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Research Article

Combination of Multi-Objective Optimization on the Basis of Ratio Analysis and ROC in the Selection of Extracurricular Activities

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Abstract: The selection of extracurricular activities for students often involves several challenges and problems. Some problems in the selection of extracurricular activities include limited time, interests and talents, limited facilities and infrastructure, and awareness of choices. Problems in the selection of extracurricular activities include limited time, interests and talents, limited facilities and infrastructure, and awareness of choices. The purpose of this study is to provide recommendations for a decision support system model for students in the selection of extracurricular activities by applying the ROC method as a method of weighting criteria and the MOORA method as an alternative ranking tool for extracurricular activities that become recommendations for students. The combination of MOORA and Rank Order Centroid (ROC) methods is an approach that can be used in complex multi-criteria decision analysis. This method combines the strengths of both methods to provide more comprehensive and effective solutions in decision-making. The results of the study on the selection of extracurricular activities using a combination of MOORA and ROC methods, recommendations for extracurricular activities for Futsal extracurricular activities with a value of 0.444 as recommendations based on the final calculation results with the MOORA method got rank 1, for rank 2 recommended extracurricular activities Basketball with a final value of 0.437, and rank 3 recommended extracurricular activities Karate with a final value of 0.426.

Keywords: decision, MOORA, recommendation, ROC, selection

1 Introduction

Information technology has become the backbone of modern society, changing the way we communicate, work, learn, and live. This paper aims to provide a comprehensive understanding of information technology, how its development has shaped our world, and the social and ethical implications associated with it [1]. The selection of extracurricular activities for students often involves several challenges and problems. Some problems in the selection of extracurricular activities include limited time, interests and talents, limited facilities and infrastructure, and awareness of choices. The number of extracurricular activities at school makes students confused in choosing extracurricular activities that suit their interests and talents. This makes students sometimes wrong in choosing extracurriculars and in the end students are only active at the beginning of extracurricular activities and over time students will feel that the extracurricular they follow is not in accordance with their interests. Another impact of students who are wrong in choosing extracurricular activities that are not in accordance with their interests and talents is the lack of development of the potential possessed by the student, even though the student participates in extracurricular activities that are in accordance with his interests and talents, the existing potential, will encourage the potential of students to be honed properly. One application of technology by using a decision support system. Decision Support Systems (DSS) have become an integral part in the world of business and information technology [2, 3]. With the growing complexity of problems and reliance on data, it is important to integrate information technology into the decision-making process. DSS is a system designed to assist decision-making in various situations and contexts. DSS uses data, models, algorithms, and information processing techniques to analyze various options and provide recommendations or optimal solutions to users [4, 5]. The main goal of DSS is to improve the quality of decisions by providing relevant, accurate, and structured information [6, 7].

Related research conducted Nasullah (2023) Based on the results of matching extracurricular sample data selected by students with the results of the decision support system, fuzzy tsukamoto can be used as an alternative in providing appropriate extracurricular recommendations for students [8]. Other research by Sipayung [9] (2020) choosing the best extracurricular activities additive ratio assesment (ARAS) is a method used for ranking, it is hoped that in the application of choosing the best extracurricular activities will be more appropriate because it is based on the value of criteria and weights that have been determined, to get maximum results. Other research by Panjaitan and Juliansa [10] (2021) sensitivity test results on the simple additive weighting (SAW) method have a total change of 8.4% and the WP method of 0.027%. Thus, it can be concluded that the SAW method is considered relevant in solving the problem of selecting extracurricular activities. The difference with research that has been done by previous studies is that this study applies multi-objective optimization on the basis of ratio analysis (MOORA) for alternative ratings and the ROC weighting method is used to determine the weight of criteria. Related research that is a reference does not use the method of weighting criteria in determining the weight of existing criteria.

Choosing the best alternative from a number of available options is a common challenge in various fields, such as management, engineering, and economics. MOORA is a method used to select the best alternative by considering several different criteria or objectives [11, 12]. This method combines ratio analysis and ranking techniques of each alternative against a given criterion to achieve optimal results in a multi-criteria context [13, 14].

