Analysis of Application of the SAW, WP and TOPSIS Methods in Decision Support System Determining Scholarship Recipients at University

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Abstract. This research is an analysis of the application of the SAW, WP and TOPSIS methods to the support system for decision making at university. The types of scholarships provided are PPA education scholarships given by the Kementerian Riset, Teknologi dan Pendidikan Tinggi. The research variables are the attributes or criteria specified by the Directorate General of Learning and Student Affairs as contained in the 2018 Academic Achievement Improvement (PPA) guidebook. Decision Support Systems apply the classic FMADM method SAW, WP and TOPSIS. The results of this study are the application of the both methods of SAW and WP produce the same ranking and TOPSIS giving different rankings.

1. Introduction

In carrying out its activities, even if it is supported by the potential of ecosystems and all-prospective excesses, on the other hand, decision making is often faced with the main problem in determining strategic problems that are difficult to realize due to heterogeneous perceptions in line with the interests of each individual or group involved in decision making [1]. A person's ability to make decisions can be improved if he knows and controls the theory and decision-making techniques. With the existence of DSS, it can provide interactive tools that allow decision makers to carry out various analyzes of available models. Utomo [2], said that DSS is an information system that uses decision models, databases, and managers' own thinking, interactive modeling processes with computers to achieve decision making. Meanwhile, the system of decision making is an integral part of the totality of the overall organizational system. Organizational systems at least include physical systems (operational systems), management systems (decision systems), and information systems. To be able to help decision makers in providing recommendations, the application of the classic FMADM method consisting of SAW, WP and TOPSIS can be used in DSS. The FMADM method is to determine the weight values for each attribute, then proceed with a ranking process that will select alternatives that have been given [3]. With the ranking method, it is expected that the recommendation will be more appropriate because it is based on the criteria and weight values that have been determined so that the results will be more accurate. To do ranking, the SAW, WP and TOPSIS methods are first converted to fuzzy data into crisp data. If fuzzy data is given in linguistic form, then the data must be converted to a fuzzy number first, then convert to crisp number again [4]. DSS is a system that is built to solve various managerial or corporate organizational problems designed to develop the effectiveness and productivity of managers to solve
problems with the help of computer technology. Another thing that needs to be understood is that DSS is not to replace the manager's duties but only as a consideration for managers to determine the final decision. Based on the application of the three FMADM methods mentioned above, the question arises whether the three methods can provide recommendations for decision makers. Which method is more accurate in providing results, so that decision-makers can provide appropriate recommendations. In the research of college ranking application design using Fuzzy Simple Additive Weighting (SAW) with case studies 25 PT Wilayah Kopertis XIII Provinsi Aceh produce ranking of tertiary institutions with the first rank at Serambi Mekkah University with a value of 0.89 and the lowest STMIK Abulyatama with a value of 0.3 [5]. Research on the application of the TOPSIS method in determining scholarship recipients at STMIK Pelita Nusantara Medan provides results of the calculation of sequential final values that can help decision makers determine students who are eligible to receive scholarships [6]. Research on the selection of candidates for the BEM chair using the WP and SAW methods. Based on the calculation results, it was found that the use of these two methods in the selection of candidates for the BEM chair had the same ranking sequence [7].

2. Teori
2.1 Decision Support System (DSS)
Decision support systems are defined as computer application programs that analyze data and present it so that users can make easier decisions. Decision support system is an information application. A decision supporter can present information graphically and may include expert systems or artificial intelligence [8].

According to Turban [9] in his book entitled Introduction to Information technology, states that Decision Support Systems are a computer-based information system combining models and data to provide support to decision makers in solving semi-structure problems or dependency problems that involve users in depth.

2.3 SAW Method
The Simple Additive Weighting (SAW) method is often also known as the weighted addition method. The basic concept of the SAW method is to find the weighted sum of performance ratings on each alternative of all attributes [10]. The SAW method requires the process of normalizing the decision matrix (X) to a scale that can be compared with all available alternative ratings. As for the completion step in using it is:

1. Determine alternatives
2. Determine criteria that will be used as a reference in decision making.
3. Provide a match rating value for each alternative on each criterion.
4. Determine the preference weight or level of importance of each criterion.
5. Make a match rating table from each alternative on each criterion.
6. Make a decision matrix formed from a match rating table from each alternative on each criterion.
7. Perform normalization of decision matrices by calculating the average performance rating of the alternative criteria.
8. The results of the standardized performance rating form a normalized matrix
9. The final result of the preference value is obtained from the sum of the multiplication of normalized matrix line elements with preference weights corresponding to the elements of the matrix column. The results of calculating a larger value indicate that the alternative is the best alternative

2.4 WP Method
Weighted Product (WP) Method is a method that uses multiplication to connect attribute ratings, where the rating of each attribute must be raised first with the weight of the attribute in question. This process is the same as the normalization process.

