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Research on Ordering and Transportation Strategy of Supply Chain Enterprises Based on AHP Analytic Hierarchy Process and Entropy Weight Method

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Abstract: *With the intensification of market competition, the improvement of the efficiency of enterprise logistics supply chain is becoming more and more important to improve the net profit of enterprises. Therefore, it is a research direction of both theoretical significance and practical value to study how to choose the best supplier and make order transportation decision. Therefore, this paper establishes a reasonable supplier selection index system to select the 50 most important suppliers, and first selects 5 secondary indicators and 12 tertiary indicators. Then, based on the Pauta criterion, the abnormal suppliers are excluded by the average supply difference; secondly, this paper uses AHP analytic hierarchy process to weight the second-level index, calculates the comprehensive weight based on three weight calculation methods and uses entropy weight method to weight the third-level index, so as to establish the supplier selection index system; then through the fuzzy comprehensive evaluation model to calculate the score of each supplier, so as to get the top 50 suppliers.*

Keywords: *Ordering and transportation, Pauta criterion, Fuzzy comprehensive evaluation model*

1. Introduction

The concept of supply chain management (SCM) was put forward by Michael Portalti in the 1980s. The supply chain [1] includes a series of links, such as the purchase of raw materials, the transportation of raw materials, the storage of raw materials, the processing of finished products, the storage of finished products, the sale of finished products, and so on. It also includes sales ports and consumer terminals. How to select the best raw material supplier and formulate the optimal raw material ordering and transportation plan is of great theoretical and practical significance. This paper takes the production enterprise of a construction and decorative plate as the research object, determines the best supplier of the production enterprise, and studies the ordering and transportation scheme of the raw materials of the enterprise [2].

This paper sets up that the raw materials used by the production enterprises can be divided into three categories A, B and C, and the production is arranged according to 48 weeks every year, and the raw material ordering and transfer plan needs to be made 24 weeks in advance. The weekly production capacity of the enterprise is fixed at 28200 cubic meters, and the demand for different raw materials per cubic meter of products is different.

2. Supplier importance evaluation index system based on AHP

2.1. Selection of evaluation indicators

The direct purpose of supplier evaluation is to comprehensively understand and evaluate the actual supply capacity [3]. The evaluation content mainly involves many aspects such as supply products, services and technology, and then analyze the supplier's ability, which is also the basis for core enterprises to select suppliers. For the supply chain of construction production enterprises in this paper, Due to the particularity of materials and the instability of supply, suppliers are the core component of their supply chain. The evaluation of suppliers mainly follows the "qcds principle" (quality, cost, delivery and service)

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and the "TQCS" principle (delivery date, quality, cost and service). Among them, supplier quality is the most important. Therefore, the supplier delivery level is established based on the supplier's perspective Supplier service level, supplier cost and supplier quality are four secondary indicators. Combined with the annex data, this paper adds the degree of enterprise dependence as an explanation of the relationship between suppliers and enterprises to the secondary overall indicator from the perspective of enterprises, so as to ensure the richness, integrity and diversity of the index system.

Ordering times and average ordering quantity can reflect the enterprise's dependence on different suppliers. The more ordering times and average ordering quantity, the greater the enterprise's dependence on the supplier. For suppliers, the more large orders they supply, the more stable the supply channel will be. When the later production capacity increases, it is more likely to provide more raw material resources. Therefore, the higher the proportion of large orders, the higher the importance of ensuring enterprise production. The specific calculation formula is as follows:

$$\mu=\frac{num(Order\ quantity>500)}{240-num(Order\ quantity=0)} \tag{1}$$

This paper considers that these three indicators are very large indicators, that is, the larger the indicator value is, and the higher the supplier delivery level is reflected. Vlookup and conutif functions are introduced to calculate the times of unsatisfied supply and the average supply difference across tables as sub indicators of the supplier's service level. The smaller the times of unsatisfied supply and the larger the average supply difference, the better the supplier's service level can be explained. Then calculate the supply error rate. Supplier quality is mainly explained by market share and satisfaction rate (i.e. meeting the supply rate of the enterprise), so the standard deviation and average value of supply quantity are calculated.

2.2. Analysis and processing of evaluation indicators

Firstly, this paper will filter and eliminate these abnormal data, and cluster the data. In order to improve the quality of data analysis [4] [5], based on the given historical data and integrating the supplier's order market and supply market, this paper adopts Pauta criterion to deal with the outliers of the data. Pauta criterion requires a column of data to conform to normal distribution or approximate normal distribution. Therefore, firstly, the scale parameters are calculated by SPSS software, and the average supply difference is selected as the reference index.

