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Decision Support System for Optimizing Supplier Selection Using TOPSIS and Entropy Weighting Methods

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Abstrak

Supplier selection is a crucial process in supply chain management, where companies must determine the best suppliers who are able to meet their needs based on various criteria. Companies often face challenges in managing the various factors that influence supplier selection decisions, suppliers that offer low prices may not always provide the best quality or consistent delivery times. Optimizing supplier selection through the DSS approach, companies can build stronger relationships with high-performing suppliers, while improving overall business resilience and competitiveness. The combination of the TOPSIS method and entropy weighting in supplier selection optimization provides a robust approach to evaluating and selecting the best suppliers based on predetermined criteria. This combination not only improves objectivity and accuracy in the evaluation process, but also allows decision-makers to consider trade-offs between various criteria more effectively. The purpose of the research of the combination of the TOPSIS method and entropy weighting in optimizing supplier selection is to produce objective and data-based criteria weighting through the application of the entropy weighting method, thereby reducing subjectivity in the supplier selection process. The results of the preference value calculated using the TOPSIS method resulted in the first rank with the highest preference value of 0.78393, followed by GH Supplier with a value of 0.75611, and FR Supplier in third place with a value of 0.6913. The next supplier is Supplier AG with a value of 0.59912, followed by Supplier BR with 0.51682, and Supplier TR in sixth position with 0.465. Supplier IH has a preference value of 0.43166, followed by Supplier YS with a value of 0.3984, and finally Supplier RT is in the lowest position with a value of 0.35517. This ranking shows that US Supplier is the best supplier, while Supplier RT is the lowest choice based on the criteria used.

Keywords: *Combination, Entropy Weighting, Optimization, Supplier, TOPSIS*

1. INTRODUCING

Supplier selection is a crucial process in supply chain management, where companies must determine the best suppliers who are able to meet their needs based on various criteria[1], [2]. Companies often face challenges in managing the various factors that influence supplier selection decisions, suppliers that offer low prices may not always provide the best quality or consistent delivery times. The application of more advanced technologies and methods in supplier selection not only helps to optimize the selection process, but also reduces the risk of decisions based on assumptions or subjectivity. Optimizing supplier selection is a strategic step that can provide a competitive advantage for companies by improving supply chain efficiency, lowering costs, and maintaining product quality. One effective approach is to use a decision support system (DSS). This approach allows companies to assess suppliers more accurately based on predetermined criteria, such as quality, price, delivery accuracy, and flexibility. In addition, the use of data analytics and machine learning technology can also provide predictive insights into supplier performance in the future, so that companies can anticipate changes and reduce risks. By optimizing supplier selection through the DSS approach, companies can build stronger relationships with high-performing suppliers, while improving overall business resilience and competitiveness.

DSS has a variety of significant benefits in aiding the decision-making process, especially when the decision involves many complex criteria and large data[3], [4]. By using DSS, organizations can objectively and systematically analyze various alternative solutions, allowing them to choose the best option based on relevant factors. DSS also improves the efficiency of the decision-making process by providing fast and accurate data-driven analysis tools, reducing the risk of human error, and helping to identify patterns or trends that may not be visible manually. In addition, DSS allows decision-makers to consider different scenarios through simulations and evaluation models[5], [6], so that decisions taken are more mature, measurable, and accountable. With the application of this technology, organizations can optimize performance, save time, and improve the quality of decisions that support the achievement of strategic goals. The advantages of DSS include several important

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aspects that can improve the quality of decision-making in various contexts, namely being able to handle complex data and large volumes of information, providing more in-depth and accurate analysis than manual methods[7], [8]. The Technique For Others Preference by Similarity to Ideal Solution (TOPSIS) method is one of the most popular DSS methods.

The TOPSIS method has significant benefits in multi-criteria decision-making processes, especially in situations that require complex alternative evaluations[9], [10]. One of its main advantages is its ability to systematically identify the best alternative based on its proximity to the positive ideal solution (the best alternative) and the distance from the negative ideal solution (the worst alternative)[11], [12]. This method provides easy-to-understand results using simple but powerful mathematical calculations, thus assisting decision-makers in assessing various options objectively. With this method, decision-makers can make more accurate, efficient, and data-driven choices, reducing the risk of subjectivity and ensuring that the decisions taken are close to the optimal solution. The advantage of the TOPSIS method is that it provides objective results because it bases decisions on numerical data, without involving the subjectivity of decision-makers and produces an easy-to-understand final preference value, making it easier to rank alternatives clearly and precisely[13]. The main weakness in TOPSIS is that the weight of the criteria is often determined subjectively by the decision maker, so the final result can be unobjective. The result of TOPSIS is highly dependent on the weight given. Small changes in weight can significantly affect the final ranking of alternatives. This can lead to instability in decisions if there is no clear method for determining weights. The entropy weighting method is a weighting technique to cover the weaknesses of TOPSIS in terms of determining the weight of the criteria.

