

IMPLEMENTATION OF SAW AND WP METHODS FOR DECISION SUPPORT SYSTEM IN DETERMINING KIP-K SCHOLARSHIP RECIPIENTS


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Article Info	ABSTRACT
<p>Article History: Received: 2026-02-28 Revised: 2026-04-21 Accepted: 2026-04-27 Available online: 2026-04-29</p> <p>Keywords: Decision Support System; SAW; WP</p>	<p>Walisongo State Islamic University Semarang (UIN Walisongo Semarang) provides a Higher Education Indonesia Smart Card (KIP-K) scholarship to prospective new students. In the selection process for determining the KIP-K scholarship, data management is still done manually by conducting interview tests and calculating the results of the interviews. The selection process that is done manually has several weaknesses, so it is possible that errors will occur in data processing. For this reason, a Decision Support System is needed that can facilitate the determination of KIP-K scholarship recipients. In this study, a comparative analysis of the SAW and WP methods was used in determining KIP-K scholarship recipients. This system is made using the SAW method because it gives the highest alternative value and gives the best ranking results.</p>
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1. INTRODUCTION

In every educational institution, especially universities, there are many scholarships offered to students. There are scholarships from the government as well as from private parties. To obtain a scholarship, one must meet the predetermined requirements. Those criteria include, among others, academic grade point index, parental income, number of siblings, number of parental dependents, semester, and others. Therefore, not all students who apply to receive a scholarship are granted one, due to the large number of students making requests and the many evaluation criteria involved, making it necessary to develop a decision support system that can help provide recommendations for scholarship recipients.

The model used in determining scholarship recipients employs the SAW (Simple Additive Weighting) method and the WP (Weighted Product) method in performing calculations in this study. Similar to studies [1][2] which found that testing using the SAW method yields higher accuracy compared to using the WP method. This method is used because it can determine the weight value for each attribute, followed by a ranking process that selects the best alternative from a number of alternatives, where the alternative referred to here is the one entitled to receive the scholarship based on the specified criteria, resulting in a more accurate outcome regarding who will receive the scholarship.

2. RESEARCH METHODS

In Figure 1, the research framework used in completing this study is described. The first step is inputting the criteria and alternative data. The data input stage for criteria and alternatives up to matrix normalization is the same for both methods. After going through the normalization process, calculations are then performed between the two decision support system methods, namely SAW and WP. The calculation values from both methods are compared to produce the final decision for each alternative [3]. The highest-ranked value among all registered students of Universitas Islam Negeri Walisongo is the chosen alternative that passes the KIP-K scholarship selection.

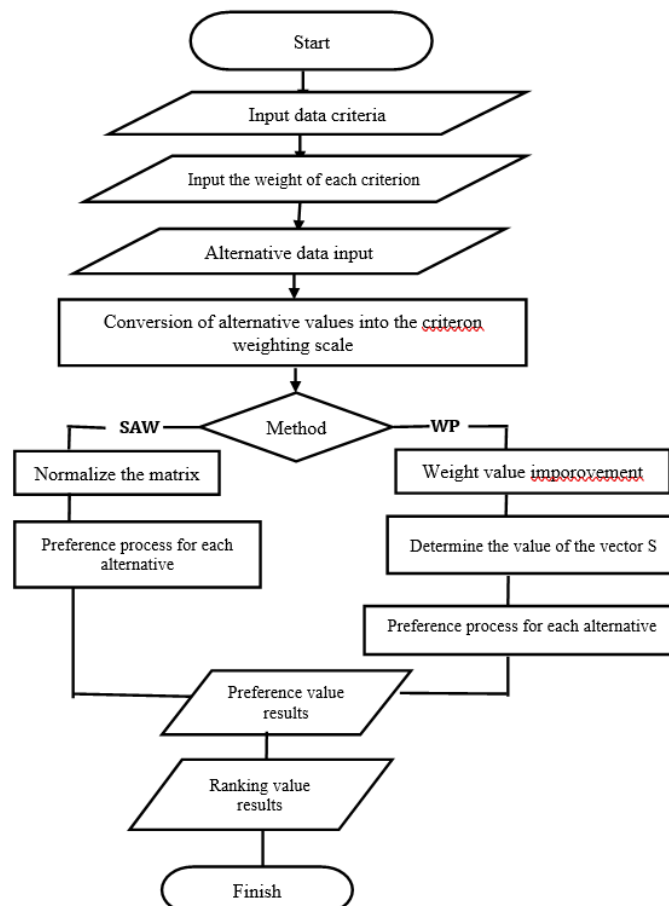


Figure 1. Research Flow

2.1 Criteria

The following are the criteria used as a reference for selecting KIP-K scholarship recipients. The five criteria can be seen in Table 1 below. The criterion with the largest weight is the Latest GPA criterion.

