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Application of the TOPSIS Method in a Decision Support System for Selecting Scholarship Recipients from Low-Income Backgrounds at Higher Education Institutions

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Abstract

Providing scholarships to underprivileged students is a strategic step to increase access to higher education. However, in its implementation, the selection process often encounters obstacles, such as subjectivity in assessments and a high number of applicants. This study aims to design a Decision Support System (DSS) to determine scholarship recipients using the Technique for Order Preference by Similarity to the Ideal Solution (TOPSIS) method. This method was chosen because it is able to produce alternative rankings based on their proximity to the positive ideal solution and their distance from the negative ideal solution. The criteria used include parental income (C1), number of dependents (C2), Grade Point Average (GPA) (C3), monthly family expenses (C4), and housing conditions or residence status (C5). The alternatives implemented consisted of 20 students who had met the administrative requirements. The data processing process was carried out through several stages, namely normalizing the decision matrix, assigning weights to the criteria, determining the ideal solution, and calculating preference values to obtain the final ranking. The results of the study indicate that the TOPSIS method is able to produce a more objective, systematic, and transparent selection process. Therefore, this SPK is expected to assist higher education institutions in more precisely targeting scholarship recipients according to established criteria.

Keywords: Decision Support System, TOPSIS, Scholarships, Criteria, Ranking

INTRODUCTION

Education is a crucial aspect of enhancing the quality of human resources. However, not all university students possess the financial means to sustain their higher education studies. Consequently, scholarship programs for underprivileged students serve as a vital solution to help

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alleviate the burden of educational costs. In practice, the process of selecting scholarship recipients often encounters various challenges, such as a high volume of applicants and a diverse set of criteria that must be considered. Furthermore, manual selection processes are prone to subjectivity and a lack of transparency, and they are relatively time-consuming, potentially resulting in decisions that do not effectively target the intended beneficiaries.

To address these issues, a system capable of supporting objective, efficient, and accurate decision-making is required. A Decision Support System (DSS) offers an effective solution to assist scholarship administrators in determining recipients based on established criteria. One method applicable within a DSS is the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS). This method ranks alternatives based on their proximity to the positive ideal solution and their distance from the negative ideal solution. Implementing this method is expected to make the selection process more objective and structured.

In this study, the criteria employed include parental income, the number of parental dependents, Grade Point Average (GPA), monthly expenses, and housing conditions. By considering all these criteria, the selection outcomes are expected to be more accurate and better aligned with the circumstances of students who are truly in need. Against this backdrop, this research aims to design and develop a Decision Support System for selecting scholarship recipients among underprivileged university students using the TOPSIS method.

TINJAUAN PUSTAKA

A Decision Support System (DSS) is an interactive, computer-based system that assists in decision-making by utilizing models and data (Sitepu & Astawa, 2025). DSS can enhance the effectiveness and efficiency of the decision-making process, particularly within dynamic and complex environments. These systems are characterized by their flexibility and interactivity, as well as their ease of customization to user needs, enabling them to adapt to a wide range of problems (Tera, 2025). Decision Support Systems (DSS) emphasize the importance of facilitating the decision-making process more effectively, particularly when dealing with complex and unstructured problems[3][4][5][6][7]. (Hasan et al., 2025), (Munir et al., 2025),(Yacob et al., 2025), (Nainggolan & Asrani, 2024) ,(Rizki et al., 2025).

1. DSSs possess four key characteristics:
2. DSSs are designed to assist decision-makers in solving semi-structured problems.
3. DSSs are designed with a user-friendly interface.
4. DSSs are designed with an emphasis on flexibility and high adaptability.

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5. DSSs are designed with the aim of supporting independent decision-making (Lim & Pratama, 2025).

Technique For Other Reference by Similarity to Ideal Solution (TOPSIS) merupakan sebagian dari metode SPK yang dikembangkan Yoon serta Hwang (Putri & Hidayat, 2018).

