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Integrated Application and Improvement of Selection Method of Storage Sales Industry

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Abstract
In recent years, in order to adapt to the rapid development of the warehouse-storage sales industry and to solve the problems of location cost and efficiency and optimization of the methods of the new retail store, we have integrated and innovated the barycenter method and grey correlation method, and analyzed the grey correlation method with the weight obtained by the comprehensive analysis. In order to achieve the optimal cost effect, we choose the optimal solution from several alternative address schemes. It is found that using the integrated method as the reference standard for the location calculation of Warehouse Logistics Enterprises under the new retail background is helpful to improve the accuracy rate, and reduce the defects and defects caused by the independent use of the various methods, and adapt to the more practical and concrete conditions of the location selection of warehouse storage enterprises. At the same time, it is also an innovative attempt to cross discrete and continuous boundaries.

Key words: Warehouse sales; Weighted set coverage; Focus approach

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INTRODUCTION

With the rapid development of China's warehouse sales industry, a number of warehousing sales industries that are fully functional and integrated into the integrated service of the supply chain stand out. The ministry of commerce issued the guidance on promoting the transformation and upgrading of the warehousing industry, which encouraged warehouse enterprises to adapt to the development requirements of modern circulation modes such as chain operation and e-commerce, and carried out warehouse retail. Overall, our traditional mode of operation of warehousing is not a fundamental change, and warehouse automation, standardization and informatization management is still at the lower levels, which caused our country circulation enterprises inventory time that is too long and ties up too much money. The "new retail" mode of online and offline needs to be solved, and the warehousing problem in the retail industry is extremely urgent due to the low level of informatization, automation and standardization. From the perspective of method, the quantitative siting method has not been combined too much, and the loss caused by the wrong location is great. At the moment, more than one number of sites are selected and no change in requirements is considered. However, the actual RDC location needs to be more dynamic and practical. There are few methods for selecting the location and methods but can be specific to warehouse sales. With the expansion of the market and the dynamic change of transportation and demand, the site will also change. The correct location of the site is not only decisive for the overall operation cost of the new retail company, but also plays an important role in the whole supply chain. Establishing the correct distribution center is beneficial to cost savings and efficiency.

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Lu and Zhan (2000) are analyzing the center of gravity method commonly used in single distribution center, and it is considered that the center of gravity method is wrong, and the reason is analyzed and the solution is given. Aickelin (2002) presents a new type of genetic algorithm for the set covering problem, the actual solutions are found by an external decoder function. The genetic algorithm itself provides this decoder with permutations of the solution variables and other parameters. The decoder will not directly seek out low cost solutions but instead aims for good exploitable solutions. These are then post-optimised by another hill-climbing algorithm. Although seemingly more complicated, we will show that this three-stage approach has advantages in terms of solution quality, speed and adaptability to new types of problems over more direct approaches. Liu (2012) proposed an interval grey number prediction model based on the number of contacts, which was only applicable to the real sequence and could not be used for the modeling of interval grey number sequences. By converting the interval grey number sequence to contact number sequence, and couplet coefficient sequence with the sequence and different sequence grey prediction model is set up respectively, and then the model value reduction for interval grey Numbers, so as to realize the simulation and prediction of interval grey number sequences, the mode provides a new forecasting method for the dynamic demand of RDC.

1. PROBLEM AND METHOD DESCRIPTION

1.1 Overview of the Problem

The market covers seven cities in the central and southern region. It is known of the company's cargo volume and demand, transportation rate, etc. to find suitable cities to build.

1.2 Method Integration Feasibility Analysis and Integrated Use Principle

The center of gravity method is as close as possible to the large number of branches, so that the larger goods can travel relatively short distances in order to save transportation costs. Set covering model can be used to make the enterprise with the minimum number of services to cover all of the requirements can point to a certain extent, reduce the underground logistics system construction in the early huge investment cost and construction difficulty, reduce the cost of enterprises to establish service facilities, so as to improve the speed of the corresponding requirements; the grey correlation analysis is small, and the sample size and sample size are equally applicable, and the results of the quantitative results are not inconsistent with the qualitative analysis results.

The use of the principle as alternative site data needs to be investigated, while the requirements and requirements of each location are known.