Table 1. Criteria

Code	Criteria Name	Criterion Properties	Percentage	Decimal
K1	Latest GPA	Benefit	35%	0.35
K2	Parent/Guardian Income	Cost	30%	0.3
K3	Number of Parent/Guardian Dependents	Benefit	20%	0.2
K4	Number of Two-Wheeled Vehicles (Motorcycles)	Cost	10%	0.1
K5	Land Area	Cost	5%	0.05

2.2 Weighting

In this study, there are weights for each criterion needed to determine who will be selected as a scholarship recipient. The following are the weights for each criterion:

1. Latest GPA, weighted as

Table 2. Latest GPA

GPA	Value
≤ 2.75	1
2.76 - 3.00	2
3.01 - 3.25	3
3.26 - 3.50	4
> 3.50	5

2. Parent/Guardian Income, weighted as

Table 3. Parent/Guardian Income

Income	Value
$< 2.000.000$	5
2.000.000 - 4.000.000	4
4.000.001 - 6.000.000	3
6.000.001 - 8.000.000	2
$> 8.000.000$	1

3. Number of Parent/Guardian Dependents, weighted as

Table 4. Number of Parent/Guardian Dependents

Number of Dependents	Value
1	1
2	2
3	3
4	4
≥ 5	5

4. Number of Two-Wheeled Vehicles (Motorcycles), weighted as

Table 5. Jumlah Kendaraan Roda Dua

Number of Vehicles	Value
1	5
2	4
3	3
4	2
≥ 5	1

5. Land Area, weighted as

Table 6. Land Area

Land Area	Value
< 25 m ²	5
25 - 50 m ²	4
51 - 90 m ²	3
100 - 200 m ²	2
> 200 m ²	1

2.3 Fuzzy Logic

Fuzzy logic is the science that studies uncertainty. One model of fuzzy rules is a model that is often used to build systems whose reasoning resembles human intuition or feelings [4]. Fuzzy logic was first introduced by Prof. Lotfi A. Zadeh in 1965 [5]. The basis of fuzzy logic is fuzzy set theory. In fuzzy set theory, the role of the degree of membership as a determinant of the existence of an element in a set is very important. The membership value, or degree of membership, or membership function, becomes the main characteristic of reasoning with fuzzy logic [6].

2.4 Fuzzy Multiple Attribute Decision Making (FAMDM)

Kusumadewi (2013) states that fuzzy multiple attribute decision making is a method used to find the optimal alternative from a number of alternatives with certain criteria. There are 3 approaches to finding attribute weight values, namely the subjective, objective, and integrated subjective-objective approaches, each of which has its own advantages and disadvantages [7][8]. There are several methods used to solve FMADM problems, including [9][10][11]:

1. Simple Additive Weighting Method (SAW).
2. Weighted Product (WP).
3. ELECTRE
4. Technique for Order Preference by Similarity to Ideal Solution (TOPSIS).
5. Analytic Hierarchy Process (AHP).

2.5 Simple Additive Weighting Method (SAW)

The Simple Additive Weighting Method (SAW) can also be referred to as the summation method. The Simple Additive Weighting Method, or SAW method, is one of the methods that can be used to solve MADM (Multi-Attribute Decision Making). MADM is a model of MCDM (Multiple Criteria Decision Making), which itself is a decision-making method for determining the best alternative from a number of alternatives based on certain criteria [12]. The SAW method requires decision makers to determine the weight for each attribute [13]. The total score for an alternative is obtained by summing all the results of the multiplication between the rating (which can be compared across attributes) and the weight of each attribute [14][1].

