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THE APPLICATION OF THE MULTI-OBJECTIVE OPTIMIZATION ON THE BASIS OF SIMPLE RATIO ANALYSIS METHOD IN A DECISION SUPPORT SYSTEM FOR PROSPECTIVE UBT STUDENT ASSOCIATION CHAIR CANDIDATES

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ABSTRACT
Decision Support Systems (DSS) have become essential tools in the decision-making process across various fields. In the context of selecting the chairman of the Computer Engineering Student Association at Universitas Borneo Tarakan, the use of DSS is also highly relevant and beneficial. The MOOSRA (Multi-Objective Optimization on the basis of Ratio Analysis) method has been chosen as the approach to implement this decision support system. This study aims to apply the MOOSRA method in the implementation of a web-based decision support system for the selection of prospective chairpersons of the Computer Engineering Student Association at Universitas Borneo Tarakan. The MOOSRA method is utilized to consider several criteria, such as leadership skills, communication abilities, dedication, and organizational experience. In this research, the use of MOOSRA is combined with web technology to enhance the efficiency and quality of the candidate selection process. The MOOSRA method offers a structured and objective approach to evaluating candidates for the chairmanship. This approach involves ratio analysis and multi-objective optimization to produce better outcomes. The results of this study are expected to facilitate a fairer and more objective selection process, as well as to improve student satisfaction within the Computer Engineering Student Association at Universitas Borneo Tarakan.

I. INTRODUCTION

THE rapid development in the field of Information and Communication Technology (ICT) has experienced significant progress, having a major impact on various aspects of life, including decision-making. In this digital era, the volume of data being produced is increasing rapidly and becoming more complex, which necessitates advanced tools to support effective and efficient decision-making. Decision Support Systems (DSS) have emerged as a solution to address the complexity of decision-making in the modern era [1], [2]. DSS is a computer-based system designed to assist in decision-making by identifying problems, analyzing data, and determining the best alternative from a range of options. Research on DSS continues to evolve to meet various needs and challenges across fields such as business, government, healthcare, and education.

The aim of this study is to design a system and apply a more innovative and adaptive DSS method, as well as to enhance understanding of how DSS can be optimally utilized in different contexts. The process of selecting a chairman is a crucial step in every organization, whether large or small, as the decision made in this selection will determine the direction and progress of the organization in the future [3], [4]. Therefore, a system is needed that can support a valid and high-quality chairman selection process. DSS can be a solution to make the selection process more effective and efficient. DSS can help in: minimizing bias, increasing transparency, saving time and resources, and improving the quality of decisions.

The Computer Engineering Student Association (HMTK), which is the student association for the Computer Engineering study program at Universitas Borneo Tarakan (UBT), held its first General Assembly (MUBES) on October 7, 2021. Two main plenary agendas were carried out: drafting and ratifying the bylaws (AD/ART) of HMTK, and electing the chairman of the departmental student association in Computer Engineering, based on mutual agreement among the MUBES participants. In the following years, the chairman was also elected through deliberation and consensus, and this approach remains in use through 2024 [5], [6], [7].

Based on these issues, the researcher sought to apply a system to help identify potential candidates based on calculated evaluation. Beforehand, the researcher reviewed related studies. One such study [5] involved a DSS used to support the selection of Bidik Misi scholarship recipients at the Banjarmasin State Polytechnic, using the Simple Additive Weighting (SAW) method to analyze files and generate final scores for each candidate. According to the literature review that supports this research, in the selection of prospective chairpersons of student associations, evaluations are often still based on subjective perspectives, relying on individual views without referring to clear, objective standards. The result is unfairness toward other students who also wish to participate in the selection process of the Computer Engineering student association. Therefore, it is necessary to establish a well-defined and objective set of criteria for selecting candidates, even if the final selection is still carried out through a majority vote by eligible students [8], [9], [10].

Factors considered in choosing the best candidate for HMTK chairman include achievements, skills, class attendance compliance, and organizational experience. Thus, a Decision Support System (DSS) is needed to facilitate and simplify the process of identifying the most suitable candidate for the position of HMTK chairman in the Computer Engineering Department at UBT and to prevent unfair practices.

II. Proposed Method

A Decision Support System (DSS) is a computer-based system designed to generate the best alternative solutions for the problems being addressed [11], thereby facilitating a more accurate decision-making process. Consequently, this system can accelerate decision-making by providing relevant alternatives to consider. The Multi-Objective Optimization on the Basis of Simple Ratio Analysis (MOOSRA) method is used to find the optimal solution by considering multiple objectives simultaneously [12], [13], [14]. In this method, various ratios are calculated for each alternative to be evaluated [15], [16], [17]. These ratios are then analyzed to determine the most optimal solution based on a balance among the different objectives to be achieved [18].

