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Decision Support System for the Selection of Outstanding Students Using the MAUT Method

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Abstract−The selection of outstanding students is one of the efforts of universities in giving awards to students who have the best academic and non-academic achievements. The problem that often occurs in the selection process of outstanding students is that assessments still focus on one main criterion, namely the Cumulative Achievement Index (GPA), so that the results obtained are less objective and do not reflect the overall ability of students. Therefore, this study aims to design and implement a Decision Support System (DSS) in the selection of outstanding students by considering various assessment criteria. The method used in this study is Multi Attribute Utility Theory (MAUT), which is one of the multicriteria decision-making methods. The criteria used in the study included GPA, foreign language skills, organizational activeness, number of scientific papers, and history of taking remedial exams. The MAUT method is used to calculate the utility value of each alternative based on the weight and value of each criterion, so that student rankings are obtained objectively. The results of the study show that the implementation of DSS using the MAUT method can help the selection process of outstanding students in a more systematic and transparent manner. Based on the calculation results, the best alternative was obtained in alternative A5 on behalf of "Loli" students with a final utility value (Ui) of 2.2196, so that it was designated as an outstanding student. The resulting system is expected to be a supporting solution in making decisions about the selection of outstanding students in the university environment.

Keywords: Outstanding Lecturer; Decision Support System (DSS); MAUT Method

1. INTRODUCTION

In the era of global competition, university graduates are expected to possess both adequate hard skills and soft skills. Therefore, universities need to identify and recognize students who demonstrate excellence in both academic and non-academic competencies. Recognition can be provided through certificates, awards, or other forms of appreciation for outstanding students. Such recognition may encourage students to improve their achievements and competitiveness during their university studies [1],[2].

In the selection of outstanding students, academic achievement, particularly Grade Point Average (GPA), is often used as the primary assessment criterion. However, outstanding student selection should not rely solely on academic performance because students may demonstrate achievements through various academic and non-academic activities. Several criteria can be considered, including GPA, foreign language ability, organizational activity, number of scientific works, and participation in remedial examinations. The consideration of multiple criteria can provide a more comprehensive assessment of student performance and support a more objective selection process. Therefore, a Decision Support System (DSS) is required to assist universities in processing multiple criteria and determining the ranking of outstanding students.

A DSS is generally developed to support decision-making processes by evaluating alternatives based on predetermined criteria. Various multi-criteria decision-making methods have been applied in DSS research, including Simple Additive Weighting (SAW), Analytical Hierarchy Process (AHP), Multi-Attributive Border Approximation Area Comparison (MABAC), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), Multi-Objective Optimization on the Basis of Ratio Analysis (MOORA), and Multi-Attribute Utility Theory (MAUT). This study applies the MAUT method because it provides a utility-based approach for evaluating alternatives according to multiple criteria and combining the resulting utility values using predetermined criterion weights [3].

Several related studies have been conducted by previous researchers. Dasril Aldo et al. investigated lecturer performance assessment using a decision support system based on the MAUT method, discusses lecturer performance assessment research. For lecturer performance assessment, a decision support system is needed. The method applied by the researcher is the MAUT method, this method was chosen because it is able to provide the best alternative ranking. The best alternative is the alternative in the name "DSN-01 and DSN-02" with a Ui value = 0.9. Research by Ratna Sri Hayati and Siti Aliyah in 2020, discussed position promotion. In the promotion of a position, an DSS is needed. This study designed DSS using the MAUT method. This method was chosen because it was able to produce the best alternative from a number of existing alternatives, as for the best alternative in this

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study, namely "Employee 1" with a value of Ui = 0.84[4]. A study conducted by Y. Setiawan and S. Budilaksono published in 2022, this study discusses the application of the Decision Support System (DSS) in the selection of the best graduate students using the Multi Attribute Utility Theory (MAUT) method. The study explains the stages of calculating MAUT starting from determining criteria, giving weights, to calculating utility values to produce student rankings. The results of the study show that the MAUT method is able to assist academics in determining the best graduate students objectively and systematically [5]. Then based on research conducted by S. Kayati, H. Yenni, and H. Asnal published in 2022, this study discusses the application of the MAUT method to the decision support system to determine the superior class at SMKN 1 Mandau. This study describes the use of assessment criteria that include academic aspects and student personalities, which are then processed using the MAUT method. The conclusion of this study is that the MAUT method can be used effectively to classify superior students based on the resulting preference scores [6].

Although these studies demonstrate the effectiveness of MAUT in various decision-making problems, differences remain in terms of decision contexts, assessment criteria, and selection objectives. The study by Dasril Aldo et al. focused on lecturer performance, while Hayati and Aliyah addressed employee promotion. Setiawan and Budilaksono focused on the selection of the best graduate students, whereas Kayati et al. addressed the determination of superior classes. These studies indicate that MAUT is applicable to multi-criteria ranking; however, there is still a need for a decision-making framework specifically designed to evaluate outstanding university students by simultaneously considering academic and non-academic criteria. In particular, the combination of GPA, foreign language ability, organizational activity, scientific works, and remedial examination participation provides a broader assessment perspective than relying solely on academic achievement.

