

Research on the Performance Evaluation of Tire Mold Suppliers: A Case Study of Company H

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Abstract: *Against the backdrop of the supplier selection for tire molds at Company H, this paper systematically analyzes the current situation and problems of its supplier evaluation and constructs a supplier evaluation index system encompassing five dimensions: quality, contract fulfillment, technology, cost, and service. Through on-site investigations and expert interviews, both objective and subjective data are obtained. The entropy weight method is used to objectively assign weights to each index, and the TOPSIS method is combined to comprehensively rank five strategic cooperation suppliers. The research results show that Supplier B has the best comprehensive performance, followed by Supplier D and Supplier A. This paper not only provides a decision-making basis for the optimization of suppliers at Company H but also offers an operable method framework for supplier performance evaluation in manufacturing enterprises.*

Keywords: Supplier performance evaluation, Entropy weight method, TOPSIS method.

1. Introduction

Raw material suppliers serve as a crucial link in an enterprise's supply chain system, and their performance levels directly impact product quality, delivery cycles, and production costs. With the increasing complexity of global supply chains, traditional supplier selection methods relying on managers' subjective experience are increasingly unable to meet the needs of modern manufacturing (Park & Melkote, 2026). Particularly in an uncertain environment, evaluation information often exhibits fuzziness and incompleteness, necessitating more scientific and systematic decision-support tools.

Multi-criteria decision-making (MCDM) methods have been widely applied in supplier evaluation (Eltarabishi et al., 2020). Classic methods such as TOPSIS, VIKOR, and ELECTRE assist decision-makers in selecting the optimal solution from multiple alternatives through quantitative analysis. In recent years, to handle the fuzzy and uncertain information in the evaluation process, the combination of fuzzy set theory and MCDM has become a research hotspot (Zadeh, 1965; Mishra et al., 2022). For instance, extended forms like interval-valued fuzzy sets, neutrosophic sets, and T-spherical fuzzy sets have been successfully introduced into the supplier selection problem (Zhang & Hu, 2024; Gurmani et al., 2023). As a tire mold manufacturing enterprise, Company H has long relied on qualitative judgments for supplier evaluation, lacking a systematic and quantitative evaluation system. Therefore, this study constructs a supplier evaluation index system tailored to the tire mold industry. The entropy weight method is used to determine the weights to avoid subjective biases, and the TOPSIS method is applied to rank suppliers. This paper aims to provide enterprises with a scientific and objective method for supplier performance evaluation and offer empirical references for relevant research in the field.

2. Analysis of the Current Situation of H Company's Tire Mold Suppliers

Currently, Company H has a large number of raw material suppliers. The performance evaluation of suppliers involves

multiple dimensions of evaluation indicators such as quality, delivery, and cost. The method of subjective weighting by managers has become difficult to adapt to the performance evaluation model of suppliers. The entropy weight method can objectively reflect the degree of dispersion of indicators based on the information entropy values of the indicators, which can, to a certain extent, avoid the biases caused by artificial weighting. The five suppliers selected in this paper are shown in Table 1.

Table 1: Supplier names and main products

No.	Main Products
Supplier A	Heat treatment products and related technologies
Supplier B	Steel
Supplier C	Aluminum blocks, aluminum ingots
Supplier D	Steel forged steel
Supplier E	Scrap steel, forged steel

The existing evaluation methods mainly rely on the experience-based judgments of procurement personnel, lacking systematic and standardized evaluation processes. This makes it difficult to quantitatively compare the performance of suppliers and fails to provide clear directions for supplier improvement. Therefore, it is an urgent task to construct a scientific and objective supplier performance evaluation system.

3. Performance Evaluation of Raw Material Suppliers of Company H

3.1 Construction of the Performance Evaluation Index System

Modern supplier evaluation systems tend to be multi-dimensional and quantitative. Research shows that the manufacturing capabilities of suppliers should be comprehensively evaluated through multiple indicators such as geometric attributes, cost, time, and quality. Based on this and combined with the characteristics of the tire mold industry, through literature analysis and industry research, this study constructs an evaluation system (Table 2) consisting of 5 first-level indicators and 12 second-level indicators. Among them, the five dimensions of quality, contract fulfillment, technology, cost, and service comprehensively

cover the key capabilities of suppliers. An evaluation index system as shown in Table 2 is constructed.

3.2 Data standardization processing

Through on - site investigations, historical data extraction, expert interviews and other methods, the performance data of five suppliers on 12 indicators were collected. For qualitative indicators, the Likert 5 - point scale was used for scoring. Five

professionals conducted independent evaluations, and the average value was calculated after removing the highest and lowest scores. The original data are shown in Table 3.

The original data were standardized, and the cost-type indicators were converted into benefit-type indicators to eliminate the influence of dimensions. The data were standardized with reference to Table 3, and the results are shown in Table 4.

