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Decision-Making System for KIP IAIN Bukittinggi Scholarship Recipients Using the SAW and TOPSIS Methods

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A B S T R A C T

The KIP scholarship is one of the scholarships available at IAIN Bukittinggi, and prospective recipients will be chosen based on the number of quotas available. Thus far, the selection process has been carried out by calculating the total value based on the sum of the percentages of each criterion arranged according to the level of importance. The procedure does not include a decision-making system for determining whether or not to accept the KIP scholarship. As a result, a decision support system is required to quickly and accurately determine which students are eligible for scholarships. In this research, the decision-making system compares the SAW and TOPSIS methods, with the latter using normalized weights in calculating the preference value as a determining value for alternative scholarship recipients to be selected. The SAW method was found to be more sensitive than the TOPSIS method in the data for the KIP scholarship 2020 recipients at IAIN Bukittinggi, with a sensitivity value of 96.87 compared to 81.96 for the TOPSIS method. Based on these findings, the SAW method can be recommended as a decision return system for KIP scholarship recipients to study at IAIN Bukittinggi the following year.

1. Introduction

Smart Indonesia Card (KIP) is one of the government's most recent initiatives to support education from elementary to tertiary levels. The KIP program is aimed at the lower middle class community in order to ensure that children can attend school properly. The KIP program is known as the KIP Lecture at the college level. Since 2020, high school students have been able to benefit from the KIP program, which allows them to continue their education in higher education. Due to various constraints, not all KIP participants are eligible for KIP educational assistance. Due to the imposed recipient quota limit, KIP recipients at State Islamic Religious Universities (PTKIN) will be re-selected to receive KIP education funding assistance at PTKIN.

The high rate of registration for the KIP program has created a challenge for PTKIN, which must select the right students to receive the KIP scholarship. Prospective students can apply as prospective recipients if they meet certain criteria. Furthermore, the recipients of the college KIP scholarships will be chosen by the university based on the qualifications proposed by the prospective recipients. In 2020, 1528 students registered as KIP recipients at IAIN Bukittinggi. According to the quota obtained by IAIN Bukittinggi for KIP 2020 recipients, only 250 students were able to pass as KIP scholarship recipients out of the total registrants. This means that only 16.36% of all applicants will be able to pass the selection process. Due to

the low pass rate in comparison to the number of applicants, the selection process must be carried out properly so that students who pass are students who truly deserve the scholarship.

IAIN Bukittinggi used a simple assessment method to determine the KIP scholarship 2020 recipients. Each selection criterion is assigned a percentage based on its importance. The total value is calculated by adding the percentage results of each standard, and it is then used to rank the criteria. Because this procedure does not employ a decision-making system, the ranking of prospective scholarship recipients' total value does not employ point normalization. In the literature study, there are several methods commonly used in Decision Making Systems (DSS), among which are the Simple Additive Weighting (SAW) method and the Technique for Order Preference by Similarity to Ideal Solution (TOPS) (TOPSIS).

Decision support systems (DSS) are information systems that aid in the preparation of unstructured and semi-structured problems by utilizing data to find solutions [1], while according to Yuspita [2] Interactive information systems that provide information, model, and manipulate data are known as decision support systems. a user-controlled support system that is flexible, adaptable, and provides quick answers. In implementing a decision support system, top management is expected to be faster in making decisions.

Previous research by Khasanah & Rofiah [3] about the scholarship recipient selection system using the Simple Additive Weighting (SAW) decision support method then Fauzan [4] about the decision support system for Bidik Misi scholarship recipients at POLIBAN using the WEB-based SAW method. While the use of the TOPSIS method in determining scholarship recipients has been studied by Wang et al [5] with the title of research on decision support systems for the selection of BBP-PPA scholarship recipients using the TOPSIS method at the Faculty of Engineering, UNTAN and Sari & Purba [6] about the decision support system for selecting scholarship recipients using the TOPSIS method. According to the findings of these studies, both the SAW and TOPSIS methods are capable of providing appropriate recommendations for scholarship recipients as well as assisting researchers in making scholarship recipient decisions. Research with a comparison of the two methods, namely SAW and TOPSIS has also been carried out by Augusto et al [7] With the title comparison of the TOPSIS and SAW methods for determining the recipients of the DY SMA scholarships, it was discovered that the SAW method obtained a higher accuracy result of 65% compared to the TOPSIS method, which was only 60%.