Based on this research gap, this study aims to develop a Decision Support System for selecting outstanding students using the Multi-Attribute Utility Theory (MAUT) method. The proposed assessment considers five criteria, namely GPA, foreign language ability, organizational activity, number of scientific works, and participation in remedial examinations. The main contribution of this study is the development of a multi-criteria ranking framework that integrates academic and non-academic indicators to provide a more comprehensive and objective assessment of outstanding students. The resulting ranking is expected to assist universities in identifying high-achieving students and provide a systematic basis for selecting students who are eligible to receive academic recognition or awards.

2. RESEARCH METHODOLOGY

This study applies a quantitative decision-making approach to develop a Decision Support System (DSS) for selecting outstanding students using the Multi-Attribute Utility Theory (MAUT) method. The research methodology consists of several sequential stages, including problem identification, literature review, data collection, criterion and weight determination, MAUT calculation, ranking of alternatives, and conclusion. Each stage is conducted systematically to ensure that the selection process is based on measurable criteria and produces an objective ranking of student alternatives.

2.1 Research Stages

This study was conducted through several systematic stages, beginning with the identification of criteria, followed by the determination of criteria weights using the Rank Order Centroid (ROC) method, and concluding with the ranking of alternatives using the Multi-Attribute Utility Theory (MAUT) method. The overall research process is presented in Figure 1.

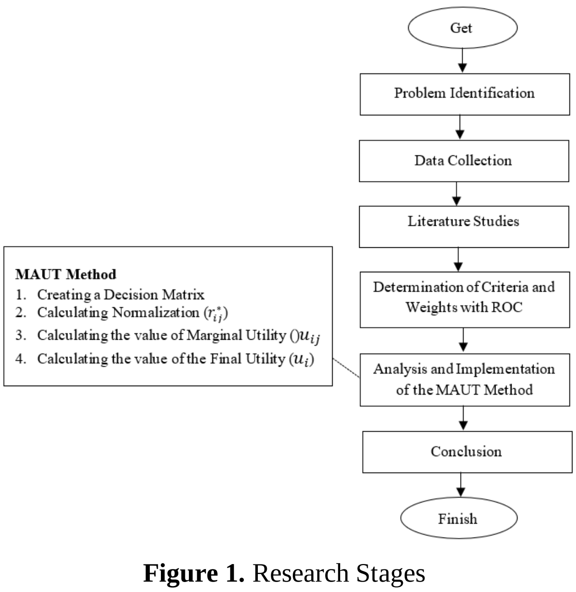

Figure 1. Research Stages

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Based on Figure 1, the research stages consist of several interrelated processes carried out sequentially to obtain the final decision in the form of a ranking of outstanding students. Each stage is described in greater detail in the following sections, starting from the determination of criteria and weights to the calculation of the final scores and ranking of alternatives.

a. Problem Identification
   The first stage identifies the problems associated with the selection of outstanding students. The initial selection process commonly emphasizes academic achievement, particularly GPA, while other academic and non-academic factors may also represent student achievement. Therefore, a multi-criteria decision-making approach is required to consider several indicators simultaneously.
b. Literature Studies
   The literature review was conducted by examining relevant scientific publications concerning Decision Support Systems, outstanding student selection, multi-criteria decision-making, and the MAUT method. The literature review was used to establish the theoretical foundation, identify relevant assessment criteria, and compare the proposed approach with previous studies.
c. Data Collection
   The data collection stage involves obtaining student assessment data required for the selection process. The collected data consist of the values of each student alternative according to the predetermined criteria. The criteria considered in this study are GPA, foreign language ability, organizational activity, number of scientific works, and participation in remedial examinations.
d. Criterion and Weight Determination (Rank Order Centroid (ROC) Weighting)
   Five criteria are used to evaluate the student alternatives. Four criteria are classified as benefit criteria because higher values indicate better performance, while participation in remedial examinations is classified as a cost criterion because a lower number of remedial examinations indicates better performance.
   The Rank Order Centroid (ROC) method is used to determine the relative weights of the criteria in the selection of outstanding students. ROC assigns weights based on the priority order of the criteria, where criteria with higher priority receive greater weights. The ranking of the criteria is determined according to their relative importance in the decision-making process.
e. Analysis and Application of the MAUT Method
   After determining the criteria, alternatives, and criterion weights, the MAUT method is applied to calculate the utility value of each student. The calculation consists of constructing the decision matrix, normalizing the criterion values, calculating the marginal utility, and aggregating the weighted utility values to obtain the final utility score.
   The final utility value obtained from the MAUT calculation is used to rank the student alternatives. A higher final utility value indicates a higher priority in the selection of outstanding students. The alternative with the highest utility value is identified as the best-ranked student.
f. Conclusion
   The final stage summarizes the results of the MAUT-based selection process and identifies the highest-ranked student. The results are then used to evaluate the applicability of the proposed DSS in supporting the selection of outstanding students.

