Selection of Scholarships for Underprivileged Students Using the TOPSIS

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Abstract−Scholarships that will be given to someone must have conditions, including, the scholarship recipient is a person who is less well off economically or financially, the prospective scholarship recipient has achievements, especially in the field of interest or has a contribution to social activities, but it all depends on the institution involved. give it. Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) with the concept that the best chosen alternative not only has the shortest distance from the positive ideal solution, but also has the longest distance from the negative ideal solution. The results of the calculation of the selection of scholarships for underprivileged students using the Technique for Order of Preference by Similarity to Ideal Solution method are obtained for rank 1 with a preference value of 0.7749 is Cassandra student, rank 2 with a preference value of 0.7587 is John's student, rank 3 with a preference value of 0.5569 is Gonzales students, rank 4 with a preference value of 0. 4788 is Maria's student, ranked 5th with a preference value of 0. 4547 is Moriera's student

Keywords: Scholarships, Selection, Achievements, Students, TOPSIS.

1. INTRODUCTION

Every scholarship that will be given to someone must have conditions, including, the recipient of the scholarship is a person who is less well off economically or financially, the prospective scholarship recipient has achievements, especially in the field of interest or has a contribution to social activities, but it all depends on the institution. who gave it [1],[2]. The scholarship program for underprivileged children is a program to help pay [3];[4];[5] finance children whose parents are not / economically disadvantaged so that the child can continue his education . The high number of dropouts and not being able to continue their education stems more from economic problems, because many school-aged people come from poor families [6],[7].

SPK (Decision Support System) is generally defined as a system that is able to provide bai, problem solving and communication capabilities for semi-structured problems. In particular, SPK is defined as a system that supports the work of a manager or a group of managers in solving semi-structured problems by providing information or proposals towards certain decisions. TOPSIS is a category of Multi-Criteria Decision Making (MCDM), which is a decision-making technique of several alternative options available, especially MADM (Multi Attribute Decision Making). TOPSIS aims to determine both positive ideal solutions and negative ideal solutions. The positive ideal solution maximizes the benefit criterion and minimizes the cost criterion, while the negative ideal solution maximizes the cost criterion and minimizes the benefit criterion. Decision Support System is a software product that was developed specifically to assist in the decision-making process [8],[9]. As the name implies, the purpose of using this system is as a second opinion or information source that can be used as consideration before deciding on certain policies [10];[11].

The decision-making system includes four stages that are interconnected and sequential, namely Intelligence is the process of tracing and detecting the scope of problems and the process of recognizing problems. Input data is obtained, processed, and tested in order to identify problems [12];[13];[14]. Design is the process of finding and developing alternatives. This stage includes the process of understanding the problem, deriving solutions and testing the feasibility of the solution [15]. Choice is the process of choosing among various alternative actions that may be carried out . This stage includes searching, evaluating, and recommending suitable solutions for the model that has been made. The solution of the model is a specific value for the outcome variable in the selected alternative [16]–[18]. Implementation is the implementation stage of the decisions that have been taken. At this stage, it is necessary to arrange a series of planned actions, so that the results of decisions can be monitored and adjusted if improvements are needed [19]–[21].

Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) with the concept that the best chosen alternative not only has the shortest distance from the positive ideal solution, but also has the longest distance from the negative ideal solution [22],[23]. In general, the TOPSIS procedure follows the steps, namely making a normalized decision matrix, creating a weighted normalized decision matrix, determining a positive ideal solution matrix and a negative ideal solution matrix, determining the distance between the values of each alternative and a positive ideal solution matrix and a negative ideal solution matrix. , and define a reference value for each alternative [24],[25]. Topsis is based on the concept that the best chosen alternative not only has the shortest distance from the positive ideal solution, but also has the longest distance from the negative ideal solution. This concept is widely used in several MADM models to solve practical decision problems [26], [27].

2. RESEARCH METHODS

2.1 Research Stages

There are several stages of this research that must be carried out to find the link between one criterion and another by going through several stages starting from problem analysis, research objects, data collection, analytical methods used and implementation results.

