

Comparison of Two Methods Between TOPSIS and MAUT In Determining BIDIKMISI Scholarship

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Comparison of Two Methods Between TOPSIS and MAUT In Determining BIDIKMISI Scholarship

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Abstract— Bidikmisi is one of the scholarships provided to students in universities, including Mulawarman University. To get the scholarship, students must meet the requirements and standards set by the government. The problem is the number of applicants who ask for Bidikmisi scholarship to make the decision maker must be fair, fast, transparent and objective in deciding who is eligible for a scholarship. There are two methods in this study to compare the accuracy of the decision of the scholarship recipient; namely TOPSIS method and MAUT method. In some studies, The Technique For Order Of Preference By Similarity To Ideal Solution (TOPSIS) method has been used in the case of Bidikmisi scholarship acceptance. While the method of Multi-Attribute Utility Theory (MAUT) is a new method and not many researchers are using it. Therefore, in this study conducted comparison method between TOPSIS and MAUT. The test data of Bidikmisi scholarship acceptance test using 150 students in 2017 with National Selection of State University Entrance (SNMPTN), 100 students accepted and 50 unaccepted students. The result of accuracy is done by comparing the original data with both methods so that the accuracy of TOPSIS method is 48% and MAUT method is 94,667%. Based on the analysis of the two methods, an application has been developed that compares MAUT method and TOPSIS method for Bidikmisi scholarship selection.

Keywords—e-learning; Decision Support System; Scholarship; Bidikmisi; TOPSIS; MAUT;

I. INTRODUCTION

Bidikmisi is an educational cost aid from the Ministry of Research Technology and Higher Education of the Republic of Indonesia which provides facilities for the exemption of tuition fees and subsidized living expenses for prospective students who are not able to economically and have a good academic potential to study at universities in program superior studies to pass precisely time. The Bidikmisi is issued every year for new students and active students. To obtain the scholarship must be in accordance with the rules set by Bidikmisi at Mulawarman University, with criteria to determine who is elected to receive the scholarship in accordance with the conditions that have been determined [1]. Due to the large number of participants who apply for

Bidikmisi scholarship at Mulawarman University and the indicators in the selection of the scholarship application file still use manual way to determine the Bidikmisi scholarship recipient, so the data processing is less effective, and also takes a relatively long time. Thus required a system that can provide an appropriate, effective and efficient decision in the management of data of scholarship recipients and to ease and ease the work of the student affairs section in data management scholarship recipients [2].

The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) method is used to solve practical decision-making. This is because the concept is simple and easy to understand, computing is efficient, and has the ability to measure the relative performance of decision alternatives [3][4][5]. This method has been used in several previous studies on Bidikmisi scholarships. While the method of Multi-Attribute Utility Theory (MAUT), each existing criteria has several alternatives that can provide solutions by multiplication of the priority scale that has been determined [6][7][8][9].

Based on the problems that arise, it will be built a decision support system to help determine the recipients of Bidikmisi scholarship in Mulawarman University by performing a comparative analysis of the two methods of TOPSIS and MAUT methods.

Bidikmisi is a government program to provide access to higher education for the poor to be able to break the poverty chain. Until now the number of Bidikmisi recipients has reached the number 432 409 students, thus contributing to increase the Gross Participation Rate (APK) of Higher Education [2].

Bidikmisi also has a different scheme with the help of other costs, with its philosophy to pick up recipients, Bidikmisi provides collateral financing from registration to recipient of Bidikmisi completing higher education

II. LITERATURE REVIEW

A. THE TECHNIQUE FOR ORDER OF PREFERENCE BY SIMILARITY TO IDEAL SOLUTION (TOPSIS)

The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) is one of the multicriteria decision-making methods. TOPSIS uses the principle that the chosen alternative must have the shortest distance from the ideal solution and the longest distance from the ideal solution from a geometric point of view by using the Euclidean distance (the distance between two points) to determine the relative proximity of an alternative with the optimal solution [3][4][5].

The TOPSIS algorithm steps are as follows:

1) Determine the ranking of each alternative TOPSIS requires the performance ranking of each alternative A_i in each normalized C_j criteria, namely:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}} \quad (1)$$

With $i = 1, 2, \dots, m$ and $j = 1, 2, \dots, n$.

