Decision Support System Scholarship Selection Using Simple Additive Weighting (SAW) Method

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***Abstract** –* Scholarships are given to students to motivate students and compete with each other in pursuit of the best grades and achievements during their studies. As the name implies, factors such as GPA, competition participation, lecturer recommendations, and organizational participation are the criteria that will be considered for the selection process. In addition, parental income will also be an additional criterion. To minimize errors and reduce bias in the selection process, students who are eligible for scholarships will be assisted by using a Decision Support System (DSS). DSS will support decision making in selecting outstanding scholarship recipients from a pool of alternatives, namely students who register for the outstanding scholarship program by calculating student eligibility based on consideration of the criteria that students have in accordance with predetermined criteria, the alternatives in this research are student from the university. This calculation is carried out using the Simple Additive Weighting (SAW) method which is suitable for use in Multiple Attribute Decision Making (MADM) problems. As a result, each student will get an eligibility score which will influence the final decision. After the ranking of students who are most entitled to a scholarship according to the system calculations are obtained, the final decision will still be taken by the university.

***Keywords** – Scholarship Awardee, Decision Support System, Simple Additive Weighting (SAW)*

I. INTRODUCTION

Achievement can be likened to a measure of the success of a student during his academic journey, both at school and college. Scholarships are the provision of financial assistance to students for the continuation of their education and can be one of the things that can motivate students in pursuing achievements[1]. Providing scholarships to outstanding students is not only a reward or a gift, but also triggers academic competition between fellow students. The existence of competition in a learning ecosystem is very important to build the character of students who are persistent and exemplary, so that they can adapt more quickly to the world of work later. In addition, scholarships also provide an alternative to students with financial deficiencies. Scholarships are a cutting-edge solution for universities to provide assistance and awards as well as learning motivation to students which are useful in helping to improve the accreditation of study programs and the reputation of the university[2].

Traditionally, scholarships are awarded after an intensive selection process carried out by the responsible department of the university. This process usually does not take place quickly because many factors can cause the selection of scholarships to be not targeted quickly, for example, such as human error [3]. There are many factors or criteria that must be considered carefully in making decisions, namely in the form of things that directly impact student achievement such as current IPS/GPA scores, increase in GPA compared to last semester's GPA, and competition participation. Not only that, other things such as the family's financial condition that does not meet can also be taken into consideration [4]. One way that can be used to make this selection process faster is by utilizing a Decision Support System.

Decision Support System (DSS) is a system developed with a specific purpose, namely to assist an organization or individual in making a decision. DSS has been widely applied to help solve problems in the world of education and in general the way it works is to calculate how well an alternative choice is based on the preferences or criteria you want to consider[5]. There are various calculation methods used, such as Simple Additive Weighting (SAW), Weighted Product (WP), and Analytical Hierarchy Process (AHP). Each method has a different way of calculating to get the final result. The SAW method itself can be used to solve decision-making problems that have many attributes (Multiple Attribute Decision Making) whose way of working is by calculating the total weight of each criterion owned by the alternative[6].[7], [8]. Simple Additive Weighting Method is used based on previous research stated that it is mostly suitable to compute decision support system based problem, especially for scholarship awardee.

This study will use the Simple Additive Weighting method to design a Decision Support System that aims to assist the university in selecting students who deserve scholarships. The next section will describe the theoretical basis that will be used in this study, discussing the mathematical formulas of calculations used in the SAW method. In Chapter 3, it is shown the application of the SAW formula in the selection process for scholarship recipients.

II. RESEARCH METHODOLOGY

Today, every field can take advantage of technology to help facilitate the work carried out in that field. For the case of selecting scholarship recipients, it is also possible to apply a system that can make it easier, namely the decision support system (SPK). This system provides an alternative that can be an aid to decision makers. It can also be said that this system converts existing data into information for decision making from semi-structured problems [9],[10]. The decision support system is intended to facilitate decision making by providing alternatives that can be chosen [11].

