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Application of AHP and TOPSIS methods for supplier selection in manufacturing industry

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Abstract

The selection of suppliers in the manufacturing industry involves the identification, ranking and selection of effective suppliers by purchasing firms. In the present paper, we present the application of two methods, namely the Analytic Hierarchy Process (AHP) and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), for the supplier selection in the manufacturing industry. The AHP method facilitates decision-makers in systematically prioritizing and evaluating various supplier attributes and criteria based on their relative importance. The TOPSIS method is used to rank suppliers by assessing the proximity of their criteria weights to an ideal positive solution and the distance from a negative ideal solution. By utilizing these methods, manufacturers can make informed decisions and choose suppliers that align with their strategic goals and performance.

***Keywords* -** AHP Method, Multi Criteria Decision Making, TOPSIS Method, Supplier Selection, Supply chain management.

1.1 Introduction

Supply chain management (SCM) is a strategic approach that oversees the movement of goods, information, and services from suppliers to end customers. It encompasses the coordination and integration of activities, processes, and stakeholders throughout the entire supply chain network, including suppliers, manufacturers, distributors, retailers, and customers [1]. The main objective of SCM is to optimize the performance and efficiency of the supply chain, ensuring timely delivery of the right products in the right quantity to the right location. An essential component of effective supply chain management is supplier selection. Supplier's selection directly influences the quality, cost, and availability of inputs for production [2]. By choosing reliable and capable suppliers, supply chain managers can guarantee a consistent and high-quality supply of materials or services. The advancements in communication technology and globalization have expanded access to new consumers and procurement sources, providing firms with more opportunities and methods for managing and controlling supply chain activities.

Supplier selection is a complex process that involves evaluating different criteria and supplier attributes, often treated as a Multiple Criteria Decision-Making Problem (MCDM) [3]. Industrial experts have proposed various decision-making methods for supplier selection, including the AHP method, TOPSIS method, Multi-attribute utility theory, Fuzzy sets, Judgmental modelling, and Linear weighted point approach etc.

1.2 Basic principles of supplier selection

In manufacturing industries, the cost of raw materials and components constitutes a significant of the total product cost, especially in high-technology firms where purchased materials and services can make up to 80 % of the total cost [4].

Consequently, selecting the appropriate suppliers is a primary objective in the procurement cycle of Supply Chain Management, presenting a significant opportunity for cost reduction throughout the entire supply chain. The selection of the right supplier method plays a crucial role in reducing purchase risks and increasing the availability of Just in Time (JIT) suppliers, thereby minimizing inventory costs [5]. The purchasing manager assumes a key role in the supplier selection process, facilitating meetings with technical, operational, and legal experts within the industry. They act as professional negotiators and coordinates across various internal and external parties. Utilizing the information provided by the purchasing manager, effective suppliers are determined by considering available supplier alternatives and aligning them with the industry's goals [6].

1.3 Supplier selection steps

The supplier selection process typically involves four important steps. The first step is criteria identification, where the key criteria for supplier selection are determined. These criteria often include aspects such as quality, price, delivery, service etc. The specific criteria chosen depends on the purchasing situation and the priorities of the company [7]. The second step is conducting a questionnaire survey, in which decision-makers assign weights to each criterion. This step helps in quantifying the relative importance of different criteria in the supplier selection process. The third step involves the implementation of a Multi-Criteria Decision Making (MCDM) model. This step utilizes a decision-making framework that considers the identified criteria and their assigned weights. The MCDM model helps in evaluating and comparing different supplier alternatives based on their performance against the established criteria. The fourth step involves the utilization of mathematical tools such as the AHP method for criteria weighting and TOPSIS method for ranking the supplier alternatives.

