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Comparison of Simple Additive Weighting and Profile Matching Methods in Scholarship Recipient Selection

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A B S T R A C T

Private Universities organize scholarship programs that are given to prospective scholarship recipients with the aim of being able to help reduce the cost of education. So it is necessary to make the correct and targeted selection. However, the selection of scholarship recipients is still done manually. This can be done with accurate analysis. This study aims to determine the best algorithm of the two methods compared, namely Simple Additive Weighting and Profile Matching. The assessment criteria used consisted of parents' income, home owner status, parents' home condition, number of dependents and parental status. The results of the study using the Profile Matching method produced an accuracy of 100% while the Simple Additive Weighting method produced an accuracy of 96%.

1. Introduction

Higher education is one of the educational institutions with higher education costs. Through the scholarship program, outstanding students and economically disadvantaged students can be used to continue their studies in higher education[1]. As for determining scholarship recipients, there are several requirements that must be met[2]. There are quite a number of scholarship applicants, this can make it difficult for the selection team to determine the best scholarship recipients. Therefore, these problems can be solved using the SPK (decision support system) method in the selection of scholarship recipients[3].

Decision support system is the best method in determining scholarship recipients [2]. Several DSS methods have been carried out. Study[3][4]using the Analytic Hierarchy Process (AHP) method to build a scholarship recipient selection system. This research resulted in this method being able to provide recommendations effectively and efficiently in determining scholarship recipients. Study[5]using the Weighted Product (WP) and Simple Additive Weighting (SAW) methods to analyze the determination of scholarship recipients in the form of ranking. The results of the SAW accuracy test are lower than WP by 60.45%. according to[2]SAW method can determine scholarship recipients based on ranking results. The results of the ranking variations are obtained from the preference weight parameters. according to[5]The SAW method is simpler than the WP method, which is more precise. In this study, the SAW method was used for manual calculations.

Other research by [6]using the Profile Matching (PM) method in analyzing the determination of scholarship recipients. Research results can provide information whenever needed and make it easier to provide scholarship recommendations according to criteria. according to[7] The PM method has a profile value commensurate with the guidelines set in the selection of scholarship recipients.

Therefore, this study will use the SAW and Profile Matching methods to compare the results of the highest accuracy and determine the best method. In addition, it can speed up the selection process and be effective in determining the target recipients of scholarships.

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2. Method

The research method is a stage carried out during the study. These stages consist of scientific literature, problem identification, data collection, analysis, testing and conclusions.

Decision support system (DSS) has several methods. One of the DSS methods is Simple Additive Weighting (SAW). The stages of the SAW method can be carried out as shown in Figure 1[5][2]:

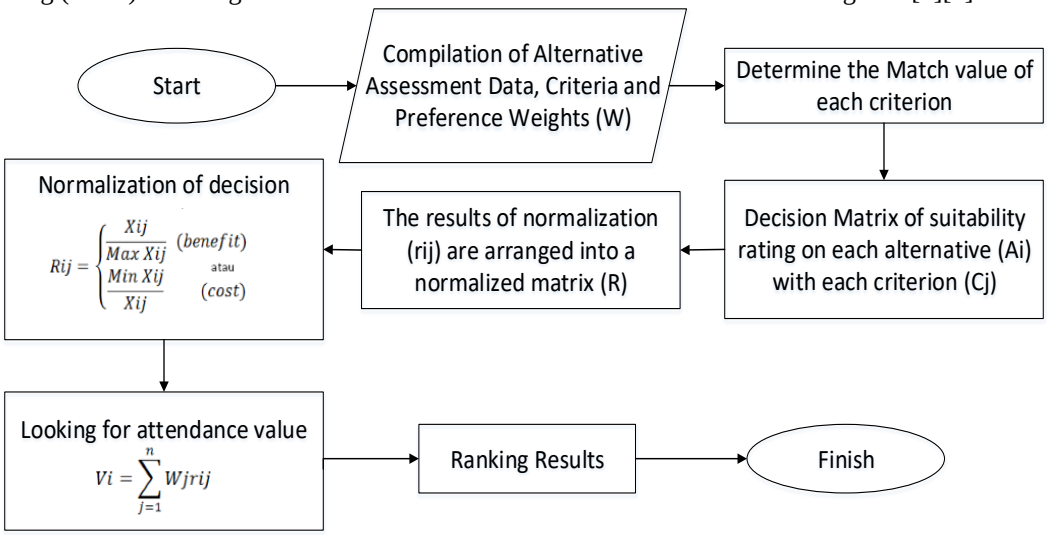

Fig 1. SAW Flowchart

Figure 1 above is a flowchart of the SAW method. The initial stage is compiling alternative assessment data, criteria and weights (w). Then determine the suitability value of each criterion, make a decision matrix of the suitability rating on each alternative with each criterion. Then the normalization results are arranged into a normalized matrix. Normalization calculation can be done with the equation:

$$Rij = \begin{cases} \frac{Xij}{Max\ Xij} & (benefit) \\ \frac{Min\ Xij}{Xij} & (cost) \end{cases} \quad \text{.....(1)}$$