The steps in calculating the Weighted product (WP) method are as follows [7]:
1. Normalization or improvement of weight
\[ w_j = \frac{w_j}{\sum_{j=1}^{n} w_j} \]  

Normalize to produce value where, value \( j = 1, 2, \ldots, n \), with \( n \) is the number of alternatives and \( \sum w_j \) is the total number of weights of the criteria.

2. Determine vector values \( S \)

\[ s_i = \prod_{j=1}^{n} x_{ij}^{w_{ij}} \]  

The vector value of \( S \) is obtained by multiplying all criteria with the weight that has been normalized. Where is the criteria preference, is the criteria value and is the number of criteria.

3. Determine vector values \( V \)

\[ v_i = \frac{\prod_{j=1}^{n} x_{ij}^{w_{ij}}}{\prod_{j=1}^{n} (x_{ij}^{w_{ij}}) w_{ij}} \]  

Determine the value of vector \( (V) \) where the vector is an alternative preference that will be used for ranking of each number of values of vector \( (S) \) with the sum of all vector values \( (S) \).

2.5 TOPSIS Method

The TOPSIS method provides a solution for a number of possible alternatives by comparing each alternative with the best alternative and the worst alternative that exists between alternative alternatives. The alternatives that have been ranked are then used as a reference for decision makers to choose the best solution they want. This method is widely used to resolve practical decision making. This is because the concept is simple and easy to understand, its computation is efficient, and has the ability to measure the relative performance of decision alternatives. Following are the steps of the TOPSIS method [3].

1. TOPSIS starts with building a decision matrix. \( X \) decision matrix refers to alternative \( m \) which will be evaluated based on \( n \) criteria.

2. Making normalized decision matrices.

3. Make a weighted normalized decision matrix.

4. Determine the matrix of ideal positive solutions and negative ideal solutions.

5. Calculating Equations.

6. Calculate proximity relative to positive ideal solutions.

7. Ranking Alternative.

3. Case Study

In this study, case studies were conducted at universities that would provide PPA education scholarships given by the Ministry of Research, Technology and Higher Education. The research variables are the attributes or criteria determined by the Direktorat Jenderal Pembelajaran dan Kemahasiswaan as stated in the 2018 PPA guidebook. The criteria (attributes) of the requirements that must be met by students to be determined as scholarship recipients are as follows [10]:

1. Minimum GPA value of 3.0 (C1)

2. The number of SKS that have been completed (C2)

   The SKS variable is the Semester Credit System. To meet the learning program achievement, students are required to study a minimum load in a 4-5 year study period for a Bachelor program with a load of 144 credits and a 3-4 year study period for a Diploma Three program with a load of 108 credits. Provisions for the total semester credit load of at least 18 credits

3. Achievements in co-extracurricular activities (Excise)

   Performance variables are achievements of students in the form of certificates, certificates or trophies in the penalty / extra-curricular activities in areas of interest, interest and interest. Achievements achieved in the period starting from semester 1 to semester run. Achievements are categorized in three levels, namely national, international and national and international merger.

4. Parent Income (C4)
The old expectation variable is the number of income of permanent or non-permanent parents every month.

The following is taken a sample of 5 data on prospective scholarship recipients from the 7th semester of undergraduate programs, which will be tested based on predetermined criteria. Provisions for the number of SKS expenses that must be met are for 6 (six) semesters, namely a minimum of 108 credits.

| Alternative | GPA  | SKS  | Achievement         | Parent Income |
|-------------|------|------|---------------------|---------------|
| A1          | 3.45 | 108  | National            | Rp. 1750000   |
| A2          | 3.10 | 108  | National and International | Rp. 2750000   |
| A3          | 3.25 | 111  | National            | Rp. 2000000   |
| A4          | 3.30 | 114  | International       | Rp. 3500000   |
| A5          | 3.75 | 108  | National            | Rp. 5250000   |