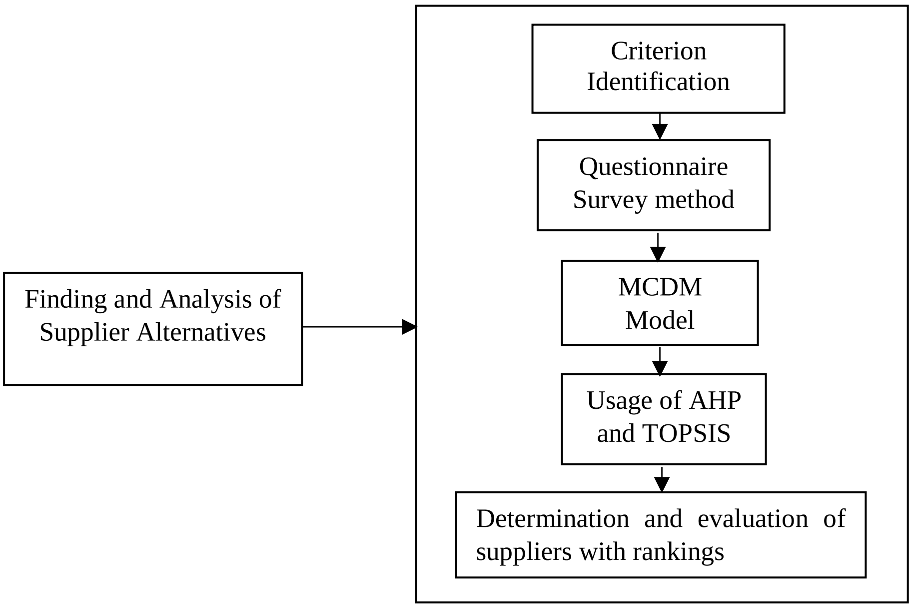

Fig 1.1: Schematic Diagram of Supplier selection

1.4 Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) is a decision-making method developed by Thomas Saaty in the 1970s [8]. It offers a structured approach for handling situations that involve multiple criteria, incorporating intuitive, rational, qualitative, and quantitative aspects. When it comes to supplier selection, the key objectives influencing the selection criteria are typically categorized into three main groups: performance assessment, business structure capability assessment, and quality system assessment. In the supplier selection problem, the goal is to identify the best supplier, with criteria such as quality, on-time delivery, price, etc., and the alternatives are the suppliers or proposals of the suppliers. AHP combines both qualitative and quantitative criteria. The hierarchy within AHP generally consists of three levels: goals, criteria, and alternatives [9]. By employing a ratio scale for human judgements, AHP allows for the determination of weights for the alternatives, reflecting the relative importance of the criteria in achieving the overall goal of the hierarchy.

AHP finds broad application across various fields, including business, engineering, and operations research, as it supports complex decision-making processes. Its versatile nature and ability to handle both subjective and objective factors make it a valuable tool for analysing and prioritizing criteria in supplier selection and other decision-making contexts.

