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Combination of Response to Criteria Weighting Method and Multi-Attribute Utility Theory in the Decision Support System for the Best Supplier Selection

Faruk Ulum[1], Junhai Wang[2], Dyah Ayu Megawaty[3], Ari Sulistiyawati[4], Riska Aryanti[5], Sumanto[6], Setiawansyah[7*]

[1]*Universitas Teknokrat Indonesia, Faculty Engineering and Computer Science, Department of Technology Information, Jl. ZA. Pagar Alam No.9 -11, Labuhan Ratu, Kota Bandar Lampung, 35132, Indonesia*
[2]*Zhejiang Technical Institute of Economics, Department of Commerce and Circulation, Xue Zheng Jie, Jianggan Qu, 310018, China*
[3,4]*Universitas Teknokrat Indonesia, Faculty Engineering and Computer Science, Department of Information System, Jl. ZA. Pagar Alam No.9 -11, Labuhan Ratu, Kota Bandar Lampung, 35132, Indonesia*
[5,6]*Universitas Bina Sarana Informatika Indonesia, Faculty Engineering and Informatics, Department of Informatics, Jl. Kramat Raya No.98, RT.2/RW.9, Kota Jakarta Pusat, Daerah Khusus Ibukota Jakarta 10450, Indonesia*
[7]*Universitas Teknokrat Indonesia, Faculty Engineering and Computer Science, Department of Informatics, Jl. ZA. Pagar Alam No.9 -11, Labuhan Ratu, Kota Bandar Lampung, 35132, Indonesia*

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****Corresponding Author:***
setiawansyah@teknokrat.ac.id

Abstract

Choosing the right supplier is a strategic factor in supporting operational efficiency and a company's competitive advantage. This process requires a decision support system that is able to assess various alternatives objectively and in a structured manner. This study aims to develop a decision support system in the selection of the best supplier by combining the Response to Criteria Weighting (RECA) and Multi-Attribute Utility Theory (MAUT) methods. The RECA method is used to objectively determine the weight of each criterion based on the variation of data between alternatives, so as to reduce subjectivity in the weighting process. Meanwhile, the MAUT method functions to calculate the total utility value of each supplier based on the normalization value and weight that has been obtained. The results of the RECA method show the objective weight of each criterion, which is then used in the MAUT calculation process. The results of the analysis, obtained in the best supplier selection based on the total score of each candidate, it can be seen that PT Global Niaga Mandiri ranks first with the highest score of 0.6512, this shows that this company is the best choice in the supplier selection process. In second place is UD Anugrah Bersama with a score of 0.399, followed by PT Indo Logistik Prima in third place with a score of 0.3451. The combination of the RECA and MAUT methods has been proven to be able to produce accurate, rational, and accountable decisions. This system provides a measurable approach in filtering supplier

alternatives efficiently and is relevant to be applied to various other multi-criteria decision-making contexts.

1. Introduction

In an era of increasingly fierce business competition, choosing the right supplier is a crucial element in the sustainability and competitive advantage of a company[1], [2], [3]. Suppliers not only play the role of a supplier of raw materials or components, but also as a strategic partner in ensuring a smooth supply chain, final product quality, cost efficiency, and timeliness of production and distribution. Mistakes in choosing suppliers can cause supply disruptions, increased operational costs, and decreased customer satisfaction. The supplier selection process must be carried out systematically and objectively by considering various relevant criteria[4], [5], [6]. The main challenge in the supplier selection process lies in determining the weight of criteria which is often subjective and inconsistent, especially when it involves many decision-makers with different points of view.

In complex decision-making, especially when it involves many criteria that interact with each other and influence each other, decision support systems (DSS) play a very important role. DSS is a computer-based system designed to assist decision-makers in solving semi-structured or unstructured problems by utilizing specific data, models, and analytical approaches[7], [8], [9]. In the case of supplier selection, for example, decision-makers are faced with various criteria such as quality, price, delivery reliability, and flexibility. DSS enables systematic data processing as well as the application of multi-criteria decision-making methods (MCDM) that can identify the best alternatives based on predetermined preferences and priorities[10], [11], [12]. DSS not only speeds up the decision-making process, but also improves accuracy, objectivity, and transparency in selecting the best alternatives[13], [14]. One of the main strengths of DSS lies in its ability to incorporate a variety of analytical methods in the decision-making process. In the context of supplier selection, the use of a combination of multi-criteria methods of respond to criteria weighting (RECA) and multi-attribute utility theory (MAUT) in DSS provides a comprehensive and scalable approach.

The RECA method is an objective approach used to determine the weight of criteria based on the real response of decision-makers to the importance of each criterion in the alternative evaluation process[15]. RECA emphasizes the direct involvement of decision-makers in assessing each criterion by considering the urgency, influence, and level of relevance to the decision objectives to be achieved. These assessments are then converted into numerical form and mathematically processed to produce proportional weights and free from excessive personal bias. The main advantage of this method lies in its ability to accommodate collective preferences in a structured and consistent manner, thereby increasing objectivity in weighting criteria[16], [17], [18]. By using RECA, the decision-making process becomes more transparent, accountable, and accountable, especially in the context of a multi-criteria decision support system that demands fair and logical judgment. The RECA method is very suitable for strategic decision-making that involves various complex criteria, such as in the process of selecting suppliers, selecting employees, or evaluating projects. When RECA is applied in a decision support system, the resulting weighting results can be directly integrated into alternative evaluation methods such as the MAUT method.

The MAUT method is one of the structured approaches in multi-criteria decision-making that has significant advantages in calculating the total utility of each alternative[19], [20], [21], [22]. The main advantage of MAUT lies in its ability to quantify decision-makers' preferences over various criteria and bring them together in a single utility value that represents the level of desirability of an alternative as a whole. MAUT uses a utility function that is linear or non-linear to convert the performance value of an alternative into a utility score based on a predetermined weight and preference scale[23], [24], [25]. This process makes comparisons between alternatives more objective, transparent, and easy to interpret. In addition, MAUT is flexible in handling various types of data (quantitative and qualitative that have been normalized), and is able to accommodate trade-offs between conflicting criteria. With these advantages, MAUT is very effective in a decision support system that requires a thorough and logical evaluation of alternatives.

