

# Evaluation and Selection of Suppliers Using TOPSIS Method

Keshav.jp<sup>1</sup>, sofia Vincent.j<sup>2</sup>

*Student<sup>1</sup>, Associate Professor<sup>2</sup>, Master of Business Administration<sup>12</sup>*

*Panimalar Engineering Collage<sup>12</sup>, Ponnammallee, Chennai*

**Abstract**—This paper presents a comprehensive framework for evaluating and selecting suppliers in the cement industry using the TOPSIS technique integrated with AHP and Entropy methods. The study aims to improve procurement decisions by combining subjective expert opinions and objective data analysis. Through detailed multi-criteria decision-making (MCDM), this study analyzes supplier performance across various criteria such as price, quality, delivery, pollution control, and green competencies. The results provide actionable insights for improving supply chain performance and building resilient, sustainable supplier relationships.

**Keywords**—Topsis, AHP, Multi-Criteria Decision-Making (MCDM), Data-driven supplier selection, suppliers selection, Sustainable supply chain, Performance analysis.

## I. INTRODUCTION

In today's competitive business landscape, selecting the right suppliers is vital for maintaining cost efficiency, ensuring product quality, and enhancing overall supply chain resilience. The cement industry, as a key player in infrastructure development, faces unique challenges such as environmental regulations, raw material fluctuations, and logistical complexities. Supplier performance significantly influences operational efficiency, cost control, and sustainability outcomes. Traditionally, supplier selection was based largely on price; however, the growing complexity of global supply chains now requires a holistic, multi-criteria approach. Multi-Criteria Decision-Making (MCDM) techniques such as AHP, Entropy, and TOPSIS have emerged as robust tools to support objective, data-driven supplier selection. This study focuses on evaluating suppliers using a hybrid MCDM framework combining expert judgment (AHP), objective data weighting (Entropy), and uncertainty handling (Fuzzy TOPSIS), providing a case study within the cement industry.

## Need of the Study

Supplier selection involves multiple conflicting criteria such as cost, quality, delivery performance, environmental compliance, and innovation. A purely price-based approach often leads to supply chain disruptions and poor long-term performance. This study addresses the need for a systematic, quantitative framework that integrates subjective expert insights and objective data to improve the transparency, consistency, and reliability of supplier selection decisions. It also aims to reduce the risks associated with poor supplier choices and improve supply chain sustainability.

## Scope of the Study

1. The study focuses on evaluating and selecting the most suitable suppliers using Multi-Criteria Decision-Making (MCDM) methods, specifically AHP for weight assignment and TOPSIS for ranking the alternatives.
2. The study includes both qualitative (e.g., service quality, vendor responsiveness) and quantitative (e.g., delivery time, price) evaluation criteria, making it a comprehensive model for supplier assessment.
3. The study allows for the incorporation of fuzzy logic to handle ambiguity in human judgments, which makes it suitable for real-world, uncertain environments.

## Limitation of the Study

1. The AHP method depends heavily on expert judgment, which can introduce subjectivity and inconsistencies in weight assignment.
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3. Limited Criteria Scope, Although common supplier evaluation criteria are considered, other important parameters like financial stability, legal compliance, or innovation capability might be overlooked.

II. RESEARCH METHODOLOGY

TYPE OF RESEARCH

- This study adopts a descriptive and analytical research design.
- It aims to analyze supplier performance and assist in decision-making using multi-criteria evaluation.

DATA COLLECTION METHOD

- SECONDARY DATA:
  - Secondary data was collected related to suppliers evaluation the information used to design the evaluation criteria, linguistic

ratings were systematically converted into numerical score using a predefined scale

- Used simplified rating system excellent to poor to assess the each supplier qualitatively, than assigned score based on those labels

DATA ANALYSIS TOOL

- Microsoft Excel was used for
  - AHP pairwise comparison calculations.
  - TOPSIS normalization and ranking.
  - Final evaluation and ranking of suppliers.

III. DATA ANALYSIS AND INTERPRETATION

Step1: Each supplier is assigned qualitative ratings as shown in the Table 3.2.1 showing the Supplier data

	S1	S2	S3	S4
Pollution control	Good	Very Good	Average	Average
Green competencies	Average	Good	Excellent	Average
Price	Very Good	Excellent	Good	Excellent
Quality	Very Good	Good	Excellent	Excellent
Delivery	Good	Very Good	Good	Good

Step 2: The quality ratings are converted into numerical values based on the predefined scale as shown in the Table 3.2.2 showing the Supplier score

Supplier	Pollution Control	Green Competencies	Price	Quality	Delivery
S1	62	58	62	93	72
S2	67	57	55	78	89
S3	52	79	64	96	77
S4	46	40	55	95	72

AHP

Step 3: Each criterion is compared to other to form a pairwise comparison matrix with the help of saaty’s scale of relative importance as shown in the Table 3.2.3 showing Pairwise comparison matrix

	Pollution control	Green competencies	Price	Quality	Delivery
Pollution Control	1.000	0.250	0.143	0.167	0.500
Green Competencies	4.000	1.000	0.333	0.333	0.500
Price	7.000	3.000	1.000	2.000	3.000
Quality	6.000	3.000	0.500	1.000	2.000
Delivery	5.000	2.000	0.333	0.500	1.000
SUM	23.00	9.25	2.31	4.00	7.00

Step 4: Each value in the pairwise matrix is divided by the column sum → to create a normalized matrix and criteria weights as shown in the Table 3.2.4 showing the Normalised pairwise comparison matrix

