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Decision support system for new student selection at railako vocational technical school using the TOPSIS method

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Abstract

The student admission selection process is a crucial stage in ensuring the quality of education, yet it is often conducted manually, leading to inefficiency and subjectivity. This study aims to develop a Decision Support System (DSS) for new student selection at Railako Vocational Technical School using the TOPSIS method. Data were collected through observation, interviews, and literature study, while system development employed the SDLC Waterfall model with PHP and MySQL implementation. The system evaluates candidates based on multiple criteria, including academic test scores, interview results, distance, and age. The results show that the TOPSIS method successfully ranks candidates objectively, with preference values of 0.625 (A2), 0.509 (A1), and 0.034 (A3), where A2 is identified as the best alternative. The system improves selection efficiency and reduces subjectivity compared to manual methods. This study contributes by integrating TOPSIS into a web-based system and demonstrating its effectiveness in real-case student selection scenarios.

Keywords: Decision Support System; TOPSIS; Student Selection; PHP; MySQL.

1. Introduction

The development of information technology has had a significant impact on various sectors, including education, particularly in the selection process for new student admissions which aims to obtain quality prospective students [1]. However, in practice, the selection process is still often carried out manually using spreadsheets such as Microsoft Excel, which gives rise to various problems such as low efficiency, high levels of subjectivity, and the potential for errors in data processing and interpretation.

Decision Support Systems (DSS) are present as a solution to improve the quality of decision-making objectively and systematically, one of which is through the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method which is able to determine the best alternative based on proximity to the positive ideal solution and distance to the negative ideal solution [2]. However, based on a review of previous research, there are still several research gaps, namely the implementation of the TOPSIS method which is generally not integrated into a web-based system, limited application in real contexts, especially in vocational schools, and a lack of transparency in the resulting selection process.

Therefore, this research offers novelty in the form of developing a web-based decision support system for new student selection that integrates the TOPSIS method end-to-end, from data processing to the presentation of ranking results in a transparent and measurable manner. Furthermore, this research also contributes to real-world applications in vocational schools and a more objective analysis of selection results, which is expected to improve accuracy, efficiency, and accountability in the decision-making process.

2. Method

Method of collecting data

Data collection in this study was carried out using a qualitative and quantitative approach to obtain comprehensive information regarding the new student selection process [3]. The observation technique is carried out by directly observing the selection process taking place at school, especially in data processing and decision making [4]. Interviews were conducted with school officials involved in the selection process to obtain information regarding system requirements, assessment criteria, and challenges encountered with conventional selection methods. Furthermore, a literature review was conducted by reviewing various previous studies, scientific journals, and relevant references related to decision support systems and the TOPSIS method to strengthen the theoretical foundation of the research.

System development methods

The system development in this research uses the System Development Life Cycle (SDLC) approach with the Waterfall model, which is carried out in stages and systematically [5]. The first stage is needs analysis, which identifies user needs and existing problems in the existing student selection system. The second stage is system design, which includes the design of the system flow, database structure, and user interface that will be used in the web-based system. The next stage is implementation, which is the process of developing the system using the PHP programming language integrated with the MySQL database. After the system is developed, a testing phase is carried out to ensure that the system runs according to requirements and is error-free. The final stage is maintenance, which aims to maintain system performance and make improvements if problems are encountered in use.

Assessment criteria

The criteria used in the new student selection process are determined based on the results of interviews with the school and the needs of the selection system. These criteria consist of test scores (C1), interview scores (C2), distance from residence (C3), and age (C4). Criteria C1 and C2 are categorized as benefit criteria, where higher scores indicate better quality. Meanwhile, criteria C3 and C4 are categorized as cost criteria, where lower scores are preferred. Determining these types of criteria aims to ensure that the alternative evaluation process is carried out proportionally and in accordance with the selection objectives.

TOPSIS method

The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method is used in this study to determine the best alternative based on proximity to the ideal solution [6]. The TOPSIS calculation process involves several main stages. The first stage is normalizing the decision matrix to equalize the scale between criteria so they can be compared proportionally. The second stage is creating a weighted normalized matrix by multiplying the normalized value by the weight of each criterion, thus reflecting the level of importance of each criterion in decision-making.