The purpose of this study is to apply an effective and measurable decision support system in the process of selecting the best supplier through a combination of RECA and MAUT methods. This combination is designed to overcome the problem of subjectivity in determining the weight of criteria and increase accuracy in the evaluation and ranking of alternative suppliers. Through the implementation of RECA, the weight of each criterion is objectively determined based on the direct response to its level of importance, while MAUT is used to calculate the total utility value of each alternative based on the performance of the weighted criteria. By integrating these two methods into a decision support system, this study aims to provide a more systematic, transparent, and reliable solution for decision-makers in choosing the supplier that best suits the needs and strategies of the organization.

The integration of RECA and MAUT is designed to combine the advantages of the correlation-based weighting objectivity of RECA with MAUT multi-tiered utility approach. In contrast to other hybrid methods such as AHP-MAUT which tends to be subjective in determining weights or CRITIC-TOPSIS which focuses on ideal distances, this approach offers a uniqueness in balancing the analysis of the relationship between criteria with the numerical and rational evaluation of alternative preferences. The correlation-based weighting process in RECA allows the identification of relative influences between criteria without reliance on subjective preferences, while MAUT provides a systematic approach in measuring the utility of each alternative. This combination results in a model that is adaptive and relevant for the context of evaluation with complex and dynamic data. This approach can make a real contribution to the development of hybrid methods that are more accurate and applicable in decision support systems.

2. Research Method

2.1 Research Framework

A research framework is a basic structure or systematic design that is used as a guideline in the implementation of a research[26], [27], [28]. This framework includes important elements such as problem background, problem formulation, objectives, benefits, theoretical foundations, research methods, and data analysis plans. With the existence of a research framework, research steps can be arranged in a directed and logical manner, so that the process of searching for data and analyzing results becomes more efficient and in accordance with the goals to be achieved. This framework also helps to ensure that all stages of research are interrelated and supportive in answering the problems that have been formulated as shown in Figure 1.

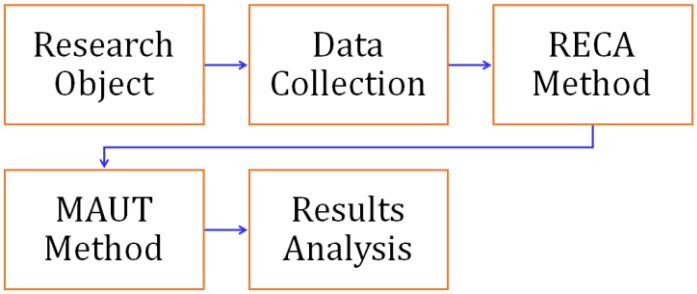

Figure 1. Research Framework

The research framework of figure 1 starts from the research object in this study is a number of alternative suppliers that will be evaluated based on various important criteria that affect the decision to choose a supplier. The data used is collected through a questionnaire that is distributed to decision-makers or parties who have direct experience in the supplier evaluation process, and supported by secondary data from company documents. In the data processing process, the RECA method is used to objectively determine the weight of criteria based on responses to the importance of each criterion. This method measures how much response to certain criteria is considered crucial in the context of supplier selection. After the weights are obtained, the MAUT method is applied to calculate the utility value of each alternative supplier based on its performance against each criterion, resulting in the final ranking. The result analysis was carried out by interpreting weight,

utility score, and final rating to evaluate whether the combination of RECA and MAUT methods was able to provide rational, transparent, and can effectively support decisions in selecting the best supplier.

2.2 RECA Method

The RECA method is an objective approach in determining the weight of criteria based on the level of response or sensitivity of the assessment data to each criterion. This method calculates weights based on how much influence or contribution each criterion has on the difference in assessment between alternatives. In other words, the higher the response (variation or spread) of a criterion to alternative data, the greater the weight given to that criterion. RECA aims to avoid subjectivity in giving weight by utilizing available empirical data, so that decision-making results become more fair and statistically accountable.

The first stage in the RECA method of creating a decision matrix is a representation of a table that is used to describe decisions taken based on certain criteria. This matrix contains information regarding available alternatives and assessment criteria. Each cell in the matrix indicates the value given for each alternative based on predetermined criteria, the decision matrix is made using (1).

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

The second stage in the RECA method of calculating the preference value of each alternative is a measure that shows the extent to which the alternative is preferable compared to other alternatives based on certain criteria. This value is usually obtained through an evaluation or assessment conducted by the decision-maker, where the highest value indicates a stronger preference for the alternative, the preference value of each alternative is calculated using (2).

$$PV_{ij} = \frac{x_{ij}}{\sqrt[n]{\prod_{j=1}^{n} x_{ij}}} \quad (2)$$

The third stage in the RECA method of calculating matrix normalization is the process of changing the scale of values in the decision matrix to a uniform range, so that comparisons between values can be made objectively. Usually, normalization is done by dividing each value in the matrix by the maximum value or using another formula that ensures that the values in the matrix are on a consistent scale and can be compared fairly, the normalization value of the matrix is calculated by using (3).

$$R_{ij} = \frac{PV_{ij}}{PV_j^{max}} \quad (3)$$

The fourth stage in the RECA method of calculating the value of the standard matrix is the result of a normalization process that produces a matrix that has a value that has been adjusted to a certain scale, the value of the standard matrix is calculated using (4).

$$N_i = \frac{1}{N} \sum R_{ij} \quad (4)$$

The fifth stage in the RECA method calculates the value of preference variation, measures the extent to which preferences for each alternative vary based on different criteria. It reflects the level of uncertainty or change in preferences that arises when alternatives are evaluated based on various criteria. Higher variation indicates that there is a greater difference in preference to a particular alternative when viewed from the perspective of various criteria, the value of preference variation is calculated using (5).

$$\emptyset_j = \sum_{i=1}^{m} \left[R_{ij} - N_i\right]^2 \quad (5)$$

The sixth stage in the RECA method calculates the value of preference deviation shows the extent to which the preference value of each alternative deviates from the average value of the preference. This deviation describes how consistent or inconsistent an alternative is compared to other alternatives based on existing criteria. A

higher deviation signifies a greater mismatch in preference for a particular alternative, the value of the preference deviation is calculated using (6).

$$\Omega_j = \left|1 - \emptyset_j\right| \quad (6)$$

The seventh stage in the RECA method of calculating the weighted value of the criteria is a step to determine the relative contribution of each criterion in decision-making. This weight is used to show the importance of each criterion to the final decision, the value of the criterion weight is calculated by using (7).

$$w_j = \frac{\Omega_j}{\sum_{j=1}^{n} \Omega_j} \quad (7)$$

Applying the RECA method, the decisions taken will reflect more appropriate needs and priorities based on existing data, avoiding biased decisions due to non-objective weight. This method also facilitates adjustment to changes in data or conditions, since the calculated weights are directly influenced by the response to the criteria in question. The RECA method is an effective method in increasing the objectivity and reliability of the decision-making process based on different criteria.