2.2 Decision Support System (DSS)

Decision Support System (DSS) is a computer-based system designed to support the decision-making process in handling semi-structured and unstructured problems. DSS has the ability to adapt to changing conditions and user needs flexibly [7]. This system integrates specific data, models, and analysis methods to produce relevant and accurate information for decision-making considerations. With the existence of DSS, decision-makers can analyze various alternative solutions objectively and systematically [1],[8]. Therefore, DSS is very helpful in improving the effectiveness, efficiency, and quality of decisions produced in various fields [9].

2.3 Outstanding Students

An outstanding student is a student who has superior achievements in the university environment and deserves a certificate or award for his or her achievements [10]. These achievements are not only assessed from academic aspects, such as the cumulative achievement index (GPA), but also from non-academic aspects, including activeness in organizations, scientific works, competitions, and positive contributions to the institution. The assessment of outstanding students is carried out based on criteria and indicators that have been set by universities so that the selection process runs objectively and transparently. With this assessment, it is hoped that it can motivate students to continue to improve their quality and achievements [11],[12].

2.4 Multi Attribute Utility Theory (MAUT) Method

The MAUT method is a scheme in which the final evaluation, v(x), of an object x is defined as a weight summed by a value relevant to its dimensional value[2], [3],[5],[17]. Solution Steps :

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a. Preparing the Decision Matrix (X_{ij})

$$X_{ij} = \begin{bmatrix} r_{11} & \cdots & r_{1j} & \cdots & r_{1n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ r_{i1} & \cdots & r_{ij} & \cdots & r_{in} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ r_{m1} & \cdots & r_{mj} & \cdots & r_{mn} \end{bmatrix} \quad (1)$$

b. Calculating Normalization (r^*_{ij})

$$r^*_{ij} = \frac{r_{ij-\min(r_{ij})}}{max(r_{ij})-\min(r_{ij})} \quad \text{(max)} \quad (2)$$

$$r^*_{ij} = 1 + \left(\frac{min(r_{ij})-r_{ij}}{max(r_{ij})-min(r_{ij})}\right) \quad \text{(min)} \quad (3)$$

r*ij is the value of the normalized result of the decision matrix for each alternative, while Row is an element in the decision matrix that represents the alternative value to thei against the criteria forj. Symbols i stating the assessed alternatives, j indicate the criteria used, and nnn is the sum total of the criteria that are the basis for the decision-making process [18],[19].

c. Calculating Utilities (u_{ij})

$$u_{ij} = \frac{e^{\left(r^*_{ij}\right)^2}-1}{1.71} \quad (4)$$

UIJ is a marginal utility value that shows an alternative level of importance to-i against the criteria forj, while Row value of normalization results from the decision matrix on each alternative. Symbols e expresses the exponential number used in the calculation, iii indicate the alternatives represented in the row, and j Declare the attributes or criteria represented in the columns on the decision matrix [20].

d. Calculating Final Utility (u_i)

$$u_i = \sum_{j=1}^{n} u_{ij} * w_{ij} \quad (5)$$

u_i is the final utility value obtained from the aggregation of all marginal utilities in each criterion, while u_{ij} is a marginal utility value that shows an alternative contribution to-iii against the criteria forj. The symbol expresses the alternative weight of thew_{ij}iii on the criteria ofj, while iii represent the alternatives shown on the line and j Indicates the attributes or criteria displayed in the column in the calculation process [6].

3. RESULTS AND DISCUSSION

The selection of outstanding students in this study was conducted using the Multi-Attribute Utility Theory (MAUT) method. The MAUT method requires a set of criteria, criteria weights, and alternatives as the basis for evaluating and ranking the candidates. In this study, the criteria weights were determined using the Rank Order Centroid (ROC) method, while the MAUT method was subsequently applied to normalize the decision matrix, calculate the marginal utility, and obtain the final utility value of each alternative.

3.1 Determination of Criteria, Weights and Alternatives

The first stage in the selection of outstanding students is the determination of the criteria, criteria weights, and alternatives used in the decision-making process. Five criteria were considered in this study, namely Grade Point Average (GPA), Foreign Language Skills, Organizational Activity, Number of Scientific Papers, and Taking the Remedial Exam. The criteria weights were determined using the ROC method [21], [22] according to the priority order of the criteria. The resulting criteria, their weights, and attribute types are presented in Table 1.

Table 1. Criteria

Criteria	Remarks	Weight	Type
C1	GPA	0,457	Benefit
C2	Foreign Language Skills	0,257	Benefit
C3	Organizational Activity	0,157	Benefit
C4	Number of Scientific Papers	0,090	Benefit
C5	Taking the Remedial Exam	0,040	Cost

As shown in Table 1, GPA (C1) has the highest weight of 0.457, indicating that academic achievement is considered the most important criterion in the selection process. Foreign Language Skills (C2) and Organizational Activity (C3) have weights of 0.257 and 0.157, respectively, while the Number of Scientific Papers (C4) and Taking

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the Remedial Exam (C5) have relatively smaller weights. The benefit criteria indicate that higher values are preferred, whereas the cost criterion indicates that a lower value is preferred.