The next stage is determining the positive ideal solution and the negative ideal solution, where the positive ideal solution represents the best condition for each criterion, while the negative ideal solution represents the worst condition. Next, the distance between each alternative and the two solutions is calculated to determine the level of closeness and distance between the alternatives to the ideal condition. The final stage is calculating the preference scores, which are used to determine the final ranking of the alternatives. The alternative with the highest preference score is selected as the best alternative in the student selection process.

Matrix normalization

Matrix normalization is the initial stage in the TOPSIS method which aims to equalize the scale between criteria so that they can be compared proportionally [7]. The normalization process is performed by dividing each alternative value by the square root of the sum of the values for the same criterion. This normalization results in values on a uniform scale, thus avoiding the dominance of certain criteria due to differences in units or value ranges. The normalization formula used is.

$$R_{ij} = \frac{X_{ij}}{\sqrt{\sum X_{ij}^2}} \tag{1}$$

Where:
R_{ij} = normalized value for the i-th alternative on the j-th criterion
X_{ij} = initial value (original data) of the ith alternative on the jth criterion
M = number of alternatives

Weighted normalized matrix

The weighted normalized matrix is the result of multiplying the normalized value by the weight of each criterion [8]. This step aims to incorporate the importance of each criterion into the alternative evaluation process. Thus, criteria with greater weight will have a more significant influence on the final outcome. This process ensures that decision-making is not based solely on the performance value of the alternatives but also considers the priority of each criterion used.

$$Y_{ij} = W_j \times R_{ij} \tag{2}$$

Where:
Y_{ij} = weighted normalized matrix values
W_j = weight of the jth criterion
R_{ij} = weight of the jth criterion

Ideal solution

- Positive ideal solution (A^+)
- Negative ideal solution (A^-)

Euclidean distance

In the TOPSIS method, Euclidean distance is used to measure the closeness of each alternative to the positive ideal solution (A^+) and the negative ideal solution (A^-) [9]. This concept is at the heart of the decision-making process, because the best alternative is the one that is closest to the positive ideal solution and furthest from the negative ideal solution [10]. The formula used is:

$$D_i^+ = \sqrt{\sum_{j=1}^{n} \left(Y_{ij} - Y_j^i\right)^2}\ D_i^- = \sqrt{\sum_{j=1}^{n} \left(Y_{ij} - Y_j^i\right)^2} \tag{3}$$

Where:
D_i^+ = distance of the i – th alternative to the positive ideal solution.
D_i^- = distance of the i – th alternative to the negative ideal solution.
Y_{ij} = weighted normalized matrix values.
Y_j^i = positive ideal solution value on the j – th criterion.
Y_i = negative ideal solution value on the j – th criterion.
n = number of criteria.

Euclidean distance is used to measure the level of closeness of each alternative to the positive ideal solution and the negative ideal solution [11]. This calculation is performed by calculating the difference between the weighted normalized matrix value and the ideal solution value for each criterion. The distance to the positive ideal solution value indicates how close the alternative is to the best condition, while the distance to the negative ideal solution indicates how far the alternative is from the worst condition [12]. The alternative with the smallest distance value from the positive ideal solution and the largest distance value from the negative ideal solution is considered the better alternative. The use of Euclidean distance in the TOPSIS method allows for a comprehensive evaluation of alternatives, because it simultaneously considers proximity and distance to two extreme conditions, namely the best and worst conditions [13].

$$D_i^+ and D_i^- \tag{4}$$

Where:
D_i^+ = distance of the i-th alternative to the positive ideal solution
D_i^- = distance of the i-th alternative to the negative ideal solution

Preference value

$$V_i = \frac{D_i^-}{D_i^- + D_i^+} \tag{5}$$

3. Results and Discussion

Calculation results

The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method is one of the methods in Multi-Criteria Decision Analysis (MCDA) which is used to determine the best alternative based on its proximity to the positive ideal solution and distance to the negative ideal solution [14]. This method is widely used in decision support systems because it is able to accommodate various criteria simultaneously and produce objective decisions [15]. In applying the TOPSIS method, the initial step is to determine the assessment criteria and their weights. The criterion weights (Wj) reflect the relative importance of each criterion in the decision-making process. Weight values are generally expressed on a scale of 0 to 1 or as a percentage (0%–100%), with higher values indicating higher importance. The criteria used in this study are arranged in tabular form to facilitate the alternative evaluation process. Table 1 criteria serves as a basis in the TOPSIS calculation process, so that each alternative can be compared objectively based on the predetermined criteria.

Table 1. Assessment criteria.