In conducting the initial selection process for prospective KIP scholarship recipients, the decision-making system is an appropriate procedure. Based on data from KIP 2020 registrations, this study will compare the use of the SAW and TOPSIS methods for the decision-making system of prospective scholarship recipients at IAIN Bukittinggi. The best method is obtained from the method with the highest sensitivity value and will be used to determine KIP scholarship recipients, as well as recommended to top management at the IAIN Bukittinggi campus to determine students who are eligible to receive KIP scholarships the following year.

2. Method

2.1. Decision Support System

A decision support system is an information system that generates data aimed at solving a problem or assisting top management in making sound decisions. A decision support system is essentially a more advanced version of a computerized management system that is designed to be interactive with the user. According to Eniyati [8] To produce good decisions in a decision support system, it needs to be supported by quality information and facts, including: (1) Accessibility, accessibility is an attribute related to the ease of obtaining information, if information is easy to obtain, it will be more meaningful to the user because it will be related to the activity of the value of the information. (2) Completeness, this attribute refers to the completeness of the information content, which in this case includes not only the volume but also the suitability of the user's expectations, making this completeness difficult to quantify quantitatively. (3) Accuracy, this attribute refers to the level of error that may occur during the processing of large amounts of

data (volume). Calculation errors are the most common type of error. (4) Exactness, this attribute refers to the suitability of the information generated in relation to the user's needs. Like completeness, is extremely difficult to quantify quantitatively. (5) Punctuality, the timeliness and actualization of information also have a large impact on its quality. For example, daily planning information will be very useful if it is submitted every two days. (6) Clarity, this attribute refers to the manner in which information is delivered. Information presented in the form of graphs, histograms, or pictures is usually more meaningful to a leader than information presented in the form of long words. (7) Flexibility, this attribute refers to the degree to which the information produced is tailored to the requirements of various decisions to be made and a group of different decision makers.

2.2. *Research Framework*

The research framework is helpful in planning the stages that will be followed when conducting research. Each stage is completed as planned. As a result, all stages of this study's research framework influence the next stage. The following is an Figure of the research framework:

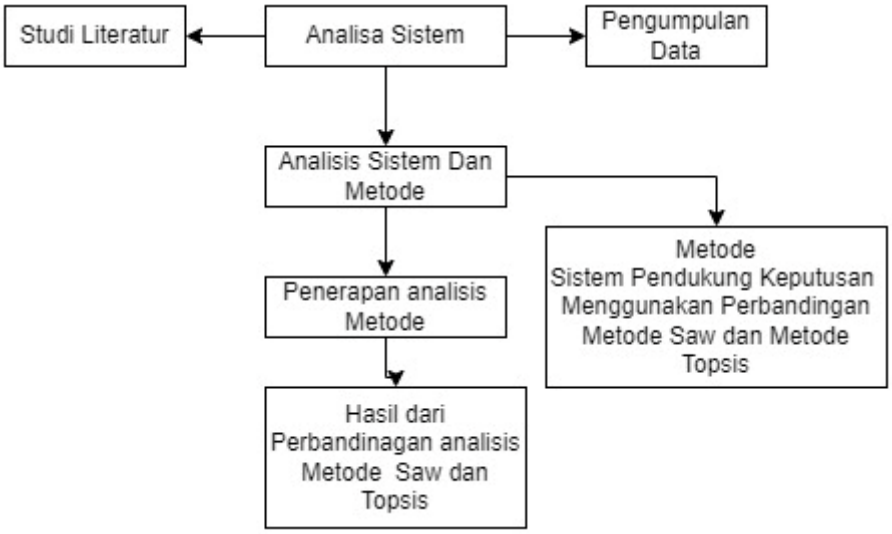

Figure 1. Research Framework

2.3. *System Analysis*

System analysis in data collection is carried out in accordance with the previous framework of thought, namely in a variety of ways or methods: (1) Study of literature, the process of studying the literature is carried out by searching for information and conducting a literature study in order to collect information about the methods used in determining the method in the right decision support system in determining scholarships. (2) Interview, the interview is conducted by asking several questions to the head of academic and student affairs (AKAMA) at IAIN Bukittinggi about the awarding and determining of attributes for the selection of KIP scholarship recipients.