Steps for solving fuzzy MADM using the SAW method [3]:

1. Determining alternatives.
2. Determining criteria.
3. Converting alternative values into compatibility rating values for each criterion.
4. Determining the preference weight (W)

$$W=[W_1 W_2 W_3 \dots W_j] \quad (1)$$

5. Creating the decision matrix (X) based on criteria, formed from the compatibility rating table.
6. Normalizing the decision matrix by calculating the normalized performance rating value r_{ij} of alternative A_i on attribute $C_j=1,2,\dots,m$ and $j=1,2,\dots,n$

$$r_{ij} = \begin{cases} \frac{x_{ij}}{\text{Max}x_i(x_{ij})} & \text{if } j \text{ attribute benefit} \\ \frac{\text{Min } x_i(x_{ij})}{x_{ij}} & \text{if } j \text{ attribute cost} \end{cases} \quad [2]$$

7. The result of the normalized performance rating forms the normalized matrix (R).

$$R = \begin{bmatrix} r_{11} & r_{12} & \dots & r_{1j} \\ r_{i1} & r_{i2} & \dots & r_{ij} \end{bmatrix} \quad [3]$$

8. The final result is obtained from the ranking process (V), which is the sum of the multiplication of the row elements of the normalized matrix (R) with the preference weight (W) corresponding to the column elements of the matrix

$$V_i = \sum_{j=1}^n W_j r_{ij} \quad [4]$$

2.6 Simple Additive Weighting Method (SAW)

The Weighted Product (WP) method uses multiplication to connect attribute ratings, and the attribute ratings must first be raised to the power of the corresponding attribute weight. This process is similar to the normalization process.

Steps for solving fuzzy MADM using the WP method [2]:

1. Determining the criteria that will serve as references in decision making.
2. Converting the input criteria data into compatibility rating values.
3. Performing weight value improvement for each criterion.

$$W_j = \frac{W_j}{\sum W_j} \quad [5]$$

4. Determining the preference value for alternative S_i .

$$S_i = \prod_{j=1}^n X_{ij}^{W_j}; i = 1, 2, \dots, m \quad [6]$$

5. Calculating the preference value V_i for each alternative.

$$V_i = \frac{\prod_{j=1}^n X_{ij}^{W_j}}{\prod_{j=1}^n (W_j)^{W_j}}; i = 1, 2, \dots, m \quad [7]$$

2.7 Match Rating

Based on the criteria data and weighting above, the next step is to create the compatibility rating as shown in the following table:

Table 7. Match Rating

No	Name	Latest GPA	Parent/Guardian Income	Number of Parent/Guardian Dependents	Number of Two-Wheeled Vehicles (Motorcycles)	Land Area
1	HSA	5	5	1	5	4
2	NR	4	2	2	4	2
3	ASP	5	4	1	4	1
4	AOS	5	3	1	5	4
5	GHM	5	3	4	4	4
⋮						
24	HS	5	4	3	3	3
25	DA	4	5	2	4	4

3. RESULTS AND DISCUSSION

This section explains the results of the SAW and WP method calculations.

3.1 Result

3.1.1 SAW Method Calculation

The first process is the calculation using the SAW method. The initial stage is determining the criteria and alternatives. Then the decision matrix is normalized by calculating the normalized performance rating r_{ij} of alternative A_{ij} on criterion C_{ij} . The criteria are then classified as either benefit or cost. If it falls into the benefit group, the value X_{ij} is divided by the max X_{ij} of each column, while if it falls into the cost group, the min X_{ij} value of each column is divided by the value X_i . The decision making provides preference weights as follows:

$$W = (0,35 \ 0,3 \ 0,2 \ 0,1 \ 0,05)$$

The decision matrix is formed from the compatibility rating table as follows:

$$X = \begin{bmatrix} 5 & 5 & 1 & 5 & 4 \\ 4 & 2 & 2 & 4 & 2 \\ 5 & 4 & 1 & 4 & 1 \\ 5 & 3 & 1 & 5 & 4 \\ 5 & 3 & 4 & 4 & 4 \\ \vdots & & \ddots & & \vdots \\ 5 & 4 & 3 & 3 & 3 \\ 4 & 5 & 2 & 4 & 4 \end{bmatrix}$$

