Analysis of the Simple Additive Weighting Method in Educational Aid Decision Making

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Abstract:
Learning education aid is a government program aimed at assisting improverished children with high achievement in completing their 12-year compulsory education by assisting them in gaining access to adequate educational resources. Every school undertakes screening processes to determine potential scholarship applicants. This selection is done to ensure that the students who receive this help are those who are eligible. Concerning the difficulties faced by the selection committee, such as the difficulty in swiftly determining who is chosen as a candidate for aid receivers based on subjective or uncertain factors. To overcome these problems, a decision support system was designed using the Simple Additive Weighting (SAW) method, which is a simple ranking method by finding a weighted sum based on predetermined assessment criteria. Total Income of Parents, Number of Dependents of Parents, Value of Report Cards, Personality, Achievements, Poor People, Number of Alpha Student Attendances, and Received Government Program assistance were the criteria used. The goal of this research is to develop a decision-making tool that will aid the school in selecting children who will receive assistance. The method used can get the first rank with 18.51 being the top average value.
Keywords: System, Scholarship, Students, Decision Support System, Simple Additive Weight.

1. Introduction

Help education is government assistance in the form of amount cash given directly to students according to established criteria. The smallest amount of income of the students' parents, site of living, mode of transportation to school, multiple siblings, and the value of the students concerned are all characteristics that indicate that these students are incapable/poor (Cahyanul et al., 2019). The Poor Student Assistance Program is a National Program that aims to eliminate the barriers for poor students to participate in school by assisting them in gaining access to decent education services, preventing dropouts, attracting poor students to return to school, assisting students in meeting their learning needs, supporting the Compulsory Program Learning Nine Years of Basic Education, and even up to the upper secondary level, as well as helping the smooth running of school programs (Nurjanah & Akbar, 2020).

The *Simple Additive Weight* (SAW) method is often also known as the weighted addition method. The basic concept of the *Simple Additive Weight* (SAW) method is to find the weighted sum of the performance ratings for each alternative on all attributes. The *Simple Additive Weighting* (SAW) method is recommended to solve the selection problem in a multi-process decision-making system. The *Simple Additive Weight* (SAW) method is a method that is frequently used in decision making that has many attributes (Frieyadie, 2016).

Assistance in the implementation of Education's schools frequently confront difficulties in determining the recipients where not all students who come from poor families can receive Assistance Program Education (Irvanizam, 2017). So, not all of the many potential scholarship recipients who meet the criteria for receiving poor student aid will become poor students assistance recipients. As a result, a Decision Support System (SPK) must be used in the identification of potential receivers of poor student aid. So in this case, it will help the school in the uncertain right candidate receiving the help so that each of the families who are unable to receive such assistance.

The method used for the decision support system is to use *Simple Additive Weighting* (SAW). SAW was chosen because it can determine the weight value for each attribute, then proceed with a ranking process that will select the best alternative from several alternatives (Putra & Pratama, 2016). In this case, the intended alternative is students who are entitled to receive assistance based on specified criteria.

A decision support system is a set of model-based procedures for processing and evaluating data to assist individuals (managers, doctors, etc.) in making decisions. (Hasugian & Cipta, 2018) . The concept of Decision

Support Systems (DSS) or Decision Support Systems (DSS) was first introduced by Michael Scott Morton, it is known as Management Decision Systems. The DSS concept is characterized by a computer-based interactive system that helps decision-making by utilizing data and models to solve unstructured and semi-structured problems (Hermawati, 2013).

In the decision-making process, the data and information processing carried out aim to produce various alternative decisions that can be taken (Yani et al., 2018). DSS which is the application of the information system is intended only as a management tool in decision making. DSS is not intended to replace the function of decision-makers in making decisions, but only as a tool for decision-makers in carrying out their duties (Ciptayani et al., 2018). DSS is designed to produce various alternatives that are offered to decision-makers in carrying out their duties. So it can be said that DSS provides benefits for management in terms of increasing the effectiveness and efficiency of its work, especially in the decision-making process. In addition, DSS unites the capabilities of computers in interactive services to their users by processing or manipulating data that utilizes unstructured models or rules to produce situational decision alternatives (Hermawati, 2013).