The entropy weighting method offers significant benefits in the decision-making process, especially in the context of multi-criteria evaluation[14], [15]. One of its advantages is its ability to provide objective weights based on data variations, so that each criterion is judged according to its contribution to the overall system. This method analyzes the uncertainty of information in the available data, by measuring the extent to which each criterion contributes to the total information, and assigns a higher weight to the criteria that indicate greater variation[16], [17]. With this approach, entropy helps to reduce subjectivity in weighting, so that decision-makers can obtain fairer and more accurate results. The application of the entropy weighting method makes the decision-making process more transparent, measurable, and able to optimize results based on valid data. The entropy weighting method also allows for a more in-depth analysis of the relationships between criteria[18], [19], providing valuable insights into determining priorities in decision-making. Using this approach, organizations can easily identify which criteria have the most influence on the desired outcome, allowing them to make appropriate strategy adjustments. Another advantage of entropy is its ability to adapt in situations where the available data is heterogeneous or unbalanced, ensuring that all criteria are considered proportionately. In addition, this method helps to increase confidence in the evaluation results, as a transparent and data-driven calculation process reduces the risk of errors or biases that may occur if the weights are determined manually. Thus, the use of entropy weighting methods not only improves the quality of decision-making[20], but also strengthens the legitimacy of the decisions taken, supporting the successful implementation of strategies that are more effective in achieving organizational goals.

The combination of the TOPSIS method and Entropy weighting in supplier selection optimization provides a robust approach to evaluating and selecting the best suppliers based on predetermined criteria. This combination not only improves objectivity and accuracy in the evaluation process, but also allows decision-makers to consider trade-offs between various criteria more effectively. By using the underlying Entropy weighting method of TOPSIS, organizations can optimize supplier selection with a more transparent data-driven approach, support operational sustainability, and increase competitiveness in the market. The implementation of this combination also allows companies to adapt to changing market dynamics, ensuring that supplier selection decisions remain relevant and strategic. The purpose of the research of the combination of the TOPSIS method and entropy weighting in optimizing supplier selection is to produce objective and data-based criteria weighting through the application of the entropy weighting method, thereby reducing subjectivity in the supplier selection process.

2. RESEARCH METHOD

The research stages in optimizing supplier selection can be designed to ensure a comprehensive and structured approach. The first stage is problem identification, is the process of selecting an optimal supplier that is often challenging for companies because it involves a variety of complex criteria, such as product quality, price, delivery reliability, and flexibility, all of which must be considered simultaneously. Supplier selection decisions are not based on systematic and objective analysis, but rather on intuition or past experience, which can lead to inefficiencies, increased operational costs, and risks to the quality of products or services.

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The second stage is data collection involves the process of obtaining relevant and accurate information from various sources to evaluate the performance and characteristics of suppliers based on predetermined criteria. Data can be obtained through surveys to purchasing managers and staff responsible for the procurement process, in-depth interviews, as well as from historical data on supplier performance, such as product quality reports, delivery times, and prices. At this stage, it is important to ensure the validity and reliability of the data collected to support objective and credible analysis.

The third stage is data processing using the TOPSIS and entropy methods, starting with data normalization to equalize the scale between the criteria. Furthermore, the entropy method is used to calculate the weight of each criterion based on its level of importance, where this weight is obtained from the degree of diversity of the data. After that, the normalized value is multiplied by the weights to get the weighted normalized matrix. In the next step, a positive ideal solution (the best value for each criterion) and a negative ideal solution (worst value) are determined. The distance between each alternative to the positive and negative ideal solution is calculated, then the preference value is calculated to determine how close the alternative is to the ideal solution. The alternative with the highest preference value is considered the most optimal supplier.