System analysis is an important stage in which data is transformed from writings in the form of interviews or observation notes into data that contains the researcher's interpretation and understanding, as well as the relationship with the theory and substance of the research topic. The Decision Support System Analysis using the Comparison of SAW and Topsis Methods was used in this research.

2.4. *SAW Method*

The Simple Additive Weighting (SAW) method is one of the methods in the Decision Support System (DSS). Because the ranking results are obtained by weighted summation of the performance ratings or criteria for each alternative, this method is also known as the weighted addition method [7],[9],[10] This method is also known as the weighted addition method because the ranking results are obtained by a

weighted sum of the performance ratings or criteria for each alternative [3]. By determining the type of attribute of each criterion, a normalized matrix can be formed. The criteria contasin two types of attributes: benefit attributes and cost attributes. The normalized matrix value is then calculated using the formula:

$$R_{ij} = \begin{cases} \frac{x_{ij}}{Max\,(x_{ij})}, if\ j\ is\ attribute\ benefit \\ \frac{Min(x_{ij})}{x_{ij}}, if\ j\ attribute\ cost \end{cases} \quad .....(1)$$

R_{ij} : normalized criterion rating value

x_{ij} : attribute value of alternative to i criteria to j

$Max(x_{ij})$: the greatest value of each criterion

$Min(x_{ij})$: the smallest value of each criterion

$benefit$: if the biggest value is the best

$\mathrm{cos}t$: if the smallest value is the best

The ranking is obtained by calculating the preference value on the normalized matrix using the following formula:

$$V_i = \sum_{j=1}^{n} W_j R_{ij} \quad .....(2)$$

V_i : preference value for each alternative

W_j : point value of each criterion

R_{ij} : normalized criterion rating value

The preference values for each alternative V_i can then be sorted from highest to lowest to obtain an alternative ranking. The ranking results are then used as needed. The following flowchart diagram can be used to analyze decision making when using the SAW method:

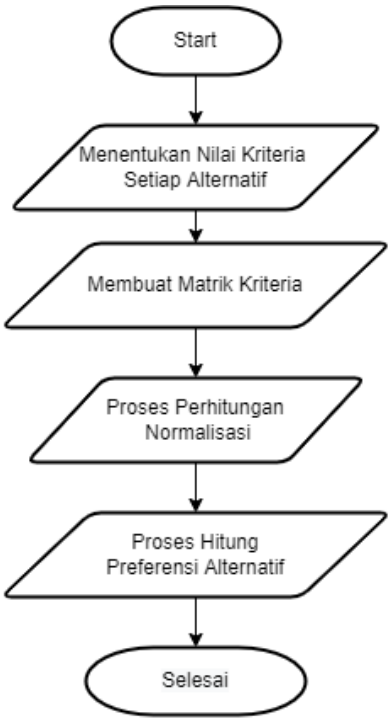

Figure 2. Flowchart of The Calculation Analysis Diagram of The SAW Method

2.5. TOPSIS Method

The TOPSIS method makes decisions on alternatives based on the principle that the chosen alternative is the closest to the positive ideal solution and the furthest/longest distance from the negative ideal solution from a geometric standpoint, by using Euclidean distance (distance between two points) to determine the relative proximity of a relative solution. The alternative solution with the shortest distance from the positive ideal solution does not have to be the alternative solution with the greatest distance from the negative ideal solution [11], [12]. These conditionss are taken into account simultaneously in the TOPSIS method, resulting in better results. The first step in calculating the TOPSIS method is to determine the decision matrix's normalization by calculating the normalized value using the following formula.