By combining ratio analysis and ranking techniques, MOORA provides a systematic framework for selecting the best alternatives in a variety of contexts [15, 16]. The advantages of this method in considering many criteria at once make it a valuable tool in tackling complex problems in various fields [17].

In criteria weighting using rank order centroid (ROC), weighting refers to the process of determining the relative weights or values for each attribute or criterion used in multi-criteria selection or decision-making analysis [17]. This weight reflects the level of importance or preference of each criterion in decision-making. In multi-criteria decision-making, it is important to consider the right weight of criteria so that the decisions taken are more accurate and by priorities [16]. ROC is a method used to rank alternatives based on certain criteria. Weighting in ROC is a critical step to give appropriate weight to different criteria to obtain better decision results [18]. Weighting in ROC involves determining the appropriate level of importance or weighting for each criterion used in decision-making [19]. ROC weighting has an important role in producing accurate decisions according to the preferences of decision-makers. By assigning appropriate weight to relevant criteria, decision-makers can produce rankings that are more accurate and in line with their preferences [20]. In complex, multi-criteria environments, weighting in ROC helps translate decision-makers preferences into more informed and consistent decisions [21].

The combination of MOORA and ROC methods is an approach that can be used in complex multi-criteria decision analysis. The ROC method is used to determine the weight of criteria in the selection of extracurricular activities, while the MOORA method is used to help produce a decision in the selection of extracurricular activities. The ROC weighting method helps to overcome weaknesses in the MOORA method in the sensitivity of the weights assigned to each criterion, so that the combination of these two methods provides a more comprehensive and effective solution in decision making.

The purpose of this study is to provide recommendations for a decision support system model for students in the selection of extracurricular activities by applying the ROC method as a method of weighting criteria and the MOORA method as an alternative ranking tool for extracurricular activities that become recommendations for students, so that the combination of MOORA and ROC methods can be recommendations for students in determining the decision on the selection of extracurricular activities to be taken.

2 Research Method

Research stages are systematic processes designed to achieve specific research objectives. Research begins with the identification of a problem or research question, followed by the formation of a specific hypothesis or research question [22]. Next, design the research methodology, including sample selection, data collection, and selection of appropriate analytical tools. The research phase concludes with a critical evaluation of the methodology and findings, as well as suggestions for future research. This entire process aims to ensure the accuracy, sustainability, and relevance of research to scientific contributions. The research stages are a sequence of steps or processes carried out to plan, gather data, perform analysis, and conclude a research study. These stages assist researchers in organizing the framework and ensuring that the research is conducted using systematic and structured methods. The steps will be explained in detail and illustrated in the form of a graph in Figure 1.

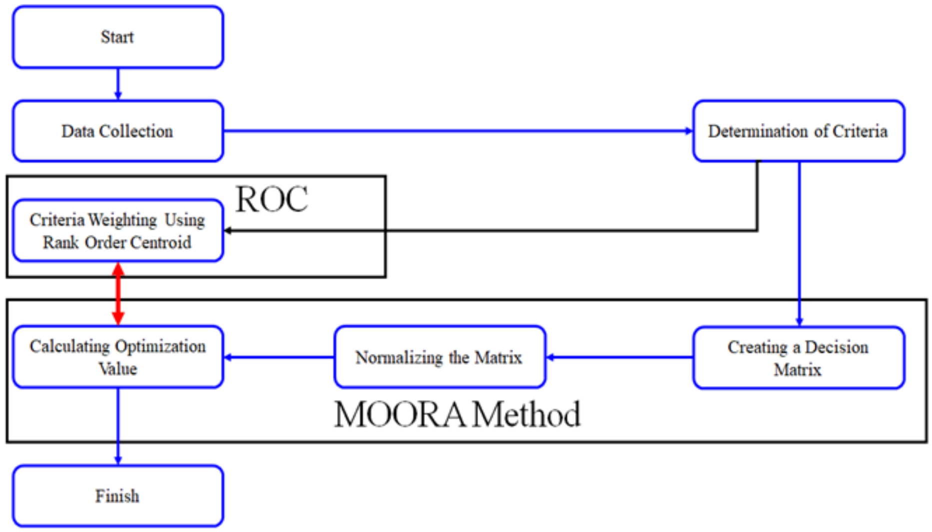

Figure 1: Stages of research.