The last stage is the analysis of results in supplier selection using the TOPSIS and entropy methods aimed at assessing how effective the data processing process is in determining the best suppliers. Suppliers with the highest preference scores indicate that they are closest to the ideal solution, which means they meet most important criteria, such as price, quality, reliability, or delivery timeliness. This analysis allows for more objective and measurable decision-making. These results provide in-depth insights for companies in choosing the optimal supplier according to their strategic needs.

2.1. Entropy Weighting Method

The Entropy Weighting Method is a method used to determine the weight of each criterion in a multi-criteria analysis based on the degree of variation or uncertainty of the data[16]. The main principle of this method is that criteria with more varied information are considered more important or influential, while criteria with uniform data are considered to have low information and less weight.

This matrix presents information in the form of numerical values that show the performance of each alternative for each criterion. The formula of the decision matrix is.

$$X = \begin{bmatrix} x_{11} & \cdots & x_{n1} \\ \vdots & \ddots & \vdots \\ x_{1m} & \cdots & x_{nm} \end{bmatrix} \tag{1}$$

Each data value from the decision matrix is normalized so that all criteria can be fairly compared. Normalization is done by dividing each value by the total score for each criterion. The normalization formula is.

$$r_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}} \tag{2}$$

Entropy measures the level of uncertainty in data. The greater the entropy, the smaller the variation in the data, which means that the criteria are less significant. The entropy formula is.

$$E_j = \frac{-1}{\ln m} \sum_{i=1}^{m} r_{ij} \ln r_{ij} \tag{3}$$

Degrees of diversity are used to measure how important a criterion is based on the information it contains. The formula for diversity degrees is.

$$D_j = 1 - E_j \tag{4}$$

The weights for each criterion are calculated based on the degree of diversity with a formula.

$$W_j = \frac{D_j}{\sum_{j=1}^{n} D_j} \tag{5}$$

The entropy method is widely used in decision-making, performance analysis, and alternative evaluation that involves many criteria to gain more objective weight.

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2.2. TOPSIS Method

The TOPSIS method is a multi-criteria decision-making method used to determine the best alternative from a number of options based on predetermined criteria[21]. This method is a powerful tool for decision-making that involves many criteria, and a deep understanding of this process can help organizations in achieving better and more informed decisions.

The stages in the TOPSIS method are to compile a decision matrix that contains the performance value of each alternative for each criterion. Each row represents an alternative, and each column represents a criterion by using equation (1). Normalization is done to convert all values into the same scale so that they can be compared, this process is carried out with equation (2). Calculating the weighted normalization matrix is a matrix obtained after multiplying the normalization value by the weight that has been set for each criterion, calculated by a formula.

$$v_{ij} = w_j * r_{ij} \tag{6}$$

Calculating the value of the positive and negative ideal solution is the value of the positive ideal solution (Y+) and the value of the negative ideal solution (Y-) is the combination of the best and worst values of the existing criteria, calculated by formula.

$$y_i^+ = \begin{cases} max\, v_{ij}; benefit\ attributes \\ min\, v_{ij}; cost\ attributes \end{cases} \tag{7}$$

$$y_i^- = \begin{cases} min\, v_{ij}; benefit\ attributes \\ max\, v_{ij}; cost\ attributes \end{cases} \tag{8}$$

Calculating the distance to the ideal solution is a measure of how close each alternative is to the positive ideal solution and how far away from the negative ideal solution, calculated by formula.

$$D_i^+ = \sqrt{\sum_{j=1}^{n} \left(y_i^+ - v_{ij}\right)^2} \tag{9}$$

$$D_i^- = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - y_i^-\right)^2} \tag{10}$$

Calculating the preference value shows how well an alternative compares to other alternatives, based on its proximity to the positive ideal solution and its distance away from the negative ideal solution, calculated by the formula.

$$A_i = \frac{D_i^-}{D_i^- + D_i^+} \tag{11}$$

The TOPSIS method provides a systematic and structured approach to decision-making that involves many criteria. By following these stages, decision-makers can evaluate and choose the most appropriate alternative based on predetermined criteria.