3.1 Application of the SAW Method

The steps of the SAW method consist of:
1. Determine criteria and weights. The criteria and weight are as follows:

| Criteria (Ci) | Information                                                                 | Weigh |
|---------------|-----------------------------------------------------------------------------|-------|
| C1            | GPA Value                                                                   | 1.00  |
| C2            | The number of SKS that have been completed                                   | 0.60  |
| C3            | Achievements in national and / or international co-curricular activities (reasoning, interests and talents) | 0.80  |
| C4            | Parent Income                                                               | 1.00  |

The criteria that must be met by scholarship applicants are as follows:

a. Criteria for Value of GPA (C1)

The criteria for the GPA value are the requirements specified in decision making. Based on the provisions of the Ministry of Research, Technology and Higher Education, the lowest grade point average (GPA) of 3.00 is ratified by the university leadership. The higher the student GPA, the higher the weight value.

| GPA Value | Variable | Weight |
|-----------|----------|--------|
| 3.00 < GPA ≤ 3.20 | Very Low | 0.20   |
| 3.20 < GPA ≤ 3.40 | Low      | 0.40   |
| 3.40 < GPA ≤ 3.60 | Enough   | 0.60   |
| 3.60 < GPA ≤ 3.80 | High     | 0.80   |
| 3.80 < GPA ≤ 4.00 | Very High | 1.00   |

b. Criteria Number SKS completed (C2)

SKS stands for Semester Credit System. To meet the learning achievements of program graduates, students must take a minimum study load in the 4-5 year study period for Bachelor programs with a load of 144 credits and a 3-4 year study period for Diploma Three programs with a load of 108 credits. Provisions for the number of credits for each semester are a minimum of 18 credits. The more number of credits that have been completed in one class, the higher the weight.
Table 4. Weight for criteria for total credit

| Total SKS  | Variable | Weight |
|------------|----------|--------|
| 108        | Enough   | 0.60   |
| >108       | High     | 0.80   |

c. Achievement Criteria (C3)
Achievement Criteria are achievements that have been achieved or obtained by students in co-curricular activities in the fields of reasoning, interests and talents at the national and / or international level. If the student achievements obtained are national and international categories, the weight is higher

Table 5. Weight for achievement criteria

| Achievement                        | Variable | Weight |
|------------------------------------|----------|--------|
| National Achievement               | Enough   | 0.60   |
| International Achievement          | High     | 0.80   |
| National and International Achievement | Very High | 1.00   |

b. Parent Income Criteria (C4)
Criteria for the amount of parent income is one of the requirements needed for decision making, based on the amount of income of permanent or non-permanent parents each month. The higher the income of parents, the lower the weight.

Table 6. Weight for Parent Income Criteria

| Parent Income (X)          | Variable | Weight |
|---------------------------|----------|--------|
| X ≤ 2.000.000             | Very Low | 1.00   |
| 2.000.000 < X ≤ 3.000.000 | Low      | 0.80   |
| 3.000.000 < X ≤ 4.000.000 | Enough   | 0.60   |
| 4.000.000 < X ≤ 5.000.000 | High     | 0.40   |
| X ≥ 5.000.000             | Very High| 0.20   |

Table 7. Compatibility of alternative data against criteria

| Alternative | C1    | C2    | C3    | C4    |
|-------------|-------|-------|-------|-------|
| A1          | 0.60  | 0.60  | 0.60  | 1.00  |
| A2          | 0.20  | 0.60  | 1.00  | 0.80  |
| A3          | 0.40  | 0.80  | 0.60  | 1.00  |
| A4          | 0.40  | 0.80  | 0.80  | 0.60  |
| A5          | 0.80  | 0.60  | 0.60  | 0.20  |

