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Decision Support System for Selecting the Best Raw Material Supplier Using Simple Multi Attribute Rating Method Technique

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Decision;
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Abstract

Problems that occur in the selection of raw material suppliers There is no assessment process for raw material suppliers based on the performance of these suppliers, so that companies cannot choose which suppliers best match the criteria used based on the performance of raw material suppliers for the company. This study aims to carry out the selection of raw material suppliers using a decision support system model by utilizing the SMART method in supporting decision making, so that the ranking results provide recommendations for companies in choosing raw material suppliers to be selected by companies based on the decision support system model made. The Simple Multi Attribute Rating Technique method is a simple but effective approach in making multi-criteria decisions. With a focus on assessing and comparing alternatives based on a number of criteria, SMART provides an intuitive framework to overcome the complexity of choosing the best option. The ranking results based on the table above Vendor C with a final score of 0.735 getting rank 1, Vendor D with a final value of 0.588 getting rank 2, Vendor B with a final score of 0.5 getting rank 3.

1.INTRODUCING

An Information System (IS) is a set of elements that are related and work together to collect, store, manage, and disseminate information to support decision making in an organization. These systems involve hardware, software, networks, people, and procedures that are integrated with each other[1]. The main goal of Information Systems is to provide accurate, relevant, and timely data to users, both at the operational and managerial levels, so as to improve efficiency, productivity, and quality of decisions at all levels of the organization. With the continuous development of technology, Information Systems also play an important role in supporting digital transformation and innovation in various industrial sectors[2].

Information Systems have an important role in the process of selecting suppliers in an organization. IS can be used to facilitate, support and improve efficiency throughout the supplier selection cycle. Information Systems can be used to store and manage information about suppliers, including data about previous supplier performance, product or service quality, and financial information. This helps organizations make better decisions in choosing suppliers that best suit their needs. Information systems can assist in monitoring and evaluating current supplier performance, including aspects of quality, timeliness, and cost. Historical information about suppliers can be presented in a structured manner, assisting management in assessing the risks and benefits of engaging with a particular supplier. In addition, information systems can facilitate communication and collaboration between the various departments involved in the supplier selection process, speed up workflows, and improve the overall efficiency of the procurement process. With good data integration, organizations can make more informed and strategic decisions related to supplier selection that affect performance and the entire supply chain. The process of selecting raw material suppliers involves various issues that can affect the

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performance and sustainability of an organization. The main problem is ensuring the quality of raw materials that meet the standards and specifications set, delays in the delivery of raw materials can cause disruptions in the supply chain and production. Problems that occur in the selection of raw material suppliers There is no assessment process for raw material suppliers based on the performance of these suppliers, so that companies cannot choose which suppliers best match the criteria used based on the performance of raw material suppliers for the company.

Decision Making System (DSS) is a concept or approach used in the context of business and management to assist individuals or organizations in making decisions[3], [4]. DSS uses information technology, data, analytical models, and specific processes to provide better support in decision making. Decision Making System (DSS) is a concept or approach that uses information technology and data analysis to assist individuals or organizations in overcoming problems and making effective decisions. By utilizing relevant data, DSS designs decision models and provides information that supports the decision-making process[5]. A structured decision-making process, from problem identification to monitoring results, is at the core of DSS implementation, ultimately benefiting from increased efficiency, decision accuracy, and strategic support in a dynamic business environment[6]. The importance of DSS is increasing along with the complexity of the business environment and the ever-growing volume of data[7].

The Simple Multi Attribute Rating Technique method is a simple but effective approach in making multi-criteria decisions[8]. With a focus on assessing and comparing alternatives based on a number of criteria, SMART provides an intuitive framework to overcome the complexity of choosing the best option. The stages in this method, including assessment of alternatives, determination of relative weighting of criteria, and ranking based on total score, form a clear basis for identifying solutions that best suit decision makers' preferences[9]. With an approach that is easy to understand and implement, SMART becomes a useful tool in helping decision makers make informed and informed decisions in the context of various criteria that must be considered.