3. RESULT AND DISCUSSION

DSS to optimize supplier selection Using the TOPSIS method and entropy weighting is a systematic approach that integrates several criteria to evaluate and select the best suppliers. The system uses the TOPSIS method, which sorts suppliers based on their proximity to the ideal solution, allowing decision-makers to effectively identify the most suitable alternatives. To improve the reliability of the decision-making process, the entropy weighting method is used to objectively determine the weight of the selection criteria, reflecting the relative importance of each criterion. By combining these two methodologies, DSS provides a comprehensive framework that enables organizations to make informed and optimal supplier selection decisions, improve efficiency, reduce costs, and build long-term partnerships.

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3.1. Data Collection

The data collection process in the study to optimize supplier selection using the TOPSIS and entropy weighting methods is an important step that must be done carefully to ensure the accuracy and relevance of the information obtained. The first process determines relevant criteria for supplier evaluation, such as price, product quality, delivery time, customer service, and reputation. These criteria should reflect the needs and goals of the organization. Table 1 is the criteria data used in the selection of suppliers.

Tabel 1. Supplier Selection Criteria Data

Code	Name	Type	Description
P	Price	Cost	Price is the monetary value offered by the supplier for the product or service provided. Competitive pricing is essential to reduce operational costs and increase profit margins.
PQ	Product Quality	Benefit	Product quality includes characteristics and attributes that meet or exceed specified standards, including durability, reliability, and conformance to specifications. High product quality has a direct effect on customer satisfaction and reduces the risk of product returns and losses due to defective products.
DT	Delivery Time	Benefit	Delivery time is the period it takes for the supplier to deliver the product after receiving the order. These criteria include the speed of delivery and compliance with the agreed schedule. Proper delivery times are crucial in maintaining smooth operations and meeting market demands.
SC	Customer Service	Benefit	Customer service includes the support and assistance provided by the supplier to the customer before, during, and after the transaction. This includes responsive communication, complaint handling, and the ability to provide adequate solutions. Good customer service can improve the customer experience and help build long-term relationships between the company and suppliers. Suppliers who are responsive and helpful will be more trusted, making it easier to collaborate in the future.
R	Reputation	Benefit	Reputation is a general perception of a supplier based on their previous experience, and performance history. A good reputation shows that the supplier is trustworthy and consistent in providing quality products and services.

Assessment data for supplier selection criteria is usually compiled in the form of a table that includes alternatives (suppliers) and their performance values against each criterion. Table 2 of this assessment data provides a comprehensive overview of the performance of each supplier based on the criteria that have been determined. This data can be used as a basis for further analysis using the TOPSIS and entropy weighting methods in making supplier selection decisions.

Tabel 2. Supplier Assessment Data

Supplier Name	P	PQ	DT	SC	R
Supplier AS	8	9	6	8	4
Supplier BR	7	8	5	7	3
Supplier YS	9	9	3	9	5
Supplier RT	8	7	4	6	4
Supplier GH	7	8	6	7	4
Supplier FR	8	7	5	9	5
Supplier AG	7	6	6	6	3
Supplier IH	8	9	4	8	4
Supplier TR	6	6	4	7	5

The assessment data table above provides comprehensive information on the performance of various suppliers. Data can be collected directly from procurement teams, managers, or end-users who have experience with suppliers. This data can be used as a basis for further analysis with the TOPSIS and entropy weighting methods in making optimal supplier selection decisions.

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3.2. Implementation of the Entropy Method in Determining the Weight of Criteria

The implementation of the entropy method in determining the weight of criteria is an important step in the multi-criteria decision-making process, including in the selection of suppliers. This method helps in measuring the relative importance of each criterion based on the variation in information provided by the data.

This matrix presents information in the form of numerical values that show the performance of each alternative for each criterion. The formula of the decision matrix is by using (1).

$$X = \begin{bmatrix} 8 & 9 & 6 & 8 & 4 \\ 7 & 8 & 5 & 7 & 3 \\ 9 & 9 & 3 & 9 & 5 \\ 8 & 7 & 4 & 6 & 4 \\ 7 & 8 & 6 & 7 & 4 \\ 8 & 7 & 5 & 9 & 5 \\ 7 & 6 & 6 & 6 & 3 \\ 8 & 9 & 4 & 8 & 4 \\ 6 & 6 & 4 & 7 & 5 \end{bmatrix}$$

Each data value from the decision matrix is normalized so that all criteria can be fairly compared. Normalization is done by dividing each value by the total score for each criterion. The normalization formula is by using (2).

$$r_{11} = \frac{x_{11}}{\sum_{i=1}^{m} x_{11,19}} = \frac{8}{68} = 0.1176$$

The results of the calculation of the matrix normalization values for all alternatives of each criterion are shown in table 3.

