KLIK: Kajian Ilmiah Informatika dan Komputer
ISSN 2723-3898 (Media Online)
Vol 4, No 4, February 2024, Hal 2330-2341
DOI 10.30865/klik.v4i4.1677
https://djournals.com/klik

Combination of Multi-Attributive Ideal-Real Comparative Analysis and Rank Order Centroid in Supplier Performance Evaluation

Muhammad Waqas Arshad[1], Setiawansyah[2,*], Mesran[3], Desyanti[4]

[1] Department of Computer Science and Engineering, University of Bologna, Bologna, Italy
[2] Faculty of Engineering and Computer Science, Informatics, Universitas Teknokrat Indonesia, Bandarlampung, Indonesia
[3] Department of Computer Science, Universitas Budi Darma, Medan, Indonesia
[4] Department of Informatics Engineering, Sekolah Tinggi Teknologi Dumai, Riau, Indonesia
Email: [1]muhammad.waqas.arshad.1@gmail.com , [2,*]setiawansyah@teknokrat.ac.id , [3]mesran.skom.mkom@gmail.com, [4]desyanti734@gmail.com
Email Corresponding Author: setiawansyah@teknokrat.ac.id

Abstract−Supplier performance evaluation is a critical aspect of supply chain management that focuses on assessing and monitoring the performance of suppliers. Supplier performance evaluation not only provides benefits for the company, but also motivates suppliers to improve their quality standards and operational efficiency. This study aims to evaluate supplier performance based on existing assessment data by applying the ROC method to determine the weight of the criteria used, then the MAIRCA method will evaluate supplier performance so that it will produce a rating of supplier performance evaluation which will be a decision recommendation for companies in assessing the performance of existing suppliers. The combination of ROC and MAIRCA weighting methods forms a powerful approach in addressing the complexity and challenges of multi-criteria decision making. ROC with its focus on relative ranking criteria, whereas MAIRCA which considers the difference between ideal and real conditions, presents complementary perspectives. By combining the two, decision makers can generate a more contextual and informational weight of criteria. The ranking result graph in figure 4 shows the best supplier performance obtained on behalf of Supplier C with a final value of 0.05239144 ranked 1, then on behalf of Supplier F with a final value of 0.050077222 ranked 2, and on behalf of Supplier G with a final value of 0.049074028 ranked 3.

Keywords: Combination; Evaluation; MAIRCA; ROC Weighting; Supplier Performance

1. INTRODUCTION

Supplier performance evaluation is a critical aspect of supply chain management that focuses on assessing and monitoring the performance of suppliers. Supplier performance includes a number of factors that reflect their ability to meet the company's needs, such as timeliness of delivery, quality of products or services, compliance with standards, and ability to respond to changing demands. The supplier performance evaluation process may involve collecting quantitative data, satisfaction surveys, or direct audits of production facilities. By systematically monitoring and evaluating supplier performance, companies can identify potential risks, improve supply chain efficiency, and build stronger relationships with business partners[1]. As supply chain complexity grows and globalization, a focus on supplier performance is key to achieving resilience and competitive advantage in a dynamic business environment. Supplier performance evaluation not only provides benefits for the company, but also motivates suppliers to improve their quality standards and operational efficiency. By utilizing advanced technology and information systems, companies can proactively monitor and respond to changes in supplier performance, making performance evaluation a strategic tool in achieving efficiency, flexibility, and competitive advantage in global supply chain management. The use of computers in supplier performance evaluation has a crucial role in simplifying, speeding up, and improving the accuracy of the process. Modern supply chain management systems use information technology and specialized software to efficiently manage supplier performance data.

Previous research conducted by Giannakis (2020) The purpose of this study is to introduce an innovative decision-making evaluation framework that can be used in sustainable supplier selection using the method proposed in this study is the Analytic Network Process (ANP)[2]. Research by Utama (2021) This study successfully applied the integration of the Analytical Hierarchy Process (AHP) and Supplier Evaluation Rating (SUR) methods in evaluating supplier performance. The results of this study are also able to provide performance ratings that can be used as a reference in supplier selection[3]. Research by Lizhong (2020) Assessing supplier ratings and selecting those that meet the criteria can be done effectively through the use of fuzzy PROMETHEE II. By carefully stratifying and classifying suppliers, companies can allocate their limited resources more efficiently, especially with a focus on key suppliers. This approach helps in reducing overall costs and improving the optimization of the use of company resources[4]. Research by Serdar (2022) Evaluating 69 suppliers and designing appropriate development strategies for relevant performance segments are the objectives of implementing ISSED-F. The successful implementation of ISSED-F shows that this approach can serve as a guide for chemical manufacturers to adopt sustainability practices. In addition, it also helps ensure continuous development in their supply chain by utilizing Analytic Network Process (ANP) and PROMETHEE methods[5]. The results of a literature study in evaluating supplier performance by applying a decision support system model to evaluate and rank based on supplier performance.

Decision Support Systems (DSS) have become an integral element in the world of business and management, playing an important role in helping decision makers deal with the complexity and uncertainty of information management. In an era where data is becoming increasingly abundant, DSS is emerging as an effective solution to process information into useful insights. DSS is designed to provide decision-makers with a structured framework, enabling them to analyze data, design scenarios, and select optimal solutions[6]. By utilizing advanced technology and algorithms, DSS not only supports more informed decision making, but also speeds up the process. Along with the evolution of technology, DSS continues to experience significant developments, utilizing artificial intelligence, machine learning, and high-level data analysis. This allows DSS not only to manage large and complex data, but also to provide more accurate predictions, pattern identification, and solutions based on a deeper understanding of context[7]. The success of organizations today is closely related to their ability to take the right and fast decisions. The advantages of DSS involve its ability to increase efficiency, accuracy, and consistency in the decision-making process, as well as provide more competitiveness in various aspects of business and management[8]–[10]. The use of DSS is not only as a tool, but as an essential strategic partner to support better decisions and organizational adaptation to future challenges. Previous research used ANP, AHP, and PROMETHEE II methods in determining supplier performance evaluation, while the research conducted used the Multi-Attributive Ideal-Real Comparative Analysis method.