Suppose that the average supply difference is measured with equal precision, $x_1, x_2, x_3 \cdots x_n$ is obtained independently, the arithmetic mean value and residual error $\bar{x}$ are calculated, and the standard deviation, $v_i = \bar{x} - x_i$ （$i = 1, 2, \cdots 402$）is calculated based on Bessel formula. If the residual error $v_i (1 \leqslant i \leqslant 402)$ of a measured value meets the following formula:

$$|v_i| = \left| x_i - \bar{x} \right| > 3\sigma \tag{2}$$

Representation of screening results:

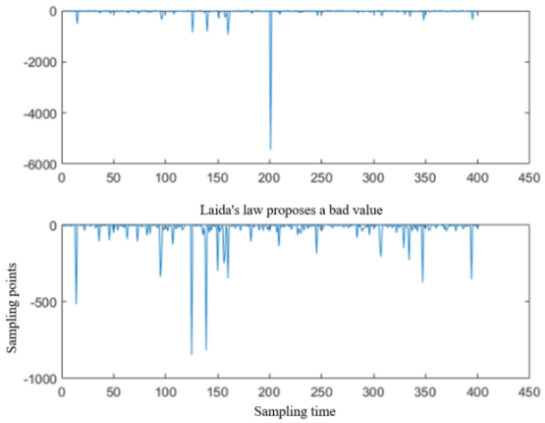

Figure 1: Sampling filter results

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Table 1: Average supply difference

Supplier ID	Material classification	Average supply difference
S160	C	-921.2205882

2.3. Determination of weight of evaluation index

Firstly, the comparison matrix between the target layer and the criterion layer is constructed, and the criterion layer contains five indicators [6].

Table 2: Reference matrix

Z-C1	Enterprise dependence	Supplier delivery level	Supplier service level	Supplier cost	Supplier quality
Degree of enterprise dependence.	1	1/3	1/3	1/3	1/5
Supplier delivery level.	3	1	1	1	1/3
Supplier service level.	3	1	1	1	1/3
Supplier cost.	3	1	1	1	1/3
Supplier quality	5	3	3	3	1

Calculate the maximum eigenvalue of the matrix $\lambda_{\max} = 5.0420$. In this paper, arithmetic average method, geometric average method and eigenvalue method are used to solve respectively. Sum up the weights obtained by different methods and calculate the average weight, as shown in the table:

Table 3: The average weight

	Arithmetic average method	Geometric average method	Eigenvalue method	Comprehensive weight
Degree of enterprise dependence.	0.0631	0.062	0.0627	0.063
Supplier delivery level.	0.165	0.1655	0.1645	0.165
Supplier service level.	0.165	0.1655	0.1645	0.165
Supplier cost.	0.165	0.1655	0.1645	0.165
Supplier quality	0.4418	0.4414	0.4438	0.442

3. Weight determination of three level index based on entropy weight method

The negative index is treated positively according to the inverted inverse transformation method, and the negative index X is treated positively.

$$x_{ij} = \max\{x_{ij}\} - x_{ij} (1 \leqslant i \leqslant n) \tag{3}$$

For positive indicators, we use the normalization method to normalize the index data, and the calculation method is as follows

$$\text{s}\, x_{ij} = \frac{x_{ij} - \min\left\{x_{ij}\right\}}{\max\left\{x_{ij}\right\} - \min\{x_{ij}} , j = 1, 2, \cdots, n \tag{4}$$

Calculate the proportion of the index value of the JTH secondary index and the ith supplier under each primary index:

$$P_{ij} = \frac{x_{ij}}{n} \tag{5}$$

Calculate the entropy value of the jth second-level indicator under each first-level indicator. According to the definition of information entropy in information theory $E_j = -\ln(n)^{-1} \sum_{i=1}^{n} p_{ij} \ln p_{ij}$, define $\lim_{p_{ij} \to 0} p_{ij} \ln p_{ij} = 0$.

The weight of each index can be obtained by calculating the information entropy through the above formula:

$$w_i = \frac{1 - E_i}{k - \Sigma E_i} (i = 1, 2, \cdots, k) \tag{6}$$

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4. Supplier selection model based on fuzzy comprehensive evaluation method

According to the three-tier comprehensive evaluation index system, a multi-level fuzzy comprehensive evaluation model is established to quantitatively analyze the importance of suppliers.