The meaning of each criterion is defined according to its role in assessing student achievement. GPA represents the average academic performance obtained by a student throughout the study period. Foreign Language Skills represent the student's ability to communicate or demonstrate proficiency in foreign languages, such as English or Mandarin. Organizational Activity represents the student's level of participation in organizational activities on campus. The Number of Scientific Papers represents the number of scientific works or research publications produced by the student. Taking the Remedial Exam represents whether the student has taken a remedial or grade-improvement examination, particularly for courses with relatively low grades.

After determining the criteria and their respective weights, the next stage is to identify the alternatives to be evaluated. The alternatives consist of five students who are considered candidates for the selection of outstanding students. The initial data for each alternative based on the five criteria are presented in Table 2.

Table 2. Alternative Data

Alternatives	GPA (C1)	Foreign Language Proficiency (C2)	Organizational Activity (C3)	Number of Scientific Papers (C4)	Taking the Remedial Exam (C5)
Boni (A1)	3,68	Pretty Good	Active	2 Scientific Works	Ever
Polan (A2)	3,70	Pretty Good	Active	3 Scientific Works	Ever
Gina (A3)	3,78	Good	Inactive	7 Scientific Works	Never
Ika (A4)	3,72	Good	Inactive	5 Scientific Works	Ever
Loli (A5)	3,80	Excellent	Active	8 Scientific Works	Never

Table 2 presents the initial assessment data for each student candidate. The data consist of numerical and categorical values, meaning that the categorical data cannot be directly processed in the MAUT calculation. Therefore, categorical criteria must first be converted into numerical values according to their respective assessment scales.

The transformation of categorical values is performed for Foreign Language Skills, Organizational Activity, and Taking the Remedial Exam. The numerical weighting assigned to each category is presented in Table 3.

Table 3. Weighting of Criteria

Criteria	Remarks	Value
C1	Excellent	3
	Good	2
	Pretty Good	1
C3	Active	2
	Inactive	1
C5	Never	2
	Ever	1

The weighting scheme in Table 3 converts the categorical assessment data into numerical values that can be processed using the MAUT method. A higher value is assigned to a more favorable condition for the corresponding criterion. For the remedial examination criterion, the value is reversed because C5 is classified as a cost criterion, where not taking a remedial examination is considered more favorable than having taken one.

After the categorical data have been converted into numerical values, the resulting values are combined with the numerical criteria to form the match rating. This step produces a uniform decision matrix that can be processed in the subsequent MAUT calculations. The resulting match rating is presented in Table 4.

Table 4. Match Rating

Alternatives	GPA (C1)	Foreign Language Proficiency (C2)	Organizational Activity (C3)	Number of Scientific Papers (C4)	Taking the Remedial Exam (C5)
Boni (A1)	3,68	1	2	2	1
Polan (A2)	3,70	1	2	3	1
Gina (A3)	3,78	2	1	7	2
Ika (A4)	3,72	2	1	5	1
Loli (A5)	3,80	3	2	8	2

The values in Table 4 represent the decision matrix used as the input for the MAUT calculation. At this stage, all alternatives have been represented using numerical values for each criterion, allowing the alternatives to be evaluated consistently. The next stage is the normalization of the decision matrix according to the characteristics of each criterion.

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3.2 MAUT Calculation

After the criteria, weights, alternatives, and match rating have been determined, the next stage is the implementation of the MAUT method. The calculation is performed sequentially through the preparation of the decision matrix, normalization, calculation of marginal utility, and calculation of final utility. The formulas used in each stage have been presented in the Methodology section; therefore, this section focuses on the implementation and results of the calculations.

a. Preparing the Decision Matrix

The first stage is to prepare the decision matrix based on the match rating presented in Table 4. The values in Table 4 are arranged according to the alternatives and criteria so that they can be processed in the subsequent MAUT calculation. The resulting decision matrix is presented below.

$$X_{ij} = \begin{bmatrix} 3{,}68 & 1 & 2 & 2 & 1 \\ 3{,}70 & 1 & 2 & 3 & 1 \\ 3{,}78 & 2 & 1 & 7 & 2 \\ 3{,}72 & 2 & 1 & 5 & 1 \\ 3{,}80 & 3 & 2 & 8 & 2 \end{bmatrix}$$

The decision matrix provides the initial numerical representation of the performance of each alternative for all criteria. This matrix is subsequently used as the input for the normalization process.

b. Normalization Matrix

After the decision matrix has been prepared, the next stage is to normalize the criterion values. The normalization calculation is performed using the formula presented in Equation (2 and 3) in the Methodology section. This process is required because the criteria have different value ranges and consist of both benefit and cost attributes. For illustration, the normalization calculation for selected values of C1 is presented below. The same procedure is applied to the remaining alternatives and criteria using Equation (2 and 3).