Tabel 3.The Calculation of the Matrix Normalization Values

Supplier Name	P	PQ	DT	SC	R
Supplier AS	0.1176	0.1304	0.1395	0.1194	0.1081
Supplier BR	0.1029	0.1159	0.1163	0.1045	0.0811
Supplier YS	0.1324	0.1304	0.0698	0.1343	0.1351
Supplier RT	0.1176	0.1014	0.0930	0.0896	0.1081
Supplier GH	0.1029	0.1159	0.1395	0.1045	0.1081
Supplier FR	0.1176	0.1014	0.1163	0.1343	0.1351
Supplier AG	0.1029	0.0870	0.1395	0.0896	0.0811
Supplier IH	0.1176	0.1304	0.0930	0.1194	0.1081
Supplier TR	0.0882	0.0870	0.0930	0.1045	0.1351

Entropy measures the level of uncertainty in data. The greater the entropy, the smaller the variation in the data, which means that the criteria are less significant. The entropy formula is by using (3).

$$E_1 = \frac{-1}{\ln 9} \sum_{i=1}^{m} r_{11,19} \ln r_{11,19} = (-0.4551) * (-2.19110) = 0.99721$$
$$E_2 = \frac{-1}{\ln 9} \sum_{i=1}^{m} r_{21,29} \ln r_{21,29} = (-0.4551) * (-2.18570) = 0.99476$$
$$E_3 = \frac{-1}{\ln 9} \sum_{i=1}^{m} r_{31,19} \ln r_{31,39} = (-0.4551) * (-2.17335) = 0.98914$$
$$E_4 = \frac{-1}{\ln 9} \sum_{i=1}^{m} r_{41,49} \ln r_{41,49} = (-0.4551) * (-2.18699) = 0.99534$$
$$E_5 = \frac{-1}{\ln 9} \sum_{i=1}^{m} r_{51,59} \ln r_{51,59} = (-0.4551) * (-2.18081) = 0.99253$$

Degrees of diversity are used to measure how important a criterion is based on the information it contains. The formula for diversity degrees is by using (4).

$$D_1 = 1 - E_1 = 1 - 0.99721 = 0.00279$$
$$D_2 = 1 - E_2 = 1 - 0.99476 = 0.00524$$
$$D_3 = 1 - E_3 = 1 - 0.98914 = 0.01086$$
$$D_4 = 1 - E_4 = 1 - 0.99534 = 0.00466$$
$$D_5 = 1 - E_5 = 1 - 0.99253 = 0.00747$$

The weights for each criterion are calculated based on the degree of diversity with a formula is by using (5).

$$W_1 = \frac{D_1}{\sum_{j=1}^{n} D_{1,5}} = \frac{0.00279}{0.03103} = 0.0899$$

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$$W_2 = \frac{D_2}{\sum_{j=1}^{n} D_{1,5}} = \frac{0.00524}{0.03103} = 0.1690$$
$$W_3 = \frac{D_3}{\sum_{j=1}^{n} D_{1,5}} = \frac{0.01086}{0.03103} = 0.3502$$
$$W_4 = \frac{D_4}{\sum_{j=1}^{n} D_{1,5}} = \frac{0.00466}{0.03103} = 0.1502$$
$$W_5 = \frac{D_5}{\sum_{j=1}^{n} D_{1,5}} = \frac{0.00747}{0.03103} = 0.2408$$

The application of the entropy method provides an objective approach in determining the weight of criteria based on the information contained in the data. With systematic measurement, companies can ensure that the most relevant criteria that contribute greatly to the final decision are recognized and given the right weight. Figure 1 is the result of calculating the weight of the criteria using entropy.