Simple additive weight (SAW) is a method that is often used in a decision support system, this method is also known as the weighted addition method. SAW is a method that looks for the weighted sum of the rating criteria on the alternatives for each criterion [12].

The calculation steps using the Simple Additive Weighting (SAW) method:
1. Determining Alternative (Ai)
2. Determine the criteria to be used as a reference in decision making (Cj)
3. Determine the preference weight or level of importance (W) for each criterion
4. Determine the Match Value of each criterion
5. Make a decision matrix (x) obtained from the suitability rating for each alternative (Ai) with each criterion (Cj).
6. Perform the normalization step of the decision matrix (x) by calculating the value of the normalized performance rating (Rij) from the alternative (Ai) on the criteria (Cj) with the formula:

$$R_{ij} = \left\{ \frac{x_{ij}}{Max\ \{x_{ij}\}} \right\}$$

If j is an attribute of benefit (benefit)

$$R_{ij} = \left\{ \frac{Min\ \{x_{ij}\}}{x_{ij}} \right\}$$

If j is an attribute of cost (cost)

7. The result of normalization (Rij) forms a normalized matrix (R)

$$R = \begin{bmatrix} R_{11} & \dots & R_{1j} \\ \vdots & \ddots & \vdots \\ R_{i1} & \dots & R_{ij} \end{bmatrix}$$

8. The final result of the preference value (Vi) is obtained from the sum of the normalized matrix row elements (R) with the preference weights (W) corresponding to the matrix column elements (W).

With:
= rank for each alternative
= weighted value of each criterion
= normalized performance rating value.

III.   RESULTS AND DISCUSSION

The results of the research on the calculation of decision support systems to determine scholarships with the SAW method can be seen as follows:

a. *Alternatives*

Determine alternatives for the selection of scholarship recipients, namely 23 students who register for the outstanding scholarship program.

Table 1. ALTERNATIVE DECISION

Code	Description
A1	Ade Budiyanto
A2	Dewi Kuswandari
A3	Elvina Usamah
A4	Gabriella Mandasari
A5	Genta Safitri
A6	Hamima Kuswandari
A7	Hasan Hutagalung
A8	Ibrahim Firgantoro
A9	Jarwadi Prasasta
A10	Keisha Puspasari
A11	Mahmud Firmansyah
A12	Nasrullah Wijaya
A13	Nilam Widiastuti
A14	Okta Gunarto
A15	Prima Simanjuntak
A16	Agus Juliansyah
A17	Radit Hutasoit
A18	Saadat Wacana
A19	Sabrina Yuniar
A20	Tedi Hutasoit
A21	Unggul Natsir
A22	Vanya Andriani
A23	Vicky Nurdiyanti

b. *Criteria*
criteria that become the reference for consideration for the selection of scholarship recipients in the form of academic and non-academic factors are in the following table 2.

Table 2. DECISION CRITERIA

Code	Description
C1	GPA This Semester
C2	Percentage increase in GPA
C3	Organizational participation
C4	Participation in competitions
C5	Lecturer recommendation
C6	Parent Income

c. *Attribute Criteria*

Gives attributes to each criterion that has been determined. There are 2 types of attributes that can be assigned to each criterion, namely *benefits* and *costs*.

a) *Benefit,* given to criteria that are beneficial or *beneficial*.

b) *Cost,* given to the criteria that are giving a loss or *cost*.

Table 3. ATTRIBUTE CRITERIA

Code	Description	Attribute
C1	GPA this semester	Benefit
C2	Percentage increase in GPA	Benefit
C3	Organizational participation	Benefit
C4	Participation in competitions	Benefit
C5	Lecturer recommendation	Benefit
C6	Parents income	Cost

c) *Criteria Weight*
Giving weight to each predetermined criterion. The nominal number of weights corresponds to how important the criteria are related to the selection process.