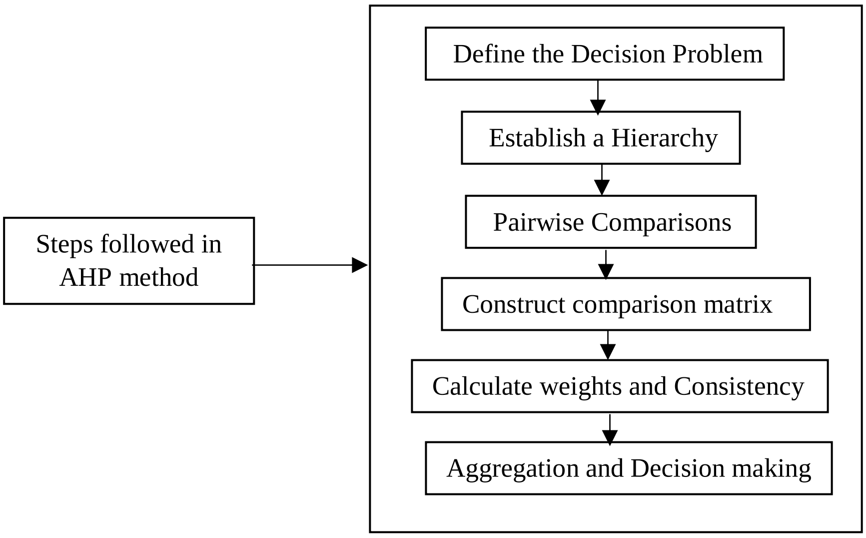

Fig 1.2: Steps in AHP method

1.5 Technique for the Order Performance by Similarity to Ideal Solution (TOPSIS)

The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), is a multi-criteria decision-making method developed by Hwang and Yoon in 1981 [10]. It serves as a tool to determine the best alternative from a set of options. The underlying concept of TOPSIS involves defining a closeness coefficient to establish the ranking order of all suppliers [11]. TOPSIS operates on the principle that the optimal alternative should have the shortest distance to the positive ideal solution (PIS) and the farthest distance from the negative ideal solution (NIS). This approach enables decision-makers to evaluate and rank alternatives based on their relative performance and preferences across multiple criteria. By calculating the distances to both the PIS and NIS, TOPSIS provides a comprehensive assessment of each alternative.

TOPSIS method finds extensive application in various fields, including Operations Research, Management Science, and Engineering. Its effectiveness lies in its ability to assist decision-makers in selecting the most favourable alternative based on their defined criteria and objectives.

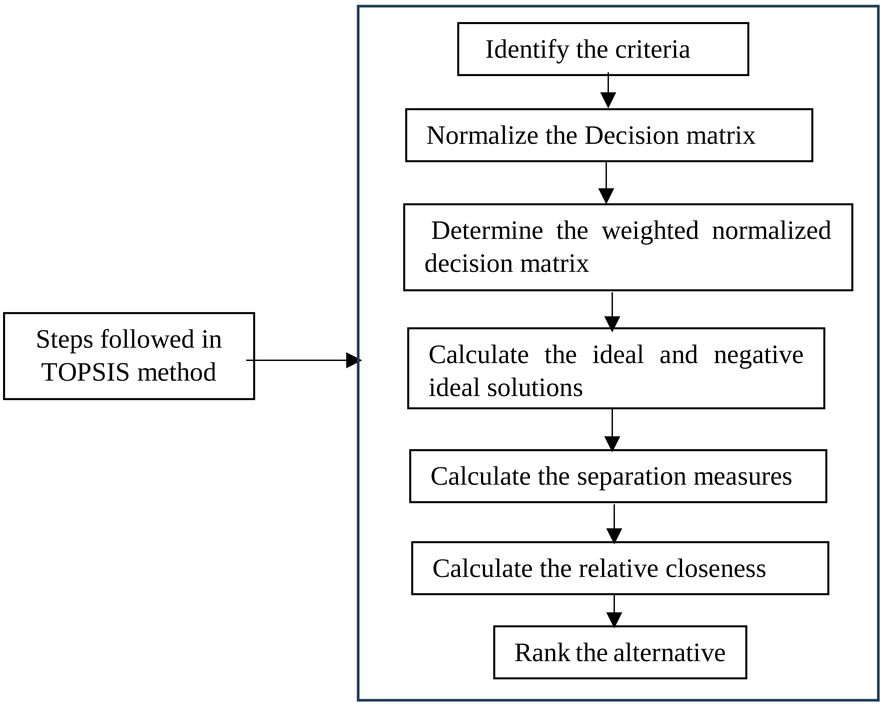

Fig 1.3: Steps in TOPSIS method

2. Literature Review

There has been extensive research in the field of Multiple criteria decision-making (MCDM) approaches, indicating its significance in dealing with complex decision-making problems, particularly in supplier selection.