The steps taken in the research stage will be explained in the following stages.

2.1 Database Collection

The process of gathering requirements in research demands precision, clarity, and accuracy to ensure the successful attainment of research objectives and the generation of impactful research outcomes. In the requirement-gathering process, interviews are conducted to obtain issues concerning student extracurricular activity selection, followed by the determination of criteria used in selecting student extracurricular activities.

2.2 Determination of Criteria

Based on the collected data, the selection of student extracurricular activities with six criteria has been identified. These criteria include activity schedule, student interest, student talent, student ability, achievements, and student hobbies.

2.3 Criteria Weighting using ROC

ROC is a technique in multi-criteria decision making that aims to give priority and rank alternatives based on several criteria. This approach proves to be very beneficial when faced with a number of alternative options, with the aim of determining the best order or ranking based on their respective attributes or characteristics. The ROC method involves calculating centroids for each criterion within a multi-dimensional space created by these criteria. The centroids represent the average positions of an alternative concerning all the criteria. Subsequently, the alternatives are sorted by how far away they are from the reference point., which can be an ideal point or another predefined point within the criteria space. The stages in the weighting process of ROC utilize (**??**).

$$w_k = \frac{1}{n}\sum_{i=1}^{k}\left(\frac{1}{k}\right) \tag{1}$$

2.4 Creating a Decision Matrix

The decision matrix is a tool used to assist in decision-making among various distinct options using specific criteria. The process of creating a decision matrix involves inputting the assessment outcomes of each alternative for every existing criterion. The equation form of the decision matrix (X) is shown in (2).

$$X = \begin{bmatrix} x_{i1} & \cdots & x_{in} \\ \vdots & \ddots & \vdots \\ x_{m1} & \cdots & x_{mn} \end{bmatrix}$$

A decision matrix is a representation of a data structure in the form of a matrix used in multi-criteria decision analysis. This matrix reflects the relationship between the alternatives evaluated and the criteria used to assess those alternatives. The decision matrix has rows for each alternative and columns for each criterion. In the context of multi-criteria decision analysis, each cell in the decision matrix contains a value or scores that reflect the performance or contribution of each alternative to each criterion. These values can be provided by decision makers or can be generated through a process of evaluation and measurement.

2.5 Normalizing the Matrix

The next step involves normalizing the previously constructed decision matrix, resulting in a normalization matrix. The formula for normalization is as depicted in (3).

$$X_{ij}^{*} = \frac{x_{ij}}{\sqrt{\sum_{j=1}^{m} x_{ij}^{2}}} \tag{3}$$

Matrix normalization is an important step in multi-criteria decision analysis because it helps overcome scale differences between criteria that may exist in the decision matrix. The criteria used to assess alternatives often have different units and ranges of values. Without normalization, this difference can cause large-scale criteria to dominate the calculation, resulting in unbalanced results. With normalization, the values in the matrix are converted into a uniform scale between 0 and 1. This allows each criterion to make a balanced contribution to the ranking of alternatives, ensuring that the resulting decisions are fair, and consistent. Normalization also improves the interpretability of decision analysis results, facilitates relative understanding between alternatives and facilitates more accurate and precise decision making.

2.6 Calculating Optimization Value

When criteria for each alternative are not assigned weight values, the normalized measures are aggregated by addition in the case of maximization (for advantageous attributes) and by subtraction in the case of minimization (for disadvantageous attributes). In other words, the maximum and minimum values in each row are subtracted to obtain rankings in each row. If formulated, this process can be expressed using (4).

$$Y_j^* = \sum_{j=1}^{g} X_{ij^*} - \sum_{j=g+1}^{n} X_{ij^*} \tag{4}$$

When criteria for each alternative are assigned importance weight values, the allocation of these weights follows the rule that the weight of a higher-benefit attribute is greater than that of a lower-benefit attribute. This is done to signify the relative importance of each attribute and its coefficient of significance. The formula for calculating the Multi-Objective Optimization Value in MOORA involves subtracting the product of the weight of each criterion and the maximum attribute value from the product of the weight of the criterion and the minimum attribute value. If formulated, this can be expressed using (5).