2) Make a weighted, normalized decision matrix

$$y_{ij} = w_j \cdot r_{ij} \quad (2)$$

With $i = 1, 2, \dots, m$ and $j = 1, 2, \dots, n$.

3) Determine positive and negative ideal solutions. A^+ positive ideal solution and an ideal negative A^- the solution can be determined based on normalized weighting rankings as follows:

$$A^+ = (y_1^+, y_2^+ \dots \dots, y_n^+) \quad (3a)$$

$$A^- = (y_1^-, y_2^- \dots \dots, y_n^-) \quad (3b)$$

Under the condition

$$y_i^+ = \begin{cases} \max y_{ij}; & \text{if } j \text{ is a benefit attribute} \\ \min y_{ij}; & \text{if } j \text{ is a cost attribute} \end{cases}$$

$$y_i^- = \begin{cases} \max y_{ij}; & \text{if } j \text{ is a cost attribute} \\ \min y_{ij}; & \text{if } j \text{ is a benefit attribute} \end{cases}$$

4) Calculate the distance with the ideal solution. An alternative distance with a positive ideal solution is calculated using the formula in equation 4.

$$D_i^+ = \sqrt{\sum_{j=1}^n (y_{ij}^+ - y_{ij})^2} \quad (4)$$

5) The alternative distance with the ideal solution is calculated by using the formula in equation 5.

$$D_i^- = \sqrt{\sum_{j=1}^n (y_{ij}^- - y_{ij})^2} \quad (5)$$

6) Determine the preference value for each alternative. The preference value for each alternative is given as

$$V_i = \frac{D_i^-}{D_i^- + D_i^+} \quad (6)$$

B. Multi Attribute Utility Theory (MAUT)

Multi-Attribute Utility Theory is used to change from multiple interests into numerical values on a scale of 0-1 with 0 representing the worst and best 1 choice. This allows direct comparison of various sizes. That is, with the right tools, it's possible to compare apples with oranges. The end result is a ranking sequence of alternative evaluations that describe the choices of decision makers. The overall evaluation value can be defined by equation 7 [6][7][8][9].

$$V_{(x)} = \sum_{i=1}^n w_j \cdot x_{ij} \quad (7)$$

In summary, the steps in the MAUT method are as follows [8][9].

- 1) Break up a decision into a different dimension.
- 2) Determine the relative weights on each dimension.
- 3) List all alternatives.
- 4) Enter the utility for each alternative according to its attributes.
- 5) Multiply the utility by weight to find the value of each alternative.
- 6) Normalization of the matrix :

$$U_{(x)} = \frac{x - x_i^-}{x_i^+ - x_i^-} \quad (8)$$

Keterangan:

$U(x)$ = Normalization of alternative weight

x = Alternative weight

x_i^- = The worst (minimum) weights of the x-criteria

x_i^+ = The best weight (maximum) of x-criteria

III. RESEARCH METHODOLOGY

A. RESEARCH PLAN

At the planning stage, data collection is done. There are two processes of data collection conducted, namely by interview and observation [10]. Interviews were conducted with resource persons, Head of Sub Department for Student Welfare of Mulawarman University, to obtain data and to determine the value of weight and criteria, that can be used as the basis for determining the scholarship recipient. The weights of criteria are translated in Table I. While the weight of sub criteria in Table II. The observation is done by conducting direct observation to find information on criteria, weight, and data from Bidikmisi scholarship at Mulawarman University.

TABLE I. CRITERIA AND VALUE WEIGHT

Bidikmisi Scholarship Recipient Criteria	Weight
Student achievement (average UAN score)	9
Class rating (High XII)	8
Achievement of curricular field	8
Electric power used in house / Voucher	8

Monthly electricity payment (last month's payment account)	8
Water bill payment	8
Land and property tax payment (PBB)	8
Parent income	9
Number of dependents according to family card	9
Parent's student status	9
Parental home status	8
The condition of the house is inhabited	8

From each of these criteria then there are subcriteria that have been determined in a determination of ¹¹ Bidikmisi scholarship recipient. The sample of subcriteria can be seen in Tables II, Table III and Table IV.