The final stage of calculating the preference value (Vi) with the equation:

$$Vi = \sum_{j=1}^{n} Wjrij \quad \text{.....(2)}$$

The results of the calculation of the preference value are concluded, if the value is greater then alternative Ai is the best alternative[8]. The results are in the form of ranking to get the highest value to the lowest.

In addition to using the SAW method, this research also uses the Profile Matching (PM) method. The PM method steps can be carried out as shown in Figure 2[9][10]:

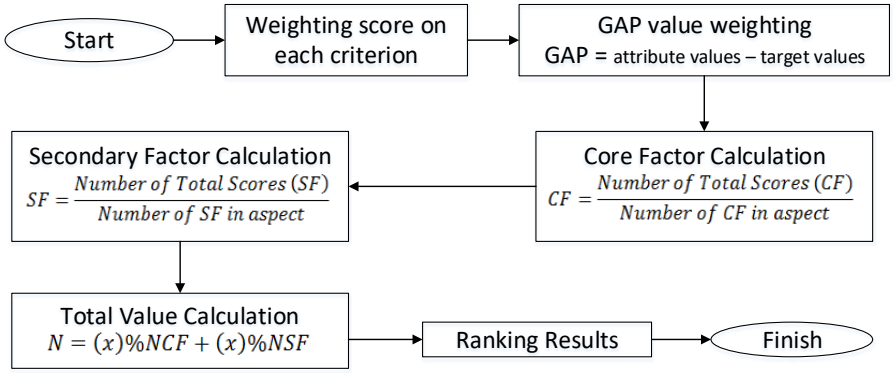

Fig 2. PM Flowchart

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Figure 2 above is a flowchart of the PM method. The initial stage is weighting the value on each criterion. Next, calculate the GAP value to get the difference between the attribute and target values. Then perform the calculation of the core factor using the equation:

$$CF = \frac{Number\ of\ Total\ Scores\ (CF)}{Number\ of\ CF\ in\ aspect} \quad (3)$$

In addition, secondary factor calculations are also carried out using the equation:

$$SF = \frac{Number\ of\ Total\ Scores\ (SF)}{Number\ of\ SF\ in\ aspect} \quad (4)$$

The results of the calculation of the core factor and secondary factor are summed to get the total value and multiplied by the value (x) percent which is inputted using the equation:

$$N = (x)\%NCF + (x)\%NSF \quad (5)$$

The final stage is the result of ranking the highest to the lowest value of the total value calculation.

3. Results and Analysis

3.1 Dataset

The research dataset is primary data obtained from private university data. The amount of data that will be used as an alternative is 50 data for 2020 scholarship recipients.

Table 1
Sample Data

Alternative	C1	C2	C3	C4	C5
A1	<=Rp.1.000.000	Rent/contract	Permanent	5 to 7 souls	Mom & Dad Are Still Alive
A2	<=Rp.1.000.000	Private Property	Permanent	<= 4 Souls	Father Died + Mother Alive
A3	>Rp. 2,000,000 to Rp. 3,000,000	Private Property	Permanent	5 to 7 souls	Mom & Dad Are Still Alive
A5	>Rp. 2,000,000 to Rp. 3,000,000	Private Property	Permanent	<= 4 Souls	Father Died + Mother Alive
….	….	….	….	….	….
A50	>Rp. 1,000,000 to Rp. 2,000,000	Private Property	Semi Permanent	<= 4 Souls	Father Died + Mother Alive

3.2 Determining Criteria and Weights

Determination of criteria and weights obtained based on table 2.