Table 4. WEIGHT CRITERIA

Code	Description	Weight
C1	GPA this semester	5.0
C2	Percentage increase in GPA	1.5
C3	Participation in organizations	1.0
C4	Participation in competitions and the like	2.0
C5	Lecturer recommendations	1.0
C6	Parents income	1.5

d) *Alternative Values on Each Criterion*
Give a weighted value for each alternative to each criterion according to the suitability of the alternative to each of the relevant criteria.attribute type *benefit* , the higher the alternative weight value means the higher the possibility of the alternative being the best choice at the time of calculation, on the contrary, *cost* means the lower the probability.

Table 5. CRITERIA WEIGHTING

Alt.	Criteria					
	C1	C2	C3	C4	C5	C6
A1	3.8	1.0	1.0	2.0	10.0	8.0
A2	3.8	2.0	3.0	3.0	8.0	12.0
A3	3.0	5.0	4.0	1.0	2.0	6.0
A4	2.9	1.0	10.0	1.0	1.0	6.0
A5	3.0	2.0	5.0	1.0	1.0	7.0
A6	3.1	1.0	6.0	4.0	3.0	15.0
A7	3.7	3.0	1.0	10.0	5.0	20.0
A8	3.3	4.0	7.0	2.0	4.0	11.0
A9	3.4	3.0	3.0	8.0	6.0	8.0
A10	2.9	4.0	4.0	4.0	1.0	9.5
A11	3.0	4.0	6.0	1.0	1.0	9.0
A12	2.2	4.0	5.0	1.0	1.0	6.0
A13	3.8	3.0	9.0	4.0	2.0	7.0
A14	3.1	2.0	8.0	3.0	4.0	11.0
A15	3.4	1.0	2.0	2.0	1.0	20.0
A16	2.9	3.0	1.0	1.0	3.0	7.6
A17	1.9	2.0	5.0	1.0	1.0	6.6
A18	2.8	4.0	4.0	4.0	1.0	13.0
A19	3.7	2.0	6.0	7.0	7.0	5.0
A20	2.8	5.0	10.0	2.0	1.0	9.0
A21	2.9	2.0	8.0	8.0	6.0	5.0
A22	3.9	1.0	4.0	1.0	4.0	8.2
A23	3.7	3.0	3.0	2.0	1.0	14.0

e) *Value Normalization*

Normalize the weight value of each alternative to simplify the calculation process.criteria *benefit* use the formula:

$$R_{ij} = \left\{ \frac{x_{ij}}{Max\ \{x_{ij}\}} \right\}$$

An example for the first alternative (A_1):

$$R_{11} = \left\{ \frac{x_{11}}{Max\ \{x_{11}\}} \right\} = \left\{ \frac{3.8}{3.8} \right\} = 1.00$$

$$R_{12} = \left\{ \frac{x_{12}}{Max\ \{x_{12}\}} \right\} = \left\{ \frac{1.0}{5.0} \right\} = 0.20$$

$$R_{13} = \left\{ \frac{x_{13}}{Max\ \{x_{13}\}} \right\} = \left\{ \frac{1.0}{10.0} \right\} = 0.10$$

$$R_{14} = \left\{ \frac{x_{14}}{Max\ \{x_{14}\}} \right\} = \left\{ \frac{2.0}{10.0} \right\} = 0.20$$

$$R_{15} = \left\{ \frac{x_{15}}{Max\ \{x_{15}\}} \right\} = \left\{ \frac{10.0}{10.0} \right\} = 1.00$$

criteria *benefit* use the formula:

$$R_{ij} = \left\{ \frac{Min\ \{x_{ij}\}}{x_{ij}} \right\}$$

An example for the first alternative (A_1):

$$R_{16} = \left\{ \frac{Min\ \{x_{16}\}}{x_{16}} \right\} = \left\{ \frac{8.0}{20.0} \right\} = 0.75$$

So that the normalization value is obtained as shown in the following table.