Table 2: Supplier Evaluation Index System

Primary Indicator	Secondary Indicator	Indicator Type	Evaluation Basis
Quality	product defect rate	cost-type	defective products / total products
	market complaint rate	cost-type	complaining customers / total customers
	production anomaly rate	cost-type	production anomaly occurrences / total production cycles
Fulfillment	on-time delivery rate	benefit-type	on-time deliveries / total deliveries
	plan achievement rate	benefit-type	plans completed / total plans
Technology	new product delivery pass rate	benefit-type	qualified new products / total new products
	technical response speed	benefit-type	ability to handle and respond to technical issues
Cost	product-service price	benefit-type	acceptability of product or service price
	cost reduction & efficiency enhancement	benefit-type	comprehensive capability to reduce costs and improve efficiency
	product price negotiability	benefit-type	potential for supplier price reduction
Service	product after-sales support	cost-type	reliability of product quality guarantee
	problem response speed	benefit-type	response speed to product issues

Table 3: Scoring Table for Raw Material Suppliers of Company H

Indicators	Supplier A	Supplier B	Supplier C	Supplier D	Supplier E
product defect rate	89	94	89	95	87
market complaint rate	95	90	88	92	98
production anomaly rate	83	89	92	85	90
on-time delivery rate	96	89	93	90	87
plan achievement rate	90	88	85	93	87
new product delivery pass rate	95	86	89	93	90
technical response speed	83	94	80	86	92
product-service price	93	85	90	97	88
cost reduction & efficiency enhancement	90	90	96	85	93
product price negotiability	85	80	93	90	87
product after-sales support	80	92	83	86	80
problem response speed	97	83	85	92	95

Table 4: Standardized Risk Scoring Table

Indicators	Supplier A	Supplier B	Supplier C	Supplier D	Supplier E
product defect rate	0.75	0.125	0.75	0	1
market complaint rate	0.3	0.8	1	0.6	0
production anomaly rate	1	0.33	0	0.78	0.22
on-time delivery rate	1	0.22	0.67	0.33	0
plan achievement rate	0.625	0.375	0	1	0.25
new product delivery pass rate	1	0	0.33	0.78	0.44
technical response speed	0.21	1	0	0.43	0.86
product-service price	0.33	1	0.58	0	0.75
cost reduction & efficiency enhancement	0.45	0.45	1	0	0.73
product price negotiability	0.38	0	1	0.77	0.54
product after-sales support	0	1	0.25	0.5	0
problem response speed	1	0	0.14	0.64	0.86

3.3 Determination of Evaluation Index Weights

In this study, the entropy weight method is employed for objective weighting. Precisely, it determines the index weights based on the dispersion degree of the data itself, which conforms to the data-driven decision-making trend.

1) Calculate the weight of each indicator in the standardized matrix

Based on the results of the standardization process, a 12×5 data matrix can be obtained, as shown in the following standardized matrix:

$$y_{ij} = \begin{pmatrix} 0.2857 & 0.0476 & 0.2857 & 0 & 0.3809 \\ 0.1111 & 0.2963 & 0.3703 & 0.2222 & 0 \\ 0.4285 & 0.1429 & 0 & 0.3333 & 0.0953 \\ 0.4500 & 0.1000 & 0.3000 & 0.1500 & 0 \\ 0.2778 & 0.1667 & 0 & 0.4444 & 0.1111 \\ 0.3913 & 0 & 0.1304 & 0.3043 & 0.1739 \\ 0.0857 & 0.4 & 0 & 0.1714 & 0.3428 \\ 0.1250 & 0.3750 & 0.2187 & 0 & 0.2812 \\ 0.1724 & 0.1724 & 0.3793 & 0 & 0.2758 \\ 0.1429 & 0 & 0.3714 & 0.2857 & 0.2000 \\ 0 & 0.5713 & 0.1429 & 0.2857 & 0 \\ 0.3783 & 0 & 0.0541 & 0.2432 & 0.3243 \end{pmatrix}$$

2) Calculate the entropy value of the indicators

The core of the entropy weight method is to objectively

determine the weight of each indicator based on the magnitude of its information entropy. The information entropy value of an indicator can effectively reflect the amount of information contained in each indicator. The specific calculation method is as follows:

$$P_{ij} = \frac{y_{ij}}{\sum_{i=1}^m y_{ij}} (i = 1, 2 \dots m; j = 1, 2 \dots n) \quad (1)$$

$$e_j = -k \sum_{i=1}^m p_{ij} \ln(p_{ij}), k = \frac{1}{\ln(m)} \quad (2)$$

when $p_{ij} = 0, p_{ij} \ln p_{ij} = 0$.

The final results of the index entropy values are shown in Table 5.