2. Normalizing the Matrix
The next step is to normalize the matrix by calculating the normalized performance rating value \( r_{ij} \) of the alternative \( A_i \) in the \( C_j \) attribute based on the equation adjusted for the type of attribute.
The formula for normalizing is as follow:
\[ r_{ij} = \begin{cases} \frac{X_{ij}}{M_{ij} \times x_{ij}} \\ \frac{X_{ij}}{m_{ij} \times x_{ij}} \end{cases} \]

a. GPA Value

\[ r_{11} = \frac{0.60}{\max(0.60; 0.20; 0.40; 0.40; 0.80)} = 0.60 \]
\[ r_{21} = \frac{0.20}{\max(0.60; 0.20; 0.40; 0.40; 0.80)} = 0.20 \]
\[ r_{31} = \frac{0.40}{\max(0.60; 0.20; 0.40; 0.40; 0.80)} = 0.40 \]
\[ r_{41} = \frac{0.80}{\max(0.60; 0.20; 0.40; 0.40; 0.80)} = 0.80 \]
\[ r_{51} = \frac{0.80}{\max(0.60; 0.20; 0.40; 0.40; 0.80)} = 0.80 \]

b. The number of SKS that have been completed

\[ r_{12} = \frac{0.60}{\max(0.60; 0.60; 0.80; 0.60; 0.60)} = 0.60 \]
\[ r_{22} = \frac{0.60}{\max(0.60; 0.60; 0.80; 0.80; 0.60)} = 0.60 \]
\[ r_{32} = \frac{0.80}{\max(0.60; 0.60; 0.80; 0.80; 0.60)} = 0.80 \]
\[ r_{42} = \frac{0.80}{\max(0.60; 0.60; 0.80; 0.80; 0.60)} = 0.80 \]
\[ r_{52} = \frac{0.80}{\max(0.60; 0.60; 0.80; 0.80; 0.60)} = 0.80 \]

c. Achievements in national and / or international co-curricular activities

\[ r_{13} = \frac{0.60}{\max(0.60; 1.00; 0.60; 0.80; 0.60)} = 0.60 \]
\[ r_{23} = \frac{1.00}{\max(0.60; 1.00; 0.60; 0.80; 0.60)} = 1.00 \]
\[ r_{33} = \frac{0.60}{\max(0.60; 1.00; 0.60; 0.80; 0.60)} = 0.60 \]
\[ r_{43} = \frac{0.80}{\max(0.60; 1.00; 0.60; 0.80; 0.60)} = 0.80 \]
\[ r_{53} = \frac{0.60}{\max(0.60; 1.00; 0.60; 0.80; 0.60)} = 0.60 \]

d. Parent Income

\[ r_{14} = \frac{0.20}{\max(1.00; 0.80; 1.00; 0.60; 0.20)} = 0.20 \]
Based on the calculation, the results of the selection can be seen in Table 8 below:

\[
\begin{align*}
    r_{24} &= \frac{\min(1.00; 0.80; 1.00; 0.60; 0.20)}{0.80} = \frac{0.20}{0.80} = 0.25 \\
    r_{34} &= \frac{\min(1.00; 0.80; 1.00; 0.60; 0.20)}{1.00} = \frac{0.20}{1.00} = 0.20 \\
    r_{44} &= \frac{\min(1.00; 0.80; 1.00; 0.60; 0.20)}{0.60} = \frac{0.20}{0.60} = 0.30 \\
    r_{54} &= \frac{\min(1.00; 0.80; 1.00; 0.60; 0.20)}{0.20} = \frac{0.20}{0.20} = 1.00
\end{align*}
\]

Normalization results are formed in the form of a matrix as follows:

\[
R = \begin{bmatrix}
    0.75 & 0.75 & 0.60 & 0.20 \\
    0.25 & 0.75 & 1.00 & 0.25 \\
    0.50 & 1.00 & 0.60 & 0.20 \\
    0.50 & 1.00 & 0.80 & 0.30 \\
    1.00 & 0.75 & 0.60 & 1.00
\end{bmatrix}
\]

4. Ranking Process
The ranking process uses equations:

\[
    V_i = \sum_{j=1}^{n} W_j r_{ij}
\]

Information:
- \( V_i \) = Ranking for each alternative
- \( W_j \) = Weight value of each criterion [1.00; 0.60; 0.80; 1.00]
- \( r_{ij} \) = Normalized performance rating value