TABLE II. STUDENT ACHIEVMENT

No	Student Achievement	Weight Value
1	>90	4
2	80 - 90	3
3	70 - <80	2
4	<70	1

TABLE III. MONTHLY ELECTRICITY PAYMENT

No.	Monthly Electricity Payment	Weight Value
1	Rp. 50.000 - Rp. 110.000	5
2	>Rp. 110.000 - Rp. 210.000	4
3	>Rp. 210.000 - Rp. 310.000	3
4	>Rp. 310.000 - Rp. 510.000	2
5	>Rp. 510.000	1

TABLE IV. HOME STATUS

No.	Parental Home Status	Weight Value
1	Ayah & Ibu meninggal (Yatim Piatu)	4
2	Ayah/ibu meninggal (Yatim/Piatu)	3
3	Ayah & Ibu bercerai (single parent)	2
4	Ayah dan Ibu masih hidup (bersatu)	1

TABLE V. CRITERIA

	Criteria											
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
A1	1	1	1	5	5	6	6	6	2	1	1	2
A2	1	1	1	5	5	6	5	6	2	1	1	1
A3	1	2	2	3	4	6	5	6	1	1	1	1

Produce recommendations for students who are entitled to receive Bidikmisi according to criteria Table V.

B. System Implementation

The admin login page is the admin's initial page to enter into the menus on the system for determining Bidikmisi scholarship acceptance, but before that, the admin must enter the username and password as a system security in managing the system data. Admin login page can be seen in Fig. 1.



Fig. 1. Login Page

The first stage is alternative data input. On this page admin can perform data management of prospective scholarship recipients like entering, altering, deleting, and storing data. The alternative data input page can be seen in Fig. 2.

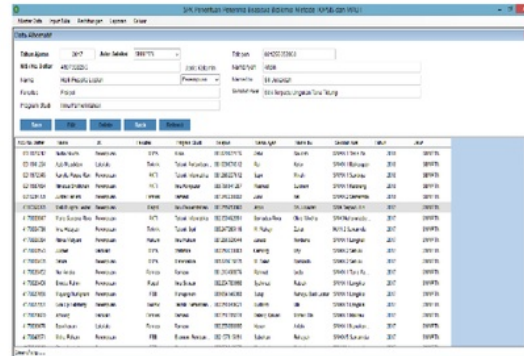


Fig. 2. Alternative Data Input Page

The second stage is to enter an alternative value according to the criteria and subcriteria data. The input page sample value can be seen in Fig. 3.

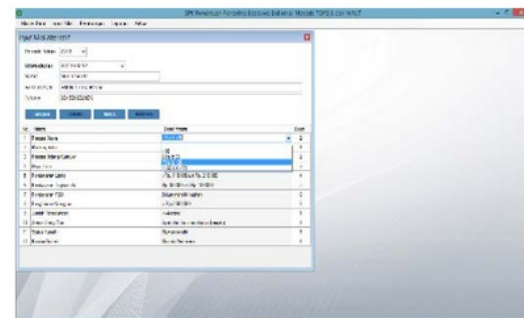


Fig. 3. Page of Alternative Value

The calculation page is the page used by the admin to perform the calculation process. Calculations are based on the school year, the selection path, and the amount of data received. The calculation page of the TOPSIS and MAUT methods can be seen in Fig. 4 and Fig. 5.

No	Nilai	U1	U2	U3	U4	U5	U6	U7	U8	U9	U10	U11	U12
1	010101	1	1	1	1	1	1	1	1	1	1	1	1
2	010102	1	1	1	1	1	1	1	1	1	1	1	1
3	010103	1	1	1	1	1	1	1	1	1	1	1	1
4	010104	1	1	1	1	1	1	1	1	1	1	1	1
5	010105	1	1	1	1	1	1	1	1	1	1	1	1