Calculating Normalization (r_{ij}^{*})

For C1 Criteria

$$r_{11}^{*} = \frac{3{,}68-3{,}68}{3{,}80-3{,}68} = \frac{0}{0{,}12} = 0$$

$$r_{21}^{*} = \frac{3{,}70-3{,}68}{3{,}80-3{,}68} = \frac{0{,}02}{0{,}12} = 0{,}167$$

$$r_{31}^{*} = \frac{3{,}78-3{,}68}{3{,}80-3{,}68} = \frac{0{,}1}{0{,}12} = 0{,}833$$

$$r_{41}^{*} = \frac{3{,}72-3{,}68}{3{,}80-3{,}68} = \frac{0{,}04}{0{,}12} = 0{,}333$$

$$r_{51}^{*} = \frac{3{,}80-3{,}68}{3{,}80-3{,}68} = \frac{0{,}12}{0{,}12} = 1$$

For Criterion C2

$$r_{12}^{*} = \frac{1-1}{3-1} = \frac{0}{2} = 0$$

$$r_{22}^{*} = \frac{1-1}{3-1} = \frac{0}{2} = 0$$

$$r_{32}^{*} = \frac{2-1}{3-1} = \frac{1}{2} = 0{,}5$$

$$r_{42}^{*} = \frac{2-1}{3-1} = \frac{1}{2} = 0{,}5$$

$$r_{52}^{*} = \frac{3-1}{3-1} = \frac{2}{2} = 1$$

For Criterion C3

$$r_{13}^{*} = \frac{2-1}{2-1} = \frac{1}{1} = 1$$

$$r_{23}^{*} = \frac{2-1}{2-1} = \frac{1}{1} = 1$$

$$r_{33}^{*} = \frac{1-1}{2-1} = \frac{0}{1} = 0$$

$$r_{43}^{*} = \frac{1-1}{2-1} = \frac{0}{1} = 0$$

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$r_{53}^{*} = \frac{2-1}{2-1} = \frac{1}{1} = 1$

For C4 Criteria

$r_{14}^{*} = \frac{2-2}{8-2} = \frac{0}{6} = 0$

$r_{24}^{*} = \frac{3-2}{8-2} = \frac{1}{6} = 0{,}167$

$r_{34}^{*} = \frac{7-2}{8-2} = \frac{5}{6} = 0{,}833$

$r_{44}^{*} = \frac{5-2}{8-2} = \frac{3}{6} = 0{,}5$

$r_{54}^{*} = \frac{8-2}{8-2} = \frac{6}{6} = 1$

For C5 criteria

$r_{15}^{*} = 1 + \left(\frac{1-1}{2-1}\right) = 1 + \left(\frac{0}{1}\right) = 1$

$r_{25}^{*} = 1 + \left(\frac{1-1}{2-1}\right) = 1 + \left(\frac{0}{1}\right) = 1$

$r_{35}^{*} = 1 + \left(\frac{2-1}{2-1}\right) = 1 + \left(\frac{1}{1}\right) = 2$

$r_{45}^{*} = 1 + \left(\frac{1-1}{2-1}\right) = 1 + \left(\frac{0}{1}\right) = 1$

$r_{55}^{*} = 1 + \left(\frac{2-1}{2-1}\right) = 1 + \left(\frac{1}{1}\right) = 2$

The normalization process produces the normalized matrix for all alternatives and criteria. The resulting normalized values are then used in the next stage to calculate the marginal utility.

$$r_{ij} = \begin{bmatrix} 0 & 0 & 1 & 0 & 1 \\ 0{,}167 & 0 & 1 & 0{,}167 & 1 \\ 0{,}833 & 0{,}5 & 0 & 0{,}833 & 2 \\ 0{,}333 & 0{,}5 & 0 & 0{,}5 & 1 \\ 1 & 1 & 1 & 1 & 2 \end{bmatrix}$$

c. Calculating Marginal Utilities ()u_{ij}
The normalized values obtained from the previous stage are subsequently converted into marginal utility values. The calculation is performed using the formula presented in Equation (4) in the Methodology section. This stage determines the utility contribution of each alternative for each criterion based on the normalized values.

For C1 Criteria

$u_{11} = \frac{e^{(0)^2}-1}{1.71} = 0$

$u_{21} = \frac{e^{(0{,}167)^2}-1}{1.71} = 0{,}016$

$u_{31} = \frac{e^{(0{,}833)^2}-1}{1.71} = 0{,}586$

$u_{41} = \frac{e^{(0{,}333)^2}-1}{1.71} = 0{,}068$

$u_{51} = \frac{e^{(1)^2}-1}{1.71} = 1{,}005$

For Criterion C2

$u_{12} = \frac{e^{(0)^2}-1}{1.71} = 0$

$u_{22} = \frac{e^{(0)^2}-1}{1.71} = 0$

$u_{32} = \frac{e^{(0{,}5)^2}-1}{1.71} = 0{,}166$

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$$u_{42} = \frac{e^{(0,5)^2} - 1}{1.71} = 0,166$$