$$Y_i^* = \sum_{j=1}^{g} W_j X_{ij^*} - \sum_{j=g+1}^{n} W_j X_{ij^*} \tag{5}$$

Eq. (4) is used for the calculation of the MOORA optimization value for criteria with benefit types, while (5) is for the calculation of MOORA optimization values for the type of cost criteria, so that the final result of the MOORA optimization value is reduced between the final total optimization value of the benefit criteria and the total final optimization value of the cost criteria.

This study employs the calculation of optimization values using (5), as the existing criteria have been weighted using the ROC method.

3 Result

The discussion will commence by establishing the criteria, followed by the weighting of criteria using the ROC method, and subsequently assessing alternative extracurricular activity selection using the MOORA method. The outcomes obtained from the extracurricular activity selection process can aid students in choosing their activities based on the given criteria.

3.1 Criteria Weighting using ROC

Based on the data collection that has been carried out, a selection of extracurricular activities that have six criteria including achievement, activity schedule, student interests, student talents, student abilities, and student hobbies are obtained. The initial stage of mixed data tables does not yet include weights, so the use of the ROC method is necessary to obtain the weights of relevant criteria. The process of calculating the weight of criteria is carried out through the application of (1).

$$w_1 = \frac{1 + \frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \frac{1}{5} + \frac{1}{6}}{6} = 0.408$$

$$w_2 = \frac{0 + \frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \frac{1}{5} + \frac{1}{6}}{6} = 0.242$$

$$w_3 = \frac{0 + 0 + \frac{1}{3} + \frac{1}{4} + \frac{1}{5} + \frac{1}{6}}{6} = 0.158$$

$$w_4 = \frac{0 + 0 + 0 + \frac{1}{4} + \frac{1}{5} + \frac{1}{6}}{6} = 0.103$$

$$w_5 = \frac{0 + 0 + 0 + 0 + \frac{1}{5} + \frac{1}{6}}{6} = 0.061$$

$$w_6 = \frac{0 + 0 + 0 + 0 + 0 + \frac{1}{6}}{6} = 0.028$$

Using the ROC approach, the weight of the criteria is calculated and analyzed, the achievement criteria have a weight of 0.408, the activity schedule has a weight of 0.242, student interest has a weight of 0.158, student talent has a weight of 0.103, student ability has a weight of 0.061, and student hobbies have a weight of 0.028.

3.2 Creating a Decision Matrix

The alternatives used in this study to determine extracurricular activities are basketball, futsal, scouts, karate, and dance. From the existing alternatives, it is assessed based on the six criteria used, the assessment results are obtained as in Table 1.

Table 1: Table of criteria

Criteria Code	Criteria Name	Criteria Type
C1	Achievement	Benefit
C2	Schedule	Benefit
C3	Student Interests	Benefit
C4	Student Talent	Benefit
C5	Student Abilities	Benefit
C6	Student Hobbies	Cost

In the selection of extracurricular activities in the school environment, benefit-type criteria play a crucial role to ensure that the selected activities can have a positive impact on students and minimize negative consequences. Further creating an assessment table of each alternative for each criterion used can be seen in Table 2.

Table 2: Alternative assessment

Alternative	Criteria					
	C1	C2	C3	C4	C5	C6
Basketball	8	7	8	7	8	6
Futsal	7	8	9	9	7	7
Scout	9	6	6	6	6	8
Karate	8	6	9	9	5	7
Dance	6	5	9	9	8	8

The results of alternative assessments in Table 2 are obtained based on data collection from students against existing alternative assessments, data is collected through questionnaires given to students to assess alternatives based on existing criteria. The assessment data is the basis for applying the combination of ROC and MOORA in determining the selection of extracurricular activities that will be recommended to students based on the assessment results that have been given.