Table 2
Criteria and Weights

Code	Criteria	Weight	Sub Criteria	Index	Mark
C1	Parents' Income	20%	<=Rp.1.000.000	100	20
			>Rp. 1,000,000 to Rp. 2,000,000	60	12
			>Rp. 2,000,000 to Rp. 3,000,000	30	6
			>=Rp. 3,000,000	10	2
C2	Home Ownership Status	20%	There is not any	100	20
			Official residence	60	12
			Family Property	30	6
			Private Property	10	2
C3	Parent's House Condition	20%	There is not any	100	20
			Semi Permanent	60	12
			Permanent	30	6
			Real Estate	10	2
C4	The number of dependents	30%	There is not any	100	30
			8 to 10 souls	60	18
			5 to 7 souls	30	9
			<= 4 Souls	10	3
C5	Parental Status	10%	There is not any	100	10
			Father Died + Mother Alive	60	6
			Father Alive + Mother Dies	30	3
			Mom & Dad Are Still Alive	10	1

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Based on Table 2 above, there are 10 criteria used, consisting of C1 parental income, C2 home ownership status and C3 parental home condition having a weight of 20%. C4 the condition of the number of dependents has the highest weight of 30%. And C5 parental status has the lowest weight 10%. Then from the 5 criteria each has 4 sub-criteria with the highest score to the lowest.

3.3 Simple Additive Weighting (SAW) Calculation Method

The initial stages of the SAW calculation to normalize each criterion are in table 3.

Table 3
Alternative Normalization Results

Alternative	Criteria				
	C1	C2	C3	C4	C5
A1	20	20	6	9	1
A2	20	2	6	3	6
A3	6	2	6	9	1
A4	6	2	6	3	6
A5	20	2	12	3	1
….	….	….	….	….	….
A50	12	2	12	3	6

Based on the table above, each criterion has the highest to the lowest assessment score.

Then the weight improvement steps are carried out using Equation 6:

$$Wj = \frac{wj}{\sum wj} \quad \text{.....(6)}$$

The improvement of the criteria weights are as follows:

$$W1 = \frac{20}{20+20+20+30+10} = \frac{20}{100} = 0{,}2$$

$$W2 = \frac{20}{20+20+20+30+10} = \frac{20}{100} = 0{,}2$$

$$W3 = \frac{20}{20+20+20+30+10} = \frac{20}{100} = 0{,}2$$

$$W4 = \frac{30}{20+20+20+30+10} = \frac{30}{100} = 0{,}3$$

$$W5 = \frac{10}{20+20+20+30+10} = \frac{10}{100} = 0{,}1$$

The next stage is the calculation of each normalized data divided by the maximum value of each criterion using Equation (2). The results of normalization are arranged into a normalized matrix (R).

$$\begin{bmatrix} 20/20 & 20/20 & 6/20 & 9/30 & 1/10 \\ 20/20 & 2/20 & 6/20 & 3/30 & 6/10 \\ 6/20 & 2/20 & 6/20 & 9/30 & 1/10 \\ 4/20 & 2/20 & 6/20 & 3/30 & 6/10 \\ \dots & \dots & \dots & \dots & \dots \\ 12/20 & 2/20 & 12/20 & 3/30 & 6/10 \end{bmatrix}$$

$$\begin{bmatrix} 1 & 1 & 0{,}3 & 0{,}3 & 0{,}1 \\ 1 & 0{,}1 & 0{,}3 & 0{,}1 & 0{,}6 \\ 0{,}3 & 0{,}1 & 0{,}3 & 0{,}3 & 0{,}1 \\ 0{,}3 & 0{,}1 & 0{,}3 & 0{,}1 & 0{,}6 \\ \dots & \dots & \dots & \dots & \dots \\ 0{,}6 & 0{,}1 & 0{,}6 & 0{,}1 & 0{,}6 \end{bmatrix}$$

Then proceed with the calculation of the preference value using equation (3).

V1= 0.2*1 + 0.2*1 + 0.2*0.3 + 0.3*0.3 + 0.1*0.1 = 0.560

Perform the calculation of the preference value using the steps above until the 50th alternative. The calculation results are in Table 4.

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Table 4
Results Preference Value (Vi)

Alternative	Criteria					Total Value
	C1	C2	C3	C4	C5	
A1	0.2	0.2	0.06	0.09	0.01	0.560
A2	0.2	0.02	0.06	0.03	0.06	0.370
A3	0.06	0.02	0.06	0.09	0.01	0.240
A4	0.06	0.02	0.06	0.03	0.06	0.230
….	….	….	….	….	….	….
A50	0.12	0.02	0.12	0.03	0.06	0.350

The final stage is the calculation of the preference value of each criterion and the ranking of the highest to the lowest values of all alternatives is in table 5.

Table 5
SAW Ranking Results

Alternative	Total Value
A10	0.650
A1	0.560
A43	0.540
A7	0.520
A11	0.520
A23	0.520
….	….
A4	0.230

The result of ranking the highest total score, the greater the opportunity to get a scholarship. Based on the table above, the best scholarship recipients were obtained by alternative 10 with a value of 0.650.