Table 5: Entropy value table of evaluation indicators

Indicators	Supplier A	Supplier B	Supplier C	Supplier D	Supplier E	Entropy
product defect rate	0.2857	0.0476	0.2857	0	0.3809	0.7636
market complaint rate	0.1111	0.2963	0.3703	0.2222	0	0.8121
production anomaly rate	0.4285	0.1429	0	0.3333	0.0953	0.7653
on-time delivery rate	0.4500	0.1000	0.3000	0.1500	0	0.7679
plan achievement rate	0.2778	0.1667	0	0.4444	0.1111	0.7826
new product delivery pass rate	0.3913	0	0.1304	0.3043	0.1739	0.8074
technical response speed	0.0857	0.4	0	0.1714	0.3428	0.7747
product-service price	0.1250	0.3750	0.2187	0	0.2812	0.8185
cost reduction & efficiency enhancement	0.1724	0.1724	0.3793	0	0.2758	0.8261
product price negotiability	0.1429	0	0.3714	0.2857	0.2000	0.8239
product after-sales support	0	0.5713	0.1429	0.2857	0	0.5945
problem response speed	0.3783	0	0.0541	0.2432	0.3243	0.7673

3) Calculate the coefficient of variation

The coefficient of variation reflects the degree of difference among indicators, that is, the greater the difference, the more important the indicator. The specific calculation method is as follows:

$$g_i = 1 - e_j \quad (3)$$

Based on the results in Table 3 and applying Formula (3), the difference coefficient values of each indicator can be obtained. The specific values are shown in Table 6.

Table 6: Summary of coefficient of variation results

Indicators	Information Entropy	Information Utility
product defect rate	0.7636	0.2364
market complaint rate	0.8121	0.1879
production anomaly rate	0.7653	0.2347
on-time delivery rate	0.7679	0.2321
plan achievement rate	0.7826	0.2174
new product delivery pass rate	0.8074	0.1926
technical response speed	0.7747	0.2253
product-service price	0.8185	0.1815
cost reduction & efficiency enhancement	0.8261	0.1739
product price negotiability	0.8239	0.1761
product after-sales support	0.5945	0.4055
problem response speed	0.7673	0.2343

4) Determine the index weights

The index weights were calculated using formula (4), and the results are presented in Table 7.

Table 7: Weights of evaluation indicators

Indicators	Information Entropy	Information Utility	w_j
product defect rate	0.7636	0.2364	0.0877
market complaint rate	0.8121	0.1879	0.0697
production anomaly rate	0.7653	0.2347	0.0870
on-time delivery rate	0.7679	0.2321	0.0861
plan achievement rate	0.7826	0.2174	0.0807
new product delivery pass rate	0.8074	0.1926	0.0714
technical response speed	0.7747	0.2253	0.0836
product-service price	0.8185	0.1815	0.0673
cost reduction & efficiency enhancement	0.8261	0.1739	0.0645
product price negotiability	0.8239	0.1761	0.0653
product after-sales support	0.5945	0.4055	0.1504
problem response speed	0.7673	0.2343	0.0863

From the weight results, it can be seen that the weight

allocation of the problem response speed is relatively large. This indicates that the data of the problem response speed index has a large degree of dispersion, and the index is relatively important. The weights of other indicators basically remain in a reasonable and balanced range. The reasonable allocation of weights points out the direction for the next evaluation of raw material suppliers in the tire mold division of Company H.

5) Analysis of supplier ranking results

Using the previously obtained weights w_j , the following matrix can be obtained:

$$z_{ij} = w_j \times y_{ij}$$

$$= \begin{pmatrix} 0.0658 & 0.0110 & 0.0658 & 0 & 0.0877 \\ 0.0209 & 0.0558 & 0.0697 & 0.0418 & 0 \\ 0.0871 & 0.0290 & 0 & 0.0677 & 0.0194 \\ 0.0861 & 0.0191 & 0.0574 & 0.0287 & 0 \\ 0.0504 & 0.0303 & 0 & 0.0807 & 0.0202 \\ 0.0714 & 0 & 0.0238 & 0.0556 & 0.0318 \\ 0.0179 & 0.0836 & 0 & 0.0358 & 0.0716 \\ 0.0224 & 0.0673 & 0.0393 & 0 & 0.0505 \\ 0.0293 & 0.0293 & 0.0645 & 0 & 0.0469 \\ 0.0251 & 0 & 0.0653 & 0.0502 & 0.0352 \\ 0 & 0.1504 & 0.0376 & 0.0752 & 0 \\ 0.0863 & 0 & 0.0123 & 0.0555 & 0.0740 \end{pmatrix}$$

Based on the calculation results of the weighting matrix, the result table of the optimal and worst solutions can be obtained, as shown in Table 8.