The TOPSIS method was first introduced by Hwang and Yoon in 1981 and remains widely used in multi-criteria decision-making due to its calculation process, which is relatively simple yet effective. The fundamental principle of TOPSIS relies on establishing two reference points: the positive ideal solution, representing the best possible condition, and the negative ideal solution, representing the worst. Each alternative is then evaluated based on its proximity to these two solutions. The best alternative is the one that is closest to the positive ideal solution and farthest from the negative ideal solution (Simanjorang et al., 2026), (Yuda & Widhiarso, 2025) , (Sari et al., 2024).

The TOPSIS method (used to identify the best alternative based on predetermined criteria, but does not determine priority weights that can be balanced with meaningful criteria to increase priority) [1]. Kelebihan ini memungkinkan TOPSIS menghasilkan peringkat yang objektif berdasarkan evaluasi multi-kriteria. TOPSIS memiliki kemampuan analisis yang cepat dan akurat dalam mengintegrasikan data penilaian kinerja dari berbagai indicator [13][14][15]. (Dermawan et al., 2025) ,(Faizal, 2025) (Damanik,2025 n.d.) The steps for solving a problem using the TOPSIS method comprise several stages (Ersada & Khair, 2025).

METHOD

To address the selection of scholarship recipients for underprivileged students in higher education using the TOPSIS method, a systematic research methodology is required to achieve optimal results. The steps involved in this research include:



Figure 1. Research Methodology

The following are the steps of the TOPSIS method for determining the final result:

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1. Create a normalized decision matrix using the formula:

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

   Dengan,

   r = matriks keputusan ternormalisasi

   x = nilai alternatif
2. Calculate the weighted normalized value using the formula:

   $$y_{ij} = w_i . r_{ij}$$

   Where,

   y = weighted normalized decision matrix

   w = weights

   r = normalized decision matrix
3. Determine the positive ideal solution value using the formula:

   $$A^+ = (y_1^+, y_2^+, \dots, y_n^+)$$
4. Determining the negative ideal solution value using the formula:

   $$A^- = (y_1^-, y_2^-, \dots, y_n^-)$$
5. Determine the weighted value distances from the positive and negative ideal solutions using the equationn:

   $$D_i^+ = \sqrt{\Sigma_j^n} = i\,(y_1^+ - y_{ij})^2$$

   $$D_i^- = \sqrt{\Sigma_j^n} = i\,(y_{ij} - y_1^-)^2$$
6. Determine the preference value for each alternative, using the equation:

   $$V_1 = \frac{D_1^-}{D_1^- + D_1^+}$$

RESULTS AND DISCUSSION

a. Data processing within a Decision Support System (DSS) to determine scholarship recipients for underprivileged university students using the TOPSIS method involves analyzing student alternatives based on predefined criteria—such as parental income, number of dependents, Grade Point Average (GPA), monthly expenses, and housing conditions. The data is first organized into a decision matrix, normalized to standardize the varying scales across criteria, and then weighted according to the relative importance

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of each criterion. The subsequent stage involves determining the positive and negative ideal solutions to serve as a basis for evaluation, followed by calculating the distance of each alternative from these two solutions. The resulting values are used to compute preference scores, which guide the ranking of scholarship candidates, thereby ensuring the selection process is more objective, structured, and accurately targeted.

b. Data on scholarship recipients from low-income backgrounds using a sample of 20.

Kriteria	C1	C2	C3	C4	C5
Y1	4	2	5	5	4
Y2	5	3	4	3	5
Y3	5	4	4	4	4
Y4	5	4	4	3	3
Y5	3	2	4	3	4
Y6	2	5	3	4	5
Y7	3	5	3	3	3
Y8	2	4	4	2	2
Y9	1	3	5	3	3
Y10	1	4	4	5	4
Y11	1	3	5	4	5
Y12	5	4	4	3	2
Y13	5	4	5	5	3
Y14	5	4	3	3	4
Y15	5	5	4	3	4
Y16	4	3	5	4	4
Y17	3	3	4	4	5
Y18	4	4	3	4	5
Y19	3	1	4	4	5
Y20	4	4	4	4	3
	16,91153453	16,52271164	18,35755975	16,70329309	17,74823935

c. Determination of research criteria weight rankings

In this study, the author employs five criteria for assessment:

1. Parental Income (C1)
   Represents the parents' total monthly income, used to assess the student's family economic capacity.
2. Number of Parental Dependents (C2)
   Indicates the number of family members being supported, thereby influencing the economic burden that must be borne.
3. GPA (Grade Point Average) (C3)
   Represents the student's average academic score, reflecting their level of achievement and learning ability during their studies.
4. Family Monthly Expenses (C4)
   Represents the total costs incurred by the family each month for daily necessities.
5. Housing Condition / Residential Status (C5)
   Indicates the student's living situation—such as home ownership, renting, or staying with others—which reflects the family's socioeconomic condition.