Previous research that became literature in this study includes by Maya Nur Amalia, and Maxsi Ary (2021) The Simple Multi Attribute Rating Technique (SMART) method in this decision support system can help companies provide the best supplier recommendations with standard criteria that are in accordance with the company they want[10]. Further research by Jemmy Immanuel, David Andrian, Lusi Mei Cahya Wulandari (2022) the purpose of the research is to create a selection support system for suppliers in UD Bahtera, aiming at supplier priorities using the SMART (Simple Multi Attribute Rating Technique) method, which is a decision-making technique to be able to help and provide convenience, for companies in determining the best suppliers with standard criteria that are in accordance with the company want and produce yield supplier results for elbow 5 milli meters x 5 milli meters x 6 meters is BP[11]. Further research by Annisa Zafhitri Nasution (2022) the SMART method helps in selecting several suppliers so that PT Azkha Medical Indonesia gets the right criteria and alternatives. The criteria and weights used in this method are Price(C1) with a weight of 35, Quality (C2) with a weight of 25, Time(C3) with a weight of 25, Service(C4) with a weight of 20, and Responsibility(C5) with a weight of 15[8]. The difference with the research conducted is the criteria used product quality, timeliness of delivery, reliability, and product cost with the initial weight of criteria obtained from decision makers in the company.

This study aims to carry out the selection of raw material suppliers using a decision support system model by utilizing the SMART method in supporting decision making, so that the ranking results provide recommendations for companies in choosing raw material suppliers to be selected by companies based on the decision support system model made.

2.RESEARCH METHOD

The research stage is a series of systematic and structured steps to achieve research objectives. The research process generally begins with the formulation of the problem or research question to be answered[12]. The next stage is to design a theoretical framework as a basis for research. After that, research involves collecting data through certain methods, such as surveys, experiments, or case studies. Data analysis is then performed to evaluate the findings and draw conclusions[13]. The final step is to compile a research report that includes the methodology, findings, interpretation, and implications of

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the research[14], [15]. All these stages help ensure that research is carried out systematically and that the results can be relied upon to support the contribution of new knowledge in the field concerned. The stages of research carried out can be seen in figure 1 below.

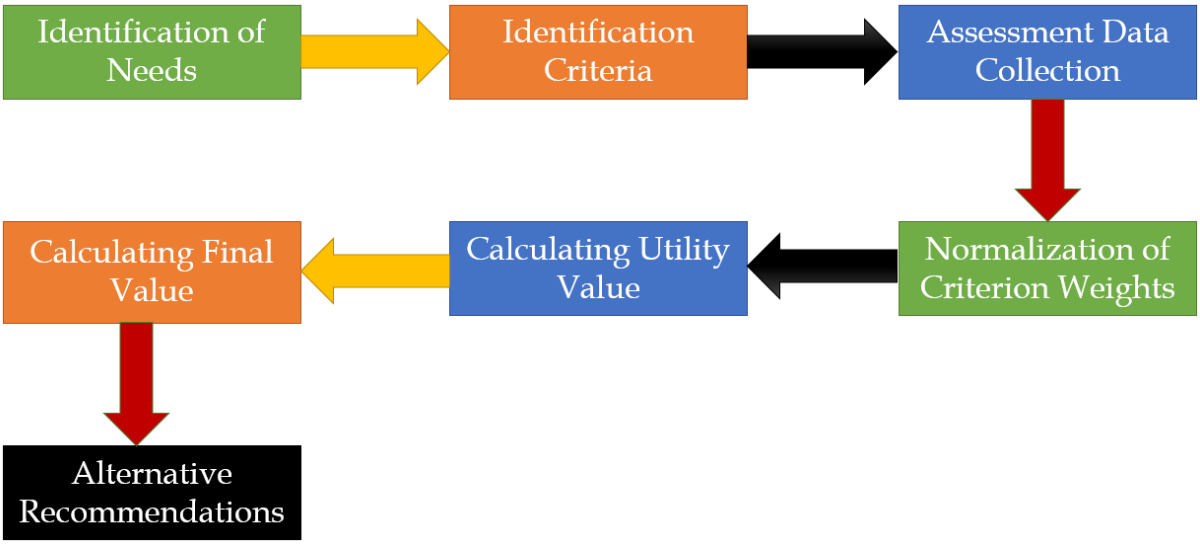

Figure 1. Stage of Research

The stages carried out in solving problems using the SMART method include:

1. Identification of Needs
   Needs identification in decision support systems (DSS) plays a key role in ensuring that these technologies can provide effective support in an organization's decision-making process. With a deep understanding of the company's challenges and goals, DSS needs identification guides the design and implementation of systems that can optimize data analysis, provide relevant information, and facilitate better decision making. In this process, determine the problem in the selection of raw material suppliers for the company, then provide a decision support system recommendation in determining the selection of raw material suppliers.
2. Identification Criteria
   The identification of criteria in a decision support system (DSS) is a critical step in ensuring that it can provide appropriate guidance in decision making. By defining criteria that are relevant and appropriate to the needs of the organization, DSS can effectively direct the process of evaluating, analyzing, and interpreting data to aid more informed decision making. A clear understanding of these criteria helps detail evaluation parameters, creates a solid foundation for algorithm development, and ensures that the information generated by the DSS matches the needs and priorities of the organization. By identifying the right criteria, organizations can maximize the benefits of decision support systems, improve decision responsibility, and achieve more optimal results in various operational and strategic aspects. The criteria used in the selection of raw material suppliers are product quality, timeliness of delivery, reliability, and product cost.
3. Assessment Data Collection
   Assessment data plays a central role in the functioning of decision support systems (DSS), forming the basis of critical analysis in organizational decision making. Through information gathered from a variety of sources, assessment data enables DSS to provide detailed evaluations of various decision options. Identification and deep understanding of assessment data helps determine relevant evaluation criteria, provides a foundation for the selection of the best solution, and optimizes the decision-making process. Therefore, in discussing the role of assessment data in DSS, we explore the importance of structured and high-quality information in crafting a strong decision foundation.
4. Normalization of Criterion Weights
   The first stage normalizes the weight of each criterion that has been given using the following equation.

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$$w_i = \frac{w_i}{\sum_{j=1}^{w} w_j} \quad (1)$$

5. Calculating Utility Value
The second stage calculates the utility value of each alternative for each criterion using the following equation.

$$u_{i(a_i)} = \frac{\max x_{ij} - x_{ij}}{\max x_{ij} - \min x_{ij}} \quad (2)$$

$$u_{i(a_i)} = \frac{x_{ij} - \min x_{ij}}{\max x_{ij} - \min x_{ij}} \quad (3)$$

Equation (2) for criteria with type of cost, and equation (3) for criteria with type of benefit.

6. Calculating Final Value
The third stage determines the final value of each alternative using the following equation.

$$u_{(ai)} = \sum_{j=1}^{n} w_j . u_{i(a_i)} \quad (4)$$

7. Alternative Recommendations
Alternative recommendations in decision support systems (DSS) open the door to smarter and informed decision making. Alternative recommendations are obtained based on an assessment of the decision support system.

3.RESULTS AND DISCUSSION

The selection of raw material suppliers is a critical stage in supply chain management that can affect the performance and operational sustainability of an organization. This process involves evaluating various factors, including product quality, timeliness of delivery, supplier reliability, and cost factors. Identification of organizational needs, desired quality standards, and risks associated with the supply of raw materials becomes the first step in the selection of effective suppliers. In addition, considering aspects of sustainability, regulatory compliance, and the ability of suppliers to innovate are also important criteria. By implementing a careful supplier selection process, organizations can ensure that their supply chains are sustainable, risks are minimized, and production needs are met efficiently.

Determination of Criteria, and Assessment of Alternatives

The first stage determines the criteria used in the selection of raw material suppliers to the company, the criteria used can be seen in table 1 below.

Table 1. Data Criteria

Criteria Name	Criteria Type	Weight Criteria
Product quality	Benefit	5
Timeliness of Delivery	Benefit	4
Reliability	Benefit	3
Product Cost	Cost	5

The next stage is to assessment each supplier based on the criteria used. Assessment data is obtained from companies by filling out questionnaires on the assessment results of each alternative.

Table 2. Assessment Data Collection

Alternative	Product Quality	Timeliness of Delivery	Reliability	Product Cost
Vendor A	5	3	4	5
Vendor B	5	4	4	5
Vendor C	4	4	5	3
Vendor D	3	4	5	3
Vendor E	4	4	3	4
Vendor F	3	5	3	5
Vendor G	5	4	3	5
Vendor H	3	5	4	5

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The next process uses Simple Multi Attribute Rating Method Technique in determining the best alternative.

Simple Multi Attribute Rating Method Technique

Simple Multi-Attribute Rating Technique (SMART) is a method of decision making used to evaluate and select alternatives based on several attributes or criteria. SMART usually involves several systematic steps, such as the following.