Fig. 4. MAUT Calculation Method

No	Nilai	U1	U2	U3	U4	U5	U6	U7	U8	U9	U10	U11	U12
1	010101	1	1	1	1	1	1	1	1	1	1	1	1
2	010102	1	1	1	1	1	1	1	1	1	1	1	1
3	010103	1	1	1	1	1	1	1	1	1	1	1	1
4	010104	1	1	1	1	1	1	1	1	1	1	1	1
5	010105	1	1	1	1	1	1	1	1	1	1	1	1

Fig. 5. TOPSIS Calculation Method

The report is the page used by the admin to print the report. There are several things to do before printing the report, which is choosing the school year, the selection path, the method used, as well as some data report options that want to print the report of the list of prospective scholarship recipients, the report of all assessment results, and assessment report received. As for the pages of printed reports can be seen in Fig. 6.

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Jember

No	Nilai	U1	U2	U3	U4	U5	U6	U7	U8	U9	U10	U11	U12
1	010101	1	1	1	1	1	1	1	1	1	1	1	1
2	010102	1	1	1	1	1	1	1	1	1	1	1	1
3	010103	1	1	1	1	1	1	1	1	1	1	1	1
4	010104	1	1	1	1	1	1	1	1	1	1	1	1
5	010105	1	1	1	1	1	1	1	1	1	1	1	1

Fig. 6. Report Page

1) MAUT Testing Method

11 System testing is done to determine whether the system is made in accordance with the purpose. The test is done using manual calculation. Conducted trials of 3 data of prospective recipients of existing scholarship with weighted value to determine the recommendation of candidate recipient of appropriate scholarship on criteria used.

There are 3 candidates of bidikmisi scholarship recipients are tested manually, namely:

1. A1 = Melli Puspita Sari
2. A2 = Mary Gusiana Rora
3. A3 = Julkaet

The initial stage of MAUT method calculation is to solve a decision to a different dimension then determine the relative weights in each dimension and list all alternatives for the attribute in the form of the decision matrix. x is the criterion value of each of the criteria presented as the matrix. Here is the resulting decision matrix:

$$x(\text{Matriks Keputusan}) = \begin{bmatrix} 1 & 1 & 1 & 5 & 6 & 6 & 6 & 2 & 1 & 1 & 2 \\ 1 & 1 & 1 & 5 & 6 & 6 & 5 & 6 & 2 & 1 & 1 & 1 \\ 1 & 2 & 2 & 3 & 4 & 6 & 5 & 6 & 1 & 1 & 1 & 1 \end{bmatrix}$$

After the decision matrix is made the next step is the normalization of the matrix of each alternative per attribute by using the formula in equation 8.

X₁ (Decision Matrix Column 1)

$$X_{11} = \frac{1-1}{1-1} = \frac{1}{0} = 0$$

$$X_{21} = \frac{1-1}{1-1} = \frac{0}{0} = 0$$

$$X_{31} = \frac{1-1}{1-1} = \frac{1}{1} = 0$$

X₂ (Decision Matrix Column 2)

$$X_{12} = \frac{1-1}{2-1} = \frac{0}{1} = 0$$

$$X_{22} = \frac{1-1}{2-1} = \frac{0}{1} = 0$$

$$X_{32} = \frac{2-1}{2-1} = \frac{1}{1} = 1$$

.....
X₁₂ (Decision Matrix Column 12)

$$X_{112} = \frac{2-1}{2-1} = \frac{1}{1} = 1$$

$$X_{212} = \frac{1-1}{1-1} = \frac{0}{0} = 0$$

$$X_{312} = \frac{1-1}{2-1} = \frac{0}{1} = 0$$

After the calculation is obtained the value of the matrix normalization results as follows:

TABLE VI. NORMALIZATION RESULT MATRIX

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
A1	0	0	0	1	1	0	1	0	1	0	0	1
A2	0	0	0	1	1	0	0	0	1	0	0	0
A3	0	1	1	0	0	0	0	0	0	0	0	0

The next stage after the results obtained from the normalization of the matrix than do multiplication matrix normalized with the weight of each criterion to get the overall evaluation value by using the formula in equation 7.