	Pollution Control	Green Competencies	Price	Quality	Delivery	criteria weight
Pollution Control	0.043	0.027	0.062	0.042	0.071	0.049
Green Competencies	0.174	0.108	0.144	0.083	0.071	0.116
Price	0.304	0.324	0.433	0.500	0.429	0.398

Quality	0.261	0.324	0.216	0.250	0.286	0.267
Delivery	0.217	0.216	0.144	0.125	0.143	0.169
						1.000

Step 5: Each supplier’s score for every criterion is multiplied by the respective AHP weight. All weighted scores are summed up to get the final supplier score based on AHP as shown in the Table 3.2.5 showing the Consistency index check

W = 0.049	0.116	0.398	0.267	0.169			
Pollution Control	Green Competencies	Price	Quality	Delivery	weighted sum value	criteria weight	weighted sum value/criteria weight
0.049	0.029	0.057	0.045	0.085	0.264	0.049	5.385
0.196	0.116	0.133	0.089	0.085	0.618	0.116	5.329
0.343	0.348	0.398	0.534	0.507	2.130	0.398	5.352
0.294	0.348	0.199	0.267	0.338	1.446	0.267	5.416
0.245	0.232	0.133	0.134	0.169	0.912	0.169	5.397

$$\lambda = 5.376$$

$$CI = \frac{5.376 - 5}{5 - 1} = 0.094$$

$$\frac{CI}{RI} = \frac{0.094}{1.12} = 0.083 \text{ is } < 10$$

Step 6: Each value of the supplier score is square rooted by the column sum to create normalisation as shown in the table 3.2.6 showing the Normalization

Supplier	Pollution Control	Green Competencies	Price	Quality	Delivery
S1	62	58	62	93	72
S2	67	57	55	78	89
S3	52	79	64	96	77
S4	46	40	55	95	72
	114.68	120.22	118.27	181.58	155.62

Step 7: Normalised decision matrix is created by divided the each value with the sum of normalisation table a shown in the Table 3.2.7 showing the Normalised decision matrix

Supplier	Pollution Control	Green Competencies	Price	Quality	Delivery
S1	0.54	0.48	0.52	0.51	0.46
S2	0.58	0.47	0.47	0.43	0.57
S3	0.45	0.66	0.54	0.53	0.49
S4	0.40	0.33	0.47	0.52	0.46

Step 8 : Each values are calculated by multiplying the each value from the table 7 with the respective weights as shown in the Table 3.2.8 showing the positive Ideal and negative ideal separation

W	0.049	0.116	0.398	0.267	0.169		
	Pollution control	Green competencies	Price	quality	delivery	si <sup>+</sup>	si <sup>-</sup>
S1	0.026	0.056	0.209	0.137	0.078	0.037	0.029
S2	0.029	0.055	0.185	0.115	0.097	0.034	0.040
S3	0.022	0.076	0.215	0.141	0.084	0.034	0.046
S4	0.020	0.039	0.185	0.140	0.078	0.043	0.039
IB	0.029	0.076	0.185	0.141	0.097		
IW	0.020	0.039	0.215	0.115	0.078		

Step 9 : The consistency index (CI) is calculated by the following formula  $\frac{SI^-}{SI^+ + SI^-}$  as shown in the Table 3.2.9 showing the Relative closeness of ideal solution

SI <sup>+</sup>	SI <sup>-</sup>	SI <sup>+</sup> + SI <sup>-</sup>	CI
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0.037	0.029	0.066	0.439
0.034	0.04	0.074	0.541
0.034	0.046	0.08	0.575
0.043	0.039	0.082	0.475

Table 3.2.10 Showing the Suppliers ranking

Supplier	Pollution Control	Green Competencies	Price	Quality	Delivery	RANK
S1	62	58	62	93	72	4
S2	67	57	55	78	89	2
S3	52	79	64	96	77	1
S4	46	40	55	95	72	3

#### IV. FINDINGS

The AHP-TOPSIS analysis started by determining the relative importance (weights) of each criterion through expert pairwise comparisons:

- Price: 39.8%
- Quality: 26.7%
- Delivery: 16.9%
- Green Competencies: 11.6%
- Pollution Control: 4.9%

Once weights were established, supplier scores were normalized and the ideal (best) and negative-ideal (worst) solutions were identified. The suppliers were ranked based on their closeness to the ideal solution.

AHP-TOPSIS Supplier Ranking:

1. Supplier 3
2. Supplier 2
3. Supplier 4
4. Supplier 1

Supplier 3 achieved the highest overall performance across all key criteria, demonstrating strong quality, price, and delivery performance, making it the most suitable choice.

#### V. SUGGESTIONS

- Implement a Data-Driven Supplier Management System: Use methods like TOPSIS to bring objectivity and clarity in decision-making.
- Provide training on decision-making tools like TOPSIS, AHP, and vendor negotiation strategies
- Implement procurement automation, supplier portals, and AI-based demand forecasting tools to streamline processes.

#### VI. CONCLUSION

This study successfully demonstrated the application of a hybrid MCDM framework combining AHP,

Entropy, and Fuzzy TOPSIS for supplier selection in the cement industry. The integrated approach improved the objectivity and robustness of supplier rankings. The framework can support better procurement decisions, reduce risks, and enhance supply chain sustainability. Future research can extend the model by incorporating real-time data and additional performance metrics.

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