2.3 MAUT Method

The MAUT method is an approach in multi-criteria decision making that is used to assist decision makers in choosing the best alternative based on several relevant criteria. MAUT measures the satisfaction or utility of each alternative based on the value assigned to each criterion and the weight determined for each criterion. The MAUT method has several advantages that make it very useful in decision-making involving many criteria. One of the main advantages is the higher objectivity in the assessment process. With clear weights and scores for each criterion, MAUT helps reduce the element of subjectivity in decision-making, ensuring that each criterion is evaluated fairly and consistently. The MAUT method helps decision-makers make more rational decisions, based on objective data and analysis, taking into account a variety of relevant factors.

The first stage in the MAUT method of creating a decision matrix is a representation of a table that is used to describe decisions taken based on certain criteria, the decision matrix is made using (1).

The second stage in the MAUT method calculates normalization values ensuring that all scores are on the same scale. It is important that all criteria can be compared fairly even though they have different scales, normalization values are calculated using (8) for the cost criteria and (9) for the benefit criteria.

$$r_{ij} = 1 + \frac{minx_{ij} - x_{ij}}{maxx_{ij} - minx_{ij}} \quad (8)$$

$$r_{ij} = \frac{x_{ij} - minx_{ij}}{maxx_{ij} - minx_{ij}} \quad (9)$$

The third stage in the MAUT method calculates the utility value as a numerical representation of how well an alternative meets all predetermined criteria, the utility value is calculated using (10).

$$u_{ij} = \frac{e^{\left(\left(r_{ij}\right)^2\right)} - 1}{1.71} \quad (10)$$

The fourth stage in the MAUT method calculates the total utility value for each alternative. The total utility is calculated by multiplying the normalization score of each criterion by the weight of that criterion, and then summing the result, the total utility value is calculated using (11).

$$u_{(x)} = \sum_{j=1}^{n} u_{ij} * w_j \quad (11)$$

The final results of the MAUT method provide quantitative and objective information about which alternative is the most optimal to choose. This is very helpful in the multi-criteria decision-making process because all criteria have been taken into account in a proportionate and transparent manner.

3. Result and Discussions

The combination of RECA and MAUT methods in the decision support system for the selection of the best supplier is an approach designed to increase objectivity and accuracy in the multi-criteria decision-making process. In the context of selecting the best supplier, the RECA method is used to determine the objective weight of each criterion based on the response and variation in preference values between alternatives, so that the resulting weight reflects the level of influence of each criterion quantitatively. Meanwhile, the MAUT method is used to evaluate each alternative (supplier) based on the utility value calculated from the performance score of each against the criteria that have been weighted. This process involves assessing, normalizing, and combining the weights with the utility scores to produce the final score for each alternative. The combination of these two methods allows decision-makers to obtain more rational and structured results, taking into account both the objective value of the criteria and preferences relative to the available alternatives. Thus, the decision support system built is able to produce the best supplier recommendations more accurately and accountably.

3.1 Data Collection

In this study, data collection was carried out to obtain the information needed in the assessment and evaluation process of alternative suppliers based on a number of predetermined criteria. The data collected consists of the performance value of each supplier against the criteria used, namely product quality (QP) which is a type of benefit, price (P) which is a type of cost, discount (D) which is a type of benefit, delivery timeliness (DT) which is a type of cost, product availability (PA) which is a type of benefit, and responsiveness (R) which is a type of benefit. Data sources can come from internal company documents, such as supplier evaluation reports, delivery performance records, or from questionnaires or interviews involving related parties such as logistics staff, and purchasing managers. Table 1 is the assessment data used in the supplier assessment conducted by the company.

Table 1. Performance Appraisal Data from Suppliers

Supplier Name	QP	P	D	DT	PA	R
PT Sumber Jaya Abadi	9	8	6	9	8	7
CV Karya Niaga Sejati	7	9	7	8	7	8
PT Indo Logistik Prima	8	7	8	8	9	6
CV Makmur Sentosa	6	6	6	7	6	7
PT Global Niaga Mandiri	9	8	9	9	9	9
UD Anugrah Bersama	7	6	7	6	7	6
PT Cahaya Nusantara	8	7	6	8	8	7
CV Surya Perkasa	6	9	8	7	7	8
PT Mitra Sari Utama	8	7	7	8	8	8

The data source in table 1 in this study comes from the company's internal assessment of nine suppliers who have collaborated in the procurement of goods and services. Data was obtained through a supplier performance evaluation questionnaire filled out by the company. The assessment was carried out based on six main criteria. This data is primary because it is obtained directly from the results of the assessment of experienced internal stakeholders and interacting directly with suppliers. The questionnaire uses an assessment scale of 1-9 from the assessment made by the company on the supplier's performance. The assessment team of the company consists of two logistics managers and two procurement staff from the company, who have experience in supplier decision-making. Each respondent was asked to rate all supplier alternatives based on previous cooperation experience as well as historical data on partner performance.

3.2 RECA Method in Determining the Weight of Criteria Objectively

The RECA method is an objective approach in determining the weight of criteria used in the multicriteria decision-making process. Unlike subjective methods that rely on expert opinions or user preferences, RECA

emphasizes data dissemination patterns from alternatives to each criterion to generate weights that reflect the importance of a criterion based on the response of the data itself.

The first stage in the RECA method to create a decision matrix is a representation of a table that is used to describe decisions taken based on certain criteria made using (1) based on the assessment data in table 1 in the following general form.

$$X = \begin{bmatrix} x_{11} & x_{21} & x_{31} & x_{41} & x_{51} & x_{61} \\ x_{12} & x_{22} & x_{32} & x_{42} & x_{52} & x_{62} \\ x_{13} & x_{23} & x_{33} & x_{43} & x_{53} & x_{63} \\ x_{14} & x_{24} & x_{34} & x_{44} & x_{54} & x_{64} \\ x_{15} & x_{25} & x_{35} & x_{45} & x_{55} & x_{65} \\ x_{16} & x_{26} & x_{36} & x_{46} & x_{56} & x_{66} \\ x_{17} & x_{27} & x_{37} & x_{47} & x_{57} & x_{67} \\ x_{17} & x_{28} & x_{38} & x_{48} & x_{58} & x_{68} \\ x_{19} & x_{29} & x_{39} & x_{49} & x_{59} & x_{69} \end{bmatrix}$$

The results of the decision matrix from the assessment data that have been carried out are as follows.