1.3 Insufficient Analysis

Grey correlation analysis is affected by P values (P for distinguish coefficient, main while excessive Δ Max correlation coefficient of distortion effects), different P values have different results, can appear even reverse phenomenon, at the same time also can better describe the similar degree between the curve. Secondly, the selection of indicators is too qualitative and lack of quantitative verification. The demand is uncertain, because the season, marketing policy and so on change, and this article cannot reflect this trend; the site selection of RDC will also be influenced by factors such as competitors or national policies. However, this paper only analyzes the factors that affect the location of RDC, and has certain limitations.

2. EMPIRICAL ANALYSIS

2.1 The Center-of-Gravity Method

2.1.1 Basic Assumptions

The transportation cost is related to the linear distance between the distribution center and the demand point, regardless of the urban traffic condition, and the transport rate does not vary with the transport distance. Other costs, such as the construction cost of distribution center, are not considered. Assuming that customer demand comes from some point, the actual customer demand originates from multiple points in one region.

2.1.2 Model Establishment

K is the demand point $Pj(x_k,y_k)$, $k \subset K$, the location coordinates are $P_0(x_0,y_0)$, the transportation rate is a_k, and the traffic volume is w_k, so the minimum coordinate p_0 of transportation expense is requested.

$$\text{MinF}=\text{Min}\sum a_k w_k d_k,$$

$$d_k=\sqrt{(x_0-x_k)^2+(y_0-y_k)^2},$$

$$x_0=\frac{\sum a_k w_k x_k / d_k}{\sum a_k w_k / d_k}, y_0=\frac{\sum a_k w_k y_k / d_k}{\sum a_k w_k / d_k}.$$

Because (x_0, y_0) contains the unknown quantity, so we first calculate the initial value and gradually iterate until $T^{j+1} \geq T^j$:

(a) Ignoring, the initial coordinates of the location facility are obtained:

$$X_{01}=\frac{\sum a_k w_k x_k}{\sum a_k w_k},$$

$$y_{01}=\frac{\sum a_k w_k y_k}{\sum a_k w_k}.$$

(b) Substitute (X_{01}, y_{01}) into d_k to calculate d_{k0} and then substitute d_{k0} into T to calculate T_0.

(c) Iterative calculation of d_k and T, until $T^{j+1} \geq T^J$.

2.1.3 Example Analysis

Seven cities known coordinates, and the demand of each point, need to establish a distribution center *P* for seven node distribution, transport rate is fixed, to calculate where is the most economic and reasonable. The above calculation can be realized with excel:

(a) Input the initial data

Table 1
The Initial Data

Node	Coordinates		Traffic volume *Wk* (kg)	Transportation rate *Ak* (rmb/kg·km)
	X coordinates	Y coordinates		
	2,511,475	726,955.5	62,513.22	0.28
Wuhan	3,866,764	606,555.4	67,411.26	0.28
Changsha	3,138,420	582,952.9	63,824.46	0.28
Guangzhou	3,408,940	701,014	86,694.72	0.28
Nanning	3,138,420	582,952.9	48,116.04	0.28
Haikou	2,525,233	139,912.2	40,131	0.28
Shenzhen	2,220,741	334,446.7	84,081.06	0.28

(b) Calculate the initial coordinates

Table 2
The Initial Coordinates

Node	Coordinates		Traffic volume Wk (kg)	Transportation rate Ak (rmb/kg·km)	p	
	X Coordinate	Y Coordinate			X	Y
Zhengzhou	2,511,475	726,955.5	62,513.22	0.28	298,7332	543,538.1
Wuhan	3,866,764	606,555.4	67,411.26	0.28		
Changsha	3,138,420	582,952.9	63,824.46	0.28		
Guangzhou	3,408,940	701,014	86,694.72	0.28		
Nanning	3,138,420	582,952.9	48,116.04	0.28		
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(c) Planning and solving

With the goal of the minimum total transportation cost, repeated iteration and the coordinate of the most economical and reasonable distribution center are obtained.

Table 3
Target Cell (Minimum)

	Name	Initial value	Final value
G35	Ti Sum	66,988,807,279	64,552,028,373

Table 4
Variable Cell

	Name	Initial value	Final value	Integer
I15	X	2,987,331.941	3,093,101.264	Constraint
J15	Y	543,538.0954	550,519.1718	Constraint

Finally, the distribution center coordinates (3093101.264, 550519.1718) were obtained.