DSS components consist of data management, model management, user interface, and knowledge-based subsystems. DSS includes three main stages, namely the stage of intelligence, design, and selection. But then added the fourth stage, namely the implementation stage (Basyaib. 2006). The four stages can be explained as follows: 1. Stages of Search (*Intelligence*) is the stage of defining the problem and identifying the required information related to the problems faced and the decisions to be taken. This step is very important because before any action is taken, of course, the problems faced must be formulated first; 2. *Design* is an analysis stage in terms of finding or formulating alternative problem-solving. After the problem is formulated well, then the next stage is to design or build a problem-solving model and develop various alternative problem solving; 3. Selection (*Choice*) is to choose an alternative solution that is estimated to be the most appropriate. This alternative selection will be easy to do if the desired result is measurable or has a certain quantity value; 4. Implementation is the implementation stage of the decisions that have been taken. At this stage, it is necessary to arrange a series of planned actions, so that the results of decisions can be monitored and adjusted if improvements are needed (Kurniawan et al., 2019).

The source of the complexity of the decision problem is only because of the uncertainty factor or imperfect information. However, there are still other causes such as factors that influence the existing choices, with the variety of selection criteria and also the weight value of each criterion, which is a very complex form of problem-solving (Vanicek & Kucerova, 2018). In this day and age, multi-criteria problem-solving methods have been widely used in various fields. After establishing the objectives of the problem, the criteria by which to measure, and possible alternatives, decision-makers can use one or more methods to solve their problems. The method that can be used to overcome multi-criteria problems is the Simple Additive Weighting (SAW) method. SAW was introduced by Fishburn (1967) and MacCrimmon (1968) to be used as a method in solving multi-criteria problems (Wira et al., 2018).

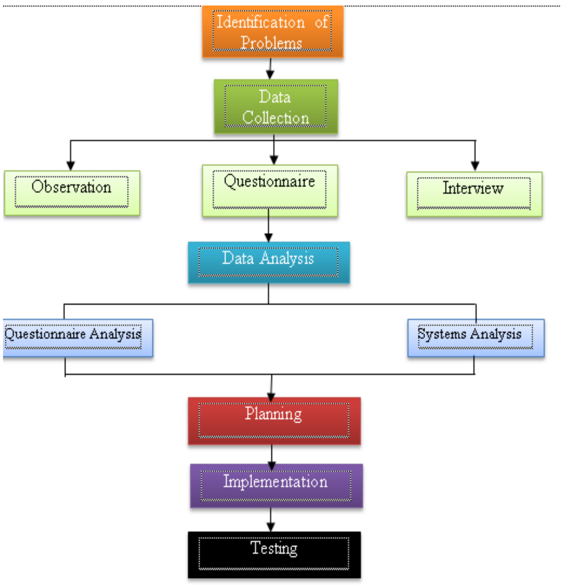
The Simple Additive Weighting (SAW) method is known as the weighted addition method. The SAW method is done by finding the sum of the weights of the performance rating on each alternative on all attributes so that it can determine the best alternative. (Andianggara et al., 2019). The SAW method recognizes 2 (two) types of criteria, namely: benefit criteria and cost criteria. A parameter is classified as a benefit type criterion if the parameter has a value which if it increases it will be better (related to the topic being studied) (Pranolo & Muslimah Widyastuti, 2014). While a parameter is classified as a price type criterion (cost), if the parameter has a value, the less it is, the better it will be (Andianggara, et al., 2019).

2. Methodology

2.1. The Research Framework

The conceptual framework of research is a relationship or link between a concept and another concept of the problem to be studied. The conceptual framework can explain the relationship in detail of the subject under study. The conceptual framework is obtained from the synthesis of deductive thought processes (application of the theory) and inductive (existing, empirical facts), then with creative-innovative capacities, ending with a new concept or idea called the conceptual framework.

In this study, the conceptual framework starts from the problem in determining the beneficiaries of educational scholarships. The initial stage is to determine the problem and then collect data through interviews and field observations. After collecting data, then analyze the data and analyze the system. The next stage is planning and implementation. After deployment, the system test is performed.



Picture 1. Research Framework

From the picture above, it can be concluded that there are several stages in this research. Where the research starts from the problem identification stage as an affirmation of the boundaries of the problem so that the scope of the research remains at the initial goal. Next is the data collection stages where the data needed are primary data and secondary data. Secondary data collection is done by studying and reviewing sources such as books, scientific articles, and writings related to research. While the primary data was obtained from the results of interviews and analysis of distributed questionnaires. After the data is collected, it will be analyzed according to the standard using the Simple Additive Weight (SAW) method. The next stage is system analysis. At this stage is done to design the system to be made. Then in the design phase, the researcher uses the *Unified Modeling Language* (UML) as a tool in explaining the program flow for the calculation of the questionnaire. UML consists of use case *diagrams, class diagrams, sequence diagrams, activity diagrams,* and *deployment diagrams* (Meirina et al., 2019).