A. Research design

The research design begins with identifying the necessary requirements, which involves collecting data to determine what the application needs in order to be developed or implemented. This stage also functions to gather information that the system will later provide. Following this, an analysis is conducted to examine and develop an understanding of both the software system requirements and the specific needs of its users. During this phase, the researcher also prepares documentation detailing the functional requirements. Based on the results of the analysis, an application design is then created to form a web-based decision support system. The final stage is implementation, where all the prepared designs are executed according to the previously defined requirements.

B. Data Collection Technique

Based on the results of observations and information gathering conducted, the requirements needed for the development of the decision support system were obtained. Candidate data refers to subject data selected based on interest, activeness, and having a vision and mission; this system will process these subjects to obtain the necessary scores. The information dataset is a collection of central information about individuals, including attendance, cumulative grade point average, organizational experience activities, repeated courses, and vision and mission.

C. Determination of Data Requirements

Alternative data is an important component in the Decision Support System [18], [19], [20]. Below is Table I which contains the alternative data:

TABLE I
ALTERNATIVE DATA

Alternative	Candidate Name
A1	Name 1
A2	Name 2
A3	Name 3
A4	Name 4
A5	Name 5

Based on Table I, it can be explained that five alternatives were used as sample data in the selection of prospective candidates. The table is arranged to identify each alternative with a specific code, which will later be used in the

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decision-making process, thus making the following steps easier and clearer [16], [17], [19], [21], [22].

In this study, the MOOSRA method was used for the selection of prospective candidates. The MOOSRA method requires criteria and preference weights to assess relative performance and decision alternatives in a simple mathematical form. Table II below presents the data on criteria, types, and weights for each criterion.

TABLE II
CRITERIA

Criteria	Description	Type	Weight
C1	Description of Criterion 1	Cost	10%
C2	Description of Criterion 2	Benefit	30%
C3	Description of Criterion 3	Benefit	30%
C4	Description of Criterion 4	Benefit	20%
C5	Description of Criterion 5	Benefit	10%

The process continue for compiling a decision matrix that includes criteria and several alternatives. The matrix is then normalized to produce processed values ready for the next stage of calculation. The MOOSRA method is applied as shown in Equation 1.

$$x_{ij} = \begin{bmatrix} x_{11} & x_{12} & x_{13} & x_{1n} \\ x_{21} & x_{22} & x_{23} & x_{2n} \\ x_{31} & x_{23} & x_{33} & x_{3n} \\ x_{m1} & x_{m2} & x_{m3} & x_{mn} \end{bmatrix} \tag{1}$$

The purpose of matrix normalization is to unify each data point so that the values in the matrix are comparable, as shown in Equation 2:

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

where :

X_{ij}^{*} : normalized value of the i-th alternative for the j-th criterion
x_{ij} : original value of the i-th alternative for the j-th criterion
m : total number of alternatives
$\sum_{i\,=\,1}^{m} x_{ij^2}$: sum of squares of all alternative values for the j-th criterion

Criterion scores are determined using Equation 3:

$$X_i = \frac{\sum_{j=1}^{g} w_j x_{ij}^{*}}{\sum_{j=g+1}^{n} w_j x_{ij}^{*}} \tag{3}$$

where :

X_i : final score of the i-th alternative
w_j : weight of the j-th criterion
x_{ij}^{*} : normalized weighted value of the i-th alternative for the j-th criterion
g : number of benefit criteria (criteria where higher values are better)
n : total number of criteria
j=g+1 sampai n : cost criteria (criteria where lower values are preferred)

Ranking of alternatives is done based on the highest score obtained from the calculations.

III. RESULT

In the process of selecting prospective candidates for the student association chair, the system goes through several stages based on an established procedure. The process begins with students who are interested in nominating themselves. The Administrative Team then carries out the first stage, which involves analyzing and collecting the necessary data from the students. If the student data has been verified and meets the applicable requirements and conditions, the data will be passed on to the data processing admin. The data processing admin

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is responsible for entering the student data into the system to ensure the completeness and accuracy of the information. In the calculation process of the Decision Support System (DSS) using the MOOSRA method, the determination of criteria and alternatives plays a very important role [11]. In this study, five criteria are used to select student candidates. Table 3 shows the data related to the resulting criteria.