2.2 Grey Correlation Analysis

Using grey correlation analysis of Zhengzhou, Wuhan, Changsha, Guangzhou, Nanning, Haikou, Shenzhen seven cities to evaluate the total cost, the evaluation indicators include: transportation costs, land costs, resource costs, labour costs.

2.2.1 Indicators Description

Transportation costs include transportation costs and the costs incurred during transportation; Land cost is the lease, purchase or construction cost of RDC; the resource cost includes the purchase and maintenance of the infrastructure, the use of water and electrical resources, etc. The labor cost is the sum of the wages paid to the workers. Through investigation and overcoming the subjective conditions, multiple cases are verified and analyzed, and the weight can be used to reflect the general situation.

2.2.2 Calculation

The following table can be obtained from the dimensionless processing of the original data.

Table 5
The Original Data

		Transportation costs	Land cost	Resource costs	Labour costs
X_1	Zhengzhou	1	6	4	7
X_2	Wuhan	4	4	7	5
X_3	Changsha	8	8	6	5
X_4	Guangzhou	9	2	8	3
X_5	Nanning	5	9	3	9
X_6	Haikou	3	6	5	6
X_7	Shenzhen	7	1	8	3

Determine the reference series: $\{X_0\}=\{9,9,8,9,8\}$

To calculate difference I $X_0(k)$—$X_i(k)$I, As shown in the following table:

Table 6
The Calculated

	Transportation costs	Land cost	Resource costs	Labour costs
X_1	8	3	4	2
X_2	5	5	1	3
X_3	1	1	2	3
X_4	0	7	0	5
X_5	4	0	5	0
X_6	6	3	3	3
X_7	2	8	0	6

$$§_{i(k)} = \frac{\triangle(\min)+\rho\triangle(\max)}{\triangle_{0i}(k)+\rho\triangle(\max)}.$$

P is the resolution coefficient, generally between 0 and 1, usually 0.5; Δ min is the second smallest, Δ Max is two levels of biggest difference; Δ oi (k) is the absolute difference value between the comparative sequence Xi each point on the curve and the reference sequence X0 curve of each point; by the absolute difference value form, Δ min = 0, Δ Max = 8. Use the formula to calculate available $§_{i(k)}$ to form is as follows:

Table 7
The Result

	$§_{i(1)}$	$§_{i(2)}$	$§_{i(3)}$	$§_{i(4)}$
X_1	0.333	0.571	0.5	0.667
X_2	0.444	0.444	0.8	0.571
X_3	0.8	0.8	0.667	0.571
X_4	1	0.364	1	0.444
X_5	0.5	1	0.444	1
X_6	0.4	0.571	0.571	0.571
X_7	0.667	0.333	1	0.4

By the method of AHP, the weight of transportation cost, land cost, resource cost and labor cost is 0.56, 0.26, 0.12 and 0.06. And CR=0.04<0.1, which is consistent. The value of correlation coefficient of each index of each city is calculated respectively:

R_{01} =0.44 R_{02} =0.49 R_{03} =0.77 R_{04} =0.80 R_{05} =0.65 R_{06} =0.48 R_{07} =0.60

$$R_{04} > R_{03} > R_{05} > R_{07} > R_{02} > R_{06} > R_{01}$$

The closer the final correlation coefficient is to 1, the closer it is to the participating data, and the more cost advantage. So its most cost advantage is Guangzhou, in order to Changsha, Nanning, Guangzhou, Wuhan, Haikou, Zhengzhou.

2.3 The Weighted Set Coverage Method

Table 8
City List

Number	1	2	3	4	5	6	7
Urban	Zhengzhou	Wuhan	Changsha	Guangzhou	Nanning	Haikou	Shenzhen

Table 9
Distance Between Cities (Meet the Range of 650 km in Red.)