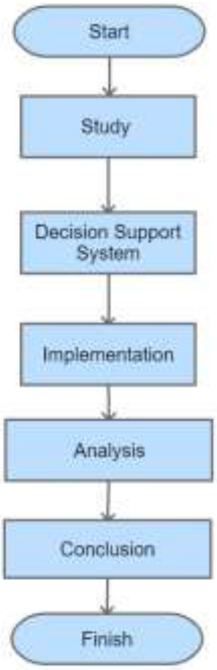

Figure 1. Research Stages

1. Study
   Studies to formulate background problems to be discussed such as analyzing problems, studying some literature and analyzing data that will be used as research samples.
2. Decision Support System
   Identify the problems found. Next, describe it to find solutions to problems by processing data using the Technique for Order of Preference by Similarity to Ideal Solution method.
3. Implementation
   After getting the results of the solutions that have been found. So implementation is needed to get the results of the analysis in accordance with system needs and user needs.
4. Analysis Results
   The results of the analysis are the final results of calculations using the Technique for Order of Preference by Similarity to Ideal Solution based on a system that has been designed to produce a decision in the Selection of Scholarships for Underprivileged Students.

2.2 Application of TOPSIS Method

TOPSIS considers both the distance to the ideal solution and the distance to the negative ideal solution by taking the close relationship to the ideal solution [28]–[30]. By comparing the two the order of choice can be determined. The steps taken in solving the problem using the TOPSIS method are as follows:

1. TOPSIS requires a performance rating of each alternative A_i on each normalized C_j criterion, namely:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad ;dengan\ i=1,2,\ldots,m;dan\ j=1,2,\ldots,n. \qquad (1)$$

2. The positive ideal solution A^+ and the negative ideal solution A^- can be determined based on the normalized weight rating (y_ij) as;

   $y_{ij} = W_i r_{ij}$; with i= 1,2,….,m;and j=1,2,….,n.
   $A^+ = (y_1^+, y_2^+, \ldots, y_n^+)$;
   $A^- = (y_1^-, y_2^-, \ldots, y_n^-)$;

   with
   y_j^+= { max y_{ij}; if j is a profit attribute
   { min y_{ij}; if j is the cost attribute
   y_j^-= { min y_{ij}; if j is a profit attribute
   { max y_{ij}; if j is the cost attribute
   J = 1,2,…,n.
3. The distance between alternative Ai and the positive ideal solution is formulated as:

$$D_i^+ = \sqrt{\sum_{j=1}^{n} (y_i^+ - y_{ij})^2}; \quad i = 1,2,\ldots,m \qquad (2)$$

   The distance between alternative A〗_i and the negative ideal solution is formulated as:

$$D_i^- = \sqrt{\sum_{j=1}^{n} (y_{ij} - y_i^-)^2}; \quad i = 1,2,\ldots,m \qquad (3)$$

4. The reference value for each alternative V_i is given as:

$$V_i = \frac{D_i^-}{D_i^- + D_i^+} ;i=1,2,\ldots\ldots m. \qquad (4)$$

5. A larger value of V_i indicates that alternative A_i is preferred..
6. TOPSIS requires a performance rating of each alternative A_i on each normalized C_j criterion, namely:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad ;dengan\ i=1,2,\ldots,m;dan\ j=1,2,\ldots,n. \qquad (6)$$

7. The positive ideal solution A^+ and the negative ideal solution A^- can be determined based on the normalized weight rating (y_ij) as;

   $y_{ij} = W_i r_{ij}$; with i= 1,2,….,m;and j=1,2,….,n.
   $A^+ = (y_1^+, y_2^+, \ldots, y_n^+)$;
   $A^- = (y_1^-, y_2^-, \ldots, y_n^-)$;

   with
   y_j^+= { max y_{ij}; if j is a profit attribute
   { min y_{ij}; if j is the cost attribute
   y_j^-= { min y_{ij}; if j is a profit attribute
   { max y_{ij}; if j is the cost attribute
   J = 1,2,…,n.
8. The distance between alternative Ai and the positive ideal solution is formulated as:

$$D_i^+ = \sqrt{\sum_{j=1}^{n} (y_i^+ - y_{ij})^2}; \quad i = 1,2,\ldots,m \qquad (8)$$

The distance between alternative A〗_i and the negative ideal solution is formulated as:

$$D_i^- = \sqrt{\sum_{j=1}^{n} (y_{ij} - y_i^-)^2}; \quad i = 1,2,\ldots,m \qquad (9)$$

9. The reference value for each alternative V_i is given as:

$$V_i = \frac{D_i^-}{D_i^- + D_i^+} ;i=1,2,\ldots\ldots m. \qquad (10)$$

Value V_i the larger one shows that alternative A_i preferred.