Multi-Attributive Ideal-Real Comparative Analysis (MAIRCA) is an analytical method that aims to compare the performance of alternatives based on a number of different criteria. In the world of decision-making, MAIRCA is becoming an increasingly significant approach to evaluating options taking into account the difference between ideal conditions and existing reality[11]–[13]. MAIRCA involves comparing alternatives against desired ideal conditions, and furthermore, considering the extent to which each alternative achieves the standard. Along with the complexity of decisions in a variety of contexts, MAIRCA provides a robust framework to help decision makers evaluate trade-offs between various factors and come up with more optimal solutions. This research will explore the essence of MAIRCA as an analytical method that bases decisions on comparisons between ideal and real conditions, providing deeper and contextual insights for informational and data-driven decision making[14]–[16]. MAIRCA is becoming increasingly relevant in complex decision-making contexts, where there are diverse criteria to consider. By incorporating elements of comparison between ideal and real conditions, MAIRCA helps identify the extent to which each alternative reflects desired expectations. It also provides flexibility in determining the relative weight or importance of each criterion, allowing decision makers to tailor the analysis according to their specific context[17], [18]. Although MAIRCA has the advantage of providing a holistic view on decision making, it also has some disadvantages that need to be noted. One of the main drawbacks is the reliance on the subjectivity of the decision maker in determining the criteria and their weight. The ideal and real criteria can also vary depending on the perspective of the individual or group, generating different interpretations of the desired conditions. In addition, MAIRCA may tend to be complex especially when there are many criteria to be evaluated, complicating the understanding and interpretation of results by those unfamiliar with the method. The weighting method used to cover the weakness of MAIRCA is the Rank Order Centroid weighting method.

The Rank Order Centroid (ROC) weighting method is an approach that has evolved rapidly in the context of multi-criteria decision making. The ROC presents an innovative framework for determining the weight of criteria by utilizing the relative ranking information of each criterion provided by decision makers. In an era where decision complexity is increasing, ROC offers systematic and effective solutions and it is an important tool for understanding and managing that complexity[19]–[21]. The advantage of ROC lies in its ability to capture decision-makers' preferences and priorities relatively, creating a more accurate and contextual picture. This method can also be used to solve the problem of measuring and comparing criteria with different units, providing solutions that are more structured, and easy to interpret. ROC also offers an advantage because it can overcome challenges that may arise in multi-criteria decision making, such as uncertainty and changing preferences over time. The ROC's ability to give dynamic weight to criteria according to the relative ratings of decision makers makes it an instrument responsive to environmental changes. The clarity of concepts and frameworks provided by the ROC provides a solid foundation for integrating these methods in strategic decision making.

The combination of ROC and MAIRCA weighting methods forms a powerful approach in addressing the complexity and challenges of multi-criteria decision making. ROC with its focus on relative ranking criteria, whereas MAIRCA which considers the difference between ideal and real conditions, presents complementary perspectives. By combining the two, decision makers can generate a more contextual and informational weight of criteria. This approach provides an opportunity to harness the power of each method in dealing with complex decision-making problems. By integrating the two, it can detail the degree of conformity between the desired criteria and the existing reality. This creates a robust framework for more mature decision evaluation, where each variable is weighted according to its relative value. The combination of ROC and MAIRCA also allows for flexibility in adjusting weights according to changing preferences or dynamic market conditions.

This study aims to evaluate supplier performance based on existing assessment data by applying the ROC method to determine the weight of the criteria used, then the MAIRCA method will evaluate supplier performance so that it will produce a rating of supplier performance evaluation which will be a decision recommendation for companies in assessing the performance of existing suppliers.

2. RESEARCH METHODOLOGY

2.1 Research Stages

The research stage plays a crucial role in guiding the process of inquiry and knowledge development. Quality research requires systematic planning and execution to achieve research objectives. The research stage becomes a structured and directed process, allowing researchers to identify knowledge gaps, design appropriate methodologies, and present research results with accuracy and reliability. The stages of research carried out are as shown in Figure 1.

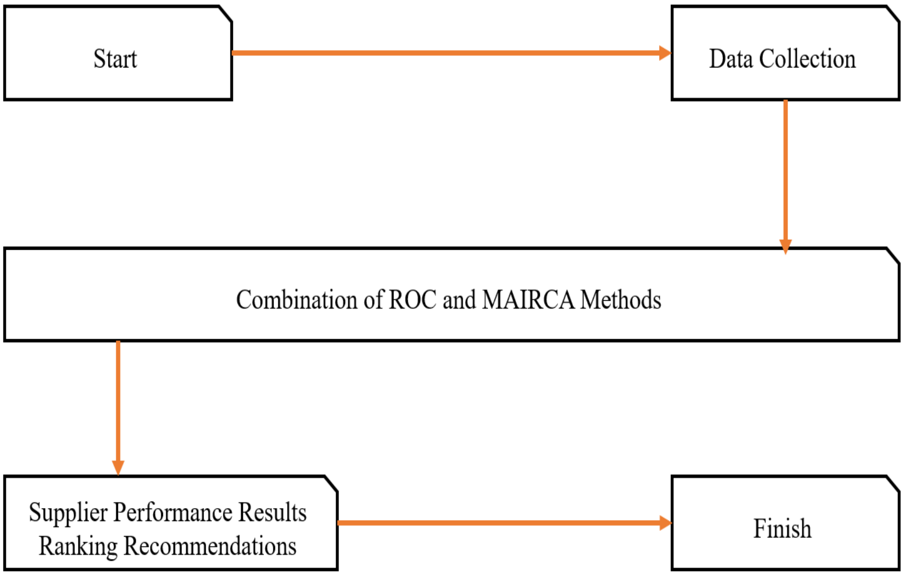

Figure 1. Research Stage

The stages of research carried out in evaluating supplier performance in figure 1, the first collection of needs is by determining the criteria used in evaluating supplier performance and collecting assessment data on supplier performance results. The next process is the ROC and MAIRCA methods in evaluating supplier performance, finally making supplier rankings based on the performance results of each supplier.