Based on the results of the alternative assessment shown in Table 2, then make a decision matrix (X) from the results of the assessment of each alternative against existing criteria. The formula of the decision matrix is shown in (2).

$$\begin{bmatrix} 8 & 7 & 8 & 7 & 8 & 6 \\ 7 & 8 & 9 & 9 & 7 & 7 \\ 9 & 6 & 6 & 6 & 6 & 8 \\ 8 & 6 & 9 & 9 & 5 & 7 \\ 6 & 5 & 9 & 9 & 8 & 8 \end{bmatrix}$$

3.3 Normalizing the Matrix

The second step in the MOORA method involves the process of normalizing the decision matrix already made, with the aim of generating a normalization matrix, as shown in (3).

$$x_{11} = \frac{8}{\sqrt{8^2+7^2+9^2+8^2+6^2}} = \frac{8}{17.15} = 0.467$$

$$x_{12} = \frac{7}{\sqrt{8^2+7^2+9^2+8^2+6^2}} = \frac{7}{17.15} = 0.408$$

$$x_{13} = \frac{9}{\sqrt{8^2+7^2+9^2+8^2+6^2}} = \frac{9}{17.15} = 0.525$$

$$x_{14} = \frac{8}{\sqrt{8^2+7^2+9^2+8^2+6^2}} = \frac{8}{17.15} = 0.467$$

$$x_{15} = \frac{6}{\sqrt{8^2+7^2+9^2+8^2+6^2}} = \frac{6}{17.15} = 0.35$$

$$x_{21} = \frac{7}{\sqrt{7^2+8^2+6^2+6^2+5^2}} = \frac{7}{14.49} = 0.483$$

$$x_{22} = \frac{8}{\sqrt{7^2+8^2+6^2+6^2+5^2}} = \frac{8}{14.49} = 0.552$$

$$x_{23} = \frac{6}{\sqrt{7^2+8^2+6^2+6^2+5^2}} = \frac{6}{14.49} = 0.414$$

$$x_{24} = \frac{6}{\sqrt{7^2+8^2+6^2+6^2+5^2}} = \frac{6}{14.49} = 0.414$$

$$x_{25} = \frac{5}{\sqrt{7^2+8^2+6^2+6^2+5^2}} = \frac{5}{14.49} = 0.345$$

$$x_{31} = \frac{8}{\sqrt{8^2+9^2+6^2+9^2+9^2}} = \frac{8}{18.52} = 0.432$$

$$x_{32} = \frac{9}{\sqrt{8^2+9^2+6^2+9^2+9^2}} = \frac{9}{18.52} = 0.486$$

$$x_{33} = \frac{6}{\sqrt{8^2 + 9^2 + 6^2 + 9^2 + 9^2}} = \frac{6}{18.52} = 0.324$$

$$x_{34} = \frac{9}{\sqrt{8^2 + 9^2 + 6^2 + 9^2 + 9^2}} = \frac{9}{18.52} = 0.486$$

$$x_{35} = \frac{9}{\sqrt{8^2 + 9^2 + 6^2 + 9^2 + 9^2}} = \frac{9}{18.52} = 0.486$$

$$x_{41} = \frac{7}{\sqrt{7^2 + 9^2 + 6^2 + 9^2 + 9^2}} = \frac{7}{18.11} = 0.387$$

$$x_{42} = \frac{9}{\sqrt{7^2 + 9^2 + 6^2 + 9^2 + 9^2}} = \frac{9}{18.11} = 0.497$$

$$x_{43} = \frac{6}{\sqrt{7^2 + 9^2 + 6^2 + 9^2 + 9^2}} = \frac{6}{18.11} = 0.331$$

$$x_{44} = \frac{9}{\sqrt{7^2 + 9^2 + 6^2 + 9^2 + 9^2}} = \frac{9}{18.11} = 0.497$$

$$x_{45} = \frac{9}{\sqrt{7^2 + 9^2 + 6^2 + 9^2 + 9^2}} = \frac{9}{18.11} = 0.497$$

$$x_{51} = \frac{8}{\sqrt{8^2 + 7^2 + 6^2 + 5^2 + 8^2}} = \frac{8}{15.43} = 0.519$$