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Table 2. Criterion Weight Values

Kriteria	bobot
Sangat Layak	5
Layak	4
Cukup Layak	3
Kurang Layak	2
Tidak Layak	1

Normalized decision matrix

Manual calculation is used to derive normalized values—specifically, by assigning decision values to the table of weights for each criterion based on pre-determined weight values.

Table 3. Decision Values

Kriteria	C1	C2	C3	C4	C5
Y1	16	4	25	25	16
Y2	25	9	16	9	25
Y3	25	16	16	16	16
Y4	25	16	16	9	9
Y5	9	4	16	9	16
Y6	4	25	9	16	25
Y7	9	25	9	9	9
Y8	4	16	16	4	4
Y9	1	9	25	9	9
Y10	1	16	16	25	16
Y11	1	9	25	16	25
Y12	25	16	16	9	4
Y13	25	16	25	25	9
Y14	25	16	9	9	16
Y15	25	25	16	9	16
Y16	16	9	25	16	16
Y17	9	9	16	16	25
Y18	16	16	9	16	25
Y19	9	1	16	16	25
Y20	16	16	16	16	9

After determining the values in the decision matrix based on each criterion, the next step is to assign weights to each criterion, as shown in the following table.

Table 4. Criterion Weights

C1	C2	C3	C4	C5
5	4	3	2	1

The next step is to perform calculations to generate the normalization table shown below.

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Table 5. Normalization Data

No	C1	C2	C3	C4	C5
Y1	0,236524958	0,121045507	0,272367355	0,29934217	0,225374468
Y2	0,295656198	0,18156826	0,217893884	0,179605302	0,281718085
Y3	0,295656198	0,242091013	0,217893884	0,239473736	0,225374468
Y4	0,295656198	0,242091013	0,217893884	0,179605302	0,169030851
Y5	0,177393719	0,121045507	0,217893884	0,179605302	0,225374468
Y6	0,118262479	0,302613766	0,163420413	0,239473736	0,281718085
Y7	0,177393719	0,302613766	0,163420413	0,179605302	0,169030851
Y8	0,118262479	0,242091013	0,217893884	0,119736868	0,112687234
Y9	0,05913124	0,18156826	0,272367355	0,179605302	0,169030851
Y10	0,05913124	0,242091013	0,217893884	0,29934217	0,225374468
Y11	0,05913124	0,18156826	0,272367355	0,239473736	0,281718085
Y12	0,295656198	0,242091013	0,217893884	0,179605302	0,112687234
Y13	0,295656198	0,242091013	0,272367355	0,29934217	0,169030851
Y14	0,295656198	0,242091013	0,163420413	0,179605302	0,225374468
Y15	0,295656198	0,302613766	0,217893884	0,179605302	0,225374468
Y16	0,236524958	0,18156826	0,272367355	0,239473736	0,225374468
Y17	0,177393719	0,18156826	0,217893884	0,239473736	0,281718085
Y18	0,236524958	0,242091013	0,163420413	0,239473736	0,281718085
Y19	0,177393719	0,060522753	0,217893884	0,239473736	0,281718085
Y20	0,236524958	0,242091013	0,217893884	0,239473736	0,169030851

Based on the calculation results, the maximum and minimum values for each criterion are subsequently determined, as shown in the following table.

Table 7. Maximum and minimum values from weighted normalization

MAX	0,2956562	0,6052275	0,8171021	1,1973687	1,4085904
MIN	0,0591312	0,1210455	0,4902612	0,4789475	0,5634362

The next step involves calculating the positive and negative ideal solution matrices by aggregating the values for each criterion derived from the weighted normalized matrix. The maximum value for each criterion is used for the positive ideal solution, while the minimum value is used for the negative ideal solution. Subsequently, these weighted values are squared during the calculation process to obtain the desired final result.