This area of research continues to be actively pursued by scholars, aiming to develop more accurate and effective decision support tools. The literature on supplier selection dates to the 1960s, with Dickson [12] listing various criteria such as quality, delivery, performance history, warranty, claim policies, production facilities, capacity, and price. Weber et al. [13] listed criteria such as price, delivery, quality, production facilities, capacity, geographical location, and technical capability. Zhang et al. [14] listed criteria such as price, quality, delivery, production facilities, capacity, technical capability, and financial position. Ho et al. [15] further expanded on these criteria and emphasized the importance of attributes like financial position, manufacturing capability, service, and management etc. Sonmez [16] presented decision criteria for supplier selection along with their respective weights. Chakladar and Chakraborty [17] have combined AHP and TOPSIS to rank non-traditional machining processes. Rogers model [18], which is also known as SOCCER supplier evaluation model, consists of various elements like strategy, operational capability, cost structure, and sustainability to assess suppliers. Yoon et al. [19] employed a combination of AHP and TOPSIS to evaluate nuclear fuel cycles, considering five key assessment factors. Situmorang et al. [20] devised a method for multi-criteria decision analysis using AHP-TOPSIS, enabling complex evaluations of safety culture. Anand Babu and Venkataramaiah [21] utilized an AHP-TOPSIS approach to optimize process parameters for electrical wire discharge machining, employing a CNC machine assessment case study. Salehi et al. [22] employed an AHP-TOPSIS approach to address the challenges of foreign vehicle technology purchasing. Bakioglu and Atahan [23] developed an effective process for risk assessment of self-driving vehicles by integrating AHP with TOPSIS and VIKOR. Menon and Ravi [24] successfully solved a sustainable supplier-selection problem within the electronics industry's supply chain.

Based on comprehensive literature review, six classes of MCDM techniques have been identified including AHP, Analytic Network Process (ANP), TOPSIS, mathematical programming (Linear Programming, Goal Programming, Mixed Integer Programming), probabilistic approaches, intelligent approaches (neural networks, expert systems), hybrid approaches (e.g., AHP-LP, ANP-MIP). Various criteria have been identified as important for supplier selection, including price, quality, delivery performance history, business overall performance, warranties and claims policies, production facilities and capacity, technical capability, financial position, reputation and position in the industry, desire for business, repair service, attitude, packaging ability, labour relations record, geographical location, and amount of past business.

3.1 Methodology

The supplier selection evaluation methodology consists of three phases. During the first phase, the selection process involves identifying suitable alternatives and criteria, which are tailored to the specific industry, product type, and operational requirements. Typically, the selection of alternatives and criteria is industry-specific, and the final choices are approved by purchase managers. In second phase, the determination of criteria weights is conducted using the AHP method. This method assesses the relative importance of each criterion compared to others. The approval of criteria weights is based on the measure of consistency index. If the consistency index value is below 0.1, it indicates a consistent decision-making process. In the third phase, the ranking of each supplier is established using the TOPSIS method. This process involves calculating a closeness coefficient for each supplier, and the supplier with the highest closeness coefficient is deemed the best supplier for selection.

3.2 Numerical Problem

A simulated numerical example is developed to illustrate the practical implementation of AHP and TOPSIS methodologies in the process of supplier selection. In this example 5 criteria, namely Quality, Price, Service, Location and Delivery, along with 4 suppliers denoted as S_1, S_2, S_3, S_4. This example aims to showcase the application of these methods and their effectiveness in evaluating and choosing the most suitable supplier.