TABLE III
CRITERIA FOR SELECTING STUDENT CANDIDATES

Criteria	Description	Type	Weight
C1	GPA	Benefit	30%
C2	Organizational Experience ≥ 2	Benefit	30%
C3	Active in Lectures (attendance) Within 1 Semester	Cost	10%
C4	Vision and Mission	Benefit	20%
C5	Repeating Courses	Benefit	10%

Alternative data plays an important role in the Decision Support System. The table 4 below contains the alternative data of prospective students. Based on Table 4, the number of alternatives used as samples in the student selection process remains five. The following table is arranged to identify each alternative with a specific label used in the decision-making stage, making the process more concise and valid.

TABLE IV
ALTERNATIVE DATA OF PROSPECTIVE STUDENTS

Alternative	Candidate Name
A1	Busman
A2	Fahrul
A3	Haqiqi
A4	Senya
A5	Dimi

The determination of the scores for each criterion, from criterion C1 to criterion C5, can be seen in the respective Table V-IX below.

TABLE V
CRITERION VALUE OF C1

Criteria	Scale	Value
C1	Very Good	5
C1	Good	4
C1	Sufficient	3
C1	Poor	2
C1	Very Poor	1

TABLE VI
CRITERION VALUE OF C2

Criteria	Scale	Value
C2	>4 experience	5
C2	4 experience	4
C2	3 experience	3
C2	2 experience	2
C2	1 experience	1

TABLE VII
CRITERION VALUE OF C3

Criteria	Scale	Value
C3	Total absences = 0	5
C3	Total absences = 1	4
C3	Total absences = 2	3
C3	Total absences = 3	2
C3	Total absences > 4	1

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TABLE VIII
CRITERION VALUE OF C4

Criteria	Scale	Value
C4	Present	5
C4	Not Present	1

TABLE IX
CRITERION VALUE OF C5

Criteria	Scale	Value
C5	Number of Courses = 0	5
C5	Number of Courses = 1	4
C5	Number of Courses = 2	3
C5	Number of Courses = 3	2
C5	Number of Courses >4	1

Next, the input of alternative data for the values of the criteria can be seen in Table X below. The data below is based on each alternative's data according to the entries of the criteria data.

The following are the steps designed for applying the MOOSRA method to determine students who meet the criteria as prospective candidates. This process is carried out based on five alternatives and five predetermined criteria. The solution steps are as follows:

TABLE IX
CRITERIA FOR SELECTING STUDENT CANDIDATES

Alternative	C1	C2	C3	C4	C5
A1	5	4	4	1	3
A2	4	5	4	1	4
A3	4	3	4	1	4
A4	4	4	4	5	4
A5	5	5	5	5	5

$$X = \begin{bmatrix} 5 & 4 & 4 & 1 & 3 \\ 4 & 5 & 4 & 1 & 4 \\ 4 & 3 & 4 & 1 & 4 \\ 4 & 4 & 4 & 5 & 4 \\ 5 & 5 & 5 & 5 & 5 \end{bmatrix}$$

The following are the calculation results based on the MOOSRA method formula, by dividing each element in the decision matrix by the square root of the sum of the squares of all elements in the respective column [13], for each alternative.

Normalization of C1

$$X1 = \sqrt{5^2 + 4^2 + 4^2 + 4^2 + 5^2 = \sqrt{98} = 9{,}8995}$$

- $X_{11} = \frac{X_{11}}{X_1} = \frac{5}{9{,}8995} = 0{,}5051$
- $X_{21} = \frac{X_{21}}{X_1} = \frac{4}{9{,}8995} = 0{,}4041$
- $X_{31} = \frac{X_{31}}{X_1} = \frac{4}{9{,}8995} = 0{,}4041$
- $X_{41} = \frac{X_{41}}{X_1} = \frac{4}{9{,}8995} = 0{,}4041$
- $X_{51} = \frac{X_{51}}{X_1} = \frac{5}{9{,}8995} = 0{,}5051$

Normalization of C2

$$X2 = \sqrt{4^2 + 5^2 + 3^2 + 4^2 + 5^2 = \sqrt{91} = 9{,}5394}$$

- $X_{12} = \frac{X_{12}}{X_2} = \frac{4}{9{,}5394} = 0{,}4193$
- $X_{22} = \frac{X_{22}}{X_2} = \frac{5}{9{,}5394} = 0{,}5241$
- $X_{32} = \frac{X_{32}}{X_2} = \frac{3}{9{,}5394} = 0{,}3145$