3. RESULTS AND DISCUSSIONS

At this point, a decision support system is developed to identify scholarship recipients for disadvantaged students using the Topsis method. Once the computation is done with a system, specifically the execution of the system execution, check the final result of the Topsis calculation on the system with manual calculations performed by the user

3.1 Create a Xij matrix consisting of m alternatives and n criteria

Create an evaluation matrix consisting of m alternatives and n criteria, with the intersection of each alternative and criterion given as x_ij, therefore we have a matrix (x_ij)mx

Table 1. Data Criteria and Weights

Code	Criteria	Attribute	Weight
C1	Academic achievement	5	3
C2	Non-Academic Achievements	5	2
C3	Average value	1	2
C4	Parents' Income	3	3

Table 2. Data Criteria and Weights

Code	Student	Academic achievement	Non-Academic Achievements	Average value	Parents' Income
A1	John	5	3	3	2
A2	Maria	5	5	3	5
A3	Gonzales	1	2	3	1
A4	Moriera	3	3	1	3
A5	Cassandra	4	5	3	2

3.2 Creating a normalized decision matrix

The first stage of normalization is squaring each matrix value from the value of each student

Table 3. First Stage of Normalization

Kode	C1	C2	C3	C4
A1	$5^2 = 25$	$3^2 = 9$	$3^2 = 9$	$2^2 = 4$
A2	$5^2 = 25$	$5^2 = 25$	$3^2 = 9$	$5^2 = 25$
A3	$1^2 = 1$	$2^2 = 4$	$3^2 = 9$	$1^2 = 1$
A4	$3^2 = 9$	$3^2 = 9$	$1^2 = 1$	$3^2 = 9$
A5	$4^2 = 16$	$5^2 = 25$	$3^2 = 9$	$2^2 = 4$

The second stage of normalization is to find the root of the total squared value of each criterion.

Table 4. Second Stage Total Score

Code	Calculation	Total
C1	$\sqrt{25+25+1+9+16}$	8.8178
C2	$\sqrt{9+25+4+9+25}$	8.4853
C3	$\sqrt{9+9+9+1+9}$	6.0828
C4	$\sqrt{4+25+1+9+4}$	6.5574

The third stage of normalization is to divide each element of the x_ij matrix with the results of the table above.

Table 5. Stage Three Normalization Results

Code	C1	C2	C3	C4
A1	5 / 8.7178 = 0.5735	3 / 8.4853 = 0.3536	3 / 6.0828 = 0.4932	2 / 6.5574 = 0.305
A2	5 / 8.7178 = 0.5735	5 / 8.4853 = 0.5893	3 / 6.0828 = 0.4932	5 / 6.5574 = 0.7625
A3	1 / 8.7178 = 0.1147	2 / 8.4853 = 0.2357	3 / 6.0828 = 0.4932	1 / 6.5574 = 0.1525
A4	3 / 8.7178 = 0.3441	3 / 8.4853 = 0.3536	1 / 6.0828 = 0.1644	3 / 6.5574 = 0.4575
A5	4 / 8.7178 = 0.4588	5 / 8.4853 = 0.5893	3 / 6.0828 = 0.4932	2 / 6.5574 = 0.305

3.3 Creating Weighted Normalization

The first step in calculating the weighted normalization is to divide each criterion weight by the total weight of the criteria.

Table 6. First Stage of Weighted Normalization

Kode	Perhitungan	Bobot
C1	3 / (3+2+2+3)	0.3
C2	2 / (3+2+2+3)	0.2
C3	2 / (3+2+2+3)	0.2
C4	3 / (3+2+2+3)	0.3

The second step is to multiply the normalized matrix by the normal weight above.

Table 7. Second Stage Multiplication Normalization

Code	C1	C2	C3	C4
A1	0.5735 * 0.3 = 0.1721	0.3536 * 0.2 = 0.0707	0.4932 * 0.2 = 0.0986	0.305 * 0.3 = 0.0915
A2	0.5735 * 0.3 = 0.1721	0.5893 * 0.2 = 0.1179	0.4932 * 0.2 = 0.0986	0.7625 * 0.3 = 0.2287
A3	0.1147 * 0.3 = 0.0344	0.2357 * 0.2 = 0.0471	0.4932 * 0.2 = 0.0986	0.1525 * 0.3 = 0.0457
A4	0.3441 * 0.3 = 0.1032	0.3536 * 0.2 = 0.0707	0.1644 * 0.2 = 0.0329	0.4575 * 0.3 = 0.1372
A5	0.4588 * 0.3 = 0.1376	0.5893 * 0.2 = 0.1179	0.4932 * 0.2 = 0.0986	0.305 * 0.3 = 0.0915

