)70	(D3)15	(D3)40	(D3)50	(D3)25			200
Quantity demanded	80	70	75	40	50	25	30	80	

Table 18 Distribution center candidate site throughput 4 and storage rates4

Candidate site	D1	D2	D3	D4	D5
Handling capacity	0	0	260	0	190
Storage rate	M	M	15.5	M	10.88

According to tables 18 and 15, compared with the third solution and the fourth solution, it is found that the throughput of the transshipment center does not change. So the fourth solution is the final solution. Finally, among the 5 candidate locations, D3 and D5 are selected as the distribution locations of the distribution center, namely Hangzhou and Tianjin.

5 Considers Epidemic Prevention Factors Based on Transport Problems

5.1 Model building

Based on the previous background problems, we use the transport problem to further select the site selection.

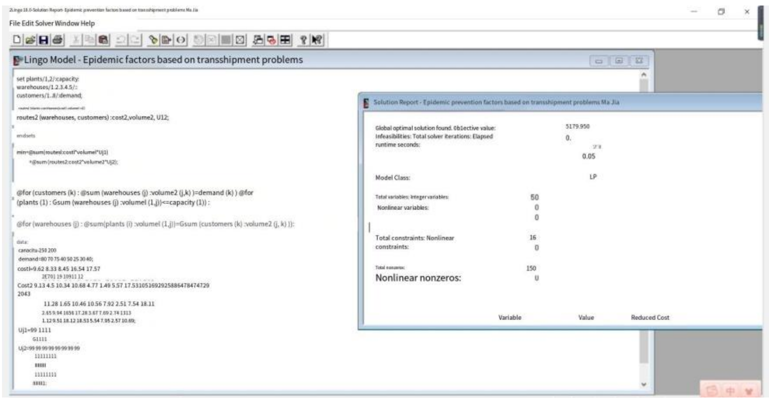

Figure 1. Add a preventive factor based on transit problems1

Objective function:

Cost represents the unit freight, volume represents the volume, and U_{ji} (i=1,2) in the code is the epidemic prevention factor we added on the basis of the original transport problem, which is a variable of 0-1. When there is no epidemic in the transport center, U_{ji} is 1, and when there is an epidemic, we take a larger number and assign it a specific value of 99. It multiplies cost and volume to minimize as the objective function. Its essence is to increase the distribution cost of transit centers with epidemic situations. Under the condition that the objective function minimizes freight costs, epidemic situations with higher costs will be automatically avoided to achieve epidemic prevention.As shown in Figure 1.

5.2 Setting a comparison group

We also set up a comparison group to compare the transport model without adding the U_{ji} variable of the epidemic prevention factor. The final solution of his process is as follows,As shown in Figure 2.

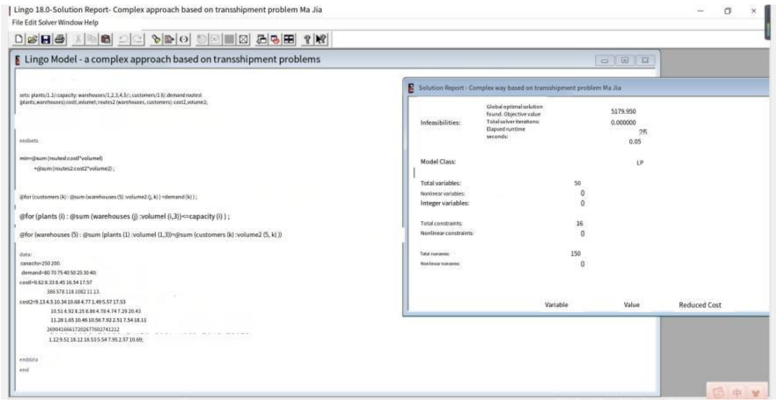

Figure 2 The control group of epidemic prevention factors was not included because of the transport problem

It can be seen that the value of the optimal solution is the same, because Hefei, the first transit center we set up, has an epidemic situation, and even without considering the epidemic situation here, we did not choose Hefei as the distribution center, because it did not achieve the minimum total freight cost compared with other transit centers. Let's change the data, assuming D2 and D4 have an epidemic situation, and the specific results are as follows,As shown in Figure 3.

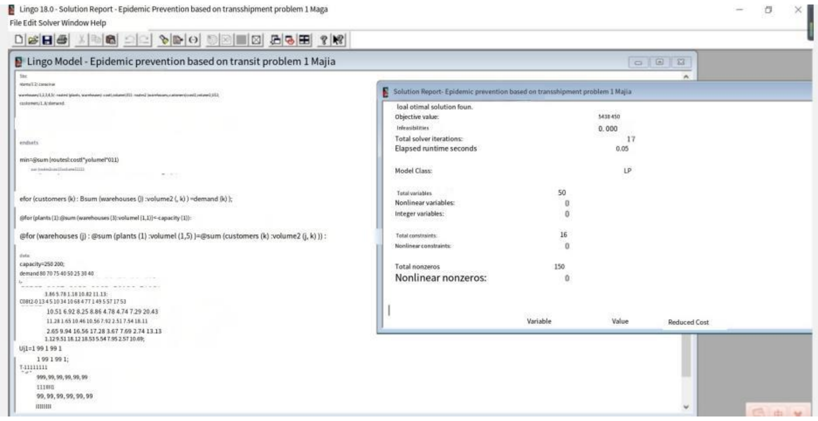

Figure 3 Add a preventive factor based on transit problems2

It can be seen that the optimal solution changed from 5179.950 to 5438.450, which indicates that after considering the emergency factors, we avoided the D2 and D4 transit centers that could have optimized the total freight on the road, and paid a certain amount of emergency costs, but the enterprise gained a sense of social responsibility and made contributions to our emergency prevention and control.