Based on the assessment results we will make a decision matrix for all existing alternatives based on the assessment data to be used. The decision matrix is as follows.

$$X = \begin{bmatrix} x_{11} & x_{21} & x_{31} & x_{41} \\ x_{12} & x_{22} & x_{32} & x_{42} \\ x_{13} & x_{23} & x_{33} & x_{43} \\ x_{14} & x_{24} & x_{34} & x_{44} \\ x_{15} & x_{25} & x_{35} & x_{45} \\ x_{16} & x_{26} & x_{36} & x_{46} \\ x_{17} & x_{27} & x_{37} & x_{47} \\ x_{18} & x_{28} & x_{38} & x_{48} \end{bmatrix} \Rightarrow X = \begin{bmatrix} 5 & 3 & 4 & 5 \\ 5 & 4 & 4 & 5 \\ 4 & 4 & 5 & 3 \\ 3 & 4 & 5 & 3 \\ 4 & 4 & 3 & 4 \\ 3 & 5 & 3 & 5 \\ 5 & 4 & 3 & 5 \\ 3 & 5 & 4 & 5 \end{bmatrix}$$

1. Normalization of Criterion Weights

   The first stage normalizes the weight of each criterion that has been given using the following equation (1), the results of normalization criteria can be seen below.

$$w_1 = \frac{w_1}{\sum_{j=1}^{w} w_{1;}w_4} = \frac{5}{5+4+3+5} = \frac{5}{17} = 0.294$$

$$w_2 = \frac{w_2}{\sum_{j=1}^{w} w_{1;}w_4} = \frac{4}{5+4+3+5} = \frac{4}{17} = 0.236$$

$$w_3 = \frac{w_3}{\sum_{j=1}^{w} w_{1;}w_4} = \frac{3}{5+4+3+5} = \frac{3}{17} = 0.176$$

$$w_4 = \frac{w_4}{\sum_{j=1}^{w} w_{1;}w_4} = \frac{5}{5+4+3+5} = \frac{5}{17} = 0.294$$

   The total total weight of existing criteria when added together is 1.

2. Calculating Utility Value

   The second stage calculates the utility value of each alternative for each criterion using the following equation, criteria Product quality, Timeliness of Delivery, Reliability because the type of benefit uses equation (3), the result of calculating the utility value is as follows.

$$u_{11} = \frac{x_{11} - \min x_{1;8}}{\max x_{11;18} - \min x_{11;18}} = \frac{5-3}{5-3} = \frac{2}{2} = 1$$

$$u_{12} = \frac{x_{12} - \min x_{1;8}}{\max x_{11;18} - \min x_{11;18}} = \frac{5-3}{5-3} = \frac{2}{2} = 1$$

$$u_{13} = \frac{x_{13} - \min x_{1;8}}{\max x_{11;18} - \min x_{11;18}} = \frac{4-3}{5-3} = \frac{1}{2} = 0.5$$

$$u_{14} = \frac{x_{14} - \min x_{1;8}}{\max x_{11;18} - \min x_{11;18}} = \frac{3-3}{5-3} = \frac{0}{2} = 0$$

$$u_{15} = \frac{x_{15} - \min x_{1;8}}{\max x_{11;18} - \min x_{11;18}} = \frac{4-3}{5-3} = \frac{1}{2} = 0.5$$

$$u_{16} = \frac{x_{16} - \min x_{1;8}}{\max x_{11;18} - \min x_{11;18}} = \frac{3-3}{5-3} = \frac{0}{2} = 0$$

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$$u_{17} = \frac{x_{17} - \min x_{1;8}}{\max x_{11;18} - \min x_{11;18}} = \frac{5-3}{5-3} = \frac{2}{2} = 1$$

$$u_{18} = \frac{x_{18} - \min x_{1;8}}{\max x_{11;18} - \min x_{11;18}} = \frac{3-3}{5-3} = \frac{0}{2} = 0$$

$$u_{21} = \frac{x_{21} - \min x_{21;28}}{\max x_{21;28} - \min x_{21;28}} = \frac{3-3}{5-3} = \frac{0}{2} = 0$$

$$u_{22} = \frac{x_{22} - \min x_{21;28}}{\max x_{21;28} - \min x_{21;28}} = \frac{4-3}{5-3} = \frac{1}{2} = 0.5$$