2.2 Concept Framework of ROC and MAIRCA Method Combination

The method of weighting criteria using rank order centroid is one approach used in multi-criteria decision making to assign relative weights to each criterion. This method focuses on evaluating the relative position of each alternative within each criterion, by ranking the relative based on relative comparisons between alternatives. Next, by calculating the centroid of the ranking of each alternative in each criterion, the relative weight of each criterion is determined. This approach considers the relative contribution of each criterion to the optimal solution and provides a better understanding of the importance of each criterion in decision making.

2.3 MAIRCA Method

The MAIRCA method is an approach used in multi-criteria decision making to compare alternatives based on predetermined criteria. This approach involves a comparison between the ideal value and the actual value of each alternative in each criterion, with the aim of assessing how close each alternative is to the desired ideal value. Using this method, decision makers can evaluate and compare the relative performance of these alternatives, and identify the advantages and disadvantages of each alternative in the context of predetermined criteria. The MAIRCA method provides a systematic and structured framework for decision making, assisting users in setting priorities and taking more informed and targeted decisions.

2.4 Concept Framework of ROC and MAIRCA Method Combination

The concept framework of the combination of ROC and MAIRCA criteria weighting methods encapsulates an innovative approach in optimizing the multi-criteria decision-making process. The ROC focuses on relative ranking criteria, opening the door to the introduction of decision makers' relative preferences. On the other hand, the MAIRCA method focuses on evaluating the difference between ideal and real conditions, providing an aspirational dimension that involves the ideal expectations of stakeholders. The combination of the two within the framework of this concept is designed to create a more contextual and adaptive weight of criteria. The merging of ROC and MAIRCA weighting methods aims to improve accuracy in determining criterion weighting, providing a deeper understanding of the extent to which an alternative reflects desired expectations and existing realities. Thus, this concept framework provides a comprehensive view to guide the implementation of criterion-weighting methods based on the combination of ROC and MAIRCA, resulting in more scalable and contextual decision-making solutions in the context of multi-criteria decision makers. The concept framework of the combination of ROC and MAIRCA as shown in Figure 2.

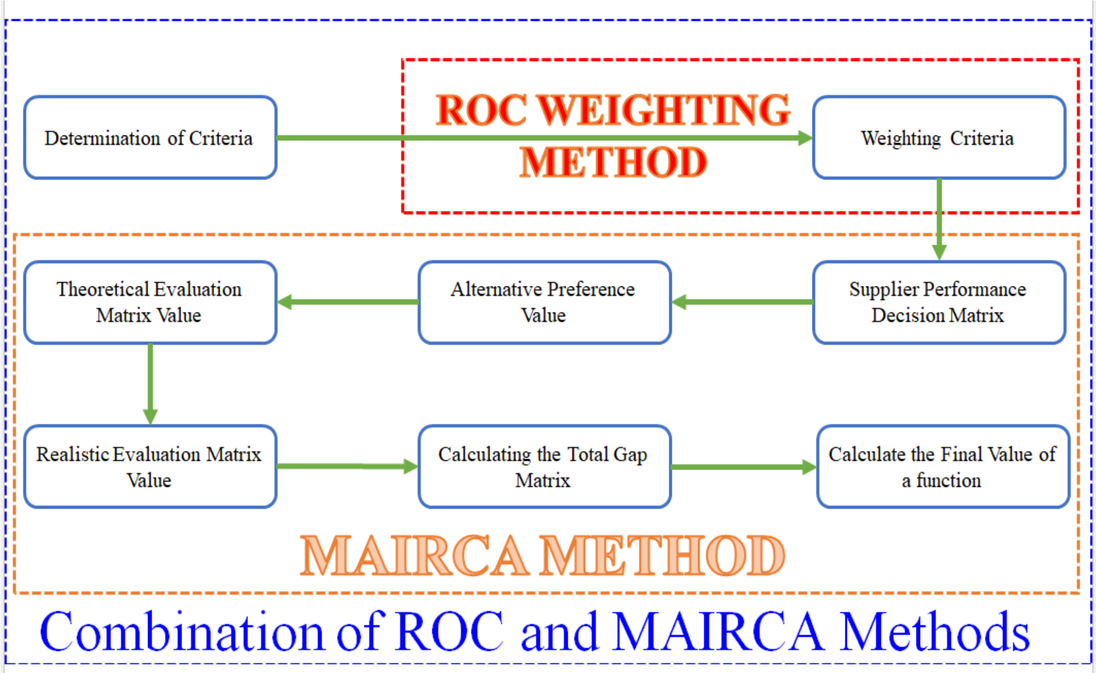

Figure 2. Concept Framework of ROC and MAIRCA Method Combination

The concept framework of the combination of ROC and MAIRCA criteria weighting methods in figure 2 explains each process of combining ROC and MAIRCA in evaluating supplier performance, the explanation of each stage of the concept framework is as follows.

a. Determination of Criteria.

Determining criteria in supplier performance evaluation is a critical step that affects the success of an organization's supply chain. The criteria chosen become the foundation for measuring supplier performance and assessing the extent to which they meet company expectations. This process involves identifying the factors that are most relevant and have a significant impact on the smooth operation and strategic objectives of the company. The criteria used in evaluating supplier performance are in table 1.

