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Research on raw material ordering and transportation decision of production enterprises based on TOPSIS and analytic hierarchy process

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Abstract: Based on TOPSIS algorithm and Analytic hierarchy process (AHP), this paper focuses on solving the difficulties of ordering, supply, transshipment and production. Quantitative analysis of the supply characteristics of suppliers, comprehensively considering the risk, the total number of supplies, the cooperation between manufacturers and suppliers, the ability of manufacturers to provide raw materials and other factors, listed the supply quantity, stability rate, up-to-standard rate, trust four standards. In order to determine the weight of each standard, the team first verifies the consistency of the matrix and determines that it meets the requirements of analytic hierarchy process (AHP). Then, the eigenvalue method is used to calculate the weight, and the corresponding weights of the four items are 0.1963, 0.1962, 0.5346, 0.728, respectively. Then the TOPSIS model is established to evaluate the suppliers combined with the four standards, and through the homogenization and normalization of the data matrix, it is calculated that the closer the closeness I value is, the higher the supplier score is; finally, the Ci value is used as the comprehensive evaluation standard to rank the 402 suppliers.

1. Introduction

It is the pursuit of every production enterprise to control the production cost from the source and improve the economic benefit of the enterprise [1]. As far as enterprises are concerned, reasonable arrangement of ordering and transfer plans according to their own production capacity plays a vital role in improving the economic benefits of enterprises. For a manufacturer of building and decorative panels, wood fiber and vegetable fiber materials are generally used as the main raw materials. On the whole, these materials can be divided into three types.

Technology is the primary productive force, and the enterprise has effectively improved the potential of production capacity through technological innovation. How to improve the production capacity of enterprises is the key research direction and optimization goal of the industry.

2. Establishment of analytic hierarchy process model

Analytic hierarchy process is a more subjective evaluation method. When weighting to obtain the weight vector, it often synthesizes with the weight vector method obtained by the objective method to obtain a comprehensive weight vector for subsequent operation [2]. For the four indicators of supply quantity, stability rate, compliance rate and trust, their importance to enterprises in selecting raw material suppliers must be different. In order to determine the weight of the four indicators, the analytic hierarchy process is used to establish a model to solve the weight.

The quantity supplied can be expressed as a symbol, which is the sum of the actual supply of the supplier in one year. It can be obtained after summation by Excel. The total actual supply of a supplier in a year can reflect its production strength and the quality level of raw materials [3] [4].

The stability rate can be expressed by the symbol γ and can be obtained according to the following formula

$$\gamma = \frac{Actual\ supply - supply}{Actual\ supply} \tag{1}$$

(Used in the following calculations γ 2 for comparison)

Available symbols for compliance rate ε represents [5], which can be obtained according to the following formula:

$$\varepsilon = \frac{The\ actual\ supply\ is\ greater\ than\ the\ order}{Total\ order\ times} \tag{2}$$

Trust available symbols θ That is, the number of times the enterprise is selected in a year, and the results can be processed by MATLAB. Stable cooperation is also the recognition of a supplier.

Table 1: Calculation results of four standards of each supplier

Supplier	T(m^3)	γ^2	ε	θ(time)
S001	49	0.816	0.209	231
S002	273	0.435	0.674	309
S003	13138	0.117	0.854	14279
…	…	…	…	…
S400	53	0.895	0.167	806
S401	67	0.655	0.373	200
S402	35	0.924	0.055	958

3. Hierarchical evaluation

For multiple indicators, we can evaluate each other and determine the importance of the two events according to table 2 (assuming that the two indicators are α, β):

Table 2: Comparison of importance of two events

α/β	Meaning
1	Compared with the two indicators, they have the same degree of importance.
3	Compared with the two indexes, α is slightly more important than β.
5	Compared with the two indexes, α is more important than β.
7	Compared with the two indexes, α is much more important than β.
2,4,6,8	The degree of importance between the corresponding two numerical values

According to this standard, the table is obtained by comparing two events.The pairwise discrimination of events is used to get the matrix.

$$A\cdot=\begin{pmatrix} 1 & 1 & \frac{1}{3} & 3 \\ 1 & 1 & \frac{1}{3} & 3 \\ \ldots\ldots & & 1 & 6 \\ 3 & 3 & 1 & 1 \\ \frac{1}{3} & \frac{1}{3} & \frac{1}{6} & 1 \end{pmatrix} \tag{3}$$