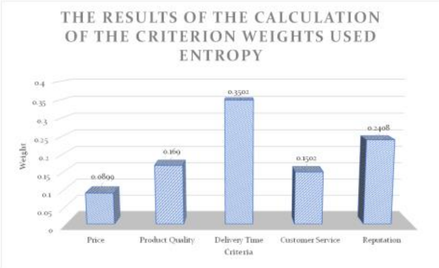

Figure. 1. The results of the calculation of the criterion weights used entropy

The criterion weighting result uses entropy for the price criterion of 0.0899, which indicates that the variation in information provided by the price criterion is lower, so it has less influence on the overall decision. The product quality criterion is 0.169, which shows that the variation in information from product quality has a greater influence on the overall evaluation. The delivery time criterion is 0.3502, which means that the variation in information in this criterion is very important. Decision-making relies heavily on delivery time performance, making it the most significant criterion in evaluation. The customer service criterion is 0.1502, indicating that the quality of customer service makes an important contribution to decision-making. The reputation criterion is 0.2408, indicating that the information contained in this criterion is also significant and influential in the final assessment.

3.3. Implementation of the TOPSIS Method in Supplier Selection

The TOPSIS method is used to select the best suppliers based on their proximity to the ideal solution. First, create a decision matrix that contains alternative suppliers and the criteria assessed, then normalize the matrix so that the comparison between the criteria is balanced. Next, calculate the weighted decision matrix by multiplying the normalization results by the weight of each criterion. Determine the positive (best) and negative (worst) ideal solutions for each criterion. The distance between each supplier to the positive and negative ideal solution is calculated, and then the relative proximity of each supplier to the ideal solution is also calculated. The supplier that has the highest relative proximity value is selected as the best supplier. This method ensures that the decision considers the criteria thoroughly with a best and worst approach.

The stages in the TOPSIS method are to compile a decision matrix that contains the performance value of each alternative for each criterion. Each row represents an alternative, and each column represents a criterion by using equation (1).

$$X = \begin{bmatrix} 8 & 9 & 6 & 8 & 4 \\ 7 & 8 & 5 & 7 & 3 \\ 9 & 9 & 3 & 9 & 5 \\ 8 & 7 & 4 & 6 & 4 \\ 7 & 8 & 6 & 7 & 4 \\ 8 & 7 & 5 & 9 & 5 \\ 7 & 6 & 6 & 6 & 3 \\ 8 & 9 & 4 & 8 & 4 \\ 6 & 6 & 4 & 7 & 5 \end{bmatrix}$$

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Normalization is done to convert all values into the same scale so that they can be compared, this process is carried out with equation (2).

$$r_{11} = \frac{x_{11}}{\sum_{i=1}^{m} x_{11,19}} = \frac{8}{68} = 0.1176$$

The results of the calculation of the matrix normalization values for all alternatives of each criterion are shown in table 4.

Tabel 4.The Calculation of the Matrix Normalization Values

Supplier Name	**P**	**PQ**	**DT**	**SC**	**R**
Supplier AS	0.1176	0.1304	0.1395	0.1194	0.1081
Supplier BR	0.1029	0.1159	0.1163	0.1045	0.0811
Supplier YS	0.1324	0.1304	0.0698	0.1343	0.1351
Supplier RT	0.1176	0.1014	0.0930	0.0896	0.1081
Supplier GH	0.1029	0.1159	0.1395	0.1045	0.1081
Supplier FR	0.1176	0.1014	0.1163	0.1343	0.1351
Supplier AG	0.1029	0.0870	0.1395	0.0896	0.0811
Supplier IH	0.1176	0.1304	0.0930	0.1194	0.1081
Supplier TR	0.0882	0.0870	0.0930	0.1045	0.1351

Calculating the weighted normalization matrix is a matrix obtained after multiplying the normalization value by the weight that has been set for each criterion, calculated with equation (6).

$$v_{11} = w_1 * r_{11} = 0.0899 * 0.1176 = 0.0106$$

The results of the calculation of the weighted normalization matrix values for all alternatives of each criterion are shown in table 5.

Tabel 5.The Calculation of the Weighted Normalization Matrix Values

Supplier Name	**P**	**PQ**	**DT**	**SC**	**R**
Supplier AS	0.0106	0.0220	0.0489	0.0179	0.0260
Supplier BR	0.0093	0.0196	0.0407	0.0157	0.0195
Supplier YS	0.0119	0.0220	0.0244	0.0202	0.0325
Supplier RT	0.0106	0.0171	0.0326	0.0134	0.0260
Supplier GH	0.0093	0.0196	0.0489	0.0157	0.0260
Supplier FR	0.0106	0.0171	0.0407	0.0202	0.0325
Supplier AG	0.0093	0.0147	0.0489	0.0134	0.0195
Supplier IH	0.0106	0.0220	0.0326	0.0179	0.0260
Supplier TR	0.0079	0.0147	0.0326	0.0157	0.0325

Calculating the value of the positive and negative ideal solution is the value of the positive ideal solution (Y+) and the value of the negative ideal solution (Y-) is the combination of the best and worst values of the existing criteria, calculated with equation (7) and (8) shown in table 6.