Table 1. Supplier Assessment Criteria

Criteria	Criteria Type	Priority Criteria
Price (P)	Cost	1
Quality (Q)	Benefit	2
Timeliness of delivery (T)	Benefit	3
Warranty (W)	Benefit	4
Flexibility (F)	Benefit	5
Responsiveness (R)	Benefit	6

The criteria used in table 1 are obtained from companies based on the collection of needs, during the collection of needs to discuss problems in performance evaluation. The results of the discussion determined that there are 6 (six) criteria used in the assessment of supplier performance evaluation that will be used in this study.

b. Weighting Criteria.

The weighting of the criteria used in this study by applying the ROC method which is a significant approach in multi-criteria decision making. This method focuses on the relative ranking of the criteria given by decision makers. Using the ROC, each criterion is weighted based on the level of preference given by the stakeholders. The equation for determining the weight of criteria using ROC is as follows.

$$W_j = \frac{1}{n}\sum_{i=1}^{n}\left(1+\frac{1}{i}\right) \quad (1)$$

Where W_j is the weight of each criterion, for n is the number of criteria, while i is the importance of each criterion weight.

c. Decision Matrix.

The decision matrix is an essential analytical tool in decision making, especially in the context of evaluating alternatives or criteria. This matrix provides a framework for structuring and comparing options based on predefined criteria. The decision matrix equation is as follows.

$$X = \begin{bmatrix} x_{11} & \cdots & x_{1n} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mn} \end{bmatrix} \quad (2)$$

d. Alternative Preference Value.

Determining preferences according to alternatives involves evaluating and comparing between various options to identify the one that best meets your needs or expectations. This process often involves assessing attributes relevant to a particular context. Each alternative is measured according to the desired ideal standard, and the gap between the actual value and the desired value can be an indicator of excellence or deficiency. The equation of preference corresponds to alternatives such as the following.

$$P_{ai} = \frac{1}{m}\sum_{i=1}^{m} P_{ai} = 1 \quad (3)$$

Where m is the number of alternatives available, P is the preference value of each alternative, for the whole P value equal to 1. Based on neutral decision making all existing preferences or alternatives are considered the same as follows.

$$P_{a1} = P_{a2} = P_{a3} = P_{am} \quad (4)$$

e. Theoretical Evaluation Matrix Value.

The Theoretical Evaluation Matrix involves an analytical approach used to determine the theoretical value or weight of various relevant criteria or variables in a context. The Theoretical Evaluation Matrix equation is as follows.

$$T_p = \begin{bmatrix} t_{p11} & \cdots & t_{p1n} \\ \vdots & \ddots & \vdots \\ t_{pm1} & \cdots & t_{pmn} \end{bmatrix} = \begin{bmatrix} p_{a11} * w_1 & \cdots & p_{a1n} * w_n \\ \vdots & \ddots & \vdots \\ p_{am1} * w_1 & \cdots & p_{amn} * w_n \end{bmatrix} \quad (5)$$

f. Realistic Evaluation Matrix Value.

The Realistic Evaluation Matrix involves a systematic process for evaluating performance or characteristics of various alternatives or entities based on defined criteria or attributes. The Realistic Evaluation Matrix equation is as follows.

$$T_r = \begin{bmatrix} t_{r11} & \cdots & t_{r1n} \\ \vdots & \ddots & \vdots \\ t_{rm1} & \cdots & t_{rmn} \end{bmatrix} \quad (6)$$

For criteria with the type of benefit is calculated using the following equation.

$$t_{rij} = t_{pij}\left(\frac{x_{ij} - x_{ij}^{-}}{x_{ij}^{+} - x_{ij}^{-}}\right) \quad (7)$$

For criteria with the type of cost is calculated using the following equation.

$$t_{rij} = t_{pij}\left(\frac{x_{ij} - x_{ij}^{+}}{x_{ij}^{-} - x_{ij}^{+}}\right) \quad (8)$$

t_{rij} is the realistic matrix evaluation value while t_{pij} is the alternative preference value, and x_{ij} is the alternative value for each criterion.

g. Calculating the Total Gap Matrix.

The Total Gap matrix involves the process of careful evaluation of the difference between actual and target values on a number of specific attributes or criteria. This matrix is used as an analytical tool to measure the gap or deviation between the actual performance of a system, product, or service and predefined expectations or standards. The total gap matrix equation is as follows.

$$G_{ij} = t_{pij} - t_{rij} \quad (9)$$

G_{ij} is the totap value of the matrix gap for each alternative.

h. Calculate the Final Value of a function.

Calculating the final value of a function involves the process of evaluating and determining the final result of a mathematical or modeling function. The end result of these calculations is often used to make decisions, perform analyses, or describe the nature of the modeled system. The calculation of the final value of the function uses the following equation.

$$Q_i = \sum_{j=1}^{n} g_{ij} \quad (10)$$

Qij represents the final value of each alternative.

3. RESULT AND DISCUSSION

The method of weighting criteria using rank order centroid is one approach used in multi-criteria decision making to assign relative weights to each criterion. The criterion weighting method using rank order centroid also allows decision makers to capture their preferences and priorities in more detail. By taking into account the relative ranking of each alternative within each criterion, this method helps identify the criteria that are most influential in influencing the final decision. In addition, because this method considers the relative position of each alternative within each criterion, it can overcome some of the challenges that may occur in multi-criteria decision making, such as uncertainty, complexity, and conflicting interests. Thus, the method of weighting criteria using rank order centroid is a powerful tool in assisting decision makers in evaluating and selecting alternatives that best suit their preferences and goals.