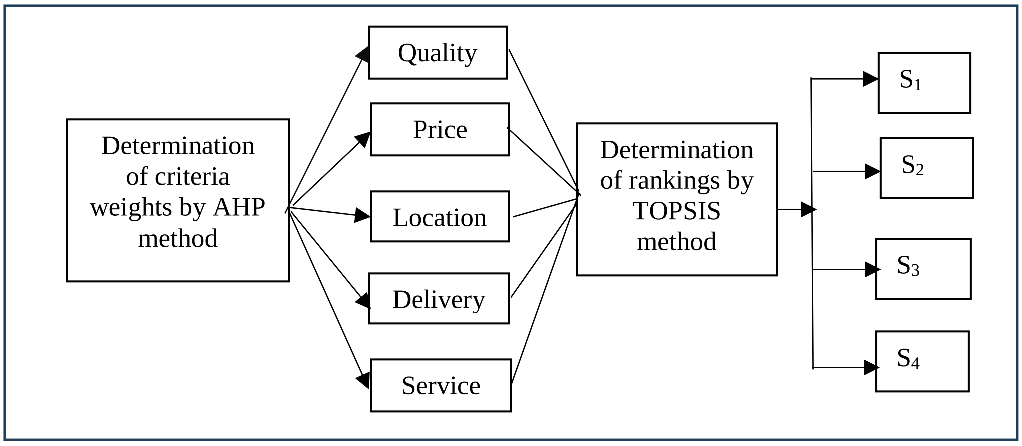

Fig 3.1: Supplier selection structure

3.2.1 AHP Method

The pair-wise comparisons in supplier selection employ the fundamental relational scale, where the intensity of importance is assessed on absolute scales ranging from 1 to 9. An absolute scale of 1 indicates equal importance, signifying that two activities contribute equally to the objective. Conversely, an absolute scale value of 3 suggests weak importance, implying that experience and judgement slightly favor one activity over another. The fundamental relational scale, presented in Table 3.1, illustrates the different levels of importance assigned to facilitate the decision-making process.

Table 3.1: The fundamental relational scale for pair-wise comparisons

Saaty Scale	Degree of importance
1	Equally Important
3	Weakly Important
5	Fairly Important
7	Strongly Important
9	Absolutely Important
2	The intermediate values between two adjacent scales
4	
6	
8	

The comparison matrix is constructed through the utilization of pair-wise comparisons, as depicted in table 3.2. Decision makers assess the importance of one criterion in relation to another within this matrix, denoted as C, decision makers determine the relative importance of criterion i with respect to criterion j. For a total of N criteria, the size is N×N, where the entry C_{ij} represents the relative importance of criterion i with respect to criterion j.

$$C = \begin{bmatrix} C_{11} & \cdots & C_{1N} \\ \vdots & \ddots & \vdots \\ C_{N1} & \cdots & C_{NN} \end{bmatrix},\ C_{ii}=1,\ C_{ij}=\frac{1}{Cij},\ C_{ij} \neq 0 \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.1)$$

Table 3.2 Comparison matrix

	A	B	C	D	E	F
1	Factor	**Quality**	**Price**	**Service**	**Location**	**Delivery**
2	**Quality**	1	7	3	1	1
3	**Price**	0.14	1	0.14	0.2	0.2
4	**Service**	0.33	7	1	1	1
5	**Location**	1	5	1	1	1
6	**Delivery**	1	5	1	1	1
	Total	3.48	25	6.14	4.20	4.20

The diagonal elements of the comparison matrix adhere to the fundamental relational scale and are always assigned a value of 1. The upper triangular matrix is populated based on the weighting score of one criterion over another. Referring to the provided table 3.2, the value in the Quality row and Price column value is 7, indicating that Quality carries a weighting of seven times more than Price. Similarly, in Quality row and Service column, the value is 3, implying that Quality is three times more important than Service. The lower triangular matrix is populated by taking the reciprocal values of the corresponding elements in the upper diagonal. If C_{ij} is the element of row i column j of the matrix, then the lower diagonal is filled using eq.3.2.

$$C_{ij}=\frac{1}{Cij}.\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.2)$$

Once the comparison matrix is constructed, the next step is to normalize the matrix by calculating the total of the numbers in each column, as shown in eq.3.3. This normalization process helps in achieving a standardized comparison matrix.

$$C_{i\,j} = \sum_{i=1}^{n} Cij \ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.3)$$

To generate a normalized pair-wise matrix ($X_{i\,j}$), each entry in the column is divided by the sum of the column, as shown in eq.3.4. Consequently, the sum of each column in the normalized pair-wise matrix is equal to 1, indicating that the values are proportionally distributed within the column.

$$X_{i\,j} = \frac{\mathrm{Ci\,j}}{\sum_{i=1}^{n} \mathrm{Cij}} \begin{bmatrix} C_{11} & \cdots & C_{1N} \\ \vdots & \ddots & \vdots \\ C_{N1} & \cdots & C_{NN} \end{bmatrix} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.4)$$

To generate the weighted matrix ($W_{i\,j}$), the sum of the normalized columns of the matrix is divided by the number of criteria (n) considered for analysis as shown in eq.3.5. The resulting weighted matrix reflects the relative importance and contribution of each criterion in the decision-making process.