Tabel 6. The Calculation of the Value of the Positive and Negative Ideal Solution

	Ideal Solution	**Positive**	**Negative**
Y_1	0.0106;0.0093;0.0119;0.0106;0.0093	0.0079	0.0119
Y_2	0.0220;0.0196;0.0220;0.0171;0.0196	0.0220	0.0147
Y_3	0.0489;0.0407;0.0244;0.0326;0.0489	0.0489	0.0244
Y_4	0.0179;0.0157;0.0202;0.0134;0.0157	0.0202	0.0134
Y_5	0.0260;0.0195;0.0325;0.0260;0.0260	0.0325	0.0195

Calculating the distance to the ideal solution is a measure of how close each alternative is to the positive ideal solution and how far away from the negative ideal solution, calculated with equation (9) and (10) shown in table 7.

Tabel 7. The Calculation of the Distance to the Ideal Solution

Supplier Name	**Positive**	**Negative**
Supplier AS	0.00737	0.02674
Supplier BR	0.01623	0.01736

Supplier YS	0.02475	0.01639
Supplier RT	0.01959	0.01079
Supplier GH	0.00838	0.02598
Supplier FR	0.00986	0.02208
Supplier AG	0.01644	0.02457
Supplier IH	0.01788	0.01358
Supplier TR	0.01842	0.01601

Calculating the preference value shows how well an alternative compares to other alternatives, based on its proximity to the positive ideal solution and its distance away from the negative ideal solution, calculated by the with equation (11).

$$A_1 = \frac{D_1^-}{D_1^- + D_1^+} = \frac{0.02674}{0.02674 + 0.00737} = \frac{0.02674}{0.03411} = 0.78393$$

The results of the calculation of the preference values for all alternatives are shown in table 8.

Tabel 8. The Results of the Calculation of the Preference Values

Supplier Name	Preference Value
Supplier AS	0.78393
Supplier BR	0.51682
Supplier YS	0.39840
Supplier RT	0.35517
Supplier GH	0.75611
Supplier FR	0.69130
Supplier AG	0.59912
Supplier IH	0.43166
Supplier TR	0.46500

The end result of the TOPSIS method is the relative proximity value for each supplier. This value describes how close the alternative (supplier) is to the positive ideal solution (best) and how far away from the negative ideal solution (worst). Figure 2 is the result of the supplier selection ranking.

Figure. 2. The result of the supplier selection ranking

Based on the preference value calculated using the TOPSIS method, the supplier ranking from best to lowest is as follows: US Supplier is ranked first with the highest preference value of 0.78393, followed by Supplier GH with a value of 0.75611, and Supplier FR is ranked third with a value of 0.6913. The next supplier is Supplier AG with a value of 0.59912, followed by Supplier BR with 0.51682, and Supplier TR in sixth position with 0.465. Supplier IH has a preference value of 0.43166, followed by Supplier YS with a value of 0.3984, and finally Supplier RT is in the lowest position with a value of 0.35517. This ranking shows that US Supplier is the best supplier, while Supplier RT is the lowest choice based on the criteria used.

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4. CONCLUSION

The decision support system for optimizing supplier selection using the TOPSIS and entropy weighting methods is that the combination of these two methods allows for a more objective and systematic evaluation process in selecting the best suppliers. The Entropy method is used to objectively calculate the weight of each criterion based on the variation of information provided by the data, thus providing a weight that corresponds to the importance of each criterion. Meanwhile, TOPSIS ensures that supplier selection is carried out by measuring the proximity of each supplier alternative to the ideal (best) solution and staying away from the worst solution. With this approach, decision-making becomes more transparent and accountable, allowing companies to select optimal suppliers based on a variety of criteria that have been comprehensively assessed. The end result is a clear ranking of suppliers, where the supplier with the highest preference value is considered the most suitable to meet the company's needs. The results of the supplier ranking, namely US Supplier is ranked first with the highest preference value of 0.78393, followed by Supplier GH with a value of 0.75611, and Supplier FR is ranked third with a value of 0.6913.

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