$$x_{52} = \frac{7}{\sqrt{8^2 + 7^2 + 6^2 + 5^2 + 8^2}} = \frac{7}{15.43} = 0.454$$

$$x_{53} = \frac{6}{\sqrt{8^2 + 7^2 + 6^2 + 5^2 + 8^2}} = \frac{6}{15.43} = 0.389$$

$$x_{54} = \frac{5}{\sqrt{8^2 + 7^2 + 6^2 + 5^2 + 8^2}} = \frac{5}{15.43} = 0.324$$

$$x_{55} = \frac{8}{\sqrt{8^2 + 7^2 + 6^2 + 5^2 + 8^2}} = \frac{8}{15.43} = 0.519$$

$$x_{61} = \frac{6}{\sqrt{6^2 + 7^2 + 8^2 + 7^2 + 8^2}} = \frac{6}{16.19} = 0.371$$

$$x_{62} = \frac{7}{\sqrt{6^2 + 7^2 + 8^2 + 7^2 + 8^2}} = \frac{7}{16.19} = 0.432$$

$$x_{63} = \frac{8}{\sqrt{6^2 + 7^2 + 8^2 + 7^2 + 8^2}} = \frac{8}{16.19} = 0.494$$

$$x_{64} = \frac{7}{\sqrt{6^2 + 7^2 + 8^2 + 7^2 + 8^2}} = \frac{7}{16.19} = 0.432$$

$$x_{65} = \frac{8}{\sqrt{6^2 + 7^2 + 8^2 + 7^2 + 8^2}} = \frac{8}{16.19} = 0.494$$

The normalized matrix results for each alternative for each criterion used can be seen in Table 3.

Table 3: Normalized matrix results

Alternative	Criteria					
	C1	**C2**	**C3**	**C4**	**C5**	**C6**
Basketball	0.467	0.483	0.432	0.387	0.519	0.371
Futsal	0.408	0.552	0.486	0.497	0.454	0.432
Scout	0.525	0.414	0.324	0.331	0.389	0.494
Karate	0.467	0.414	0.486	0.497	0.324	0.432
Dance	0.35	0.345	0.486	0.497	0.519	0.494

3.4 Calculating Optimization Value

Next, calculating the optimal value based on the results of matrix normalization from the previous step is carried out at this stage using (5). This is because each criterion has a weight calculated using the ROC method. The results of the calculation of the optimization value are as follows.

$$Y_1^* = (x_{11} \times w_1 + x_{12} \times w_2 + x_{13} \times w_3 + x_{14} \times w_4 + x_{15} \times w_5 +) - (x_{16} \times w_6)$$

$$Y_1^* = (0.467 \times 0.408 + 0.483 \times 0.242 + 0.432 \times 0.158 + 0.387 \times 0.103 + 0.519 \times 0.061) - (0.371 \times 0.028)$$

$$Y_1^* = 0.447 - 0.01 = 0.437$$

$$Y_2^* = (x_{21}w_1 + x_{22}w_2 + x_{23}w_3 + x_{24}w_4 + x_{25}w_5) - (x_{26}w_6)$$

$$Y_2^* = (0.408 \times 0.408 + 0.552 \times 0.242 + 0.486 \times 0.158 + 0.497 \times 0.103 + 0.454 \times 0.061) - (0.432 \times 0.028)$$

$$Y_2^* = 0.456 - 0.012 = 0.444$$

$$Y_3^* = (x_{31}w_1 + x_{32}w_2 + x_{33}w_3 + x_{34}w_4 + x_{35}w_5) - (x_{36}w_6)$$

$$Y_3^* = (0.525 \times 0.408 + 0.414 \times 0.242 + 0.324 \times 0.158 + 0.331 \times 0.103 + 0.389 \times 0.061) - (0.494 \times 0.028)$$

$$Y_3^* = 0.423 - 0.014 = 0.41$$

$$Y_4^* = (x_{41}w_1 + x_{42}w_2 + x_{43}w_3 + x_{44}w_4 + x_{45}w_5) - (x_{46}w_6)$$