$$V1 = (9*0)+(8*0)+(8*0)+(8*1)+(8*1)+(8*0)+(8*1)+(9*0)+(9*1) + (9*0)+(8*0)+(8*1) = 41$$

$$V2 = (9*0)+(8*0)+(8*0)+(8*1)+(8*1)+(8*0)+(8*0)+(9*0)+(9*1) + (9*0)+(8*0)+(8*0) = 25$$

$$V3 = (9*0)+(8*1)+(8*1)+(8*0)+(8*0)+(8*0)+(8*0)+(9*0)+(9*0) + (9*0)+(8*0)+(8*0) = 16$$

After obtained the value of the calculation of matrix multiplication matched with each weight of criteria then done the ranking process. The result of the calculation is obtained with the final value at V1 = 41, V2 = 25 and V3 = 16. Then the recommendation obtained with the highest and greatest value is on V1 ie Melli Puspita Sari as the recipient of the Bidikmisi scholarship. Here is a ranking with the name along with the results of the calculation:

- Melli Puspita Sari with value V1 = 41
- Maria Gusiana Rora with value V2 = 25
- Julkaet with value V3 = 16

2) TOPSIS Testing Method

The initial stage of TOPSIS method calculation is to make the decision matrix of each alternative with the criteria weights already specified. x is the criterion value of each of the criteria presented as the matrix. 8: next step is to normalize the matrix by determining the performance rank of each alternative Ai on each criterion Cj using the formula in equation 1.

Divider on column 1 (X1) :

$$X1 = \sqrt{1^2 + 1^2 + 1^2} = \sqrt{1 + 1 + 1} = \sqrt{3} = 1,73$$

R1 (Ranking Performance on Columns 1)

$$R11 = \frac{1}{1,73} = 0,58$$

$$R21 = \frac{1}{1,73} = 0,58$$

$$R31 = \frac{1}{1,73} = 0,58$$

.....
Divider on column 12 (X12) :

$$X12 = \sqrt{2^2 + 1^2 + 1^2} = \sqrt{4 + 1 + 1} = \sqrt{6} = 2,45$$

R12 (Ranking Performance on Columns 12)

$$R112 = \frac{2}{2,44} = 0,82$$

$$R212 = \frac{1}{2,44} = 0,41$$

$$R312 = \frac{1}{2,44} = 0,41$$

The results of the calculation of performance multiplied by each weight of criteria that is (9,8,8,8,8,8,9, 9,9,8,8). The multiplication result is made by a weighted normalized matrix, can be seen in Table 7.

TABLE VII. MATRIX NORMALIZED WEIGHTED

A1	5,22	3,28	3,28	5,2	4,96	4,46	5,2	5,22	6,03	5,22	4,64	6,56
A2	5,22	3,28	3,28	5,2	4,96	4,46	4,32	5,22	6,03	5,22	4,64	3,28
A3	5,22	6,56	6,56	3,12	3,92	4,46	4,32	5,22	2,97	5,22	4,64	3,28
A+	5,22	6,56	6,56	3,12	3,92	4,64	4,32	5,22	6,03	5,22	4,64	3,28
A-	5,22	3,28	3,28	5,2	4,96	4,64	5,2	5,22	2,97	5,22	4,64	6,56

After getting A + and A- then proceed to calculate the distance with the ideal solution. The calculation of the alternative distance with the ideal solution and the negative ideal solution is done by using the equations in equations 4 and 5.

D+ (Alternative Distance with Positive Ideal Solution)

$$D+ = \sqrt{\frac{(5,22 - 5,22)^2 + (3,28 - 6,56)^2 + (3,28 - 6,56)^2 + (5,2 - 3,12)^2 + (4,96 - 3,92)^2 + (4,64 - 4,64)^2 + (5,2 - 4,32)^2 + (5,22 - 5,22)^2 + (6,03 - 6,03)^2 + (5,22 - 5,22)^2 + (4,64 - 4,64)^2 + (6,56 - 3,28)^2}{0 + 10,7584 + 10,7584 + 4,3264 + 1,0616 + 0 + 0,7744 + 0 + 0 + 0 + 0 + 10,7584}} = \sqrt{38,4567} = 6,20$$