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

The second stage in the RECA method is to calculate the preference value of each alternative where the highest value indicates the stronger the preference for the alternative, the preference value of each alternative is calculated using (2).

$$PV_{11} = \frac{x_{11}}{\sqrt[9]{\prod_{j=1}^{n} x_{11,19}}} = \frac{9}{\sqrt[9]{73156608}} = \frac{9}{7.47835} = 1.2035$$

Table 2 is the result of the calculation preference value of each alternative from the calculation made.

Table 2. Preference value calculation results

Supplier Name	QP	P	D	DT	PA	R
PT Sumber Jaya Abadi	1.2035	1.0857	0.8518	1.1656	1.0516	0.9625
CV Karya Niaga Sejati	0.9360	1.2215	0.9938	1.0361	0.9201	1.1000
PT Indo Logistik Prima	1.0698	0.9500	1.1358	1.0361	1.1830	0.8250
CV Makmur Sentosa	0.8023	0.8143	0.8518	0.9066	0.7887	0.9625
PT Global Niaga Mandiri	1.2035	1.0857	1.2777	1.1656	1.1830	1.2376
UD Anugrah Bersama	0.9360	0.8143	0.9938	0.7771	0.9201	0.8250
PT Cahaya Nusantara	1.0698	0.9500	0.8518	1.0361	1.0516	0.9625
CV Surya Perkasa	0.8023	1.2215	1.1358	0.9066	0.9201	1.1000
PT Mitra Sari Utama	1.0698	0.9500	0.9938	1.0361	1.0516	1.1000

The third stage in the RECA method for calculating matrix normalization is the process of converting the scale of values in the decision matrix into a uniform range, the normalization value of the matrix is calculated using (3).

$$R_{11} = \frac{PV_{11}}{PV_1^{max}} = \frac{1.2035}{1.2035} = 1$$

Table 3 is the result of the calculation matrix normalization of each alternative from the calculation made.

Table 3. Calculation matrix normalization

Supplier Name	QP	P	D	DT	PA	R
PT Sumber Jaya Abadi	1.0000	0.8889	0.6667	1.0000	0.8889	0.7778
CV Karya Niaga Sejati	0.7778	1.0000	0.7778	0.8889	0.7778	0.8889
PT Indo Logistik Prima	0.8889	0.7778	0.8889	0.8889	1.0000	0.6667
CV Makmur Sentosa	0.6667	0.6667	0.6667	0.7778	0.6667	0.7778
PT Global Niaga Mandiri	1.0000	0.8889	1.0000	1.0000	1.0000	1.0000
UD Anugrah Bersama	0.7778	0.6667	0.7778	0.6667	0.7778	0.6667
PT Cahaya Nusantara	0.8889	0.7778	0.6667	0.8889	0.8889	0.7778
CV Surya Perkasa	0.6667	1.0000	0.8889	0.7778	0.7778	0.8889
PT Mitra Sari Utama	0.8889	0.7778	0.7778	0.8889	0.8889	0.8889

The fourth stage in the RECA method is to calculate the standard matrix value as a result of the normalization process, the standard matrix value is calculated using equation (4).

$$N_1 = \frac{1}{9}\sum R_{11,19} = \frac{1}{9} * 7.5556 = 0.8395$$

$$N_2 = \frac{1}{9}\sum R_{21,29} = \frac{1}{9} * 7.4444 = 0.8272$$

$$N_3 = \frac{1}{9}\sum R_{31,39} = \frac{1}{9} * 7.1111 = 0.7901$$

$$N_4 = \frac{1}{9}\sum R_{41,49} = \frac{1}{9} * 7.7778 = 0.8642$$

$$N_5 = \frac{1}{9}\sum R_{51,59} = \frac{1}{9} * 7.6667 = 0.8519$$

$$N_6 = \frac{1}{9}\sum R_{61,69} = \frac{1}{9} * 7.3333 = 0.8148$$

The fifth stage in the RECA method is to calculate the value of preference variation, measuring the extent to which the preference for each alternative varies based on different criteria calculated using (5).

$$\emptyset_1 = \sum_{i=1}^{m}\left[R_{11,19} - N_1\right]^2 = 3.2670$$

$$\emptyset_2 = \sum_{i=1}^{m}\left[R_{21,29} - N_2\right]^2 = 3.7533$$

$$\emptyset_3 = \sum_{i=1}^{m}\left[R_{31,39} - N_3\right]^2 = 3.1913$$

$$\emptyset_4 = \sum_{i=1}^{m} \left[R_{41,49} - N_4\right]^2 = 3.6337$$

$$\emptyset_5 = \sum_{i=1}^{m} \left[R_{51,59} - N_5\right]^2 = 3.5448$$

$$\emptyset_6 = \sum_{i=1}^{m} \left[R_{61,69} - N_6\right]^2 = 3.3813$$

The sixth stage in the RECA method calculates the value of the preference deviation which shows the extent to which the value of the preference of each alternative deviates from the average value of the preference, the value of the deviation of preferences is calculated using (6).

$$\Omega_1 = |1 - \emptyset_1| = |1 - 3.2670| = 2.2670$$

$$\Omega_2 = |1 - \emptyset_2| = |1 - 3.7533| = 2.7533$$

$$\Omega_3 = |1 - \emptyset_3| = |1 - 3.1913| = 2.1913$$

$$\Omega_4 = |1 - \emptyset_4| = |1 - 3.6337| = 2.6337$$

$$\Omega_5 = |1 - \emptyset_5| = |1 - 3.5448| = 2.5448$$

$$\Omega_6 = |1 - \emptyset_6| = |1 - 3.3813| = 2.3813$$

The seventh stage in the RECA method for calculating the weighted value of criteria is the step to determine the relative contribution of each criterion in decision-making, the value of the weighting of the criteria is calculated using equation (7).