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- $X_{42} = \frac{X_{42}}{X_2} = \frac{4}{9{,}5394} = 0{,}4193$
- $X_{52} = \frac{X_{52}}{X_2} = \frac{5}{9{,}5394} = 0{,}5241$

Normalization of C3

$$X3 = \sqrt{4^2 + 4^2 + 4^2 + 4^2 + 5^2 = \sqrt{89} = 9{,}4340}$$

- $X_{13} = \frac{X_{13}}{X_3} = \frac{4}{9{,}4340} = 0{,}4240$
- $X_{23} = \frac{X_{23}}{X_3} = \frac{4}{9{,}4340} = 0{,}4240$
- $X_{33} = \frac{X_{33}}{X_3} = \frac{4}{9{,}4340} = 0{,}4240$
- $X_{43} = \frac{X_{43}}{X_3} = \frac{4}{9{,}4340} = 0{,}4240$
- $X_{53} = \frac{X_{53}}{X_3} = \frac{5}{9{,}4340} = 0{,}5300$

Normalization of C4

$$X4 = \sqrt{1^2 + 1^2 + 1^2 + 5^2 + 5^2 = \sqrt{53} = 7{,}2801}$$

- $X_{14} = \frac{X_{14}}{X_4} = \frac{1}{7{,}2801} = 0{,}1374$
- $X_{24} = \frac{X_{24}}{X_4} = \frac{1}{7{,}2801} = 0{,}1374$
- $X_{34} = \frac{X_{34}}{X_4} = \frac{1}{7{,}2801} = 0{,}1374$
- $X_{44} = \frac{X_{44}}{X_4} = \frac{5}{7{,}2801} = 0{,}6868$
- $X_{54} = \frac{X_{54}}{X_4} = \frac{5}{7{,}2801} = 0{,}6868$

Normalization of C5

$$X5 = \sqrt{3^2 + 4^2 + 4^2 + 4^2 + 5^2 = \sqrt{82} = 9{,}0554}$$

- $X_{15} = \frac{X_{15}}{X_5} = \frac{3}{9{,}0554} = 0{,}3313$
- $X_{25} = \frac{X_{25}}{X_5} = \frac{4}{9{,}0554} = 0{,}4417$
- $X_{35} = \frac{X_{35}}{X_5} = \frac{4}{9{,}0554} = 0{,}4417$
- $X_{45} = \frac{X_{45}}{X_5} = \frac{4}{9{,}0554} = 0{,}4417$
- $X_{55} = \frac{X_{55}}{X_5} = \frac{5}{9{,}0554} = 0{,}5522$

Determine the decision matrix based on the values of the alternatives with respect to the criteria [12]. This matrix is formed based on the sample data in Table 3, which has been adjusted with the improved weight values for each alternative in Table 4, resulting in the following matrix.

$$X = \begin{bmatrix} 0{,}5051 & 0{,}4193 & 0{,}4240 & 0{,}1374 & 0{,}3313 \\ 0{,}4041 & 0{,}5241 & 0{,}4240 & 0{,}1374 & 0{,}4417 \\ 0{,}4041 & 0{,}3145 & 0{,}4240 & 0{,}1374 & 0{,}4417 \\ 0{,}4041 & 0{,}4193 & 0{,}4240 & 0{,}6868 & 0{,}4417 \\ 0{,}5051 & 0{,}5241 & 0{,}5300 & 0{,}6868 & 0{,}5522 \end{bmatrix}$$

The following are the percentage results of the weight values for each criterion:

C1 = 30% = 0.30
C2 = 30% = 0.30
C3 = 10% = 0.10
C4 = 20% = 0.20
C5 = 10% = 0.10

The following is the calculation of the weighted normalized values. Each criterion is assigned a weight that indicates its importance to the final decision [15]. The calculation of the weighted normalization can be seen in calculation below.