The MAIRCA (Multi-Attribute Ideal-Real Comparative Analysis) method is an approach used in multi-criteria decision making to compare alternatives based on predetermined criteria. In the MARIRCA method, the decision-making process begins by establishing relevant evaluation criteria to support decision-making objectives. Next, the decision maker determines the ideal value and real value of each criterion for each alternative. The ideal value describes the desired or ideal conditions, while the real value reflects the actual conditions of each alternative. Next, a comparison between ideal value and real value is used to determine the relative rank of each alternative in each criterion. Finally, these ranking results are integrated to provide an overall picture of the relative performance of each alternative. Using the MAIRCA method, decision makers can make more informed and targeted decisions, as well as consider critical aspects of each alternative more comprehensively.

The combination of ROC and MAIRCA criteria weighting methods in supplier performance evaluation presents a comprehensive and contextual approach. The ROC method provides a framework for determining the relative weight of criteria based on ratings given by decision makers. Meanwhile, MAIRCA presents an evaluation dimension that considers the difference between ideal and real conditions for each criterion. By combining the two, supplier performance evaluation becomes more holistic and adaptive.

3.1 Supplier Assessment Data

Supplier appraisal data is a collection of critical information that reflects the performance and contribution of suppliers to the supply chain of an organization, this data involves a number of criteria that have been set in the evaluation of supplier performance. This assessment data is obtained from the company that assesses the performance of suppliers so far, the results of supplier assessment data such as table 2.

Table 2. Supplier Assessment Data

Supplier Name	P	Q	T	W	F	R
Supplier A	3	5	1	2	3	2
Supplier B	4	4	2	2	2	3
Supplier C	3	3	1	1	1	4
Supplier D	2	4	2	2	2	3
Supplier E	4	5	1	2	2	3
Supplier F	5	4	2	1	3	4
Supplier G	3	3	1	1	2	5
Supplier H	2	4	1	1	1	4
Supplier I	3	3	1	2	2	5
Supplier J	4	2	2	2	3	4
Supplier K	3	3	2	2	2	5
Supplier L	2	5	1	1	3	4

The appraisal data in table 2 will be used in supplier performance evaluation and will be calculated using a combination of ROC and MAIRCA, so that it will result in a ranking of supplier performance evaluation results.

3.2 Combination of ROC and MAIRCA Methods

The combination of criteria weighting methods using ROC and supplier performance evaluation using MAIRCA creates a unique and holistic approach in evaluating alternatives based on predetermined criteria. The ROC method provides relative ratings that reflect the decision maker's preference for each criterion, while MAIRCA involves a comparison between ideal and real conditions for each alternative based on the assessment of each criterion. The integration of these two methods makes it possible to build a more contextual and dynamic weight of criteria. The stages of problem solving in supplier performance evaluation using a combination of ROC and MAIRCA are as follows.

a. Weighting Criteria Using ROC

The first stage is to determine the weight of the criteria based on existing criteria and the priority of the criteria as shown in table 1, the calculation of the weight of the criteria using ROC will be calculated using equation (1). The results of the calculation of the weight of each criterion are as follows.

$$W_1 = \frac{1 + \frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \frac{1}{5} + \frac{1}{6}}{6} = \frac{2.45}{6} = 0.40833$$

$$W_2 = \frac{0+\frac{1}{2}+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}+\frac{1}{6}}{6} = \frac{1.45}{6} = 0.24167$$

$$W_3 = \frac{0+0+\frac{1}{3}+\frac{1}{4}+\frac{1}{5}+\frac{1}{6}}{6} = \frac{0.95}{6} = 0.15833$$

$$W_4 = \frac{0+0+0+\frac{1}{4}+\frac{1}{5}+\frac{1}{6}}{6} = \frac{0.61667}{6} = 0.10278$$

$$W_5 = \frac{0+0+0+0+\frac{1}{5}+\frac{1}{6}}{6} = \frac{0.36667}{6} = 0.06111$$

$$W_6 = \frac{0+0+0+0+0+\frac{1}{6}}{6} = \frac{0.16667}{6} = 0.02778$$

The final result of calculating each criterion weight by applying the ROC weighting method as shown in Figure 3.

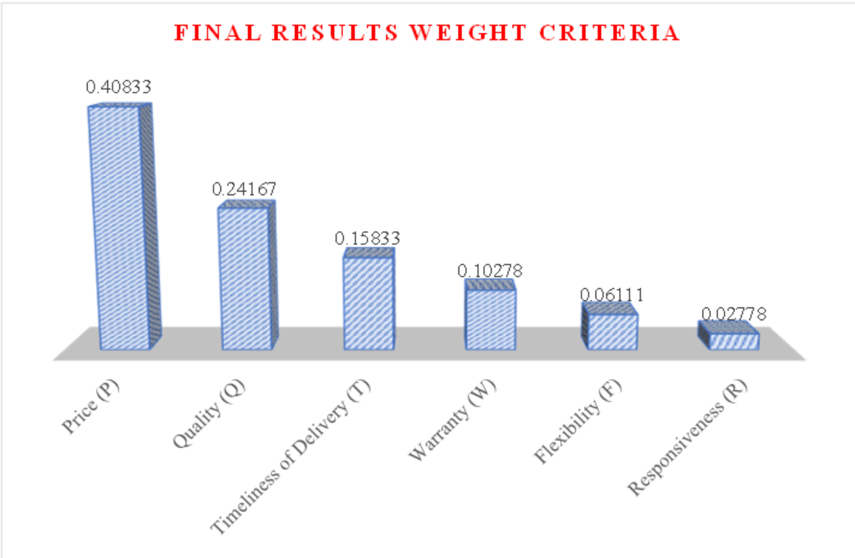

Figure 3. Final Results Weight Criteria

Based on the results of weighting criteria by applying the ROC method, weights were obtained for the Price (P) criterion of 0.40833, for the Quality (Q) criterion of 0.24167, for the Timeliness of Delivery (T) criterion of 0.15833, for the Warranty (W) criterion of 0.10278, for the Flexibility (F) criterion of 0.06111, and for the Responsiveness (R) criterion of 0.02778. The final result of this criterion weight will be used in the MAIRCA method in determining the results of the Theoretical Evaluation Matrix Value.