$$w_1 = \frac{\Omega_1}{\sum_{j=1}^{n} \Omega_{1,6}} = \frac{2.2670}{2.2670 + 2.7533 + 2.1913 + 2.6337 + 2.5448 + 2.3813} = \frac{2.2670}{14.7714} = 0.1535$$

$$w_2 = \frac{\Omega_2}{\sum_{j=1}^{n} \Omega_{1,6}} = \frac{2.7533}{2.2670 + 2.7533 + 2.1913 + 2.6337 + 2.5448 + 2.3813} = \frac{2.7533}{14.7714} = 0.1864$$

$$w_3 = \frac{\Omega_3}{\sum_{j=1}^{n} \Omega_{1,6}} = \frac{2.1913}{2.2670 + 2.7533 + 2.1913 + 2.6337 + 2.5448 + 2.3813} = \frac{2.1913}{14.7714} = 0.1483$$

$$w_4 = \frac{\Omega_4}{\sum_{j=1}^{n} \Omega_{1,6}} = \frac{2.6337}{2.2670 + 2.7533 + 2.1913 + 2.6337 + 2.5448 + 2.3813} = \frac{2.6337}{14.7714} = 0.1783$$

$$w_5 = \frac{\Omega_5}{\sum_{j=1}^{n} \Omega_{1,6}} = \frac{2.5448}{2.2670 + 2.7533 + 2.1913 + 2.6337 + 2.5448 + 2.3813} = \frac{2.5448}{14.7714} = 0.1723$$

$$w_6 = \frac{\Omega_6}{\sum_{j=1}^{n} \Omega_{1,6}} = \frac{2.3813}{2.2670 + 2.7533 + 2.1913 + 2.6337 + 2.5448 + 2.3813} = \frac{2.3813}{14.7714} = 0.1612$$

The results of the calculation using the RECA method were obtained objective weights for each criterion in the selection of the best supplier. The price criterion (P) has the highest weight of 0.1864, indicating that the price factor is the most influential aspect in distinguishing quality between suppliers. This was followed by delivery timeliness (DT) with a weight of 0.1783, and product availability (PA) with a weight of 0.1723, both of which also showed a significant role in the decision-making process. The service responsiveness criteria (R) gained a weight of 0.1612, while product quality (QP) and discount (D) had weights of 0.1535 and 0.1483, respectively. These results reflect that RECA is able to objectively reveal the relative contribution of each criterion, based on

the variation of assessment data from the alternatives, without interference from the subjectivity of decision-makers.

3.3 MAUT Method in Selecting the Best Supplier

The MAUT method is an approach in multicriteria decision-making that is used to evaluate and determine the best alternatives based on a number of attributes or criteria. In the context of selecting the best supplier, MAUT plays a role in converting qualitative and quantitative assessment data into measurable utility values, reflecting the extent to which each alternative meets the predetermined criteria. Each of the previous criteria has been objectively weighted (using the RECA method) to show its level of importance. After the normalization process and utility value calculation is carried out for each alternative, the final stage of MAUT is to combine the utility value with the weight of each criterion to obtain the total score or final ranking of each supplier. The supplier with the highest utility value is considered the best alternative, as it provides the most optimal benefit or advantage overall based on all the criteria considered.

The first stage in the MAUT method of creating a decision matrix is a representation of a table that is used to describe decisions taken based on certain criteria, the decision matrix is made using (1).

The second stage in the MAUT method calculates the normalization value by ensuring that all scores are on the same scale. It is important that all criteria can be compared fairly even though they have different scales, normalization values are calculated using (8) for criteria P and DT and (9) for criteria QP, D, PA, and R.

$$r_{11} = \frac{x_{11} - minx_{11,19}}{maxx_{11,19} - minx_{11,19}} = \frac{9-6}{9-6} = 1$$

Table 4 is the result of the calculation matrix normalization of each alternative from the calculation made.

Table 4. Calculation matrix normalization

Supplier Name	QP	P	D	DT	PA	R
PT Sumber Jaya Abadi	1.0000	0.3333	0.0000	0.0000	0.6667	0.3333
CV Karya Niaga Sejati	0.3333	0.0000	0.3333	0.3333	0.3333	0.6667
PT Indo Logistik Prima	0.6667	0.6667	0.6667	0.3333	1.0000	0.0000
CV Makmur Sentosa	0.0000	1.0000	0.0000	0.6667	0.0000	0.3333
PT Global Niaga Mandiri	1.0000	0.3333	1.0000	0.0000	1.0000	1.0000
UD Anugrah Bersama	0.3333	1.0000	0.3333	1.0000	0.3333	0.0000
PT Cahaya Nusantara	0.6667	0.6667	0.0000	0.3333	0.6667	0.3333
CV Surya Perkasa	0.0000	0.0000	0.6667	0.6667	0.3333	0.6667
PT Mitra Sari Utama	0.6667	0.6667	0.3333	0.3333	0.6667	0.6667

The third stage in the MAUT method calculates the utility value as a numerical representation of how well an alternative meets all predetermined criteria, the utility value is calculated using (10).

$$u_{11} = \frac{e\left(\left(r_{11}\right)^2\right) - 1}{1.71} = \frac{e((1.0000)^2) - 1}{1.71} = \frac{2.7183 - 1}{1.71} = \frac{1.7183}{1.71} = 1.0048$$

Table 5 is the result of the calculation utility value of each alternative from the calculation made.

Table 5. Calculation utility value

Supplier Name	QP	P	D	DT	PA	R
PT Sumber Jaya Abadi	1.0048	0.0687	0.0000	0.0000	0.3273	0.0687

CV Karya Niaga Sejati	0.0687	0.0000	0.0687	0.0687	0.0687	0.3273
PT Indo Logistik Prima	0.3273	0.3273	0.3273	0.0687	1.0048	0.0000
CV Makmur Sentosa	0.0000	1.0048	0.0000	0.3273	0.0000	0.0687
PT Global Niaga Mandiri	1.0048	0.0687	1.0048	0.0000	1.0048	1.0048
UD Anugrah Bersama	0.0687	1.0048	0.0687	1.0048	0.0687	0.0000
PT Cahaya Nusantara	0.3273	0.3273	0.0000	0.0687	0.3273	0.0687
CV Surya Perkasa	0.0000	0.0000	0.3273	0.3273	0.0687	0.3273
PT Mitra Sari Utama	0.3273	0.3273	0.0687	0.0687	0.3273	0.3273

The fourth stage in the MAUT method is to calculate the total utility value for each alternative, the total utility value is calculated using (11).

$$u_{(1)} = (u_{11} * w_1) + (u_{12} * w_2) + (u_{13} * w_3) + (u_{14} * w_4) + (u_{15} * w_5) + (u_{16} * w_6)$$

$$u_{(1)} = (1.0048 * 0.1535) + (0.0687 * 0.1864) + (0 * 0.1483) + (0 * 0.1783) + (0.3273 * 0.1723) + (0.0687 * 0.1612)$$

$$u_{(1)} = (0.1542) + (0.0128) + (0) + (0) + (0.0564) + (0.0111)$$

$$u_{(1)} = 0.2345$$

Table 6 is the result of the calculation total utility value for each alternative from the calculation made.