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \quad .....(3)$$

The value of the normalized criterion rating is represented by r_{ij} and the attribute value of the ith alternative of the jth criterion is symbolized by x_{ij}. The decision matrix's normalized weight is determined next by calculating the normalized weight value using the normalized criterion rating value. r_{ij} using the formula below.

$$Y_{ij} = w_j r_{ij} \quad .....(4)$$

The normalized point value is symbolized by Y_{ij}, futher w_j is the point value of the jth criteria and r_{ij} is an evaluation of normalized criteria. Then the positive ideal solution matrix is determined by $A^+ = \{y_1^+, y_2^+, ..., y_n^+\}$ and the negative ideal solution matrix $A^- = \{y_1^-, y_2^-, ..., y_n^-\}$ with value y_j^+ and y_j^- obtained from:

$$y_j^+ = \begin{cases} max\, y_{ij}, if\, j\, attribute\, benefit \\ min\, y_{ij}, if\, j\, attribute\, cost \end{cases} \quad .....(5)$$

and

$$y_j^- = \begin{cases} min y_{ij}, if\, j\, attribute\, benefit \\ max\, y_{ij}, if\, j\, attribute\, cost \end{cases} \quad .....(6)$$

Following the formation of a positive and negative ideal solution matrix, the distance between the values of each alternative can be calculated using the following formula.

$$D_i^+ = \sqrt{\sum_{i=1}^{n} \left(y_{ij} - y_j^+\right)^2} \quad .....(7)$$

and

$$D_i^- = \sqrt{\sum_{i=1}^{n} \left(y_{ij} - y_j^-\right)^2} \quad .....(8)$$

The final step is to compute the preference value for each option. The preference value is calculated as follows:

$$v_i = \frac{D_i^-}{D_i^+ + D_i^-} \quad .....(9)$$

Based on the preference value, we can rank and select alternatives based on the ranking. The TOPSIS method can be used to perform analysis calculations using a decision-making system, as shown in the flowchart diagram below.

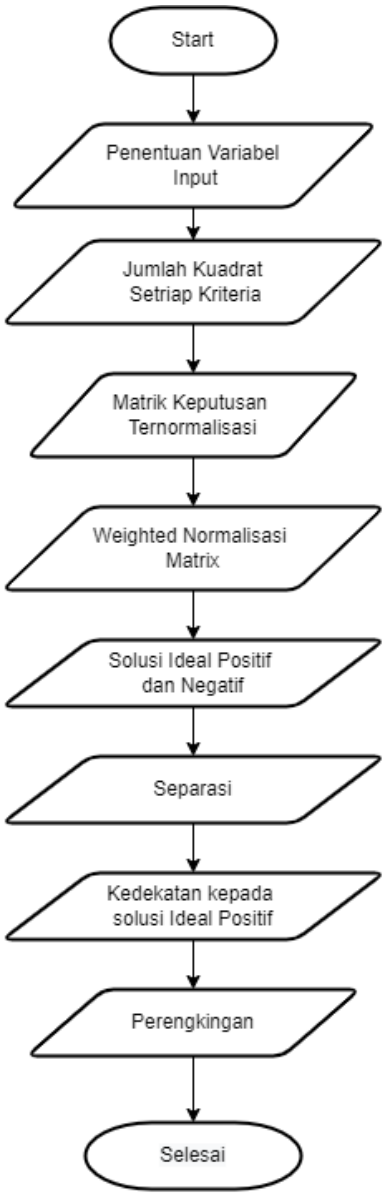

Figure 3. Flowchart of The Calculation Analysis Diagram of The SAW Method

2.6. Sensitivity Test

The sensitivity test is used to compare the two methods in the decision-making system. The sensitivity test reveals which method is more sensitive and provides better ranking results. There are several methods for testing sensitivity. Kusmiyanti et al in Sudipa & Puspitayani [13] revealed that the sensitivity test is computed using the smallest range of several existing values and variables. Based on this value, the sensitivity test can be calculated in three ways, namely by subtracting the preference value of the first alternative from the preference value of the second alternative using the formula:

$$Sensitivity = X_a - X_b \quad \text{.....(10)}$$

Value X_a is the first alternative's preference value, whereas X_b is the second alternative's preference value. The second sensitivity value is calculated by dividing the preference value of the first alternative by the total value of the overall preference. that is:

$$Sensitivity = \frac{X_a}{\sum_{i=1}^{n} X_i} \quad \text{.....(11)}$$

The average of the first and second alternative preference values can be used to calculate the third sensitivity value:

$$Sensitivity = \frac{1}{2}(X_a + X_b) \quad \text{.....(12)}$$

Roestam [14] the sensitivity test was performed by changing the point of the criteria. Changes in the point of each criterion are made by increasing or decreasing the point and then assessing the change in the preference value ranking based on the point change results. Yusnaeni & Ningsih [15] explains how to perform a sensitivity test, which includes first determining all attribute points, then increasing points on one attribute while the others remain, then continuing the calculation using the SAW and TOPSIS method procedures, and finally calculating the percentage of total changes in the first alternative value when the points are replaced with the original points. Sudipa & Puspitayani [13] explains how to perform a sensitivity test, which includes first determining all attribute points, then increasing points on one attribute while the others remain, then continuing the calculation using the SAW and TOPSIS method procedures, and finally calculating the percentage of total changes in the first alternative value when the points are replaced with the original points.

3. Results and Discussion

Secondary data in the form of prospective KIP scholarship recipients in 2020 obtained from the archives of AKAMA IAIN Bukittinggi was used in this research. The data set included 484 students who were used as an alternative to the analysis method, with each having 12 criteria, shown in Table 1.

Table 1. Assessment Criteria

No	Criteria
1	Father status
2	Mother status
3	Father's occupation
4	Mother's occupation
5	Father's Education
6	Mother's education
7	The number of dependents
8	Parents' Income
9	Raskin Status
10	Score Average
11	Memorizing Status (Hafidz)
12	Home Electric Power

Each value of the criteria of each alternative is converted into a value range of 1-5, with 1 being very low, 2 being low, 3 being sufficient, 4 being high, and 5 being very high. Each Criteria is a benefit attribute. The scholarship recipients are then chosen by sorting the results of preference values using the SAW and TOPSIS methods. Each criterion is assigned a point that will be used to calculate the preference value for both the SAW and TOPSIS methods. The points that were used are listed in the Table 2 below.

Table 2. Decision Making Criteria Along With Points

No	Criteria	Criteria Code	Priority Scale	Point
1	Father status	K1	Low	2
2	Mother status	K2	Low	2
3	Father's occupation	K3	Moderate	3
4	Mother's occupation	K4	Moderate	3
5	Father's Education	K5	Low	2
6	Mother's education	K6	Low	2
7	The number of dependents	K7	Very High	5
8	Parents' Income	K8	Very High	5
9	Raskin Status	K9	Very High	5
10	Score Average	K10	Very High	5
11	Memorizing Status (Hafidz)	K11	Moderate	3
12	Home Electric Power	K12	Low	2

A decision-making analysis is then performed on the 484 alternatives with the 12 decision-making criteria listed above, by calculating the preference value for each alternative using the SAW and TOPSIS methods. Table 3 shows the results of the preference values for the two methods:

Table 3. Results of Preference Values for SAW and TOPSIS Metode Methods

Alternative	SAW Preference Value	SAW Rank	TOPSIS Preference Value	TOPSIS Rank
1	29,33333333	7	0,4946	2
2	28,58333333	9	0,456229	6
3	28	22	0,463977	5
4	29,91666667	3	0,477947	3
5	30,75	2	0,465805	4
...	...	...	...	...
480	19,1	482	0,170574	480
481	19,36666667	479	0,225674	481
482	19,36666667	478	0,224427	482
483	17,7	484	0,197901	483
484	18,23333333	483	0,159701	484

For each alternative, the preference values are sorted from highest to lowest. Ranking is required to determine which alternative will receive the KIP scholarship. Sensitivity testing is then performed on both the SAW and TOPSIS methods to determine which one provides the best decision results for scholarship recipients. Table 4 shows that the SAW method has the lowest sensitivity value compared to the TOPSIS method, which is 0.002642572, indicating that the SAW method is the best method for determining alternative recipients of KIP data scholarships in 2020.