b. Decision Matrix

A decision matrix is an analytical tool used in the context of decision making, especially when evaluating alternatives that relate to a number of specific criteria. This matrix provides a framework for structuring and comparing options based on predetermined factors. In a decision matrix, each row represents an alternative or choice that can be made, while each column reflects a specific criterion that needs to be assessed. The decision matrix is created based on the assessment data in table 2 using equation (2), the general form of the decision matrix as follows.

$$X = \begin{bmatrix} x_{11} & x_{21} & x_{31} & x_{41} & x_{51} & x_{61} \\ x_{12} & x_{22} & x_{32} & x_{42} & x_{52} & x_{62} \\ x_{13} & x_{23} & x_{33} & x_{43} & x_{53} & x_{63} \\ x_{14} & x_{24} & x_{34} & x_{44} & x_{54} & x_{64} \\ x_{15} & x_{25} & x_{35} & x_{45} & x_{55} & x_{65} \\ x_{16} & x_{26} & x_{36} & x_{46} & x_{56} & x_{66} \\ x_{17} & x_{27} & x_{37} & x_{47} & x_{57} & x_{67} \\ x_{18} & x_{28} & x_{38} & x_{48} & x_{58} & x_{68} \\ x_{19} & x_{29} & x_{39} & x_{49} & x_{59} & x_{69} \\ x_{110} & x_{210} & x_{310} & x_{410} & x_{510} & x_{610} \\ x_{111} & x_{211} & x_{311} & x_{411} & x_{511} & x_{611} \\ x_{112} & x_{212} & x_{312} & x_{412} & x_{512} & x_{612} \end{bmatrix} \Rightarrow X = \begin{bmatrix} 3 & 5 & 1 & 2 & 3 & 2 \\ 4 & 4 & 2 & 2 & 2 & 3 \\ 3 & 3 & 1 & 1 & 1 & 4 \\ 2 & 4 & 2 & 2 & 2 & 3 \\ 4 & 5 & 1 & 2 & 2 & 3 \\ 5 & 4 & 2 & 1 & 3 & 4 \\ 3 & 3 & 1 & 1 & 2 & 5 \\ 2 & 4 & 1 & 1 & 1 & 4 \\ 3 & 3 & 1 & 2 & 2 & 5 \\ 4 & 2 & 2 & 2 & 3 & 4 \\ 3 & 3 & 2 & 2 & 2 & 5 \\ 2 & 5 & 1 & 1 & 3 & 4 \end{bmatrix}$$

c. Alternative Preference Value

The next process calculates the Alternative Preference Value using equation (2), the result of the equation is as follows.

$$P_{a11;a112} = \frac{1}{12} = 0.083333333$$

$$P_{a21;a212} = \frac{1}{12} = 0.083333333$$

$$P_{a31;a312} = \frac{1}{12} = 0.083333333$$

$$P_{a41;a412} = \frac{1}{12} = 0.083333333$$

$$P_{a51;a512} = \frac{1}{12} = 0.083333333$$

$$P_{a61;a612} = \frac{1}{12} = 0.083333333$$

d. Theoretical Evaluation Matrix Value

The next process calculates the theoretical evaluation matrix using equation (5) which is a multiplication between alternative preference values with weights from various criteria that have been calculated using the ROC weighting method. The calculation results of the theoretical evaluation matrix are as follows.

$$t_{p11;112} = p_{a11} * w_1 = 0.083333333 * 0.40833 = 0.0340275$$

$$t_{p21;212} = p_{a11} * w_1 = 0.083333333 * 0.24167 = 0.020139167$$

$$t_{p31;312} = p_{a11} * w_1 = 0.083333333 * 0.15833 = 0.013194167$$

$$t_{p41;412} = p_{a11} * w_1 = 0.083333333 * 0.10278 = 0.008565$$

$$t_{p51;512} = p_{a11} * w_1 = 0.083333333 * 0.06111 = 0.0050925$$

$$t_{p61;612} = p_{a11} * w_1 = 0.083333333 * 0.02778 = 0.002315$$

e. Realistic Evaluation Matrix Value

The next process of calculating the realistic evaluation matrix involves a systematic process to evaluate the performance or characteristics of various alternatives or entities based on specified criteria or attributes, for price criteria using equations (8), and other criteria using equations (7). The calculation results of the realistic evaluation matrix are as follows.

The calculation results for the price criteria are as follows.

$$t_{r11} = t_{p11}\left(\frac{x_{11} - x^{+}_{11;112}}{x^{-}_{11;112} - x^{+}_{11;112}}\right) = 0.0340275\left(\frac{3-5}{2-5}\right) = 0.0340275(0.666667) = 0.022685$$

The calculation results for the quality criteria are as follows.

$$t_{r21} = t_{p11}\left(\frac{x_{21} - x^{-}_{21;212}}{x^{+}_{21;212} - x^{-}_{21;212}}\right) = 0.020139167\left(\frac{5-2}{5-2}\right) = 0.020139167(1) = 0.020139167$$

The overall result of the calculation of realistic evaluation matrix value as shown in table 3.