\[
\begin{align*}
    V_1 &= (1.00\times0.75) + (0.60\times0.75) + (0.80\times0.60) + (1.00\times0.20) \\
    &= 0.75 + 0.45 + 0.48 + 0.20 \\
    &= 1.88 \\
    V_2 &= (1.00\times0.25) + (0.60\times0.75) + (0.80\times1.00) + (1.00\times0.25) \\
    &= 0.25 + 0.45 + 0.80 + 0.25 \\
    &= 1.75 \\
    V_3 &= (1.00\times0.50) + (0.60\times1.00) + (0.80\times0.60) + (1.00\times0.20) \\
    &= 0.50 + 0.60 + 0.48 + 0.20 \\
    &= 1.78 \\
    V_4 &= (1.00\times0.50) + (0.60\times1.00) + (0.80\times0.80) + (1.00\times0.30) \\
    &= 0.50 + 0.60 + 0.64 + 0.30 \\
    &= 2.04 \\
    V_5 &= (1.00\times1.00) + (0.60\times0.75) + (0.80\times0.60) + (1.00\times1.00) \\
    &= 1.00 + 0.45 + 0.48 + 1.00 \\
    &= 2.93
\end{align*}
\]
3.2 Application of the WP Method

The steps in calculating the weighted product (WP) method are as follows:

1. Normalization or improvement of weight

Perform calculation of the weighted product method that starts by making improvements to the weight of the criteria according to the equation where the value $\Sigma W_j = 1$.

$$w_1 = \frac{1.00}{1.00 + 0.60 + 0.80 + 1.00} = \frac{1.00}{3.40} = 0.29$$

$$w_2 = \frac{1.00}{0.60 + 0.60 + 0.80 + 1.00} = \frac{1.00}{3.40} = 0.18$$

$$w_3 = \frac{1.00}{0.80 + 0.60 + 0.80 + 1.00} = \frac{1.00}{3.40} = 0.24$$

$$w_4 = \frac{1.00}{1.00 + 0.60 + 0.80 + 1.00} = \frac{1.00}{3.40} = 0.29$$

2. Determine Vector $S$

$$s_i = \prod_{j=1}^{n} x_{ij}^{w_{ij}}$$

$$s_1 = (0.60^{0.29})(0.60^{0.18})(0.60^{0.24})(1.00^{(-0.29)}) = 0.696$$

$$s_2 = (0.20^{0.29})(0.60^{0.18})(1.00^{0.24})(0.80^{(-0.29)}) = 0.810$$

$$s_3 = (0.40^{0.29})(0.80^{0.18})(0.60^{0.24})(1.00^{(-0.29)}) = 0.651$$

$$s_4 = (0.40^{0.29})(0.80^{0.18})(0.80^{0.24})(0.60^{(-0.29)}) = 0.610$$

$$s_5 = (0.80^{0.29})(0.60^{0.18})(0.60^{0.24})(0.20^{(-0.29)}) = 1.206$$

3. Determine Vector $V$

After obtaining the results of the search score, then determine the vector value of each alternative. Vector values are obtained from the results of each alternative score divided by the total score according to the equation. The process of manually searching vector values is as follows:

Table 8. Ranking result

| Ranking | Alternative | $V_i$ |
|---------|-------------|------|
| 1.      | $A_5$       | 2.93 |
| 2.      | $A_4$       | 2.04 |
| 3.      | $A_1$       | 1.88 |
| 4.      | $A_3$       | 1.78 |
| 5.      | $A_2$       | 1.75 |
Based on the calculation, the results of the selection can be seen in table 9 below:

| Ranking | Alternative | \( v_i \) |
|---------|-------------|----------|
| 1.      | A_5         | 0.227    |
| 2.      | A_4         | 0.201    |
| 3.      | A_3         | 0.190    |
| 4.      | A_2         | 0.189    |
| 5.      |             |          |

### 3.3 Application of the TOPSIS Method

Following are the steps to apply with the TOPSIS method:

1. **Building a normalized decision matrix from each category** represented by \( X (i) \) where \( i = 1, 2, 3 \), and 4. The normalization formula for the matrix is as follows:

   \[
   r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{l=1}^{m} x_{ij}^2}}
   \]

   \[
   X(1) = \sqrt{0.60^2 + 0.60^2 + 0.80^2 + 0.80^2 + 0.60^2} = 1.1662
   \]

   Then:

   \[
   r_{11} = 0.5145
   \]

   \[
   r_{21} = 0.1715
   \]

   \[
   r_{31} = 0.3430
   \]

   \[
   r_{41} = 0.3430
   \]

   \[
   r_{51} = 0.6860
   \]