$$Y_{11} = 0.30 \times 0.5051 = 0.1515$$
$$Y_{12} = 0.30 \times 0.4193 = 0.1258$$
$$Y_{13} = 0.10 \times 0.4240 = 0.0424$$
$$Y_{14} = 0.20 \times 0.1374 = 0.0275$$
$$Y_{15} = 0.10 \times 0.3313 = 0.0331$$

$$Y_{21} = 0.30 \times 0.4041 = 0.1212$$
$$Y_{22} = 0.30 \times 0.5241 = 0.1572$$
$$Y_{23} = 0.10 \times 0.4240 = 0.0424$$
$$Y_{24} = 0.20 \times 0.1374 = 0.0275$$
$$Y_{25} = 0.10 \times 0.4417 = 0.0442$$

$$Y_{41} = 0.30 \times 0.4041 = 0.1212$$
$$Y_{42} = 0.30 \times 0.4193 = 0.1258$$
$$Y_{43} = 0.10 \times 0.4240 = 0.0424$$
$$Y_{44} = 0.20 \times 0.6868 = 0.1374$$
$$Y_{45} = 0.10 \times 0.4417 = 0.0442$$

$$Y_{51} = 0.30 \times 0.5051 = 0.1515$$
$$Y_{52} = 0.30 \times 0.5241 = 0.1572$$
$$Y_{53} = 0.10 \times 0.5300 = 0.0530$$
$$Y_{54} = 0.20 \times 0.6868 = 0.1374$$
$$Y_{55} = 0.10 \times 0.5522 = 0.0552$$

The resulting Weighted Normalized Matrix Y reflects the criterion weights applied to the normalized values. This matrix is used as the basis in the decision-making process using the MOOSRA method. From matrix Y, each element Y_{ij} is obtained by multiplying the normalized value of alternative i by the weight of criterion j. The results indicate the extent to which each alternative meets the predetermined criteria.

$$Y = \begin{bmatrix} 0,1515 & 0,1258 & 0,0424 & 0,0275 & 0,0331 \\ 0,1212 & 0,1572 & 0,0424 & 0,0275 & 0,0442 \\ 0,1212 & 0,0943 & 0,0424 & 0,0275 & 0,0442 \\ 0,1212 & 0,1258 & 0,0424 & 0,1374 & 0,0442 \\ 0,1515 & 0,1572 & 0,0530 & 0,1374 & 0,0552 \end{bmatrix}$$

Application of the performance score formula. The result is the performance score for each alternative, which can then be used to compare those alternatives and determine which one best aligns with the decision maker's goals or preferences [16]. The preference calculation can be seen in the following computation.

$$Y_1 = \frac{0,1515 + 0,1258 + 0,0275 + 0,0331}{0,0424} = 7,9698$$
$$Y_2 = \frac{0,1212 + 0,1572 + 0,0275 + 0,0442}{0,0424} = 8,2572$$
$$Y_3 = \frac{0,1212 + 0,0943 + 0,0275 + 0,0442}{0,0424} = 6,7738$$
$$Y_4 = \frac{0,1212 + 0,1258 + 0,1374 + 0,0442}{0,0424} = 10,107$$
$$Y_5 = \frac{0,1515 + 0,1572 + 0,1374 + 0,0552}{0,0530} = 9,4593$$

The following are ranking results using the MOOSRA Method. The Y values have been calculated up to the 5th alternative, where the Y values are obtained by multiplying the normalized matrix with the Wj values (the importance weights for each criterion). Next, the results are summed for the benefit-type criteria and divided by the cost-type criteria after each has been multiplied by its respective weight.

TABEL XII
HASIL PERANGKINGAN

Alternative	Name	Benefit	Cost	$Y = \frac{Benefit}{Cost}$	Rangking
A4	Senya	0,4285	0,0424	10,1072	1
A5	Dimi	0,5013	0,0530	9,4593	2
A2	Farul	0,3501	0,0424	8,2572	3
A1	Busman	0,3379	0,0424	7,9698	4
A3	Haqiqi	0,2872	0,0424	6,7738	5

Based on Table 12 above, it can be seen that Alternative 4, Senya, has the highest score of 10.1072 and ranks first in the recommendation using the MOOSRA method. This is followed by Alternative 5, Dimi, in second place with a score of 9.4593, and in third place is Alternative 2, Farul, with a score of 8.2572. Next, in fourth place is Alternative 1, Busman, with a score of 7.9698, and in last place is Alternative 3, Haiqiqi, with a score of 6.7738.

IV. CONCLUSION

Based on the research results, it can be concluded that the recommendation of prospective candidates for Chairperson of the UBT Computer Engineering Student Association can be carried out using the MOOSRA method. This method is capable of handling a large number of criteria, thus minimizing errors in the recommendation process made by the organizing committee. Additionally, the MOOSRA method accelerates the data processing of recommended candidates, making it more efficient and less time-consuming. The use of this method also simplifies decision-making, making it easier to understand while still following established procedures and requirements. Therefore, decision-making becomes more accurate and targeted. Consequently, the MOOSRA method proves to be effective in assisting the organizing committee in selecting the most suitable candidates to be recommended.

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