D- (Alternative Distance with Negative Ideal Solution)

$$D- = \sqrt{\frac{(5,22 - 5,22)^2 + (3,28 - 3,28)^2 + (3,28 - 3,28)^2 + (5,2 - 5,2)^2 + (4,96 - 4,96)^2 + (4,64 - 4,64)^2 + (5,2 - 5,2)^2 + (5,22 - 5,22)^2 + (6,03 - 2,97)^2 + (5,22 - 5,22)^2 + (4,64 - 4,64)^2 + (6,56 - 6,56)^2}{0 + 0 + 0 + 0 + 0 + 0 + 0 + 0 + 10,7584 + 10,7584 + 0 + 0}} = \sqrt{9,3636} = 3,06$$

8 The results of the calculation of the ideal solution and the ideal negative solution can be seen in Table 8.

TABLE VIII. PROXIMITY OF IDEAL SOLUTION

D+	D-
6,20	3,06
5,19	4,57
3,06	6,2

The last step is to calculate the preference value for each alternative by using the formula in equation 6.

$$V_1 = \frac{3,06}{3,06 + 6,2} = 0,33$$

$$V_2 = \frac{4,57}{4,57 + 5,19} = 0,468$$

$$V_3 = \frac{6,2}{3,06 + 6,2} = 0,67$$

After obtained the value of the calculation of the value of preference for each alternative then done the ranking process. The calculation results are obtained with the final value at $V_1 = 0.33$, $V_2 = 0.486$ and $V_3 = 0.67$. Then the recommendations obtained with the highest value and the largest is on V_3 that is Julkaet as the recipient of Bidikmisi scholarship. Here is a ranking with the name along with the results of the calculation:

Julkaet with value $V_3 = 0.486$
 Maria Gusiana Rora with value $V_2 = 0,67$
 Melli Puspita Sari with value of $V_1 = 0,33$

3) Accuracy Calculation

Based on the data obtained from the source is 150 data with 100 data received and 50 data rejected, then the system accuracy calculation method MAUT and TOPSIS method compared with the original data is as follows.

To calculate the level of system accuracy:

Amount of data = 150
 Amount received = 100
 Amount not received = 50

The number of system recommendations is correct

MAUT Method = 142
 TOPSIS Method = 72

To calculate the accuracy of the system is calculated by the formula :

$$\text{Accuracy} = \frac{\text{The number of referral data is correct}}{\text{amount of test data}} \times 100\%$$

So obtained calculation as follows :

$$\text{result of MAUT method accuracy} = \frac{142}{150} \times 100\%$$

$$= 94,667 \%$$

$$\text{result of TOPSIS method accuracy} = \frac{72}{150} \times 100\%$$

$$= 48\%$$

IV. CONCLUSIONS

Based on the results of research on the selection system scholarship acceptance bidikmisi, can be taken conclusion The application of Multi-Attribute Utility Theory (MAUT) method, in this case, gives accuracy result that is 94,667% from 150 amount of data. The application of The Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) method, in this case, gives accurate results of 48% of the 150 data amount.

The amount of recommendation data is correct obtained from the comparison of manual data results with the results

of calculations using the method. One example if in the original data is "accepted" while the MAUT method is also "accepted" then the data is included in the "correct" recommendation data. Whereas if the original data is "received", whereas in the MAUT method, the results are "not accepted", then the data is "wrong" recommendations. Likewise, the calculation of accuracy from the results of manual data comparison using the TOPSIS method.

From the results of the study obtained the amount of data with the correct recommendations for the MAUT method is 142 of 150 data. While the amount of data with the correct recommendation for the TOPSIS method is 72 out of 150 data. Based on the amount of data obtained, the level of accuracy is obtained by using an accuracy formula, for accuracy of the MAUT method 94.667% while for accuracy using the TOPSIS method 48%.

The distance of accuracy between the two methods is caused by the calculation of the original data with both methods more suitable using the MAUT method. The original data calculation is done by adding up all the scores that have been obtained and used as the final result. Whereas if in the TOPSIS method there are differences in the types of criteria, namely benefits and costs that will affect the calculation results. The high accuracy of the MAUT method is because the benefit and cost criteria are not used, so the calculation is in accordance with the original data.

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