$$u_{52} = \frac{e^{(1)^2} - 1}{1.71} = 1,005$$

For Criterion C3

$$u_{13} = \frac{e^{(1)^2} - 1}{1.71} = 1,005$$

$$u_{23} = \frac{e^{(1)^2} - 1}{1.71} = 1,005$$

$$u_{33} = \frac{e^{(0)^2} - 1}{1.71} = 0$$

$$u_{43} = \frac{e^{(0)^2} - 1}{1.71} = 0$$

$$u_{53} = \frac{e^{(1)^2} - 1}{1.71} = 1,005$$

For C4 Criteria

$$u_{14} = \frac{e^{(0)^2} - 1}{1.71} = 0$$

$$u_{24} = \frac{e^{(0,167)^2} - 1}{1.71} = 0,016$$

$$u_{34} = \frac{e^{(0,833)^2} - 1}{1.71} = 0,586$$

$$u_{44} = \frac{e^{(0,5)^2} - 1}{1.71} = 0,166$$

$$u_{54} = \frac{e^{(1)^2} - 1}{1.71} = 1,005$$

For C5 criteria

$$u_{15} = \frac{e^{(1)^2} - 1}{1.71} = 1,005$$

$$u_{25} = \frac{e^{(1)^2} - 1}{1.71} = 1,005$$

$$u_{35} = \frac{e^{(2)^2} - 1}{1.71} = 31,344$$

$$u_{45} = \frac{e^{(1)^2} - 1}{1.71} = 1,005$$

$$u_{55} = \frac{e^{(2)^2} - 1}{1.71} = 31,344$$

The calculation results produce the marginal utility matrix for all alternatives. These values are then combined with the criteria weights to obtain the final utility value of each alternative.

$$u_{ij} = \begin{bmatrix} 0 & 0 & 1,005 & 0 & 1,005 \\ 0,016 & 0 & 1,005 & 0,016 & 1,005 \\ 0,586 & 0,166 & 0 & 0,586 & 31,344 \\ 0,068 & 0,166 & 0 & 0,166 & 1,005 \\ 1,005 & 1,005 & 1,005 & 1,005 & 31,344 \end{bmatrix}$$

d. Calculating Final Utility (u_i)
The final stage is the calculation of the overall utility value of each alternative. The calculation is performed using the final utility formula presented in Equation (5) in the Methodology section. The marginal utility values obtained in the previous stage are multiplied by their corresponding criterion weights and then summed to obtain the final utility value. For example, the final utility calculation for alternative A1(U1) is presented below:

$$\begin{aligned} u_1 &= (0 * 0.457) + (0 * 0.257) + (1.005 * 0.157) + (0 * 0.090) + (1.005 * 0.040) \\ &= 0 + 0 + 0.1578 + 0 + 0.0402 \end{aligned}$$

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$$= 0.198$$

The final utility values for the other alternatives are calculated using the same procedure according to Equation (4). The resulting utility values are then used to determine the ranking of the outstanding student candidates.

$$\begin{aligned} u_2 &= (0.016 * 0.457) + (0 * 0.257) + (1.005 * 0.157) + (0.016 * 0.090) + (1.005 * 0.040) \\ &= 0.0073 + 0 + 0.1578 + 0.0014 + 0.0402 \\ &= 0.2067 \end{aligned}$$

$$\begin{aligned} u_3 &= (0.586 * 0.457) + (0.166 * 0.257) + (0 * 0.157) + (0.586 * 0.090) + (31.344 * 0.040) \\ &= 0.2678 + 0.0427 + 0 + 0.0053 + 1.2538 \\ &= 1.5696 \end{aligned}$$

$$\begin{aligned} u_4 &= (0.068 * 0.457) + (0.166 * 0.257) + (0 * 0.157) + (0.166 * 0.090) + (1.005 * 0.040) \\ &= 0.0311 + 0.0427 + 0 + 0.0149 + 0.0402 \\ &= 0.1289 \end{aligned}$$

$$\begin{aligned} u_5 &= (1.005 * 0.457) + (1.005 * 0.257) + (1.005 * 0.157) + (1.005 * 0.090) + (31.344 * 0.040) \\ &= 0.4593 + 0.2583 + 0.1578 + 0.0904 + 1.2538 \\ &= 2.2196 \end{aligned}$$

The final utility values obtained from the MAUT calculation are compared to determine the ranking of the alternatives. The ranking is arranged from the highest to the lowest utility value, where the alternative with the highest utility value represents the most favorable candidate based on the criteria and weights established in this study. The complete ranking results are presented in Table 5.