Table 3. Result of the Calculation of Realistic Evaluation Matrix

Supplier Name	P	Q	T	W	F	R
Supplier A	0.022685	0.02013917	0	0.008565	0.005092	0
Supplier B	0.0113425	0.01342611	0.013194	0.008565	0.002546	0.000772
Supplier C	0.022685	0.00671306	0	0	0	0.001543
Supplier D	0.0340275	0.01342611	0.013194	0.008565	0.002546	0.000772
Supplier E	0.0113425	0.02013917	0	0.008565	0.002546	0.000772
Supplier F	0	0.01342611	0.013194	0	0.005092	0.001543
Supplier G	0.022685	0.00671306	0	0	0.002546	0.002315
Supplier H	0.0340275	0.01342611	0	0	0	0.001543
Supplier I	0.022685	0.00671306	0	0.008565	0.002546	0.002315
Supplier J	0.0113425	0	0.013194	0.008565	0.005092	0.001543
Supplier K	0.022685	0.00671306	0.013194	0.008565	0.002546	0.002315
Supplier L	0.0340275	0.02013917	0	0	0.005092	0.001543

f. Calculating the Total Gap Matrix

The next process calculates the total gap matrix using equation (9), the result of calculating the total gap matrix is as follows.

$$G_{11} = t_{p11} - t_{r11} = 0.0340275 - 0.022685 = 0.0113425$$

The overall result of the calculation of total gap matrix value as shown in table 4.

Table 4. Result of the Calculation of Total Gap Matrix

Supplier Name	P	Q	T	W	F	R
Supplier A	0.0113425	0	0.013194	0	0	0.002315
Supplier B	0.022685	0.00671306	0	0	0.002546	0.001543
Supplier C	0.0113425	0.01342611	0.013194	0.008565	0.005092	0.000772
Supplier D	0	0.00671306	0	0	0.002546	0.001543
Supplier E	0.022685	0	0.013194	0	0.002546	0.001543
Supplier F	0.0340275	0.00671306	0	0.008565	0	0.000772
Supplier G	0.0113425	0.01342611	0.013194	0.008565	0.002546	0
Supplier H	0	0.00671306	0.013194	0.008565	0.005092	0.000772
Supplier I	0.0113425	0.01342611	0.013194	0	0.002546	0
Supplier J	0.022685	0.02013917	0	0	0	0.000772
Supplier K	0.0113425	0.01342611	0	0	0.002546	0
Supplier L	0	0	0.013194	0.008565	0	0.000772

g. Calculate the Final Value of a Function.

The next process performs the calculation of the final value of the function using equation (10), the result of calculating the final value of the function for each alternative as follows.

The final value of the function for alternative 1 on behalf of Supplier A is as follows.

$$Q_1 = \sum_{j=1}^{n} g_{11;61} = g_{11} + g_{21} + g_{31} + g_{41} + g_{51} + g_{61}$$

$$Q_1 = 0.0113425 + 0 + 0.013194 + 0 + 0 + 0.002315 = 0.026851667$$

The final value of the function for alternative 2 on behalf of Supplier B is as follows.

$$Q_2 = \sum_{j=1}^{n} g_{12;61} = g_{12} + g_{22} + g_{32} + g_{42} + g_{52} + g_{62}$$

$$Q_2 = 0.022685 + 0.00671306 + 0 + 0 + 0.002546 + 0.001543 = 0.033487639$$

The final value of the function for alternative 3 on behalf of Supplier C is as follows.

$$Q_3 = \sum_{j=1}^{n} g_{13;63} = g_{13} + g_{23} + g_{33} + g_{43} + g_{53} + g_{63}$$

$$Q_3 = 0.0113425 + 0.01342611 + 0.013194 + 0.008565 + 0.005092 + 0.000772 = 0.052391944$$

The final value of the function for alternative 4 on behalf of Supplier D is as follows.

$$Q_4 = \sum_{j=1}^{n} g_{14;64} = g_{14} + g_{24} + g_{34} + g_{44} + g_{54} + g_{64}$$

$$Q_4 = 0 + 0.00671306 + 0 + 0 + 0.002546 + 0.001543 = 0.010802639$$

The final value of the function for alternative 5 on behalf of Supplier E is as follows.

$$Q_5 = \sum_{j=1}^{n} g_{15;65} = g_{15} + g_{25} + g_{35} + g_{45} + g_{55} + g_{65}$$

$$Q_5 = 0.022685 + 0 + 0.013194 + 0 + 0.002546 + 0.001543 = 0.03996875$$

The final value of the function for alternative 6 on behalf of Supplier F is as follows.

$$Q_6 = \sum_{j=1}^{n} g_{16;66} = g_{16} + g_{26} + g_{36} + g_{46} + g_{56} + g_{66}$$

$$Q_6 = 0.0340275 + 0.00671306 + 0 + 0.008565 + 0 + 0.000772 = 0.050077222$$

The final value of the function for alternative 7 on behalf of Supplier G is as follows.

$$Q_7 = \sum_{j=1}^{n} g_{17;67} = g_{17} + g_{27} + g_{37} + g_{47} + g_{57} + g_{67}$$

$$Q_7 = 0.0113425 + 0.01342611 + 0.013194 + 0.008565 + 0.002546 + 0 = 0.049074028$$

The final value of the function for alternative 8 on behalf of Supplier H is as follows.

$$Q_8 = \sum_{j=1}^{n} g_{18;68} = g_{18} + g_{28} + g_{38} + g_{48} + g_{58} + g_{68}$$

$$Q_8 = 0 + 0.00671306 + 0.013194 + 0.008565 + 0.005092 + 0.000772 = 0.034336389$$

The final value of the function for alternative 9 on behalf of Supplier I is as follows.

$$Q_9 = \sum_{j=1}^{n} g_{19;69} = g_{19} + g_{29} + g_{39} + g_{49} + g_{59} + g_{69}$$

$$Q_9 = 0.0113425 + 0.01342611 + 0.013194 + 0 + 0.002546 + 0 = 0.040509028$$

The final value of the function for alternative 10 on behalf of Supplier J is as follows.