   Based on the calculation results up to \( X (5) \) and \( r_{55} \), the normalized decision matrix is obtained as follows:

   \[
   R = \begin{bmatrix}
   0.5145 & 0.3906 & 0.3638 & 0.5735 \\
   0.1715 & 0.3906 & 0.6063 & 0.4588 \\
   0.3430 & 0.5208 & 0.3638 & 0.5735 \\
   0.3430 & 0.5208 & 0.4851 & 0.3441 \\
   0.6860 & 0.3906 & 0.3638 & 0.1147
   \end{bmatrix}
   \]
2. Make a weighted normalized decision matrix (V) whose elements are determined from r (i). The calculation of weighted normalized decision matrix is as follows:

\[ v_{ij} = w_j r_{ij} \]

\[
\begin{align*}
 v_{11} &= 1.00 \times 0.5145 = 0.5145 \\
 v_{21} &= 1.00 \times 0.1715 = 0.1715 \\
 v_{31} &= 1.00 \times 0.3430 = 0.3430 \\
 v_{41} &= 1.00 \times 0.3430 = 0.3430 \\
 v_{51} &= 1.00 \times 0.6860 = 0.6860 \\
\end{align*}
\]

Based on the calculation results up to \( v_{55} \), then the weighted normalized decision matrix is obtained as follows:

\[
Y = \begin{bmatrix}
0.5145 & 0.2343 & 0.2910 & 0.5735 \\
0.1715 & 0.2343 & 0.4851 & 0.4588 \\
0.3430 & 0.3125 & 0.2910 & 0.5735 \\
0.3430 & 0.3125 & 0.3881 & 0.3441 \\
0.6860 & 0.2343 & 0.2910 & 0.1147 \\
\end{bmatrix}
\]

3. Determine the matrix of positive ideal solutions (\( A^+ \)) and negative ideal solutions (\( A^- \)) can be seen in table 10 and table 11.

**Table 10. Positive ideal solutions (\( A^+ \))**

| Positive Ideal Solutions | V(i,1) | V(i,2) | V(i,3) | V(i,4) |
|--------------------------|--------|--------|--------|--------|
|                          | 0.5145 | 0.2343 | 0.2910 | 0.5735 |
|                          | 0.1715 | 0.2343 | 0.4851 | 0.4588 |
|                          | 0.3430 | 0.3125 | 0.2910 | 0.5735 |
|                          | 0.3430 | 0.3125 | 0.3881 | 0.3441 |
|                          | 0.6860 | 0.2343 | 0.2910 | 0.1147 |
| A^+ (V max)              | 0.6860 | 0.3125 | 0.4851 | 0.5735 |

**Table 11. Negative ideal solutions (\( A^- \))**

| Negative Ideal Solutions | V(i,1) | V(i,2) | V(i,3) | V(i,4) |
|--------------------------|--------|--------|--------|--------|
|                          | 0.5145 | 0.2343 | 0.2910 | 0.5735 |
|                          | 0.1715 | 0.2343 | 0.4851 | 0.4588 |
|                          | 0.3430 | 0.3125 | 0.2910 | 0.5735 |
|                          | 0.3430 | 0.3125 | 0.3881 | 0.3441 |
|                          | 0.6860 | 0.2343 | 0.2910 | 0.1147 |
| A^- (V max)              | 0.1715 | 0.2343 | 0.2910 | 0.1147 |

4. Calculate an alternative or alternative distance from a positive ideal solution (\( S^+ \)) by formula

\[
S_i^+ = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_{ij}^+)^2}
\]

Calculate an alternative or alternative distance from a Negative Ideal Solutions (\( S^- \)):

\[
S_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_{ij}^+)^2}
\]
From the above equation, we find the distance between weighted values for each alternative to the positive ideal solution as follows:

\[ S_1^+ = \sqrt{(0.5145 - 0.6860)^2 + (0.2343 - 0.3125)^2 + (0.2910 - 0.4851)^2 + (0.5735 - 0.5735)^2} \]

\[ S_1^- = \sqrt{(-0.1715)^2 + (-0.0762)^2 + (-0.1941)^2 + (0)^2} \]

\[ S_1^+ = \sqrt{0.0732} \]

\[ S_1^- = 2.706 \]

\[ S_2^+ = 0.5329 \]

\[ S_2^- = 0.3941 \]

\[ S_3^+ = 0.4239 \]

\[ S_3^- = 0.5043 \]

\[ S_4^+ = \sqrt{(0.5145 - 0.1715)^2 + (0.2343 - 0.2343)^2 + (0.2910 - 0.2910)^2 + (0.5735 - 0.1147)^2} \]

\[ S_4^- = \sqrt{(0.3430)^2 + (0)^2 + (0)^2 + (0.4588)^2} \]

\[ S_4^+ = \sqrt{0.1176 + 0 + 0 + 0.2105} \]

\[ S_4^- = \sqrt{0.3281} \]

\[ S_5^+ = 0.5728 \]

\[ S_5^- = 0.3951 \]

\[ S_6^+ = 0.4960 \]

\[ S_6^- = 0.3124 \]

\[ S_7^+ = 0.5145 \]