$$Y_4^* = (0.467 \times 0.408 + 0.414 \times 0.242 + 0.486 \times 0.158 + 0.497 \times 0.103 + 0.324 \times 0.061) - (0.432 \times 0.028)$$

$$Y_4^* = 0.438 - 0.012 = 0.426$$

$$Y_5^* = (x_{51}w_1 + x_{52}w_2 + x_{53}w_3 + x_{54}w_4 + x_{55}w_5) - (x_{56}w_6)$$

$$Y_5^* = (0.35{\times}0.408{+}0.345{\times}0.242{+}0.486{\times}0.158{+}0.497{\times}0.103{+}0.519{\times}0.061){-}(0.494{\times}0.028)$$

$$Y_5^* = 0.386 - 0.014 = 0.372$$

3.5 Alternative Rank

The final stage ranks alternative values based on the optimization value obtained from each alternative. The results of alternative rank are shown as shown in Table 4.

Table 4: Alternative rank

Alternative	Total Optimization Value	Rank
Futsal	0.444	1
Basketball	0.437	2
Karate	0.426	3
Scout	0.41	4
Dance	0.35	5

The results of determining extracurricular activity recommendations based on the process of completing steps using a combination of MOORA and ROC methods showed that futsal extracurricular activities were ranked first with a value of 0.444. Meanwhile, the second rank was given to Basketball extracurricular activities that reached a value of 0.437. Furthermore, the third rank is occupied by Karate extracurricular activities with a value of 0.426, followed by the fourth rank obtained by Scout extracurricular with a value of 0.41. Finally, the fifth rank was given to Dance extracurricular activities with a value of 0.35. Using the ROC weighting model helps the selection of extracurricular activities not based on the weight of criteria given by decision-makers so that the weight of criteria in the selection of extracurricular activities is an objective result based on the ROC weighting model.

4 Discussion

Based on the results of research that has been conducted in the selection of extracurricular activities for students using criteria namely achievement, schedule, student interests, student talent, student abilities, student hobbies by applying a website-based application in the selection of extracurricular activities can make it easier for students to choose extracurricular activities from the criteria used. The following is the application display of the results of the selection of extracurricular activities as shown in Figure 2 (*Kegiatan ESKUL* -> Alternative; *Total Nilai Akhir* -> Total Optimization Value).

With the application that can help students determine extracurricular activities, it will make it easier for students to make selections and recommendations for activities to be

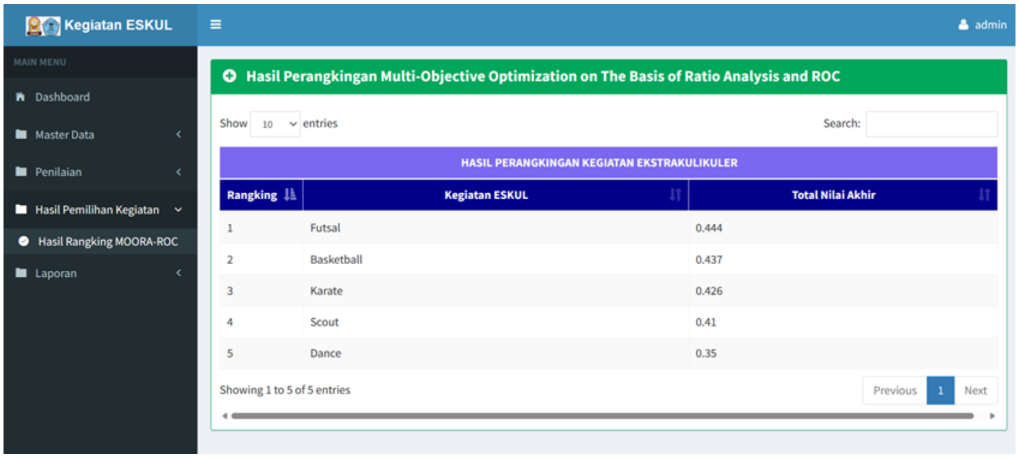

Figure 2: Ranking in the application of extracurricular activity selection.

followed. The application of the MOORA and ROC methods provides an alternative recommendation in the selection of extracurricular activities for students, with the application of the MOORA method is designed to deal with multi-objective problems, where there are several criteria that must be considered simultaneously in the selection of extracurricular activities, and the ROC uses the center of gravity or centroid of alternative groups to determine the ranking. The center of gravity is calculated based on the weight of the criteria and the performance of alternatives against each criterion. So that the application of the MOORA and ROC methods helps students in determining the extracurricular activities to be followed.