Table 5. Ranking results

No	Alternatives	Ui Value	Ranking
1	Loli (A5)	2,2196	1
2	Gina (A3)	1,5696	2
3	Polan (A2)	0,2067	3
4	Boni (A1)	0,1980	4
5	Ika (A4)	0,1289	5

Based on Table 5, alternative A5, representing Loli, obtains the highest utility value of 2.2196 and is ranked first. A3 (Gina) ranks second with a utility value of 1.5696, followed by A2 (Polan), A1 (Boni), and A4 (Ika) with utility values of 0.2067, 0.1980, and 0.1289, respectively. To further illustrate the distribution of the final utility values, a visual comparison of the alternatives is presented in Figure 2. Unlike Table 5, which provides the numerical utility values and ranking positions, the figure emphasizes the relative differences in utility among the alternatives.

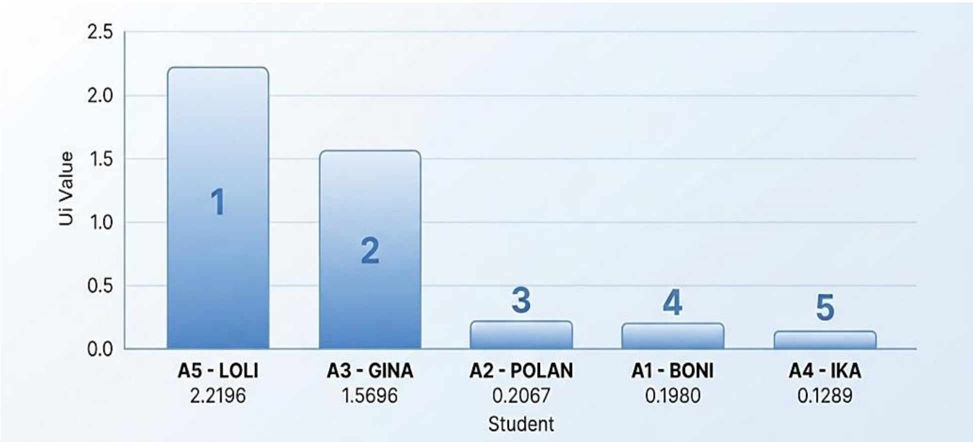

Figure 2. Comparison of Final Utility Values of Alternatives.

As shown in Figure 2, there is a clear variation in the utility values obtained by the five alternatives. The visualization confirms the differences in overall performance resulting from the aggregation of the weighted criteria, while also making the gap between alternatives more apparent. Therefore, the figure serves as a visual complement to the numerical results presented in Table 5, rather than repeating the ranking information.

3.3 Discussion

The results demonstrate that the MAUT method can be applied to evaluate and rank outstanding student candidates based on multiple criteria. The ranking is obtained by integrating the performance of each alternative with the

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criterion weights determined using the ROC method. In this study, the weighting structure places GPA as the most influential criterion, followed by Foreign Language Skills, Organizational Activity, Number of Scientific Papers, and Taking the Remedial Exam. This weighting structure indicates that academic achievement remains the primary consideration in the selection process, while other aspects provide additional contributions to the overall assessment.

The highest-ranked alternative is supported by a relatively strong performance across the criteria. In particular, the leading candidate performs favorably on the criteria that receive higher weights. This result illustrates the importance of considering the relationship between criterion performance and criterion priority in multi-criteria decision-making. An alternative does not necessarily obtain the highest ranking simply because it has the highest value on one criterion; rather, the final position is determined by the combined contribution of all criteria after the weighting and utility calculation processes.

The results further indicate that the MAUT approach provides a more comprehensive evaluation than a decision-making process based solely on GPA. Students may demonstrate different strengths across academic performance, foreign language proficiency, organizational participation, scientific productivity, and remedial examination history. By incorporating these dimensions into a single decision model, the proposed approach allows the institution to evaluate candidates based on several aspects of student achievement rather than relying on a single indicator.

Several related studies have demonstrated the applicability of MAUT in different decision support system contexts. Dasril Aldo et al. applied MAUT to lecturer performance assessment and reported that the method was able to determine the best alternatives based on the resulting utility values. In their study, alternatives DSN-01 and DSN-02 obtained the highest utility value of 0.90. The study demonstrated that MAUT can integrate several performance criteria and generate an alternative ranking to support lecturer performance evaluation. Similarly, Ratna Sri Hayati and Siti Aliyah applied MAUT to employee promotion and identified Employee 1 as the best alternative with a utility value of 0.84. Their findings demonstrated the ability of MAUT to produce a ranking from several candidate alternatives in personnel decision-making [4].

The application of MAUT has also been demonstrated in educational decision-making. Setiawan and Budilaksono (2022) investigated the use of a decision support system for selecting the best graduate students using MAUT. Their study implemented the stages of criteria determination, weighting, and utility calculation to produce a ranking of graduate students. The results showed that MAUT could assist academic institutions in identifying the best graduates through an objective and systematic decision-making process [5]. Likewise, Kayati, Yenni, and Asnal (2022) applied MAUT to determine superior classes at SMKN 1 Mandau. Their study incorporated academic and personality-related criteria and processed the assessment data using MAUT. The resulting preference scores demonstrated that MAUT could be used to support the classification and selection of superior students [6].