Table 8. Distances to Positive and Negative Ideal Solutions

Tabel Hasil Nilai D-	
DY1-	0,993244593
DY2-	0,955453678
DY3-	0,87256485
DY4-	0,592647582
DY5-	0,65585993
DY6-	1,08701662
DY7-	0,620589235
DY8-	0,402560261
DY9-	0,549677846
DY10-	0,99607415
DY11-	1,053142621
DY12-	0,521407796
DY13-	0,94346766
DY14-	0,750080113
DY15-	0,831799561
DY16-	0,862410873
DY17-	1,021262307
DY18-	1,052146881
DY19-	0,992153537
DY20-	0,706256791

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The final stage of the TOPSIS method is calculating the preference value for each alternative using the equation in formula number 7—specifically, by dividing the negative ideal value by the sum of the negative ideal value and the positive ideal value—as shown in the following table:

Table 9. Preference Values

TABEL HASIL NILAI Vi	
V1	0,681876582
V2	0,630063874
V3	0,67402976
V4	0,435899905
V5	0,485955559
V6	0,710779635
V7	0,431655676
V8	0,260708742
V9	0,403301625
V10	0,703247343
V11	0,717521501
V12	0,344414334
V13	0,620800616
V14	0,533484623
V15	0,589514698
V16	0,659184229
V17	0,720695979
V18	0,711324523
V19	0,632445439
V20	0,521580476

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Table 9. Preference Values

Alternatif	Preferensi	Rekomendasi
V1	0,681876582	
V2	0,630063874	
V3	0,67402976	
V4	0,435899905	
V5	0,485955559	
V6	0,710779635	Rekomendasi 4
V7	0,431655676	
V8	0,260708742	
V9	0,403301625	
V10	0,703247343	Rekomendasi 5
V11	0,717521501	Rekomendasi 2
V12	0,344414334	
V13	0,620800616	
V14	0,533484623	
V15	0,589514698	
V16	0,659184229	
V17	0,720695979	Rekomendasi 1
V18	0,711324523	Rekomendasi 3
V19	0,632445439	
V20	0,521580476	

The table above presents the calculated preference values for each alternative (V1 through V20) within the decision support system for scholarship recipient selection using the TOPSIS method. These preference values are derived from calculating each alternative's proximity to the ideal solution; consequently, a higher preference value indicates a greater level of suitability for an alternative to be recommended as a scholarship recipient. Based on the ranking results, alternative V17 holds the highest preference value (0.720695979), making it the top recommendation. This is followed by V11 (0.717521501) as the second recommendation, V18 (0.711324523) as the third, V6 (0.710779635) as the fourth, and V10 (0.703247343) as the fifth. These five alternatives represent the best candidates according to the TOPSIS calculations. Meanwhile, the remaining alternatives possess lower preference values, placing them lower in the rankings and outside the primary priority group for scholarship recipients. Thus, these results demonstrate that the TOPSIS method facilitates an objective and quantifiable selection process for identifying scholarship recipients from underprivileged backgrounds.

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CONCLUSION

Based on the calculations performed using the TOPSIS method within the Decision Support System (DSS), preference values (Vi) were obtained for 20 scholarship candidate alternatives. The Vi value indicates the degree of closeness of each alternative to the positive ideal solution; thus, a higher Vi value signifies a higher priority for that alternative to be selected as a scholarship recipient. The ranking results show that alternative V17 achieved the highest preference value (0.720695979), thereby securing the top rank and being identified as the most suitable candidate. This was followed by V11 (0.717521501) and V18 (0.711324523), which also demonstrated high values and could be considered as subsequent recipients. Consequently, the TOPSIS method has proven capable of providing objective, systematic, and transparent ranking results based on established criteria—namely parental income, number of dependents, GPA, monthly expenses, and housing conditions. These results can serve as a basis for making accurate, targeted decisions regarding the selection of scholarship recipients from underprivileged backgrounds.

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