Table 8: Results of the Optimal and Worst Solutions

Indicators	Optimal Solution	Worst Solution
product defect rate	0.0877	0.0110
market complaint rate	0.0697	0.0209
production anomaly rate	0.0871	0.0290
on-time delivery rate	0.0861	0.0191
plan achievement rate	0.0807	0.0303
new product delivery pass rate	0.0714	0
technical response speed	0.0836	0.0179
product-service price	0.0673	0.0224
cost reduction & efficiency enhancement	0.0645	0.0293
product price negotiability	0.0653	0
product after-sales support	0.1504	0
problem response speed	0.0863	0

Based on the standardized results in Table 8, the distances of each evaluation object to the optimal and worst solutions can be obtained, as shown in Table 9 and Table 10.

Table 9: Results table of the optimal solution distance

Indicators	Supplier A	Supplier B	Supplier C	Supplier D	Supplier E
product defect rate	0.0005	0.0059	0.0005	0.0077	0
market complaint rate	0.0024	0.0002	0	0.0008	0.0049
production anomaly rate	0	0.0034	0.0076	0.0004	0.0046
on-time delivery rate	0	0.0045	0.0008	0.0033	0.0074
plan achievement rate	0.0009	0.0025	0.0065	0	0.0037
new product delivery pass rate	0	0.0051	0.0023	0.0003	0.0016
technical response speed	0.0043	0	0.0070	0.0023	0.0001
product-service price	0.0020	0	0.0008	0.0045	0.0003
cost reduction & efficiency enhancement	0.0012	0.0012	0	0.0042	0.0003
product price negotiability	0.0016	0.0043	0	0.0002	0.0009
product after-sales support	0.2262	0	0.0127	0.0057	0.0226
problem response speed	0	0.0074	0.0055	0.0010	0.0002
D_i^+	0.1886	0.1858	0.2088	0.1738	0.2156

Table 10: Results Table of the Distance from the Worst Solution

Indicators	Supplier A	Supplier B	Supplier C	Supplier D	Supplier E
product defect rate	0.0030	0	0.0030	0.0001	0.0059
market complaint rate	0	0.0012	0.0024	0.0004	0.0004
production anomaly rate	0.0034	0	0.0008	0.0015	0
on-time delivery rate	0.0045	0	0.0015	0	0.0004
plan achievement rate	0.0004	0	0.0009	0.0025	0.0001
new product delivery pass rate	0.0051	0	0.0006	0.0031	0.0010
technical response speed	0	0.0043	0.0003	0.0003	0.0029
product-service price	0	0.0020	0.0003	0.0005	0.0008
cost reduction & efficiency enhancement	0	0	0.0012	0.0009	0.0003
product price negotiability	0.0006	0	0.0043	0.0025	0.0012
product after-sales support	0	0.2262	0.0014	0.0057	0
problem response speed	0.0074	0	0.0002	0.0031	0.0055
D_i^-	0.1563	0.1737	0.1298	0.1439	0.1363

The final comprehensive evaluation scores are as follows:

$$C_A = \frac{d_i^-}{d_i^+ + d_i^-} = 0.4532$$

$$C_B = \frac{d_i^-}{d_i^+ + d_i^-} = 0.4831$$

$$C_C = \frac{d_i^-}{d_i^+ + d_i^-} = 0.3833$$

$$C_D = \frac{d_i^-}{d_i^+ + d_i^-} = 0.4630$$

$$C_E = \frac{d_i^-}{d_i^+ + d_i^-} = 0.3873$$

From the above analysis, the ranking results of suppliers are as follows: Supplier B > Supplier D > Supplier A > Supplier E > Supplier C. From the sorting results, Supplier B has the highest comprehensive score, indicating that it is the evaluation object closest to the ideal solution. Supplier D and Supplier A follow. The comprehensive evaluation scores of these three suppliers all remain above 0.4, while those of the remaining suppliers range from 0.3 to 0.4. This means that the selection of raw material suppliers by Company H is relatively reasonable and accurate. The suppliers complement each other. Although there are differences in scores, they generally fluctuate within a reasonable range. It can also be seen from the weight coefficients obtained by the entropy weight method that the objective weights basically stay within the normal range. This shows that the original data of the raw material suppliers of Company H show little fluctuation and are scientifically and accurately distributed.

4. Conclusion

In this paper, by introducing the entropy weight - TOPSIS method, a relatively reasonable indicator system is constructed for the raw material suppliers of Company H. The suppliers are comprehensively evaluated from five dimensions: quality, delivery capacity, technological development, service and cooperation degree, and cost control. Through actual investigations and data collection, combined with the objective weighting method, subjective biases in the evaluation process are effectively avoided, providing a scientific basis for the selection and optimization of suppliers for Company H.

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