The combination of ROC and MOORA weighting methods can be used as a tool in making decisions, the ROC method is used to evaluate and determine the weight of criteria in extracurricular activities based on certain criteria by providing relative weights. The use of ROC gives flexibility to decision makers to adjust the importance of each criterion according to priority, while the MOORA method provides a more comprehensive approach by considering the comparison of ratios between alternatives to criteria. The combination of these two methods can be a valuable guide in overcoming the problem of complexity where ROC helps the weaknesses of the MOORA method of weighting criteria and ensures the selection of extracurricular activities that suit the needs and goals of the school and the interests of students.

The criterion weight sensitivity test is an important step in multi-criteria decision analysis that aims to evaluate the extent to which changes in the weights of each criterion may affect the final result or alternative rating. This process involves varying the weight of criteria to assess the stability and reliability of the resulting decisions. This sensitivity test provides an in-depth understanding of which criteria are most influential on weight change, helping decision makers identify aspects that can significantly affect decision outcomes. By testing weight sensitivity, decision makers can assess risk and make more informed decisions, ensuring that decisions taken remain consistent and relevant to desired preferences and goals. In addition, the criterion weight sensitivity test can also provide strategic insights to fine-tune the weight of criteria to improve the reliability of decision analysis models. A weight sensitivity test is carried out to determine how much the final rank or final value of each criterion changes, the following criteria weight change data is shown in the following table.

Table 5: Normalized matrix results

Criteria Code	Test 1	Test 2	Test 3
C1	0,285714	0,4	0,0848
C2	0,238095	0,15	0,1838
C3	0,190476	0,3	0,1648
C4	0,142857	0,05	0,1675
C5	0,095238	0,05	0,212
C6	0,047619	0,05	0,1871

The result of changing the weight of the criteria against the MOORA method for the final value of each alternative amsing as shown in Figure 3.

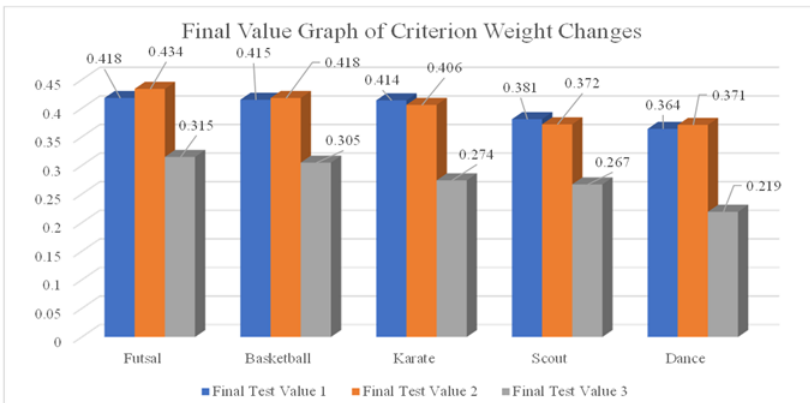

Figure 3: Final value graph of criterion weight changes.

The results of visualization of changes in criteria weights in Figure 3 shows that there is no change in rank based on alternative final values, testing weight changes while maintaining weight consistency. The total weight must remain fixed, and changes to one criterion must be balanced with changes to other criteria to maintain consistency.

5 Conclusion

The selection of student extracurricular activities uses the criteria of activity schedule, student interests, student talents, student abilities, achievements, and hobbies. In weighting the criteria used by applying the ROC weighting method so that the weight of the criteria in the selection of extracurricular activities is an objective result. From the results of research on the selection of a combination of MOORA and ROC methods for extracurricular activities, the highest recommendation was given to futsal extracurricular activities with a value of 0.444, so that it obtained rank 1 based on the final calculation carried out using the MOORA method.

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