Table 4. Total Sensitivity of SAW and TOPSIS Methods

	SAW Method	TOPSIS Method
Sensitivity 1	0,216666667	0,092816957
Sensitivity 2	0,002642572	0,003795464
Sensitivity 3	30,85833333	0,541008833

Furthermore, the sensitivity test can be performed by calculating the sensitivity percentage, which is accomplished by changing the points on each criterion and then calculating the change in preference value on the first alternative from the change in points with the preference value when the initial points are applied.

Table 5. Changes in Ranking Based on Changes in Points

Criteria	Changes in the Value of the First Alternative SAW Method	Many Changes in the SAW Method's Ranking	First Alternative Value Change TOPSIS Method	TOPSIS Method Ranking Many Changes
K1 +0,5	28,33333	471	-0,82317	265
K1 +1	78,33333	465	-1,76433	383
K2 +0,5	16,66667	472	-1,28244	251
K2 +1	33,33333	473	-2,69751	293
K3 +0,5	30	462	-0,02992	454
K3 +1	78,33333	474	-0,06309	467
K4 +0,5	50	470	0,329829	440
K4 +1	100	471	0,698587	440
K5 +0,5	50	472	-0,08112	426
K5 +1	100	462	-0,17928	462
K6 +0,5	33,33333	467	0,134088	417
K6 +1	66,66667	468	0,295808	458
K7 +0,5	50	472	-0,3501	459
K7 +1	100	468	-0,71838	477
K8 +0,5	37,5	463	-0,11752	453
K8 +1	78,33333	477	-0,24045	449
K9 +0,5	50	473	-0,36077	400
K9 +1	100	460	-0,74495	426
K10 +0,5	50	471	-0,28252	304
K10 +1	100	469	-0,58202	405
K11 +0,5	12,5	475	2,726177	405
K11 +1	25	475	5,191151	439
K12 +0,5	50	460	-0,12504	240
K12 +1	100	462	-0,27553	307
Total	1418,333	11252	-1,34248	9520
Percentage	14,18333		-0,01342	

The SAW method obtained a sensitivity percentage of 14.18 while the TOPSIS method obtained a sensitivity percentage of -0.013, implying that the SAW method has a higher sensitivity percentage value. Following that, the sensitivity value can be calculated based on the many changes in ranking after the points are replaced, yielding a sensitivity value of 96.87 for the SAW method and 81.96 for the TOPSIS method. As a result, when using the sensitivity value based on ranking changes, the SAW method outperforms the TOPSIS method.

The comparison of the decision system for the 2020 KIP scholarship recipients at IAIN Bukittinggi using two methods, namely SAW and TOPSIS, revealed that the SAW method is the best method in determining decisions. The best method is chosen based on the sensitivity value and the percentage of sensitivity. Based on these findings, decision makers for KIP scholarship recipients at IAIN Bukittinggi can use the SAW method as a guide in making scholarship recipient decisions.

4. Conclusion

The SAW method and the TOPSIS method decision-making systems can be used to select the 2020 KIP Scholarship recipients at IAIN Bukittinggi. Because points are used to calculate the preference value, the alternative rankings in the two methods produce different results. Sensitivity testing with various approaches was performed to determine the best method. The first method is to approach the preference value on the first and second alternatives; the SAW method yields the smallest sensitivity value of 0.002642572, while the TOPSIS method yields 0.003795464. The second approach is sensitivity testing, which involves calculating the change in preference value in the first alternative as the weight of each criterion is changed. The sensitivity percentage of the SAW method is 14.18, while the TOPSIS method is -0.013. In the third approach, the SAW method yields the highest value of 96.87 when the weight of each criterion is changed, while the TOPSIS method yields the lowest value of 81.96. Based on the results of the sensitivity test, it can be concluded that the SAW method is the best method, and it can be used as a recommendation for decision-making system methods for determining alternative KIP scholarship recipients at IAIN Bukittinggi.

Calculations were carried out in the SAW and TOPSIS methods in this research using Microsoft Excel software. The authors propose developing a system in making scholarship recipients' decisions using a programmed system to make it easier for the selection team to obtain alternative scholarship recipients without manually processing data in Microsoft Excel to support the implementation of the scholarship selection process, which is carried out every year.

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