3.4 Creating the Ideal Solution

Calculation of the ideal solution according to the attributes of each criterion, namely:

1. **Academic Achievement Criteria** (benefits)
   Positive Ideal Solution = max(0.1721, 0.1721, 0.0344, 0.1032, 0.1376) = 0.1721
   Negative Ideal Solution = min(0.1721, 0.1721, 0.0344, 0.1032, 0.1376) = 0.0344
2. **Non-Academic Achievement Criteria** (benefits))
   Positive Ideal Solution = max(0.0707, 0.1179, 0.0471, 0.0707, 0.1179) = 0.1179
   Negative Ideal Solution = min(0.0707, 0.1179, 0.0471, 0.0707, 0.1179) = 0.0471
3. **Criteria Average Score** (benefit))
   Positive Ideal Solution = max(0.0986, 0.0986, 0.0986, 0.0329, 0.0986) = 0.0986
   Negative Ideal Solution = min(0.0986, 0.0986, 0.0986, 0.0329, 0.0986) = 0.0329
4. **Parent's Income Criteria** (cost)
   Positive Ideal Solution = min(0.091 Parent's Income Criteria 5, 0.2287, 0.0457, 0.1372, 0.0915) = 0.0457
   Negative Ideal Solution = max(0.0915, 0.2287, 0.0457, 0.1372, 0.0915) = 0.2287

3.5 Creating the Ideal Solution Distance

The first step in calculating the ideal solution distance is to square the difference between the weighted normalization matrix and the positive and negative ideal solutions

Table 8. Positive Ideal Solution Distance

Code	C1	C2	C3	C4
A1	(0.1721 - 0.1721)^2 = 0	(0.0707 - 0.1179)^2 = 0.0022	(0.0986 - 0.0986)^2 = 0	(0.0915 - 0.0457)^2 = 0.0021
A2	(0.1721 - 0.1721)^2 = 0	(0.1179 - 0.1179)^2 = 0	(0.0986 - 0.0986)^2 = 0	(0.2287 - 0.0457)^2 = 0.0335
A3	(0.0344 - 0.1721)^2 = 0.0189	(0.0471 - 0.1179)^2 = 0.005	(0.0986 - 0.0986)^2 = 0	(0.0457 - 0.0457)^2 = 0
A4	(0.1032 - 0.1721)^2 = 0.0047	(0.0707 - 0.1179)^2 = 0.0022	(0.0329 - 0.0986)^2 = 0.0043	(0.1372 - 0.0457)^2 = 0.0084

A5	(0.1376 - 0.1721)^2 = 0.0012	(0.1179 - 0.1179)^2 = 0	(0.0986 - 0.0986)^2 = 0	(0.0915 - 0.0457)^2 = 0.0021

Table 9. Negative Ideal Solution Distance

Code	C1	C2	C3	C4
A1	(0.1721 - 0.0344)^2 = 0.0189	(0.0707 - 0.0471)^2 = 0.0006	(0.0986 - 0.0329)^2 = 0.0043	(0.0915 - 0.2287)^2 = 0.0188
A2	(0.1721 - 0.0344)^2 = 0.0189	(0.1179 - 0.0471)^2 = 0.005	(0.0986 - 0.0329)^2 = 0.0043	(0.2287 - 0.2287)^2 = 0
A3	(0.0344 - 0.0344)^2 = 0	(0.0471 - 0.0471)^2 = 0	(0.0986 - 0.0329)^2 = 0.0043	(0.0457 - 0.2287)^2 = 0.0335
A4	(0.1032 - 0.0344)^2 = 0.0047	(0.0707 - 0.0471)^2 = 0.0006	(0.0329 - 0.0329)^2 = 0	(0.1372 - 0.2287)^2 = 0.0084
A5	(0.1376 - 0.0344)^2 = 0.0107	(0.1179 - 0.0471)^2 = 0.005	(0.0986 - 0.0329)^2 = 0.0043	(0.0915 - 0.2287)^2 = 0.0188

The second step is to calculate the ideal solution distance is to root the total value of the table above (positive and negative) for each alternative. The results and calculations can be seen in the following table:

Table 10. Ideal Solution Distance

Code	Positive	Negative
A1	$\sqrt{0 + 0.0022 + 0 + 0.0021}$= 0.0657	$\sqrt{0.0189 + 0.0006 + 0.0043 + 0.0188}$= 0.2066
A2	$\sqrt{0 + 0 + 0 + 0.0335}$= 0.183	$\sqrt{0.0189 + 0.005 + 0.0043 + 0}$= 0.1681
A3	$\sqrt{0.0189 + 0.005 + 0 + 0}$= 0.1547	$\sqrt{0 + 0 + 0.0043 + 0.0335}$= 0.1945
A4	$\sqrt{0.0047 + 0.0022 + 0.0043 + 0.0084}$= 0.1402	$\sqrt{0.0047 + 0.0006 + 0 + 0.0084}$= 0.1169
A5	$\sqrt{0 + 0.0022 + 0 + 0.0021}$= 0.0572	$\sqrt{0.0107 + 0.005 + 0.0043 + 0.0188}$= 0.197

3.6 Creating Preference Values.

The calculation of the preference value based on the distance of the positive and negative ideal solutions, namely:

Table 11. Preference Value

Code	Calculation	Results
A1	0.2066/(0.2066 + 0.0657)	0.7587
A2	0.1681/(0.1681 + 0.183)	0.4788
A3	0.1945/(0.1945 + 0.1547)	0.5569
A4	0.1169/(0.1169 + 0.1402)	0.4547
A5	0.2066/(0.2066 + 0.0657)	0.7587

3.7 Ranking

The ranking is based on the value of the greatest preference of each student, namely

Table 12. Ranking

Rank	Code	Student	Preference
1	A5	Cassandra	0.7749
2	A1	John	0.7587
3	A3	Gonzales	0.5569
4	A2	Maria	0.4788
5	A4	Moriera	0.4547

Based on the results of calculations using the TOPSIS method, it is obtained that rank 1 with a preference value of 0.7749 is Cassandra's student, rank 2 with a preference value of 0.7587 is John's student, rank 3 with a preference value of 0.5569 is a Gonzales student, rank 4 with a preference value of 0. 4788 is a student Maria, ranked 5 with a preference value of 0. 4547 is a Moriera student. So based on these results, a ranking of underprivileged scholarships is obtained based on the ranking order above.

3.8 System Test Results

System testing is the most important thing that aims to find errors or deficiencies in the software being tested. The testing technique used is Black Box testing. testing focuses on the functional requirements of the software [9], [10]. The results of testing the use of the system can be seen in the following table::

Table 13. System Test

Student Data Input Test			
Input Data	**Scenario**	**Observation**	**Conclusion**
Input Student data, all fields are filled in completely and correctly	Data stored in database	Data stored in database	Ok
Incomplete input data/one of the fields is not filled	Data is not stored, into the database	A warning message appears "Please complete your input"	Ok
Decision Making Nomination Data Test			
Input Data	**Scenario**	**Observation**	**Conclusionn**
Input student data who will be nominated participants	Student data is not yet in the nomination data	Student data will be entered and the data is stored in the database	Ok
Input student data that participants will visit	Student data is already in the nomination data	A warning message "You have entered this student" and the item is not stored in the database.	Ok
Criteria Data Testing			
Input Data	**Scenario**	**Observation**	**Conclusion**
Input criteria value (%) from C1, C2, C3 and C4	Sum of values C1 + C2 + C3 + C4 = 100	Data stored in database	Ok
Input criteria value (%) from C1, C2, C3 and C4	Sum of values C1 + C2 + C3 + C4 >100	A warning message "Sorry, the total weight value exceeds 100" and the data is not stored in the database.	Ok
I input the value of the criteria (%) of C1, C2, C3 and C4	Sum of values C1 + C2 + C3 + C4 <100	A warning message "Sorry, the total weight value is less than 100" and the data is not stored in the database.	Ok

4. CONCLUSION

The results of the calculation of the selection of scholarships for underprivileged students using the Technique for Order of Preference by Similarity to Ideal Solution method, it is obtained that for rank 1 with a preference value of 0.7749 is Cassandra student, rank 2 with a preference value of 0.7587 is John's student, rank 3 with a preference value of 0.5569 is Gonzales students, rank 4 with a preference value of 0. 4788 are Maria students, rank 5 with a preference value of 0. 4547 are Moriera students. So based on these results, a ranking of underprivileged scholarships is obtained based on the ranking order above. The results of these tests can be concluded that the application for the Selection of Underprivileged Students Scholarships went well and produced the appropriate results. So that it can facilitate staff performance and can help homeroom teachers and school principals in making decisions.

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