5.3 Analyze the data and draw conclusions

Next, let's look at our first transport problem model, which considers Hefei as the site selection after the epidemic point. Analysis of some lingo results:

VOLUME1(1, 2) 165.0000

VOLUME1(1, 5) 45.00000

VOLUME1(2, 3) 165.0000

VOLUME1(2, 5) 35.00000

This is the result of volume1 in route1, volume1(i,j), which represents the volume from factory i to transfer center j. The volume of volume1 with 0 is omitted here, because it means that a factory does not take the road to the transfer center, that is, a transfer center is not selected. The same goes for volume2.

VOLUME2(2, 3)	75.00000
VOLUME2(2, 4)	40.00000
VOLUME2(2, 5)	50.00000
VOLUME2(3, 2)	70.00000
VOLUME2(3, 6)	25.00000
VOLUME2(3, 7)	30.00000
VOLUME2(3, 8)	40.00000
VOLUME2(5, 1)	80.00000

As a result, we finally selected three sites, namely D2,D3 and D5, as well as Wuhan, Hangzhou and Tianjin.

Compared with the location selection of the Baumol-wolf e model, we have set a unified epidemic point, Hefei is the transit center with the epidemic, so Hefei does not appear in the final site selection, and the site selection of the transit center model is more than one Wuhan, and also gives the specific transport volume in the transit road. Finally, the location selection results of the two models were combined, and we chose Hangzhou and Tianjin where they overlapped as the final location of our problem.

6 Conclusion

In conclusion, the integration of computer-related technologies has significantly augmented the effectiveness of the Baumorwalf model in addressing the location of transit centers under emergency prevention and control. Through the utilization of Geographic Information Systems and optimization algorithms, the model not only balances the exigencies of epidemic containment and transport efficiency but also provides logistics enterprises with robust and actionable solutions. The validation of the Baumorwalf model through LINGO simulation of transport problems and comparison with real-world outcomes underscores its applicability and accuracy in epidemic prevention and control scenarios. As the global logistics industry continues to navigate the complexities of public health emergencies, leveraging such computational tools remains imperative for informed decision-making and resilient logistical infrastructure.

7 Outlook

Although predecessors and this study have made some progress, there are still some problems and countermeasures that can make the study more perfect:

(1) Multi-scenario adaptation: This study focuses on responding to major public health emergencies, but future emergencies may be diverse. In the future, the location problem under multiple scenarios can be considered to improve the universality of the model.

Model prediction and evaluation mechanism can be established: a scene-aware prediction model can be established to predict the emergency location needs under different scenarios. Design evaluation mechanism, evaluate the performance of the model in different scenarios, and find and solve problems in time.

(2) Comprehensive consideration of social factors: Previous studies focused more on technical and economic aspects, and did not fully consider the impact of social factors on site selection. In the face of sudden major events, the emergency location can be taken into account.

Social factors can be divided into specific subcategories, such as population density, community structure, and distribution of sensitive facilities.

Then data collection and integration: Collecting high-quality data on social factors, including censuses, traffic flows, medical resources, etc. Use advanced technology to integrate various types of data to ensure that multiple aspects of information are considered.

Secondly, social factors can be weighted to reflect their importance in emergency situations. Use professional opinions, community feedback and other ways to obtain weight information.

In addition, we can also participate in community feedback: introduce a community participation mechanism to obtain residents' opinions and suggestions on emergency site selection, and enhance the practical applicability of site selection decisions.

Finally, a real-time update and feedback mechanism is introduced: a real-time update mechanism is established to obtain the latest data of social factors in time, evaluate and correct the performance of location decision making, and ensure its continuous optimization.

(3) Processing of information uncertainty: In emergency situations, information uncertainty is a common problem. It is an important task for future research to study how to deal with information uncertainty effectively and improve the prediction accuracy of the model. To optimize the shortcomings of the location selection model on information uncertainty, the following aspects can be considered:

Introduction of risk assessment model: Establish a comprehensive risk assessment model for assessing the risks of site selection decisions. This model can take into account various uncertain factors, such as market fluctuations, competitor behavior, etc., to help reduce the impact of uncertainty on location decision.

Adopt probabilistic models: Use probabilistic models to quantify uncertainty rather than simply treating it as a definite value. Through probabilistic models, the range and possibility of uncertainty can be better understood, so as to make more informed choices in location decisions.

Flexible decision making strategies: Consider adopting flexible decision making strategies, such as implementing adaptive location decisions, that is, maintaining flexibility in the location selection process and adjusting decisions in response to changing information and circumstances.

Multi-factor analysis: Multi-factor analysis is carried out to comprehensively consider various factors that may affect site selection, including market demand, transportation convenience, population distribution, etc. Through comprehensive analysis, we can reduce the influence of some uncertainties on location decision.

Using decision tree and other tools: Using decision tree and other tools to systematically evaluate and compare different location decision schemes, taking uncertainties into account, so as to select the best location scheme.

(4) Cross-regional collaborative management and resource allocation: With the expansion of the logistics network, the location of the transit center may be more and more, and the emergency location of the transit center is the same. Regardless of whether there is an emergency, cross-regional collaborative management will greatly improve the management and site selection efficiency of our transit center. However, considering the emergency site selection of the transit center, our management difficulty may increase. For example, if there is a special situation at a site selection point, it is necessary to cooperate with other site selection points for emergency response. It may cause a lot of inconvenience to our managers. The mutual resource allocation involved in the selection of different transit center sites is also based on cross-regional collaborative management. Therefore, future research should pay more attention to the cooperative management and resource allocation among multiple regions in order to establish a more efficient transport network.

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