$$W_{i\,j} = \frac{\sum_{i=1}^{n} \mathrm{Xij}}{n} \begin{bmatrix} W_{11} \\ \vdots \\ W_{N1} \end{bmatrix} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.5)$$

The consistency vector is computed by multiplying the pair-wise matrix by the weights vector and dividing the resulting weighted sum vector by the criterion weight as shown in eq.3.6. The consistency vector provides a measure of the overall consistency of the decision-making process, considering the relative importance assigned to each criterion.

$$\begin{bmatrix} C_{11} & \cdots & C_{1N} \\ \vdots & \ddots & \vdots \\ C_{N1} & \cdots & C_{NN} \end{bmatrix} * \begin{bmatrix} W_{11} \\ \vdots \\ W_{N1} \end{bmatrix} = \begin{bmatrix} Cv_{11} \\ \vdots \\ Cv_{N1} \end{bmatrix} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.6), \text{ where}$$

$$Cv_{11} = \frac{1}{W_{11}}[C_{11}W_{11} + C_{12}W_{21} + C_{13}W_{31}]$$

$$Cv_{21} = \frac{1}{W_{21}}[C_{21}W_{11} + C_{22}W_{21} + C_{23}W_{31}]$$

$$Cv_{31} = \frac{1}{W_{31}}[C_{31}W_{11} + C_{32}W_{21} + C_{33}W_{31}]$$

Then, the consistency index (CI) is calculated to measure the deviation. The CI value is defined as

$$\mathrm{CI} = \frac{\lambda_{max} - n}{n - 1} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.7)$$

Where n is the size of matrix, $\boldsymbol{\lambda}_{max}$ is the principle Eigen value of the matrix.

$$\boldsymbol{\lambda}_{max} = \sum_{i=1}^{n} \mathrm{Cvij} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.8)$$

The Random index (RI) of a pair wise comparison matrix is taken from table 3.3.

Table 3.3 Random Index Table

n	1	2	3	4	5	6	7	8
RI	0.00	0.00	0.58	0.9	1.12	1.24	1.32	1.41

The Consistency ratio (CR) is determined as the ratio between the consistency index and the random index. Typically, a higher CR value indicates a lower level of consistency in the pair-wise comparison matrix. According to Saaty, a comparison matrix can be considered consistent if its CR value is less than 0.1.

$$\mathrm{CR} = \frac{CI}{RI} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.9)$$

Table 3.4 Normalization of comparison matrix

	A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**
1	**Factor**	**Quality**	**Price**	**Service**	**Location**	**Delivery**	**Total**	**Average**	**Consistency**
2	Quality	0.29	0.28	0.49	0.24	0.24	1.53	0.31	5.37
3	Price	0.04	0.04	0.02	0.05	0.05	0.20	0.04	5.08

4	Service	0.10	0.28	0.16	0.24	0.24	1.01	0.20	5.10
5	Location	0.29	0.20	0.16	0.24	0.24	1.13	0.23	5.15
6	Delivery	0.29	0.20	0.16	0.24	0.24	1.13	0.23	5.15
								CI	0.04
								RI	1.12
								CR	0.035

Based on the information provided in table 3.4, it can be observed CR value is less than 0.10, Consequently, the comparison matrix is deemed consistent, and the weights for each criterion can be determined. The consistency of the matrix indicates a reliable and robust decision-making process, allowing for the accurate determination of the relative importance of each criterion.