No	Code	Criteria	Weight	Remark
1	C1	Test scores	2	Benefit
2	C2	Interview score	3	Benefit
3	C3	Certificate	4	Benefit
4	C4	Age	5	Benefit

Criteria weights are values that indicate the relative importance of each criterion in the decision-making process. In the TOPSIS method, criterion weights are used to emphasize criteria that are considered more important, thereby influencing the final ranking of alternatives [16]. The weighting in this study was based on interviews with schools and considerations of new student selection needs. The weighting values are expressed as a proportion of a total of 1. The criteria weights used in this study are presented in Table 2.

Table 2. Weight.

No.	Weight	Remarks
C1	1-60	La liu
	61-100	Liu
C2	1-60	La liu
	61-100	Liu
C3	1-60	La liu
	61-100	Liu

Based on the matrix normalization results presented in Table 3, it can be observed that each alternative demonstrates different performance characteristics across the evaluated criteria. The VICENTE alternative exhibits relatively balanced and consistent normalized values on most criteria, particularly on criteria C2 and C4, indicating a stable performance in aspects considered important in the decision-making process. In contrast, CAMILO achieves the highest normalized value on criterion C1, suggesting superior performance in this specific aspect compared to the other alternatives. Meanwhile, DAMIAO records the highest score on criterion C3, reflecting its comparative advantage for that criterion. These findings indicate that no single alternative dominates all evaluation criteria

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simultaneously. Therefore, a more comprehensive assessment is required through the application of criterion weights and preference value calculations. This subsequent stage enables the integration of the relative importance of each criterion, resulting in an overall ranking that identifies the most suitable alternative based on the established decision-making model.

Table 3. Matrix normalization.

Elevasaun	57	54	47	65	
No	Alternative	C1	C2	C3	C4
1	Damiao	0,0877193	0,07407	0,127659574	0,061538462
2	Vicente	0,07017544	0,09259	0,106382979	
3	Camilo	0,10526316	0,0259		

Utility values are a numerical representation of the level of preference or performance of each alternative against each criterion. In the TOPSIS method, these values are used as initial data, which are then normalized to eliminate scale differences between criteria. Table 4 presents the initial values for each alternative based on the predetermined criteria, which are then processed in the normalization and weighting stages to obtain the final preference values.

Table 4. Unity value.

No	Alternative	C1	C2	C3	C4
1	Damiao	5	4	6	5
2	Vicente	4	5	5	6
3	Camilo	6	5	4	5

The decision matrix normalization process is carried out to eliminate scale differences between criteria so that they can be compared proportionally. The normalization value is obtained by dividing each alternative value by the square root of the sum of the squares of each criterion. Based on Table 5, it can be seen that the highest normalization value for criterion C1 is owned by alternative CAMILO at 0.1053, while for criterion C3 the highest value is owned by DAMIAO at 0.1277. Meanwhile, VICENTE shows a relatively stable value across all criteria, especially in C2 and C4. These results indicate that each alternative has advantages on certain criteria, so the weighting stage and preference calculation are needed to determine the best alternative overall.

Table 5. TOPSIS normalization calculation results.

Criteria	Devider ($\sqrt{\Sigma x^2}$)	Alternative	Initial Value (Xij)	Normalization Value
C1	57	Damiao	5	0.0877193
		Vicente	4	0.07017544
		Camilo	6	0.10526316
C2	54	Damiao	4	0.07407
		Vicente	5	0.09259
		Camilo	5	0.09259
C3	47	Damiao	6	0.127659574
		Vicente	5	0.106382979
		Camilo	4	0.085106383
C4	65	Damiao	4	0.061538462
		Vicente	6	0.092307692
		Camilo	5	0.076923077

Based on the normalization matrix in Table 6, it can be seen that each alternative has a different value for each criterion. Alternative A3 (CAMILO) has the highest value for criterion C1, while A1 (DAMIAO) excels in criterion C3. Meanwhile, A2 (VICENTE) shows relatively stable performance and has the highest values for criteria C2 and C4. This indicates that there is no dominant alternative for all criteria, so a multi-criteria decision-making method such as TOPSIS is needed to objectively determine the best alternative. Consistency of values across various criteria is an important indicator in determining the best alternative in the TOPSIS method.

Table 6. R Matrix.