$$u_{23} = \frac{x_{23} - \min x_{21;28}}{\max x_{21;28} - \min x_{21;28}} = \frac{4-3}{5-3} = \frac{1}{2} = 0.5$$

$$u_{24} = \frac{x_{24} - \min x_{21;28}}{\max x_{21;28} - \min x_{21;28}} = \frac{4-3}{5-3} = \frac{1}{2} = 0.5$$

$$u_{25} = \frac{x_{25} - \min x_{21;28}}{\max x_{21;28} - \min x_{21;28}} = \frac{4-3}{5-3} = \frac{1}{2} = 0.5$$

$$u_{26} = \frac{x_{26} - \min x_{21;28}}{\max x_{21;28} - \min x_{21;28}} = \frac{5-3}{5-3} = \frac{2}{2} = 1$$

$$u_{27} = \frac{x_{27} - \min x_{21;28}}{\max x_{21;28} - \min x_{21;28}} = \frac{4-3}{5-3} = \frac{1}{2} = 0.5$$

$$u_{28} = \frac{x_{28} - \min x_{21;28}}{\max x_{21;28} - \min x_{21;28}} = \frac{5-3}{5-3} = \frac{2}{2} = 1$$

$$u_{31} = \frac{x_{31} - \min x_{31;38}}{\max x_{31;38} - \min x_{31;38}} = \frac{4-3}{5-3} = \frac{1}{2} = 0.5$$

$$u_{32} = \frac{x_{32} - \min x_{31;38}}{\max x_{31;38} - \min x_{31;38}} = \frac{4-3}{5-3} = \frac{1}{2} = 0.5$$

$$u_{33} = \frac{x_{33} - \min x_{31;38}}{\max x_{31;38} - \min x_{31;38}} = \frac{5-3}{5-3} = \frac{2}{2} = 1$$

$$u_{34} = \frac{x_{34} - \min x_{31;38}}{\max x_{31;38} - \min x_{31;38}} = \frac{5-3}{5-3} = \frac{2}{2} = 1$$

$$u_{35} = \frac{x_{35} - \min x_{31;38}}{\max x_{31;38} - \min x_{31;38}} = \frac{3-3}{5-3} = \frac{0}{2} = 0$$

$$u_{36} = \frac{x_{36} - \min x_{31;38}}{\max x_{31;38} - \min x_{31;38}} = \frac{3-3}{5-3} = \frac{0}{2} = 0$$

$$u_{37} = \frac{x_{37} - \min x_{31;38}}{\max x_{31;38} - \min x_{31;38}} = \frac{3-3}{5-3} = \frac{0}{2} = 0$$

$$u_{38} = \frac{x_{38} - \min x_{31;38}}{\max x_{31;38} - \min x_{31;38}} = \frac{4-3}{5-3} = \frac{1}{2} = 0.5$$

The Product Cost criterion is a cost will be calculated using equation (2), the calculation results are as follows.

$$u_{41} = \frac{\max x_{41;48} - x_{41}}{\max x_{41;48} - \min x_{41;48}} = \frac{5-5}{5-3} = \frac{0}{2} = 0$$

$$u_{42} = \frac{\max x_{41;48} - x_{42}}{\max x_{41;48} - \min x_{41;48}} = \frac{5-5}{5-3} = \frac{0}{2} = 0$$

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$$u_{43} = \frac{\max x_{41;48} - x_{43}}{\max x_{41;48} - \min x_{41;48}} = \frac{5-3}{5-3} = \frac{2}{2} = 1$$

$$u_{44} = \frac{\max x_{41;48} - x_{44}}{\max x_{41;48} - \min x_{41;48}} = \frac{5-3}{5-3} = \frac{2}{2} = 1$$

$$u_{45} = \frac{\max x_{41;48} - x_{45}}{\max x_{41;48} - \min x_{41;48}} = \frac{5-4}{5-3} = \frac{1}{2} = 0.5$$

$$u_{46} = \frac{\max x_{41;48} - x_{46}}{\max x_{41;48} - \min x_{41;48}} = \frac{5-5}{5-3} = \frac{0}{2} = 0$$

$$u_{47} = \frac{\max x_{41;48} - x_{47}}{\max x_{41;48} - \min x_{41;48}} = \frac{5-5}{5-3} = \frac{0}{2} = 0$$

$$u_{48} = \frac{\max x_{41;48} - x_{48}}{\max x_{41;48} - \min x_{41;48}} = \frac{5-5}{5-3} = \frac{0}{2} = 0$$