Table 6. Calculation total utility value for each alternative

Supplier Name	Utility Value
PT Sumber Jaya Abadi	0.2345
CV Karya Niaga Sejati	0.0976
PT Indo Logistik Prima	0.3451
CV Makmur Sentosa	0.2567
PT Global Niaga Mandiri	0.6512
UD Anugrah Bersama	0.3990
PT Cahaya Nusantara	0.1909
CV Surya Perkasa	0.1715
PT Mitra Sari Utama	0.2428

The final result of the MAUT method in selecting the best supplier shows the total utility value of each alternative (supplier) based on all criteria that have been assessed and weighted.

3.4 Results of the Best Supplier Selection Analysis

The results of the analysis of the selection of the best suppliers show a systematic evaluation process of a number of alternative suppliers based on several important criteria that have been determined. In this study, the decision-making process was carried out through a combination of RECA and MAUT methods. The RECA method is used to objectively determine the weight of the criteria, based on the variation of the data reflecting the extent to which each criterion contributes to differentiating the alternatives. Furthermore, the MAUT method is used to calculate the utility value of each supplier against each criterion and accumulate it into a final score. From these results, the supplier with the highest utility value is considered the most superior because it is able to meet the company's overall needs and expectations. The results of this analysis provide a clear, measurable, and accountable picture in the right and efficient supplier selection process. Figure 2 is the result of the ranking in the selection of the best supplier.

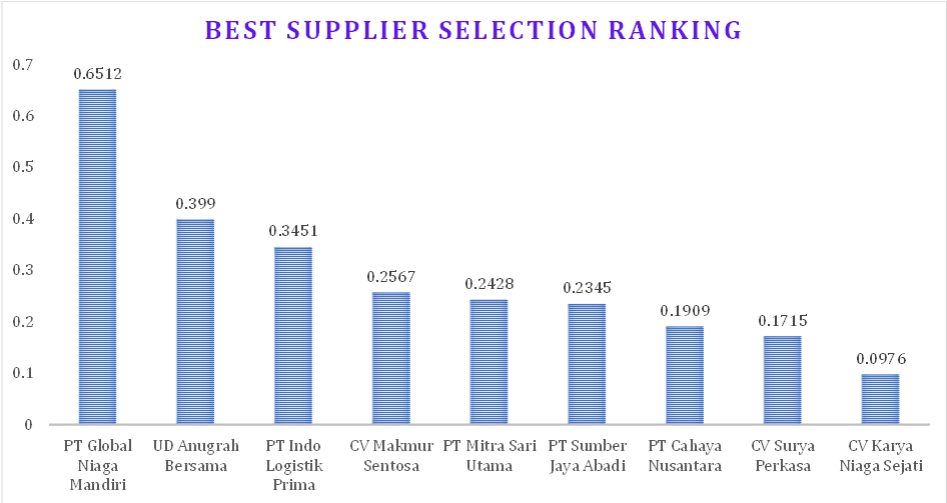

Figure 2. Best Supplier Selection Ranking

Figure 2 shows the ranking of selecting the best suppliers based on the total value of each candidate. From the bar chart, it can be seen that PT Global Niaga Mandiri ranks first with the highest score of 0.6512, indicating that this company is the best choice in the supplier selection process. In second place is UD Anugrah Bersama with a score of 0.399, followed by PT Indo Logistik Prima in third place with a score of 0.3451. Furthermore, the fourth to tenth positions were filled by CV Makmur Sentosa with a score of 0.2567, PT Mitra Sari Utama with a score of 0.2428, PT Sumber Jaya Abadi with a score of 0.2345, PT Cahaya Nusantara with a score of 0.1909, CV Surya Perkasa with a score of 0.1715, and finally CV Karya Niaga Sejati with a score of 0.0976. From this data, it can be seen that there is a significant score difference between the first rank and other suppliers, indicating the strong dominance of PT Global Niaga Mandiri in fulfilling the supplier selection criteria used.

PT Global Niaga Mandiri received the highest score because its performance consistently excelled in the criteria that have the greatest weight. The resulting weights of the RECA method show that the company places great emphasis on reliability and quality, which is reflected in the high correlation between these criteria to the final result. These results confirm that the RECA-MAUT method used not only produces final rankings, but is also able to uncover operational strategies and hidden priorities that are the basis for company decision-making.

Sensitivity analysis in criterion weights is an approach used to evaluate the extent to which changes in weights in each criterion can affect the final outcome of a multicriteria decision-making process. This process is important for testing the stability and reliability of the decisions taken, especially when the weight of the criteria is determined subjectively or through methods that contain uncertainty. By conducting a sensitivity analysis, decision-makers can identify which criteria have the most effect on alternative ratings and assess whether the results will remain consistent in the event of a small change in weight. This helps to increase confidence in the resulting decisions and provides a stronger basis for policy-making. Sensitivity analysis was carried out in this study by increasing the weight of one criterion by 0.05 and proportionally decreasing the weight of the other criteria by the same amount so that the total weight remains 1. This approach aims to simulate the impact of small changes on the importance of a criterion to the final outcome of alternative rankings. The results of the rating sensitivity analysis using the test scenario 12 times are shown in figure 1.