Alternative	C1	C2	C3	C4
A1 (Damiao)	0.0877	0.0741	0.1277	0.0615
A2 (Vicente)	0.0702	0.0926	0.1064	0.0923
A3 (Camilo)	0.1053	0.0926	0.0851	0.0769

The weighted normalization matrix is calculated by multiplying each value in the normalization matrix (R) by the weight of each criterion. This step aims to assign a level of importance to each criterion so that it can influence the final decision-making outcome. The formula used is as follows:

$$Y_{ij} = W_j \times R_{ij}$$

$$Y_{ij} = \text{weighted matrix value}$$

$$W_j = \text{criteria weight}$$

$$R_{ij} = \text{normalization value}$$

Based on the results of the weighted normalization matrix calculation, it can be seen that each alternative has a different value for each criterion. Alternative A3 has the highest value for criterion C1, while A1 excels in criterion C3. Meanwhile, A2 shows a relatively stable value and has the highest values for criteria C2 and C4. This indicates that the weighting of the criteria has a significant influence on the results of the alternative evaluation, so the next step is necessary, namely determining the ideal solution to obtain the best alternative. The results of the weighted normalization matrix calculation are presented in Table 7.

Table 7. Weighted normalization matrix (Y).

Alternatif=ve	C1	C2	C3	C4
A1 (Damiao)	0.1754	0.2222	0.5106	0.3077
A2 (Vicente)	0.1404	0.2778	0.4255	0.4615
A3 (Camilo)	0.2105	0.2778	0.3404	0.3846

The positive ideal solution (A^+) is the best value for each criterion obtained from the weighted normalization matrix. For benefit-type criteria, the positive ideal value is determined based on the maximum value, while for cost-type criteria, it is determined based on the minimum value. Based on Table 8, the positive ideal solution values obtained are (0.2105, 0.2778, 0.3404, 0.4615). These values indicate the optimal conditions expected in the selection process, so that the alternative with the closest distance to A^+ will be the best candidate.

Table 8. Determination of positive ideal solution (A^+).

Criteria	Value Alternative (Yij)	Operation	Value A^+
C1	0.1754 ; 0.1404 ; 0.2105	Max	0.2105
C2	0.2222 ; 0.2778 ; 0.2778	Max	0.2778
C3	0.5106 ; 0.4255 ; 0.3404	Min	0.3404
C4	0.3077 ; 0.4615 ; 0.3846	Max	0.4615

Table 9 shows the negative ideal solution (A^-) as the worst value for each criterion used as a comparison in the TOPSIS method. For benefit-type criteria, the A^- value is obtained from the minimum value, while for cost-type criteria, the A^- value is obtained from the maximum value. Based on the calculation results, the A^- values are (0.1404, 0.2222, 0.5106, 0.3077). These values represent the worst conditions that must be avoided by each alternative. Thus, the best alternative is the one that is furthest from the negative ideal solution and closest to the positive ideal solution.

Table 9. Negative ideal solution (A^-).

Criteria	Value (Yij)	Type	Operation	A^-
C1	0.1754 ; 0.1404 ; 0.2105	Benefit	Min	0.1404
C2	0.2222 ; 0.2778 ; 0.2778	Benefit	Min	0.2222
C3	0.5106 ; 0.4255 ; 0.3404	Cost	Max	0.5106

Criteria	Value (Yij)	Type	Operation	A^-
C4	0.3077 ; 0.4615 ; 0.3846	Benefit	Min	0.3077

Table 10 shows the distance to the positive ideal solution (D^+) used to measure the proximity of each alternative to the best condition. Based on the calculation results, the D^+ value for alternative A1 is 0.0618, A2 is 0.1103, and A3 is 0.1868. This value indicates that alternative A1 has the smallest distance from the positive ideal solution, making it closest to the optimal condition. Conversely, alternative A3 has the largest distance, indicating that it is the alternative furthest from the ideal condition. However, determining the best alternative is not only based on the D^+ value, but also considering the distance from the negative ideal solution (D^-).

Table 10. Calculation results.

Alternative	D^+ (Distance to A^+)
A1 (Damiao)	0.0618
A2 (Vicente)	0.1103
A3 (Camilo)	0.1868

Table 11 shows the distance to the negative ideal solution (D^-) used to measure how far each alternative is from the worst-case scenario. Based on the calculation results, the D^- values for alternative A1 are 0.1738, A2 0.1844, and A3 0.0067. These values indicate that alternative A2 has the greatest distance from the negative ideal solution, thus having the best ability to avoid the worst-case scenario. Conversely, alternative A3 has the smallest distance, indicating that it is closest to the worst-case scenario. Thus, alternative A2 performs better than the other alternatives based on the criteria used.