λ_{max} represents the maximum eigenvalue of the matrix, which can be obtained by bringing it into the matrix for calculation λ_{max} = 4.0206, matrix order n=4.
Recalculate one-time indicator CI:

$$\mathrm{CI}=\frac{\lambda_{max}-n}{n-1} \tag{4}$$

CI = 0.0069 can be obtained by carrying in the calculation. When n=4, the corresponding average random consistency index RI = 0.89 can be found. Finally, the consistency ratio Cr is calculated.

$$\mathrm{CR}=\frac{\mathrm{CI}}{\mathrm{RI}} \tag{5}$$

The solution shows that CR = 0.0077, as required. Therefore, the matrix A The consistency is acceptable, and the weight of each index can be calculated by analytic hierarchy process. Next, the weight is calculated by eigenvalue method. The above steps have proved the matrix A Through the consistency test, it is the consistency matrix. One eigenvalue of the uniform matrix is n and the other eigenvalues are 0. At this time, the corresponding eigenvector is:

$$k\left[\frac{1}{a_{11}},\frac{1}{a_{12}},\ldots\frac{1}{a_{1n}}\right]^{T}\left(k\neq 0\right) \tag{6}$$

Therefore, after obtaining the eigenvector, we can normalize it, and then we can get the weight of each standard: ω = [0.1963 0.1963 0.5346 0.0728].

Therefore, after obtaining the eigenvector, we can normalize it, and then we can get the weight of each standard.

Table 3: Weights corresponding to the four criteria

	T	γ^2	ε	θ
Weight	0.1963	0.1963	0.5346	0.0728

4. Establishment of TOPSIS Model

In order to make all the data in the table an effect index, that is, the larger the value, the more advantageous it is to reflect this value, this requirement can be satisfied by taking γ^2 as $1/\gamma^2$. After getting the homogenized table, the 402*4 groups of data in the table are regarded as a matrix, and the matrix is normalized, and the processed data is like the table.

Table 4: Normalized data table

Supplier	T(m^3)	γ^2	ε	θ(time)
S001	0.00025	0.01727	0.00006	0.04157
S002	0.00047	0.05571	0.00032	0.04340
S003	0.00176	0.07065	0.01534	0.09091
…	…	…	…	…
S400	0.00023	0.01379	0.00006	0.03289
S401	0.00031	0.03086	0.00008	0.03061
S402	0.00022	0.00453	0.00004	0.03335

The data in the table can be regarded as a 402*4 Z matrix. The maximum value of each column is Z^+, the minimum value is Z^-, and the elements of each row are Z_{ij}. Select Z^+ and Z^- in each column to form the best and worst scheme, and get the data as shown in the table.

Table 5: Best and worst scheme scoring index

	T(m^3)	γ^2	ε	θ(time)
Best plan	0.414	0.683	0.083	0.110
Bad plan	0.000	0.000	0.000	0.005

The proximity Di is calculated below, and the formula is as follows:

$$D_i^+ = \sqrt{\sum_{j=1}^{m} w_j \left(Z_j^+ - z_{ij}\right)^2} \quad (7)$$

$$D_i^- = \sqrt{\sum_{j=1}^{m} w_j \left(Z_j^- - z_{ij}\right)^2} \quad (8)$$

Finally, calculate the closeness Ci:

$$C_i = \frac{D_i^-}{D_i^+ + D_i^-} \quad (9)$$

The corresponding Ci of each supplier is calculated by calculation, and the order is determined according to the value of ci from the largest to the smallest. The results are shown in the following table 6:

Table 6: Ranking of comprehensive strength of suppliers

Supplier	C_i	Comprehensive ranking
S001	0.0285	301
S002	0.0589	144
S003	0.0882	48
…	…	…
S400	0.022	357
S401	0.035	244
S402	0.018	386

5. Conclusion

Based on TOPSIS algorithm and Analytic hierarchy process, this paper comprehensively considers many factors, such as risk, total supply quantity, cooperation between manufacturer and supplier, manufacturer's ability to provide raw materials, etc., lists the four major standards of supply quantity, stability rate, up-to-standard rate and trust degree, and obtains that the corresponding weights of the four items are 0.1963, 0.1962, 0.5346, 0.728 respectively. Then the TOPSIS model is established to evaluate the suppliers combined with the four criteria, and through the homogenization and normalization of the data matrix, it is calculated that the closer the value of proximity I ($0 < Ci < 1$) is, the higher the supplier score is. Finally, using the value of quoi as the comprehensive evaluation standard to rank the 402 suppliers, the top 50 suppliers are S275, S329, S229, S275, S329, S229,... , S003,S067,S076.

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