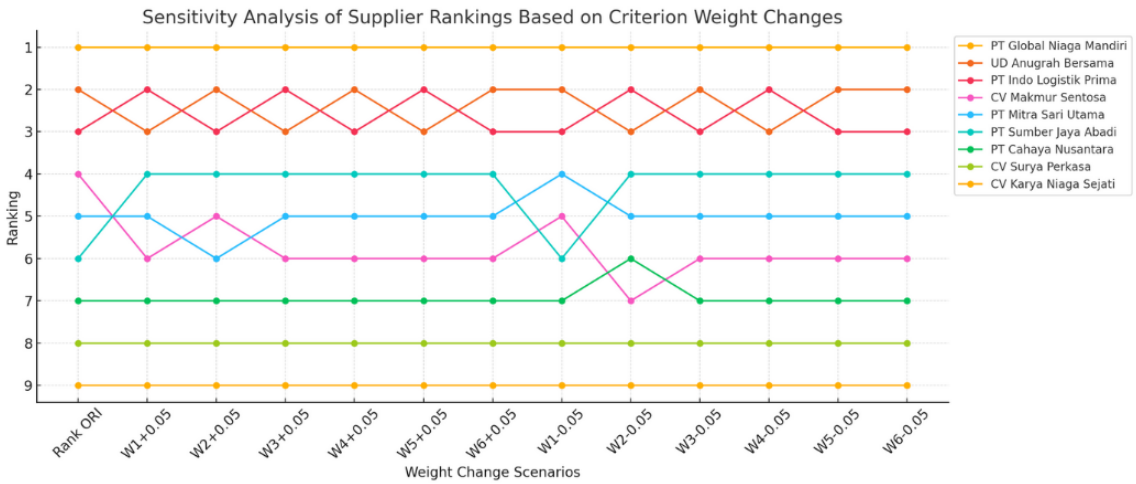

Figure 3. Alternative Ranking Sensitivity Analysis Results

The results of the supplier rating sensitivity chart to changes in the weight of the criteria show that PT Global Niaga Mandiri maintains the first ranking position in all scenarios, which indicates stability and overall performance excellence without depending on the dominance of one particular criterion. In contrast, UD Anugrah Bersama and PT Indo Logistik Prima show fluctuations in the rankings between the second and third positions depending on the criteria to which the weight is increased or decreased, reflecting their dependence on specific dimensions such as price or flexibility. CV Makmur Sentosa shows a fairly high sensitivity to weight changes, as can be seen from the variation in ranking between fourth and seventh positions, indicating that his performance is more vulnerable to evaluation priorities. Meanwhile, suppliers such as CV Surya Perkasa and CV Karya Niaga Sejati remained consistently ranked at the bottom in all scenarios, indicating that they were not competitive enough on all evaluation criteria. Overall, this chart provides a clear picture of the resilience of each supplier's rating to strategic changes in criteria evaluation priorities.

4. Conclusions and Future Works

The combination of the RECA and MAUT methods can provide an effective, objective, and structured approach in decision-making for the selection of the best supplier. The RECA method has been proven to be able to produce objective criteria weights based on the variation of assessment data from each alternative, thereby reducing subjectivity in the weighting process. Furthermore, the MAUT method is used to calculate the utility value of each supplier, which reflects their level of feasibility and performance against all predetermined criteria. The result of the combination of these two methods results in a final ranking that can be used as a basis for accurate and accountable decision-making. The results of the best supplier selection ranking based on the total score of each candidate, it can be seen that PT Global Niaga Mandiri ranks first with the highest score of 0.6512, showing that this company is the best choice in the supplier selection process. In second place is UD Anugrah Bersama with a score of 0.399, followed by PT Indo Logistik Prima in third place with a score of 0.3451. This RECA-MAUT-based decision support system can be relied upon in helping companies choose the supplier that best suits their needs and set standards.

Future work in this study can be expanded by applying a combination of RECA and MAUT methods on a larger and more complex data scale, covering more alternative suppliers as well as more varied evaluation criteria. In addition, the integration of this method with information system-based technology, such as web-based decision support systems or artificial intelligence, is also a potential development to improve the efficiency and speed of analysis. Future research may also compare the effectiveness of the RECA-MAUT combination with other multicriteria decision-making methods.

5. References

[1] S. Zeng, W. Chen, J. Gu, and E. Zhang, "An Integrated EDAS Model for Fermatean Fuzzy Multi-Attribute Group Decision Making and Its Application in Green-Supplier Selection," 2023. doi: 10.3390/systems11030162.

[2] A. Puška, D. Božanić, M. Nedeljković, and M. Janošević, "Green supplier selection in an uncertain environment in agriculture using a hybrid MCDM model: Z-Numbers–Fuzzy LMAW–Fuzzy CRADIS model," *Axioms*, vol. 11, no. 9, p. 427, 2022, doi: 10.3390/axioms11090427.

[3] I. Đalić, Ž. Stević, C. Karamasa, and A. Puška, "A novel integrated fuzzy PIPRECIA–interval rough SAW model: Green supplier selection," *Decision Making: Applications in Management and Engineering*, vol. 3, no. 1, pp. 126–145, 2020.

[4] S. M. Vadivel, D. S. Shetty, A. H. Sequeira, E. Nagaraj, and V. Sakthivel, "A Sustainable Green Supplier Selection Using CRITIC Method," in *International Conference on Intelligent Systems Design and Applications*, Springer, 2023, pp. 308–315. doi: 10.1007/978-3-031-27440-4_29.

[5] Sumanto *et al.*, "Improved LOPCOW-SAW Method for Optimal Supplier Selection in Supply Chain Management," in *2024 12th International Conference on Cyber and IT Service Management (CITSM)*, 2024, pp. 1–5. doi: 10.1109/CITSM64103.2024.10775429.

[6] A. F. O. Pasaribu, "Decision Support System for Best Supplier Selection Using Simple Additive Weighting and Rank Sum Weighting," *CHAIN: Journal of Computer Technology, Computer Engineering, and Informatics*, vol. 1, no. 3, pp. 106–112, 2023.

[7] A. Aytekin, "DETERMINING CRITERIA WEIGHTS FOR VEHICLE TRACKING SYSTEM SELECTION USING PIPRECIA-S," *Journal of process management and new technologies*, vol. 10, no. 1–2, pp. 115–124, Jun. 2022, doi: 10.5937/jpmnt10-38145.

[8] I. M. Jiskani, Q. Cai, W. Zhou, X. Lu, and S. A. A. Shah, "An integrated fuzzy decision support system for analyzing challenges and pathways to promote green and climate smart mining," *Expert Syst Appl*, vol. 188, p. 116062, 2022, doi: https://doi.org/10.1016/j.eswa.2021.116062.

[9] Z. Guo *et al.*, "An integrated MCDM model with enhanced decision support in transport safety using machine learning optimization," *Knowl Based Syst*, vol. 301, p. 112286, 2024, doi: https://doi.org/10.1016/j.knosys.2024.112286.

[10] H. Ayadi, N. Hamani, L. Kermad, and M. Benaissa, "Novel Fuzzy Composite Indicators for Locating a Logistics Platform under Sustainability Perspectives," *Sustainability*, vol. 13, no. 7, p. 3891, Apr. 2021, doi: 10.3390/su13073891.