	Zhengzhou		Wuhan		Changsha		Guangzhou		Nanning		Haikou		Shenzhen	
	Distance	Time	Distance	Time	Distance	Time	Distance	Time	Distance	Time	Distance	Time	Distance	Time
Zhengzhou	0	0	472	6	729	10	1,292	17	14,23	20	1,671	24	1,359	18
Wuhan	472	6	0	0	295	5	838	12	1,046	15	1,247	19	897	13
Changsha	729	10	295	5	0	0	568	8	758	10	952	15	642	10
Guangzhou	1,292	17	838	12	568	8	0	0	504	7	466	9	104	3
Nanning	1,423	20	1,046	15	758	10	504	7	0	0	362	8	585	9
Haikou	1,671	24	1,247	19	952	15	466	9	362	8	0	0	487	10
Shenzhen	1,359	18	897	13	642	10	104	3	585	9	487	10	0	0

Table 10
Coverage Situation

Location point	Meet the range of 650 km (No More Than 8 Hours.)
1	1, 2
2	1, 2, 3
3	2, 3, 4
4	3, 4, 5, 7
5	4, 5, 6
6	5, 6
7	4, 7

The collection coverage problem is transformed into a bipartite graph based on the coverage table.

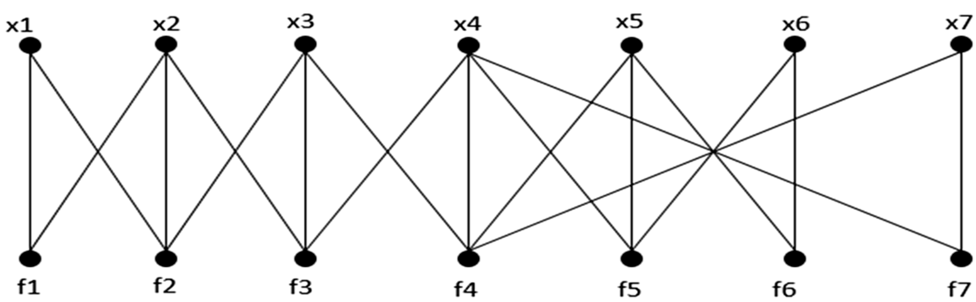

Figure 1
The Trend of Economic

Mathematical symbol:

In order to facilitate the description, the following symbols are defined in addition to the symbols defined in the problem profile and problem transformation:

"g" represents the number of nodes in the vertex class X in the node set in the binary graph G; M represents the number of nodes in the set class F in the node set in the binary graph G; N = g + m represents the total number of nodes in the binary graph; d(vi) denotes the degree of node vi, whose value is the number of bars associated with vi; N(vi) represents the adjacent point set of vertex vi in the binary graph, and

$$N(vi) = \{ vj \mid (vi, vj) \in E \}$$

represents the weight of subsets fi in subset F; Φ said an empty set. According to the results of grey relational grade, the cost weight of f1-f7 is as follows:

$w(f_4)<w(f_a)<w(f_5)<w(f_7)<w(f_2)<w(f_6)<w(f_1)$.

After converting to binary image, the result is accurate to solve the algorithm WMSC, and finally get the optimal distribution center at 2,4,5 points.

In conclusion, siting cities are Guangzhou, Wuhan and Nanning.

2.4 Gray Forecast Demand

In the case of no demand data, an algorithm should be innovatively added, which is to convert the original data into the grey prediction model of interval grey. Finally, the model value is reduced to the interval grey number, so as to realize the prediction of interval grey number sequence. However, this requires the sales data (including minimum and maximum values) of each candidate RDC in recent years. Suppose the demand for M site for nearly four years is:

Table 11
The Capitals Asset

	2014	2015	2016	2017
Maximum	b_1	b_2	b_3	b_4
Minimum	a_1	a_2	a_3	a_4

Make A = A, B = B - A

(a) Will the interval grey number sequence $X(\otimes)=([a_1,b_1],[a_2,b_2],[a_3,b_3], [a_4,b_4])$.

Convert to contact number sequence:

U = {a1 + (b1 - a1) I, a2 + b2 - a2), a3 + (b3 - a3) I, a4 + (b4 - a4) I}.

The same sequence is A=(A1, A2, A3, A4)=(A1, A2, A3, A4).

B=(B1, B2, B3,B4)=(b1-a1, B2 -a2, b3-a3, b4-a4).