3.4 Profile Matching (PM) Calculation Method

The initial PM stage determines the GAP weight value as shown in Table 6.

Table 6
GAP Weight Value

Difference	Weight Value	Information
0	28	Criteria as needed
1	27.5	Criteria for more than 1 rating
-1	27	Criteria less than 1 rating
2	26.5	Criteria for more than 2 ratings
-2	26	Criteria for less than 2 ratings
3	25.5	Criteria over 3 ranks
-3	25	Criteria for less than 3 ratings
4	24.5	Criteria over 4 ranks
-4	24	Criteria less than 4 ratings
5	23.5	Criteria over 5 ratings
-5	23	Criteria for less than 5 ratings
….	….	….
….	….	….
27	1.5	27 . excess criteria rating
-27	1	Deficiency criteria 27 rating

The next step is to calculate the GAP weighting the difference between the attribute value and the target value as shown in Table 7.

Table 7
GAP Value Weighting

Alternative	C1	C2	C3	C4	C5
A1	20	20	6	9	1
A2	20	2	6	3	6
A3	6	2	6	9	1
A4	6	2	6	3	6
….	….	….	….	….	….
A50	12	2	12	3	6
Value Target	20	20	20	30	10
A1	0	0	-14	-21	-9
A2	0	-18	-14	-27	-4

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Alternative	C1	C2	C3	C4	C5
A3	-14	-18	-14	-21	-9
A4	-14	-18	-14	-27	-4
….	….	….	….	….	….
A50	-8	-18	-8	-27	-4

Then proceed with the calculation of Core Factor (CF) using Equation (3). The assessment criteria for the core factor category, namely C1, C4 and C5, are listed in Table 8.

Table 8
Core Factor Value Results

Alternative	C1	C4	C5	NCF
A1	28	7	19	18
A2	28	1	24	17.67
A3	14	7	19	13.33
A4	14	1	24	13
….	….	….	….	….
A50	20	1	24	15

The next step is to calculate the Secondary Factor (SF) using Equation (4). The assessment criteria for the secondary factor category are C2 and C3. The results of the Secondary Factor values are in Table 9.

Table 9
Secondary Factor Score Results

Alternative	C2	C3	NSF
A1	28	14	21
A2	10	14	12
A3	10	14	12
A4	10	14	12
….	….	….	….
A50	10	20	15

The results of the NCF and NSF are added up and then calculated using Equation (5). The percentage of NCF is 60% and NSF is 40%.

Table 10
Final Score Hasil

Alternative	Final score
A1	19.2
A2	15.4
A3	12.8
A4	12.6
….	….
A50	15

The last stage, from the results of the final value in the table above, the ranking of the highest to lowest values is carried out. Alternative ranking is at Table 11.

Table 11
PM Ranking Results

Alternative	Final score
A10	21
A1	19.2
A43	18.8
A7	18.4
A11	18.4
A23	18.4
….	….
A4	12.6

The result of the highest final score ranking, the greater the opportunity to get a scholarship. Based on the table above, the best scholarship recipients are obtained by alternative 10 with a value of 21.

3.5 Comparison of SAW and PM

Comparison of SAW and PM methods in table 12.

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Table 12
Comparison of SAW and PM

NO	Real Rank	Ket	SAW Rank	Ket	PM Rank
1	A10	Corresponding	A10	Corresponding	A10
2	A1	Corresponding	A1	Corresponding	A1
3	A43	Corresponding	A7	Corresponding	A7
4	A7	Corresponding	A11	Corresponding	A11
5	A11	Corresponding	A23	Corresponding	A23
….	…	…	…	…	…
50	A4	Corresponding	A4	Corresponding	A4

3.6 Testing System

The testing system is testing the accuracy by comparing the similarity of the ranking results from the SAW and PM methods using Equation 7[5]:

$$Akurasi = \frac{jumlah\ data\ yang\ benar}{jumlah\ total\ data\ uji} \times 100\% \quad \text{.....(7)}$$

The results of the comparison test of the SAW and PM methods using 50 data obtained a SAW accuracy value of 96% with 48 appropriate data amounts and 100% PM with 50 appropriate data amounts. Based on these results, further research is recommended to use the Profile Matching method in the selection of scholarship recipients because it produces more accurate accuracy than Simple Additive Weighting.

4. Conclusion

The research that has been done has resulted in the conclusion that the Profile Matching method can select scholarship recipients better than the Simple Additive Weigthing method. The assessment criteria used consist of parents' income, home owner status, parents' home condition, number of dependents and parental status. Comparison of the Profile Matching method produces the highest accuracy of 100% compared to the Simple Additive Weighing method which only produces 96% accuracy.

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