From the calculation results obtained separation (distance) the ideal positive solution and the distance of the negative ideal solution as in table 12.

| Alternative | \( S^+ \) | \( S^- \) |
|-------------|----------|----------|
| A_1_ | 0.2706 | 0.5728 |
| A_2_ | 0.5329 | 0.3951 |
| A_3_ | 0.3941 | 0.496 |
| A_4_ | 0.4239 | 0.3124 |
| A_5_ | 0.5043 | 0.5145 |

5. Calculate the relative proximity of each alternative to the positive ideal solution (\( c_i^+ \)) with the following formula:

\[ c_i^+ = \frac{S_i^-}{S_i^- + S_i^+} \]

The results of this research are relative to the ideal solution (\( c_i^+ \)) as in table 13.
Table 13. C* Value

| Alternatif | S⁺ | S⁻ | C⁺ |
|------------|----|----|----|
| A₁         | 0.2706 | 0.5728 | 0.6792 |
| A₂         | 0.5329 | 0.3951 | 0.4257 |
| A₃         | 0.3941 | 0.496 | 0.5572 |
| A₄         | 0.4239 | 0.3124 | 0.4243 |
| A₅         | 0.5043 | 0.5145 | 0.5050 |

6. Ranking Alternatively
In the following table is the result of the calculation process that has been ranked from the largest value to the smallest value. The results of ranking of each student can be seen in table 14.

Table 14. Ranking result

| Ranking | Alternative | C⁺ |
|---------|-------------|----|
| 1       | A₁          | 0.6792 |
| 2       | A₃          | 0.5572 |
| 3       | A₅          | 0.5050 |
| 4       | A₂          | 0.4258 |
| 5       | A₄          | 0.4243 |

3.4 Comparison of Application of the SAW, WP and TOPSIS Methods
Comparison of ranking results by applying the three methods can be seen in table 15 below.

Table 15. Ranking comparison

| Ranking | Alternative Rangking |
|---------|----------------------|
|         | SAW method | WP method | TOPSIS method |
| 1       | A₅         | A₅        | A₁         |
| 2       | A₄         | A₄        | A₃         |
| 3       | A₁         | A₁        | A₅         |
| 4       | A₃         | A₃        | A₂         |
| 5       | A₂         | A₂        | A₄         |

Based on the data above, the application of the three methods gives a different alternative ranking. The first ranking position by applying the SAW method is A₅, the first ranking position by applying the WP method is A₅ while the first ranking position by applying the TOPSIS method is A₁. Analysis of the application of the three methods as follows:
1. The application of the SAW method gives the results of ranking with alternative 5 depending on the first rank. Based on sample data it is estimated that alternative 5 has a GPA value
2. The application of the WP method gives the results of ranking with alternative 5 depending on the first rank. Based on sample data it is estimated that alternative 5 has a GPA value
3. The application of the TOPSIS method gives results of ranking with Alternative 1 in the first rank. Based on sample data it is known that alternative 1 parent income is in the lowest position

4. Conclusion
This study discusses the application of the classic FMDAM method, namely SAW, WP and TOPSIS to the decision support system for determining PPA scholarships at university. Attributes or criteria based on the provisions stipulated by the Direktorat Jenderal Pembelajaran dan Kemahasiswaan Affairs are set
out in the 2018 Academic Achievement Improvement (PPA) guidebook. Criteria (attributes) of requirements that must be met by students to be designated as scholarship recipients are a minimum GPA of 3.0, the number of credits has been completed, achievements in national and / or international curricular activities (reasoning, interests and talents) and parental income. It was found that the application of the SAW and WP methods gave the same ranking results while the application of the TOPSIS method gave different results with the SAW and WP methods. The ranking results of each method can provide appropriate recommendations for decision makers in determining the provision of PPA scholarships to students who deserve to receive them.

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