Table 6. NORMALIZATION VALUE

Alt.	Criteria					
	C1	**C2**	**C3**	**C4**	**C5**	**C6**
A1	1.00	0.20	0.10	0.20	1.00	0.75
A2	0.99	0.40	0.30	0.30	0.80	0.50
A3	0.80	1.00	0.40	0.10	0.20	1.00
A4	0.76	0.20	1.00	0.10	0.10	1.00
A5	0.77	0.40	0.50	0.10	0.10	0.86
A6	0.82	0.20	0.60	0.40	0.30	0.40
A7	0.96	0.60	0.10	1.00	0.50	0.30
A8	0.87	0.80	0.70	0.20	0.40	0.55
A9	0.90	0.60	0.30	0.80	0.60	0.75
A10	0.75	0.80	0.40	0.40	0.10	0.63
A11	0.79	0.80	0.60	0.10	0.10	0.67
A12	0.58	0.80	0.50	0.10	0.10	1.00
A13	0.99	0.60	0.90	0.40	0.20	0.86
A14	0.82	0.40	0.80	0.30	0.40	0.55
A15	0.89	0.20	0.20	0.20	0.10	0.30
A16	0.76	0.60	0.10	0.10	0.30	0.79
A17	0.50	0.40	0.50	0.10	0.10	0.91
A18	0.72	0.80	0.40	0.40	0.10	0.46
A19	0.96	0.40	0.60	0.70	0.70	1.20
A20	0.73	1.00	1.00	0.20	0.10	0.67
A21	0.76	0.40	0.80	0.80	0.60	1.20
A22	1.02	0.20	0.40	0.10	0.40	0.73
A23	0.98	0.60	0.30	0.20	0.10	0.43

f) *Final Results*

The last stage is to calculate the final value by finding the total *sum* of the results of the multiplication of the alternative normalization values with the appropriate weighting criteria preferences.

$$V_l = \sum_{j=1}^{n} W_j R_{ij}$$

For example for the first three alternatives (A_1, A_2, A_3):

$$V_1 = (1.00 \times 5.0) + (0.20 \times 1.5) + (0.10 \times 1.0)$$
$$+ (0.20 \times 2.0) + (1.00 \times 1.0)$$
$$+ (0.75 \times 1.5) = 7.925$$

$$V_2 = (0.99 \times 5.0) + (0.40 \times 1.5) + (0.30 \times 1.0)$$
$$+ (0.30 \times 2.0) + (0.80 \times 1.0)$$
$$+ (0.50 \times 1.5) = 8.011$$

$$V_3 = (0.80 \times 5.0) + (0.40 \times 1.5) + (0.30 \times 1.0)$$
$$+ (0.30 \times 2.0) + (0.80 \times 1.0)$$
$$+ (0.50 \times 1.5) = 7.790$$

After all the final alternative values are calculated, then they are sorted so that a ranking list is obtained as shown in the following table.

Table 7. FINAL RESULTS RANKING

Kode	Alternatif	Nilai
A19	Sabrina Yuniar	9.916
A21	Unggul Natsir	9.219
A13	Nilam Widiastuti	9.046
A9	Jarwadi Prasasta	9.039
A7	Hasan Hutagalung	8.766
A2	Dewi Kuswandari	8.011
A1	Ade Budiyanto	7.925
A8	Ibrahim Firgantoro	7.875
A3	Elvina Usamah	7.790
A20	Tedi Hutasoit	7.675
A22	Vanya Andriani	7.489

A14	Okta Gunarto	7.313
A23	Vicky Nurdiyanti	7.225
A10	Keisha Puspasari	7.188
A11	Mahmud Firmansyah	7.037
A4	Gabriella Mandasari	6.906
A18	Saadat Wacana	6.814
A6	Hamima Kuswandari	6.694
A5	Genta Safitri	6.557
A16	Prima Simanjuntak	6.490
A12	Nasrullah Wijaya	6.413
A15	Prima Simanjuntak	5.912
A17	Radit Hutasoit	5.257

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IV. CONCLUSION

The Decision Support System made using the SAW method has succeeded in helping make decisions to determine which students are most worthy of receiving outstanding scholarships. The SAW method has been successfully used to help solve problems that are Multiple Attribute Decision Making (MADM) or decision-making problems with many attributes. By using the SAW method, the results obtained in the form of a list of alternative rankings that are considered the most suitable for receiving scholarships, so that they can help facilitate the decision-making process.

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