Firstly, the index evaluation set is determined:

$$U=\left\{U^{(1)},U^{(2)},U^{(3)},U^{(4)},U^{(5)}\right\},U_1=\left\{U_1^{(1)}\right\},U_2=\left\{U_1^{(2)},U_2^{(2)},U_2^{(3)}\right\}$$
$$U_3=\left\{U_3^{(1)},U_3^{(2)},U_3^{(3)}\right\},U_4=\left\{U_4^{(1)},U_4^{(2)}\right\},U_5=\left\{U_5^{(1)},U_5^{(2)},U_5^{(3)}\right\}\ldots\ldots \tag{7}$$

Then determine the alternative set, and use MATLAB to calculate the weight of the second-level index to the first-level index, and then determine the membership matrix. Carry on the data normalization processing to the known index, and carry on the first-level evaluation to the evaluation index. Here we use to express the membership degree of the I index to the supplier, which is a fuzzy evaluation subset on the alternative set. An evaluation matrix can be obtained by single-factor evaluation of the second-level index under each first-level index.

$$R=\begin{bmatrix}R_1\\R_2\\\vdots\\R_m\end{bmatrix}=\begin{bmatrix}r_{11}&r_{12}&\cdots&r_{1n}\\r_{21}&r_{22}&\cdots&r_{2n}\\\vdots&\vdots&\vdots&\vdots\\r_{m1}&r_{m2}&\cdots&r_{mn}\end{bmatrix} \tag{8}$$

Each element in represents the membership degree of the first evaluation index to the ith supplier under the first-level index, reflecting the fuzzy relationship between each evaluation index and supplier expressed by membership degree. Then, according to the weight calculated by using the entropy weight method, the single-factor evaluation matrix is multiplied by the weight distribution vector to obtain the first-order evaluation result:

$$B_i=W_iR_i=\begin{bmatrix}W_{i1}\\W_{i2}\\W_{i3}\\W_{im}\end{bmatrix}\begin{bmatrix}r_{i11}&r_{i12}&\cdots&r_{i15}\\r_{i21}&r_{i22}&\cdots&r_{i25}\\\vdots&\vdots&\vdots&\vdots\\r_{im1}&r_{im2}&\cdots&r_{im5}\end{bmatrix}=\begin{bmatrix}b_{i1}\\b_{i2}\\\vdots\\b_{im}\end{bmatrix} \tag{9}$$

Secondly, the one-factor evaluation matrix of the two-level evaluation is constructed by taking the first-level evaluation results as rows

$$B=\begin{bmatrix}B_1\\B_2\\\vdots\\B_5\end{bmatrix}=\begin{bmatrix}b_{11}&b_{12}&\cdots&b_{15}\\b_{21}&b_{22}&\cdots&b_{25}\\\vdots&\vdots&\vdots&\vdots\\b_{51}&b_{52}&\cdots&b_{55}\end{bmatrix} \tag{10}$$

The weight of the first-level index determined by us is multiplied by the above two-level single-factor matrix to obtain the membership vector of each index to the supplier, which is the final evaluation result.

Table 4: Evaluation result

ID	Score	ID	Score	ID	Score	ID	Score	ID	Score
S201	0.100	S126	0.022	S139	0.015	S161	0.007	S097	0.004
S361	0.054	S356	0.022	S160	0.014	S365	0.006	S031	0.004
S229	0.045	S306	0.022	S143	0.012	S210	0.006	S158	0.004
S140	0.038	S340	0.020	S307	0.012	S096	0.006	S055	0.004
S151	0.037	S395	0.020	S352	0.011	S074	0.005	S080	0.003
S108	0.028	S308	0.018	S037	0.011	S086	0.005	S040	0.003
S275	0.023	S348	0.017	S247	0.009	S157	0.004	S294	0.003
S268	0.023	S330	0.016	S015	0.008	S338	0.004	S364	0.003
S329	0.023	S131	0.016	S374	0.008	S335	0.004	S208	0.003
S282	0.023	S194	0.015	S284	0.007	S246	0.004	S244	0.003

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5. Conclusion

This paper studies how to select the best suppliers and make order and transportation decisions. Firstly, a reasonable supplier selection index system is established and the abnormal suppliers are excluded by the average supply difference based on the Pauta criterion. Then the second-level index is weighted by AHP Analytic hierarchy process, the comprehensive weight is calculated based on three weight calculation methods, and the third-level index is weighted by entropy weight method, and the score of each supplier is calculated by fuzzy comprehensive evaluation model, so as to get the top 50 suppliers.

References

[1] Liu Yushu. Optimal decision and contract coordination of supply chain under uncertain demand. Qingdao University, 2013.
[2] Wu Yingzi, Wu Liang, Xiao Wei. Production and ordering decision-making in supply chain under uncertain environment _ Wu Yingzi [J]. Science and Technology Innovation Guide, 2011 (32): 117.
[3] Research on supply chain risk identification and evaluation management _ Zhang Xin [J].
[4] Xu Xinsheng. Research on retailer's optimal ordering problem based on CVaR Criterion in the case of delayed delivery [D]. Zhejiang University of Technology, 2015.
[5] Xiao Juan. Research on supplier selection of government purchase pension service based on fuzzy multi-attribute decision-making model [J]. Reform and opening up, 2021 (13): 51-56.
[6] Su Xudong, Lu Wenxuan. Research on Fuzzy Comprehensive Evaluation of supply chain flexibility based on structural Entropy weight [Su Xudong]. Logistics Science and Technology, 2014, 37 (1): 101105113.