3.2.2 TOPSIS Method

After identifying the performance- defining criteria and supplier alternatives, a decision matrix is constructed to facilitate the decision-making process. The decision matrix has an order of M×N, where M represents the number of alternatives and N represents the number of performance-defining criteria. This decision matrix, as depicted in eq.3.10, serves as a structured representation of the available alternatives and their respective performance on each criterion.

$$D_{MxN} = \begin{bmatrix} a_{11} & \cdots & a_{1N} \\ \vdots & \ddots & \vdots \\ a_{N1} & \cdots & a_{NN} \end{bmatrix} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.10)$$

Table 3.5 Decision matrix

Weight	**0.31**	**0.04**	**0.20**	**0.23**	**0.23**
Factor	**Quality**	**Price**	**Service**	**Location**	**Delivery**
S_1	7	9	9	8	7
S_2	8	7	8	7	9
S_3	9	6	8	9	6
S_4	6	7	8	6	7
Total	15.17	14.66	16.52	15.17	14.66

To represent the performance values as linguistic variables, the decision matrix undergoes a transformation into a normalized decision matrix (a_{ij}). This normalization process involves converting the performance values within the decision matrix to a range of [0,1]. The calculation for obtaining the normalized values of each element within the normalized decision matrix is depicted by eq.3.11.

$$r_{ij} = \quad \sqrt{\sum (Xij)^2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.11)$$

Table 3.6 Normalized Decision matrix

Weight	**0.31**	**0.04**	**0.20**	**0.23**	**0.23**
Factor	**Quality**	**Price**	**Service**	**Location**	**Delivery**

S_1	0.46	0.61	0.54	0.53	0.48
S_2	0.53	0.48	0.48	0.46	0.61
S_3	0.59	0.41	0.48	0.59	0.41
S_4	0.40	0.48	0.48	0.40	0.48

The calculation of a weighted normalized decision matrix involves multiplying the normalized values of each element with the corresponding weights assigned to each criterion. This process yields a matrix that reflects the relative importance of each criterion in the decision-making process. This calculation is represented by eq.3.12.

$$\tilde{V}_{ij} = r_{ij} \times \tilde{W}_i \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.12)$$

Table 3.7 Weighted normalized Decision matrix

	Quality	**Price**	**Service**	**Location**	**Delivery**
S_1	0.141	0.024	0.111	0.119	0.108
S_2	0.162	0.019	0.098	0.104	0.138
S_3	0.182	0.016	0.098	0.134	0.092
S_4	0.121	0.019	0.098	0.089	0.108

The Positive ideal solution (PIS, $\tilde{A}^{+}$) and a Negative ideal solution (NIS, $\tilde{A}^{-}$) are determined based on the desired features for supplier selection. The PIS represents the ideal values that maximize the desired features, while the NIS represents the ideal values that minimize the desired features. These calculations are depicted in eqs.3.13 and 3.14, respectively. In the context of supplier selection, the desired features typically include high quality, effective service, fast delivery, low price, and nearest location.

$$\tilde{A}^{+} = (\tilde{V}_1^{+}, \tilde{V}_2^{+} \ldots\ldots, \tilde{V}_N^{+}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.13)$$

A^{+}	0.182	0.016	0.111	0.089	0.138

$$\tilde{A}^{-} = (\tilde{V}_1^{-}, \tilde{V}_2^{-} \ldots\ldots, \tilde{V}_N^{-}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.14)$$

A^{-}	0.121	0.024	0.098	0.134	0.092

Where $\tilde{V}_j^{+} = \begin{bmatrix} (\max \tilde{V}_{ij}) & \text{if j is benifits criteria} \\ (\min \tilde{V}_{ij}) & \text{if j is cost criteria} \end{bmatrix}$, $\tilde{V}_j^{-} = \begin{bmatrix} (\min \tilde{V}_{ij}) & \text{if j is benifits criteria} \\ (\max \tilde{V}_{ij}) & \text{if j is cost criteria} \end{bmatrix}$ for j=1, 2…N

The Euclidean distances between each alternative and the PIS and NIS are computed using eqs.3.15 and 3.16, respectively. These distances provide a measure of the proximity of each alternative to the PIS and NIS, allowing for the evaluation of their performance relative to the ideal and undesirable criteria.

$$\tilde{D}_i^{+} = \sqrt{\sum_{j=1}^{N} D\left(\tilde{V}_j^{+} - \tilde{V}_{ij}\right)^2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3.15)$$