Normalizing matrix X based on equation (2) as follows:

$$r_{11} = \frac{5}{\max \{5,4,5,5,5, \dots, 5,4\}} = \frac{5}{5}$$

$$r_{21} = \frac{4}{\max \{5,4,5,5,5, \dots, 5,4\}} = \frac{4}{5} = 0,8$$

$$r_{31} = \frac{5}{\max \{5,4,5,5,5, \dots, 5,4\}} = \frac{5}{5} = 1$$

$$r_{12} = \frac{\min \{5,2,4,3,3, \dots, 4,5\}}{5} = \frac{1}{5} = 0,2$$

$$r_{22} = \frac{\min \{5,2,4,3,3, \dots, 4,5\}}{2} = \frac{1}{2} = 0,5$$

$$r_{32} = \frac{\min \{5,2,4,3,3, \dots, 4,5\}}{4} = \frac{1}{4} = 0,25$$

And so on, so that the normalized matrix R is obtained as follows:

$$R = \begin{bmatrix} 1,000 & 0,200 & 0,200 & 0,400 & 0,250 \\ 0,800 & 0,500 & 0,400 & 0,500 & 0,500 \\ 1,000 & 0,250 & 0,200 & 0,500 & 1,000 \\ 1,000 & 0,333 & 0,200 & 0,400 & 0,250 \\ 1,000 & 0,333 & 0,800 & 0,500 & 0,250 \\ \vdots & & \ddots & & \vdots \\ 1,000 & 0,250 & 0,600 & 0,670 & 0,333 \\ 0,800 & 0,200 & 0,400 & 0,500 & 0,250 \end{bmatrix}$$

The preference values are obtained from the sum and multiplication of the row elements of the normalized matrix (R) with the preference weight (W) as in equation (4) as follows:

$$V_1 = 0,35(1)+0,3(0,2)+0,2(0,2)+0,1(0,4)+0,05(0,25) = 0,5025$$

$$V_2 = 0,35(0,8)+0,3(0,5)+0,2(0,4)+0,1(0,5)+0,05(0,5) = 0,585$$

$$V_3 = 0,35(1)+0,3(0,25)+0,2(0,2)+0,1(0,5)+0,05(1) = 0,565$$

$$V_4 = 0,35(1)+0,3(0,333)+0,2(0,2)+0,1(0,4)+0,05(0,25) = 0,5424$$

$$V_5 = 0,35(1)+0,3(0,333)+0,2(0,8)+0,1(0,5)+0,05(0,25) = 0,6724$$

$$\vdots$$

$$V_{24} = 0,35(1)+0,3(0,25)+0,2(0,6)+0,1(0,67)+0,05(0,333) = 0,62835$$

$$V_{25} = 0,35(0,8)+0,3(0,2)+0,2(0,4)+0,1(0,5)+0,05(0,25) = 0,4825$$

Based on the calculation using the SAW method, rank 1 is obtained at V₂₃, so the student with the initials BQS passes to receive the KIP-K scholarship.

3.1.2 WP Method Calculation

Setelah mendapatkan nilai preferensi dari metode SAW, selanjutnya menyelesaikan dengan metode WP. Sebelumnya akan dilakukan perbaikan bobot terlebih dahulu. Dengan cara bobot awal W_j akan dibagi dengan jumlah bobot $\sum W_j$, bisa dilihat pada persamaan (5). Sehingga nilai bobotnya menjadi W = (0,35 0,3 0,2 0,1 0,05). Kemudian vektor S dihitung berdasarkan persamaan (6) sebagai berikut:

$$S_1 = (5^{0,35})(5^{-0,3})(1^{0,2})(5^{-0,1})(4^{-0,05}) = 0,8609$$

$$S_2 = (4^{0,35})(2^{-0,3})(2^{0,2})(4^{-0,1})(2^{-0,05}) = 1,2746$$

$$S_3 = (5^{0,35})(4^{-0,3})(1^{0,2})(4^{-0,1})(1^{-0,05}) = 1,0088$$

$$S_4 = (5^{0,35})(3^{-0,3})(1^{0,2})(5^{-0,1})(4^{-0,05}) = 1,0035$$

$$S_5 = (5^{0,35})(3^{-0,3})(4^{0,2})(4^{-0,1})(4^{-0,05}) = 1,354$$

⋮

$$S_{24} = (5^{0,35})(4^{-0,3})(3^{0,2})(3^{-0,1})(3^{-0,05}) = 1,2243$$

$$S_{25} = (4^{0,35})(5^{-0,3})(2^{0,2})(4^{-0,1})(4^{-0,05}) = 0,9352$$

The vector V value to be used for ranking can be calculated based on equation (7) as follows:

$$V_1 = \frac{0,8609}{0,8609+1,2746+1,0088+\dots+0,9352} = 0,0313$$

$$V_2 = \frac{1,2746}{0,8609+1,2746+1,0088+\dots+0,9352} = 0,0463$$

$$V_3 = \frac{1,0088}{0,8609+1,2746+1,0088+\dots+0,9352} = 0,0367$$

$$V_4 = \frac{1,0035}{0,8609+1,2746+1,0088+\dots+0,9352} = 0,0365$$

$$V_5 = \frac{1,354}{0,8609+1,2746+1,0088+\dots+0,9352} = 0,0492$$

⋮

$$V_{24} = \frac{1,2243}{0,8609+1,2746+1,0088+\dots+0,9352} = 0,0445$$

$$V_{25} = \frac{0,9352}{0,8609+1,2746+1,0088+\dots+0,9352} = 0,0340$$

Based on the calculation using the WP method, rank 1 is obtained at V₂₃, so the student with the initials BQS passes to receive the KIP-K scholarship.

3.2 Discussion

The following are the ranking results from the SAW and WP methods using twenty-five student data who filled out the KIP-K scholarship questionnaire at UIN Walisongo Semarang in 2022, where from the twenty-five data, ten students who obtained the top ten rankings were selected. Those ten students are the ones who pass to receive the KIP-K scholarship, although not all institutions only select ten students entitled to receive the scholarship, as it depends on the quota of each institution.

Table 8. Method Testing Results with Questionnaire Data

No	Alternative	SAW Method Preference Value Result	WP Method Preference Value Result	SAW Ranking	WP Ranking	Scholarship Recipient
1	HAS	0,5025	0,0313	20	23	No
2	NR	0,585	0,0463	7	5	Yes
3	ASP	0,565	0,0367	9	15	No
4	AOS	0,5424	0,0365	14	17	No
5	GHM	0,6724	0,0492	3	3	Yes
6	IF	0,5525	0,0367	11	15	No
7	NA	0,555	0,0409	10	9	Yes
8	MZ	0,53165	0,0391	15	10	No
9	RKM	0,5525	0,0382	11	11	Yes
10	KHA	0,55	0,0343	13	20	No
11	ADA	0,62835	0,0445	5	6	Yes
12	RMM	0,44665	0,03	25	25	No

13	MA	0,4975	0,0363	21	18	No
14	HDS	0,6349	0,047	4	4	Yes
15	PA	0,5075	0,0377	19	12	No
16	PL	0,7266	0,0543	2	2	Yes
17	RBP	0,455	0,0306	24	24	No
18	MK	0,51	0,0376	18	13	No
19	SAL	0,5775	0,0417	8	8	Yes
20	ZHN	0,5142	0,0374	17	14	No
21	AS	0,5292	0,0353	16	19	No
22	TA	0,4575	0,0316	23	22	No
23	BQS	0,8592	0,0681	1	1	Yes
24	HS	0,62835	0,0445	5	6	Yes
25	DA	0,4825	0,034	22	21	No

From the preference results of both methods above, it is found that the preference value of the SAW method is greater than the preference value of the WP method. Using the SAW method, the alternative value of BQS=0.8592, and using the WP method, the alternative value of BQS=0.0681. Thus, the SAW solution process is more effective for the KIP-K scholarship selection case at UIN Walisongo Semarang compared to WP, as seen from the method testing results with questionnaire data, where the preference value of the SAW method is higher than that of the WP method.

4. CONCLUSION

The KIP-K Scholarship Decision Support System was created using the SAW method calculation analysis because the results of the SAW method calculation analysis obtained the highest preference value with a vector value of 0.8592 compared to the WP method with a vector value of 0.0681, as can be seen in Table 12 above. The same analytical results were obtained by previous researchers [2] who performed calculations with data testing using the SAW and WP methods, where the highest ranking result was obtained from the SAW method with a value of 0.96 and the WP method with a highest value of 0.1149.

Suggestions

1. It is advisable to consider adding criteria to the fuzzy SAW and WP methods, because with the addition of criteria the KIP-K scholarship acceptance data process can be more accurate.
2. Additional variables can be added.
3. The weighting of each criterion should be adjusted to the regulations of each institution.
4. Converting interval values to a Likert scale must be done carefully and with full consideration, as it can cause the ranking results obtained to differ greatly between the two methods.

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