The findings of the present study are consistent with the previous studies, particularly regarding the ability of MAUT to process multiple criteria and transform the resulting assessments into an ordered ranking. The similarity is particularly relevant to the studies by Setiawan and Budilaksono [5] and Kayati et al. [6], which applied MAUT in educational contexts. These studies demonstrate that MAUT is suitable for decision-making problems involving student evaluation, while the present study extends its application to the selection of outstanding students using a broader set of achievement-related criteria.

A key distinction of the present study is the integration of the ROC method with MAUT for criterion weighting. In the previous studies discussed above, the primary focus was on applying MAUT to evaluate alternatives and generate rankings. In this study, ROC is first used to determine the relative importance of the criteria, after which the resulting weights are incorporated into the MAUT calculation. This integration provides an explicit mechanism for representing the priority of each criterion before the alternatives are evaluated. Consequently, the final ranking reflects both the performance of the candidates and the relative importance assigned to each assessment criterion.

The differences in utility values between this study and previous studies should not be interpreted as a direct comparison of decision quality. Utility values are dependent on the number and characteristics of criteria, the measurement scale, normalization procedure, weighting scheme, and alternatives included in each study. For example, the utility values of 0.90 and 0.84 reported in previous studies were generated from different decision-making contexts and assessment structures. Therefore, the more meaningful comparison concerns the consistency of MAUT in converting different assessment attributes into comparable utility values and producing a systematic ranking of alternatives.

From a practical perspective, the proposed ROC-MAUT approach can support institutions in reducing subjectivity in the selection of outstanding students. The decision-making process becomes more transparent because each criterion has an explicitly defined weight and each candidate is evaluated through the same computational procedure. The approach can also provide an auditable basis for explaining why a particular candidate obtains a higher or lower ranking, which is important when the selection involves several competing candidates.

Overall, the findings confirm that the integration of ROC and MAUT provides a systematic multi-criteria decision-making framework for selecting outstanding students. The approach combines criterion prioritization through ROC with utility-based alternative evaluation through MAUT. The resulting ranking provides quantitative support for identifying the most suitable candidate while considering multiple dimensions of student achievement.

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Therefore, the proposed approach can serve as a decision support mechanism for institutions that require a structured, transparent, and multi-criteria process for selecting outstanding students.

4. CONCLUSION

This study developed a decision support approach for the selection of outstanding students using the Multi-Attribute Utility Theory (MAUT) method with Rank Order Centroid (ROC) weighting. The results demonstrate that the proposed approach can integrate multiple assessment criteria, calculate the utility values of each alternative, and produce a systematic ranking of outstanding student candidates. Based on the final calculation, alternative A5, representing Loli, obtained the highest utility value of 2.2196 and was ranked first as the selected outstanding student. The main contribution of this study is the integration of ROC weighting with the MAUT method in the selection of outstanding students. ROC provides a systematic mechanism for determining the relative importance of the assessment criteria, while MAUT integrates the weighted performance of each candidate into a final utility value. This approach provides a quantitative and structured basis for supporting the selection process and can reduce reliance on subjective judgment when evaluating candidates based on multiple criteria. Despite these contributions, this study has several limitations. The evaluation was conducted using a limited number of alternatives and five criteria, namely GPA, Foreign Language Skills, Organizational Activity, Number of Scientific Papers, and Taking the Remedial Exam. The criteria and weights were also determined according to the conditions and priorities of the study context, meaning that they may not fully represent all aspects relevant to outstanding student selection in other institutions. In addition, the study focused on the MAUT-based calculation and ranking and did not conduct a comparative evaluation with other multi-criteria decision-making methods. Future research can address these limitations by involving a larger number of alternatives, incorporating additional criteria such as academic achievements, non-academic achievements, leadership, and community involvement, and comparing MAUT with other decision-making methods. Sensitivity analysis can also be conducted to examine the stability of the ranking when the criterion weights are changed. Such developments can provide a more comprehensive evaluation of the robustness and applicability of the proposed decision support approach.

5. DECLARATIONS

5.1 Author Contributions

Conceptualization: R.M.F.L., M., N.P., S.A.N., R.F., A.P.W., S.;
Methodology: M., R.F. and S.
Software: A.P.W, and. R.F.;
Validation: R.M.F.L, and N.P.;
Formal Analysis: M., S., N.P., and S.A.N.;
Investigation: N.P., and S.A.N.;
Resources: N.P., S.A.N.;
Data Curation: N.P., S.A.N., and M.;
Writing Original Draft Preparation: R.M.F.L., N.P., S.A.N., and M.;
Writing Review and Editing: R.M.F.L., N.P., S.A.N., M., and R.F.;
Visualization: A.P.W, and. R.F.;
All authors have read and agreed to the published version of the manuscript.

5.2 Data Availability

The data presented in this study are available on request from the corresponding author.

5.3 Funding

Not applicable.

5.4 Institutional Review Board Statement

Not applicable.

5.5 Informed Consent Statement

Not applicable.

5.6 Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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