Table 11. Relationship between D^+ and D^- (Very important).

Alternative	D^+	D^-
A1	0.0618	0.1738
A2	0.1103	0.1844
A3	0.1868	0.0067

Table 12 uses preference values (V) to determine the final ranking of each alternative based on its proximity to the positive ideal solution and its distance from the negative ideal solution. The calculation results show that alternative A2 has the highest preference value, making it the best alternative in the selection process. This is because A2 has a good balance between proximity to the positive ideal solution and distance from the negative ideal solution. Meanwhile, alternative A3 has the lowest preference value because it is very close to the negative ideal solution and far from the positive ideal solution.

Table 12. Results of preference values.

Alternative	D^+	D^-	Preference Value (V)	Ranking
A1 (Damiao)	0.0618	0.1738	0.5095	2
A2 (Vicente)	0.1103	0.1844	0.6257	1
A3 (Camilo)	0.1868	0.0067	0.0344	3

Based on Table 13, the highest preference value was obtained by alternative A2 at 0.6257, followed by A1 at 0.5095, and A3 at 0.0344. This indicates that A2 is the best alternative in the new student selection process. A high preference value indicates that the alternative has a greater proximity to the positive ideal solution and a greater distance from the negative ideal solution. Thus, the TOPSIS method is able to provide objective ranking results based on predetermined criteria. The results of this study indicate that the TOPSIS-based approach is able to reduce subjectivity in the student selection process and increase transparency and accuracy in decision-making. The system developed also provides time efficiency compared to manual methods.

Table 13. Main results.

Alternative	Preference Value (V)	Ranking
Damiao	0.5095	2
Vicente	0.6257	1
Camilo	0.0344	3

Discussion

The results of the study indicate that the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method is able to provide a systematic and objective selection process in determining the best prospective students. Based on the calculation stages, starting from normalization to determining the preference value, each alternative is evaluated quantitatively based on predetermined criteria. At the normalization stage, it is clear that each alternative has advantages in certain criteria. Camilo excels in criterion C1, Damiao in C3, while Vicente shows relatively stable performance in all criteria, especially in C2 and C4. This confirms that in multi-criteria cases, the alternative with the highest score on one criterion is not always the best overall.

After weighting, the influence of the criteria's importance level becomes more visible. Criteria with higher weights contribute significantly to the final results. In this study, the stability of Vicente's scores on highly weighted criteria is the main factor that improves his position compared to other alternatives. Analysis of the positive ideal solution (A^+) and negative ideal solution (A^-) shows that the best alternative is the one with the closest distance to A^+ and the furthest from A^-. The results of the distance calculation show that Damiao has the smallest D^+ value (closest to the ideal solution), but Vicente has the largest D^- value (farthest from the worst condition). This shows that proximity to the ideal solution alone is not enough, but must be balanced with the ability to move away from the worst case.

The final preference value (V) shows that Vicente obtained the highest score of 0.6257, followed by Damiao with 0.5095, and Camilo with 0.0344. These results indicate that Vicente is the most optimal alternative because it has the best balance between proximity to the ideal condition and distance from the worst condition. Overall, the results of this study confirm that the TOPSIS method is effective in handling multi-criteria decision-making problems, especially in the context of new student selection. In addition, the use of a TOPSIS-based system can increase transparency, consistency, and efficiency compared to manual selection methods that tend to be subjective.

4. Conclusion

Based on the research results, it can be concluded that the TOPSIS method was successfully implemented in a decision support system for new student selection at Railako Vocational Technical School. This method is able to process various criteria simultaneously and produce objective decisions based on mathematical calculations. The calculation results show that the Vicente alternative obtained the highest preference value of 0.6257 and was ranked first, followed by Damiao in second place with a value of 0.5095, and Camilo in third place with a value of 0.0344. This indicates that Vicente is the best candidate recommended in the selection process. Furthermore, this study proves that the TOPSIS method not only considers the superiority of one criterion, but also assesses the balance of performance across all criteria. Thus, this method is able to reduce subjectivity and increase accuracy in decision making. Further research is recommended to combine the TOPSIS method with other methods such as AHP or SAW to improve the accuracy of criteria weighting. In addition, system testing on a larger amount of data is also needed to test the method's consistency and scalability.

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