3. Calculating Final Value

The third stage determines the final value of each alternative using the following equation (4), the calculation results are as follows.

$$u_1 = (w_1 * u_{11}) + (w_2 * u_{21}) + (w_3 * u_{31}) + (w_4 * u_{41})$$

$$u_1 = (0.294 * 1) + (0.236 * 0) + (0.176 * 0.5) + (0.294 * 0) = 0.382$$

$$u_2 = (w_1 * u_{12}) + (w_2 * u_{22}) + (w_3 * u_{32}) + (w_4 * u_{42})$$

$$u_2 = (0.294 * 1) + (0.236 * 0.5) + (0.176 * 0.5) + (0.294 * 0) = 0.5$$

$$u_3 = (w_1 * u_{13}) + (w_2 * u_{23}) + (w_3 * u_{33}) + (w_4 * u_{43})$$

$$u_3 = (0.294 * 0.5) + (0.236 * 0.5) + (0.176 * 1) + (0.294 * 1) = 0.735$$

$$u_4 = (w_1 * u_{14}) + (w_2 * u_{24}) + (w_3 * u_{34}) + (w_4 * u_{44})$$

$$u_4 = (0.294 * 0) + (0.236 * 0.5) + (0.176 * 1) + (0.294 * 1) = 0.558$$

$$u_5 = (w_1 * u_{15}) + (w_2 * u_{25}) + (w_3 * u_{35}) + (w_4 * u_{45})$$

$$u_5 = (0.294 * 0.5) + (0.236 * 0.5) + (0.176 * 0) + (0.294 * 0.5) = 0.412$$

$$u_6 = (w_1 * u_{16}) + (w_2 * u_{26}) + (w_3 * u_{36}) + (w_4 * u_{46})$$

$$u_6 = (0.294 * 0) + (0.236 * 1) + (0.176 * 0) + (0.294 * 0) = 0.236$$

$$u_7 = (w_1 * u_{17}) + (w_2 * u_{27}) + (w_3 * u_{37}) + (w_4 * u_{47})$$

$$u_7 = (0.294 * 0) + (0.236 * 1) + (0.176 * 0) + (0.294 * 0) = 0.412$$

$$u_8 = (w_1 * u_{18}) + (w_2 * u_{28}) + (w_3 * u_{38}) + (w_4 * u_{48})$$

$$u_8 = (0.294 * 0) + (0.236 * 1) + (0.176 * 0.5) + (0.294 * 0) = 0.324$$

Alternative Ranking with Simple Multi Attribute Rating Method Technique

Alternative ranking with the SMART method assists organizations or decision-making teams in identifying and selecting alternatives that best suit their preferences and goals. Clarity in criteria identification and consistent assessment is the key to the success of this method. The alternative with the highest final score will be ranked top, while the one with the lowest final score will be ranked last. It provides a ranking relative to how well each alternative meets predefined criteria. The results of alternative ranking can be seen in table 3 below.

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Table 3. Alternative Ranking with Simple Multi Attribute Rating Method Technique

Alternative	Final Value of SMART Method	Rangking
Vendor C	0.735	1
Vendor D	0.588	2
Vendor B	0.5	3
Vendor E	0.412	4
Vendor G	0.412	5
Vendor A	0.382	6
Vendor H	0.324	7
Vendor F	0.236	8

The ranking results based on the table above Vendor C with a final score of 0.735 getting rank 1, Vendor D with a final value of 0.588 getting rank 2, Vendor B with a final score of 0.5 getting rank 3.

4.CONCLUSION

Historical information about suppliers can be presented in a structured manner, assisting management in assessing the risks and benefits of engaging with a particular supplier. In addition, information systems can facilitate communication and collaboration between the various departments involved in the supplier selection process, speed up workflows, and improve the overall efficiency of the procurement process. This study aims to carry out the selection of raw material suppliers using a decision support system model by utilizing the SMART method in supporting decision making, so that the ranking results provide recommendations for companies in choosing raw material suppliers to be selected by companies based on the decision support system model made. The ranking results based on the table above Vendor C with a final score of 0.735 getting rank 1, Vendor D with a final value of 0.588 getting rank 2, Vendor B with a final score of 0.5 getting rank 3.

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