Table 3.8 Separation from positive ideal solution

	Quality	Price	Service	Location	Delivery	Total	D+
S_1	0.001645	0.000072	0	0.000892	0.000926	0.003535	0.059
S_2	0.000414	0.000009	0.000162	0.000225	0	0.000810	0.028
S_3	0	0	0.000162	0.002000	0.002097	0.004259	0.065
S_4	0.003692	0.000009	0.000162	0	0.000926	0.004789	0.069

$$\widetilde{D_\iota}^- = \sqrt{\Sigma_{j=1}^{N} D\left(\widetilde{V_J}^- - \widetilde{V_{\iota J}}\right)^2} \dots\dots\dots\dots\dots\dots\dots \quad (3.16) \text{ for i=1,2,3….M and}$$

Table 3.9 Separation from negative ideal solution

	Quality	Price	Service	Location	Delivery	Total	D^-
S_1	0.000418	0	0.000158	0.000229	0.000242	0.001048	0.032
S_2	0.001652	0.000024	0	0.000900	0.002144	0.004721	0.069
S_3	0.003703	0.000059	0	0	0	0.003762	0.061
S_4	0	0.000024	0	0.002012	0.000242	0.002279	0.048

The overall preference or fuzzy closeness index ($\tilde{C}\tilde{I}_i$) of the alternatives is determined using eq.19. This calculation provides a measure of the relative preference or closeness of each alternative based on the evaluated criteria.

$$\widetilde{CI_I} = \frac{\widetilde{D_\iota}^+}{\widetilde{D_\iota}^+ + \widetilde{D_\iota}^-} \dots\dots\dots\dots\dots\dots\dots\dots \quad (3.17)$$

Table 3.10 Fuzzy closeness index and ranking of alternatives

	D+	D^-	$\widetilde{CI_I}$	Ranking
S_1	0.059	0.032	0.35	4
S_2	0.028	0.069	0.71	1
S_3	0.065	0.061	0.48	2
S_4	0.069	0.048	0.41	3

Based on the closeness index, supplier 2 obtains the highest score (0.71) among the four suppliers, indicating its superior performance in meeting the evaluated criteria. The ranking of the suppliers is illustrated in Fig 3.2, which represents a bar graph displaying the relative positions and performance of each supplier.

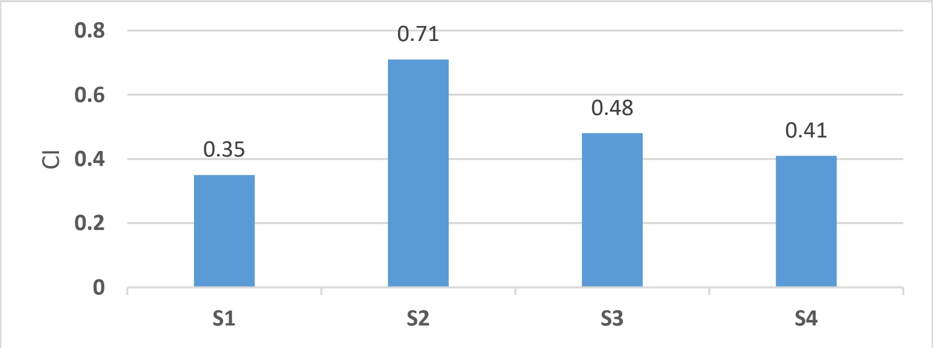

Fig 3.2: Fuzzy closeness index of suppliers

4. CONCLUSIONS

Supplier selection plays a crucial role in the manufacturing industry, and the incorporation of AHP and TOPSIS methods can significantly enhance the accuracy and efficacy of this decision-making process. These methods offer a structured and systematic approach for evaluating and ranking potential suppliers based on multiple criteria, while also accounting for uncertainty in the evaluation process.

By utilizing AHP and TOPSIS methods in supplier selection can help manufacturing companies to make more informed and effective decisions. This, in turn, can lead to stronger supplier relationships, improved product quality, and increased profitability. However, it is important to carefully consider the criteria and sub-criteria used in the evaluation process, as well as the weights assigned to each criterion. This ensures that the decision-making process remains objective, accurate, and aligned with the specific requirements and objectives of the company.

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