[11] H. Nirinarivelo and R. G. Rasoanaivo, "Multi-criteria Evaluation of Madagascar's Regions in the Context of Employment Using the CoCoFISo Method," *Spectrum of Decision Making and Applications*, vol. 2, no. 1, pp. 135–156, Jan. 2025, doi: 10.31181/sdmap21202514.

[12] M. S. Saidin, L. S. Lee, S. M. Marjugi, M. Z. Ahmad, and H.-V. Seow, "Fuzzy Method Based on the Removal Effects of Criteria (MEREC) for Determining Objective Weights in Multi-Criteria Decision-Making Problems," *Mathematics*, vol. 11, no. 6, p. 1544, Mar. 2023, doi: 10.3390/math11061544.

[13] D. Alamsyah, A. Herdiansah, H. Wijaya, and H. Rusdianto, "Combination of Rank Reciprocal Method and Composite Performance Index for Promotion Decision Support System," *J-INTECH*, vol. 12, no. 1, pp. 23–35, Jun. 2024, doi: 10.32664/j-intech.v12i1.1199.

[14] I. Ramadhan, N. Nugroho, H. Kurniawanto, and J. Warta, "Sistem Pendukung Keputusan Menggunakan Metode WASPAS Untuk Pemilihan Aplikasi Manajemen Bisnis dan Keuangan," *J-INTECH*, vol. 12, no. 1, pp. 49–61, Jun. 2024, doi: 10.32664/j-intech.v12i1.1214.

[15] D. A. Megawaty, D. Damayanti, S. Sumanto, P. Permata, D. Setiawan, and S. Setiawansyah, "Development of a Decision Support System Based on New Approach Respond to Criteria Weighting Method and Grey Relational Analysis: Case Study of Employee Recruitment Selection," *JOIV: International Journal on Informatics Visualization*, vol. 9, no. 1, 2025, doi: 10.62527/joiv.9.1.2744.

[16] Z. Çolak, "A hybrid MCDM method for enhancing site selection for wind power plants in Turkey," *Energy for Sustainable Development*, vol. 82, p. 101536, 2024, doi: https://doi.org/10.1016/j.esd.2024.101536.

[17] S. Wu and R. Niu, "Development of carbon finance in China based on the hybrid MCDM method," *Humanit Soc Sci Commun*, vol. 11, no. 1, p. 156, 2024, doi: 10.1057/s41599-023-02558-1.

[18] M. A. Al-Gerafi *et al.*, "Designing of an effective e-learning website using inter-valued fuzzy hybrid MCDM concept: A pedagogical approach," *Alexandria Engineering Journal*, vol. 97, pp. 61–87, 2024, doi: https://doi.org/10.1016/j.aej.2024.04.012.

[19] I. Taufik, C. N. Alam, Z. Mustofa, A. Rusdiana, and W. Uriawan, "Implementation of Multi-Attribute Utility Theory (MAUT) method for selecting diplomats," in *IOP Conference Series: Materials Science and Engineering*, IOP Publishing, 2021, p. 32055.

[20] Aditia Yudhistira, Setiawansyah, Temi Ardiansah, Sufiatul Maryana, Yuli Yadin, and Risma Oktaviani, "Development of Multi-Attribute Utility Theory Methods in Dynamic Decision Models Using Change-Data Driven," *Evergreen*, vol. 11, no. 4, pp. 3279–3289, Dec. 2024, doi: 10.5109/7326962.

[21] U. Akpan and R. Morimoto, "An application of Multi-Attribute Utility Theory (MAUT) to the prioritization of rural roads to improve rural accessibility in Nigeria," *Socioecon Plann Sci*, vol. 82, p. 101256, 2022.

[22] M. H. Sadeghiravesh, H. Khosravi, and A. Abolhasani, "Selecting proper sites for underground dam construction using Multi-Attribute Utility Theory in arid and semi-arid regions," *J Mt Sci*, vol. 20, no. 1, pp. 197–208, 2023.

[23] A. A. Kusuma, Z. M. Arini, U. Hasanah, M. Mesran, and M. Kom, "Analisa Penerapan Metode Multi Attribute Utility Theory (MAUT) dengan Pembobotan Rank Order Centroid (ROC) Dalam Pemilihan Lokasi Strategis Coffeshop Milenial di Era New Normal," *Jurnal Sistem Komputer dan Informatika (JSON)*, vol. 3, no. 2, pp. 51–59, 2021.

[24] F. A. AlFaraidy, K. S. Teegala, and G. Dwivedi, "Selection of a Sustainable Structural Floor System for an Office Building Using the Analytic Hierarchy Process and the Multi-Attribute Utility Theory," *Sustainability*, vol. 15, no. 17, p. 13087, 2023.

[25] A. Karim, S. Esabella, K. Kusmanto, M. Mesran, and U. Hasanah, "Analisa Penerapan Metode Operational Competitiveness Rating Analysis (OCRA) dan Metode Multi Attribute Utility Theory (MAUT) Dalam Pemilihan Calon Karyawan Tetap Menerapkan Pembobotan Rank Order Centroid (ROC)," *Jurnal Media Informatika Budidarma*, vol. 5, no. 4, pp. 1674–1687, 2021.

[26] T. E. Teddy, Muhammad Luthfi Akbar, Nola Dita Puspa, and Mesran, "Penerapan Metode MOORA dan Pembobotan ROC Dalam Pemilihan Alat KB," *Journal of Computing and Informatics Research*, vol. 2, no. 2, pp. 37–43, Mar. 2023, doi: 10.47065/comforch.v2i2.524.

[27] W. I. Safitri, M. Mesran, and S. Sarwandi, "Penerapan Metode Preference Selection Index (PSI) Dalam Penerimaan Staff IT," *Bulletin of Informatics and Data Science*, vol. 1, no. 1, p. 1, May 2022, doi: 10.61944/bids.v1i1.1.

[28] R. I. Borman, D. A. Megawaty, and A. Attohiroh, "Implementasi Metode TOPSIS Pada Sistem Pendukung Keputusan Pemilihan Biji Kopi Robusta Yang Bernilai Mutu Ekspor (Studi Kasus: PT. Indo Cafco Fajar Bulan Lampung)," *Fountain of Informatics Journal*, vol. 5, no. 1, pp. 14–20, 2020.