$$Q_{10} = \sum_{j=1}^{n} g_{110;610} = g_{110} + g_{210} + g_{310} + g_{410} + g_{510} + g_{610}$$

$$Q_{10} = 0.022685 + 0.02013917 + 0 + 0 + 0 + 0.000772 = 0.043595833$$

The final value of the function for alternative 11 on behalf of Supplier K is as follows.

$$Q_{11} = \sum_{j=1}^{n} g_{111;611} = g_{111} + g_{211} + g_{311} + g_{411} + g_{511} + g_{611}$$

$$Q_{11} = 0.0113425 + 0.01342611 + 0 + 0 + 0.002546 + 0 = 0.027314861$$

The final value of the function for alternative 12 on behalf of Supplier L is as follows.

$$Q_{12} = \sum_{j=1}^{n} g_{112;612} = g_{112} + g_{212} + g_{312} + g_{412} + g_{512} + g_{612}$$

$$Q_{12} = 0 + 0 + 0.013194 + 0.008565 + 0 + 0.000772 = 0.022530833$$

The final value results of functions in MAIRCA provide deeper insight into the relative performance of each alternative in the context of predefined criteria. Further analysis and interpretation of results can help decision makers make informed and purpose-appropriate decisions. Based on the final results of the MAIRCA method, alternative rankings are then made as shown in Figure 4.

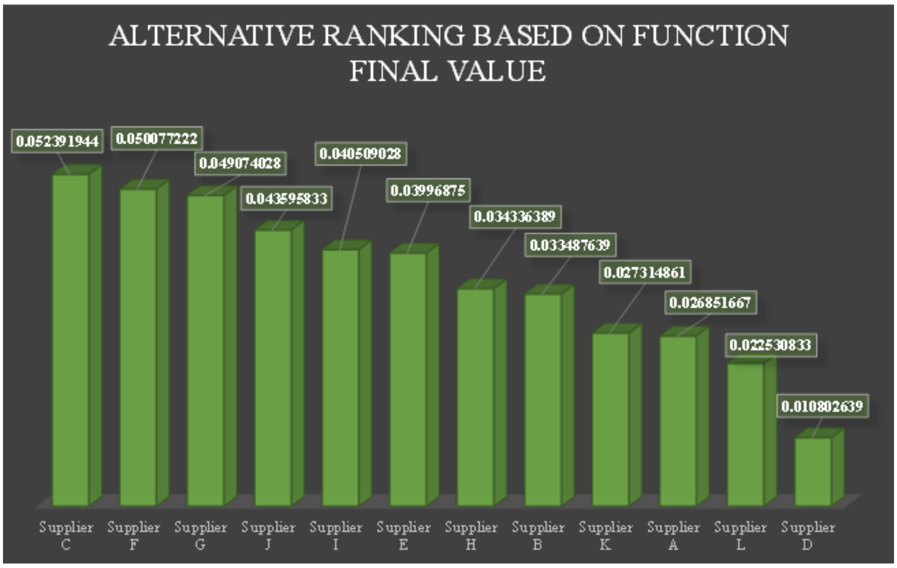

Figure 4. Alternative Ranking of Performance Evaluation Results

The ranking result graph in figure 4 shows the best supplier performance obtained on behalf of Supplier C with a final value of 0.052391944 ranked 1, then on behalf of Supplier F with a final value of 0.050077222 ranked 2, and on behalf of Supplier G with a final value of 0.049074028 ranked 3.

The ranking results from the combination of ROC and MAIRCA criteria weighting methods in supplier performance evaluation create a holistic view that combines the advantages of both methods. ROC provides a relative ranking framework for each alternative based on criteria, whereas MAIRCA enriches evaluations by considering the difference between ideal and real conditions. By integrating the two, the ranking results provide more comprehensive information about the extent to which each supplier is approaching ideal expectations on predetermined criteria. This approach makes it possible to take into account qualitative and aspirational aspects, as well as give appropriate weight to each criterion. The results of this ranking provide a strong foundation for decision makers in selecting suppliers that best suit business needs and strategies, ensuring sustainability and efficiency in the company's supply chain. By involving the evaluation of ideal, real conditions, this method allows decision makers to not only understand the extent to which suppliers meet the desired criteria, but also how their performance approaches the highest expected standards. This provides flexibility and clarity in assessing suppliers not only from a quantitative, but also qualitative perspective. In addition, the resulting ranking can provide strategic guidance on supplier selection that can provide added value and positive contribution to long-term business goals. Overall, the combination of ROC and MAIRCA provides a comprehensive method of supplier performance evaluation, ensuring more informed and sustainable decisions in supply chain management.

4. CONCLUSION

This study aims to evaluate supplier performance based on existing assessment data by applying the ROC method to determine the weight of the criteria used, then the MAIRCA method will evaluate supplier performance so that it will produce a rating of supplier performance evaluation which will be a decision recommendation for companies in assessing the performance of existing suppliers. The combination of criteria weighting methods using ROC and supplier performance evaluation using MAIRCA creates a unique and holistic approach in evaluating alternatives based on predetermined criteria. The ROC method provides relative ratings that reflect the decision maker's preference for each criterion, while MAIRCA involves a comparison between ideal and real conditions for each alternative based on the assessment of each criterion. The integration of these two methods makes it possible to build a more contextual and dynamic weight of criteria. The ranking result the best supplier performance obtained on behalf of Supplier C with a final value of 0.052391944 ranked 1, then on behalf of Supplier F with a final value of 0.050077222 ranked 2, and on behalf of Supplier G with a final value of 0.049074028 ranked 3. The ranking results from the combination of ROC and MAIRCA criteria weighting methods in supplier performance evaluation create a holistic view that combines the advantages of both methods. ROC provides a relative ranking framework for each alternative based on criteria, whereas MAIRCA enriches evaluations by considering the difference between ideal and real conditions. By integrating the two, the ranking results provide more comprehensive information about the extent to which each supplier is approaching ideal expectations on predetermined criteria

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