(b) The grey GM(1,1) prediction model was established for the same sequence and the other sequence.

i. It is suggested to generate series of sequences at a time.

$X^{(0)}=(a_1, a_2, a_3, a_4) \rightarrow X^{(1)}$
$=(a_1, a_1+a_2, a_1+a_2+a_3, a_1+a_2+a_3+a_4)$.

ii. Use the least square method for parameter a.u.

$$B=\begin{bmatrix} -1/2[X^{(1)}(1)+X^{(1)}(2)] \\ \mathbf{-1/2[X^{(1)}(2)+X^{(1)}(3)]} \\ -1/2[X^{(1)}(3)+X^{(1)}(4)] \end{bmatrix} = \begin{pmatrix} -a_1-0.5a_2 \\ \boldsymbol{-a_1-a_2-0.5a_3} \\ -a_1-a_2-a_3-0.5a_4 \end{pmatrix}.$$

$$Y = [X^{(1)}(2), X^{(1)}(3), X^{(1)}(4)]^T = [a_1+a_2, a_1+a_2+a_3, a_1+a_2+a_3+a_4]^T.$$

iii. Calculate AK's value.

Finally, $A_k=(a_1\text{-}u/a)(1\text{-}e^a)e^{-a(k-1)}$ K=1,2,3,4...n.

Among them: $\hat{a}=[a,u]^T=(B^TB)^{-1}B^T y_n$.

By the same calculation, $B_K=((b_1\text{-}a_1)\text{-}u/a)(1\text{-}e^a)e^{-a(k-1)}$.

Among them: $\hat{a}=[a,u]^T=(B^TB)^{-1}B^T y_n$.

iv. Simulation prediction of interval grey number sequence:

$\oplus k \in [a_k,b_k]$, Among them $a_k=A_k$, $b_k=A_k+B_k$, k= 1,2...n.

v. Accuracy test of grey prediction model. The method of inspection has residual test. The correlation degree test, the post-residual test, the previous paper has been very detailed introduction, this article is not detailed here.

vi. If qualified, the model can be used for prediction.

2.5 Discussion and Conclusions

This method integration is to integrate and improve the method for the location of warehouse sales. In this way, discreting site selection and continuous site selection can be used in combination with priority use of gravity method to determine the location of main RDC. On the one hand, the distance between each demand point and the RDC is different, and the arrival time is different. If the warehouse delivery is not timely, the order will be affected. On the other hand, with the continuous increase of orders, the total of RDC warehouse capacity is so limited that the time requirements of RDC replenishment operation are extremely high. So considering the set covering method to determine the location of the emergency RDC improves the distribution efficiency. At the same time, because the final location may have multiple optimal solutions, the cost advantage of each known is analyzed through the grey relational analysis method to determine the final unique solution, to realize the combination and innovation of the method, and as a new reference for site selection in dynamic environment; Avoiding the lack of flexibility in the polymorphism and collection coverage method in the center of gravity method, and combining with the actual situation, the warehouse seller can better reduce the cost and improve the profit and efficiency. At the same time, the demand and supply quantity are considered innovatively, and the demand point is considered in the reform, which is more applicable and universal. Through this integration method, the multi-solution set is filtered to achieve the integration effect of cost optimization and efficiency maximization, so as to combine theory with practice effectively.

It is suggested that this method should be used to cross discrete and continuous boundaries, to think in multiple perspectives, and to provide a new solution for the warehouse sales industry. In addition, it is suggested to quantify the P value of the gray associated fans based on this method, which is to take different values for different ranges. The indexes that affect the location of RDC should be filtered according to the actual application environment, including competitors, politics and other factors. The scale of emergency RDC should consider the seasonal cycle fully, and it can be considered to take the outsourcing measures during the peak cycle to ensure the maximization of profit and save logistics resources.

The traditional sitting method can not adapt to the development of new retail, and the proposed method can provide a new way to solve the problem of the location of the warehouse selling industry. First of all, using gravity method to choose the RDC meets the requirements of each point on the distance to the main RDC demand and the general time, when the main RDC turnover ability is insufficient, the location of the emergency RDC determined by the set covering method, improves the efficiency of distribution operation, finally through analysis of known and unknown factors by the grey correlation, the only solution to be determined as the most cost-competitive solution.

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