2.2. Simple Additive Weight (SAW) Method

2.2.1 SAW Criteria

The development of decision support applications using the simple additive weighting (SAW) method requires several criteria. The criteria needed are: Parent's Income Criteria listed in table 1 below.

Table 1. The Parental Income Amount Criteria

C1	Weight (W)
> Rp. 1.500.000 - <= Rp. 2.000.000	1
> Rp. 1.500.000 - <= Rp. 2.000.000	2
> Rp. 1.000.000 - <= Rp. 1.500.000	3
> Rp. 500.000 - <= Rp. 1.000.000	4
< Rp. 500.000	5

The next criterion is the dependents of parents where the number of dependents or the number of siblings in the family this data can be obtained from the guidance and counseling teacher contained in the student's data book contained in table 2 below.

Table 2. Parent’s Responsibility

C2	Weight (W)
1 – 2 Children	1
3 – 4 Children	2
5 – 6 Children	3
7 – 8 Children	4
>= 9 Children	5

The next criterion is the value of the report card. The value of student report cards is taken from the sum of all aspects of the value of the subject whose total results are seen in the student’s data book according to the school year that has been taken.

Table 3. Report Value Criteria

C3	Weight (W)
< 1.840	1
1.840 – 2.713	2
2.714 – 3.403	3
4.404 – 4.140	4
4.141 – 4.600	5

Furthermore, personality criteria, where personality data is taken from BK teachers who are assessed for their appropriateness, honesty, sense of responsibility, emotions, relationships with friends both at school and outside school, relationships with teachers, from all aspects it is assessed how behavior students listed in the student report card.

Table 4. Personality Criteria

C4	Weight (W)
Ugly	1
Not Good	2
Pretty Good	3
Good	4
Very Good	5

The next criterion is an achievement. Achievements are taken from student activities or competitions that they have participated in based on the levels in the following table.

Table 5. Achievement

C5	Weight (W)
Nothing	1
Sub-District Level	2
District Level	3
Provincial Level	4
National Level	5

The next criterion is poor, which is based on students who still have both parents or are dead or it could be that these students come from orphanages

Table 6. Dhuafa Clan

C6	Weight (W)
Both parents are still there	1
Students from the orphanage	2
No mother	3
No father	4
Do not have both parents	5

The next criterion is the absence of students who are alpha or not present. This student's attendance is based on the last semester's attendance who was alpha or did not attend school without explanation.

Table 7. Alpha Student Attendance

C7	Weight (W)
>= 7	1
5 – 6	2
3 – 4	3
1 – 2	4
0	5

The next criterion is to have a government program card, see whether both parents or guardians of students are registered with the government's social protection card program (KPS) or the family of hope program (PKH).

Table 8. Get Government Program Assistance

C8	Weight (W)
Registered KPS	5
Registered PKH	4
Have SKTM	3
Not getting help	2

There are 8 criteria, each of which has a weight and type of criteria. The type of criteria is divided into 2, namely profit (*benefit)* and cost (*Cost*). The type of *benefit* criteria is a criterion that is beneficial to the alternative, while the type of *cost* criterion is a criterion that is detrimental to the alternative. More details can be seen in the following table:

Table 9. Criteria

Criteria	Description	Weight	Type
C1	Parents' Income	4	*Cost*
C2	Parental Responsibilities	3	*Benefit*
C3	Report Value	3	*Benefit*
C4	Personality	2	*Benefit*
C5	Achievement	3	*Benefit*
C6	Dhuafa	4	*Benefit*
C7	Alpha Student Attendance	2	*Cost*
C8	Have a Government Program Card	5	*Cost*

2.2.2 SAW Method Steps

There are several steps in completing the SAW method, as follows: (Hermanto & Izzah, 2018)

1. Determine the criteria that will be used as a reference in decision making, namely Ci.
2. Determine the suitability rating of each alternative on each criterion.
3. Make a decision matrix based on the criteria (Ci), then normalize the matrix based on the equation that is adjusted to the type of attribute (profit attribute or cost attribute) to obtain a normalized matrix R.
4. The final result is obtained from the ranking process, namely, the addition of the normalized matrix multiplication R with the weight vector so that the largest value is chosen as the best alternative (Ai) as the solution.

The formula to perform the normalization is:

The formula for the benefit attribute:

$$Rin = \left\{ \frac{Xin}{Max\ (Xin)} \right. \qquad (1)$$

The formula for the Cost Attribute :

$$Rin = \left\{ \frac{Min\ (Xin)}{Xin} \right. \qquad (2)$$

Where :

Rin = normalized performance rating
Maxin = maximum value of each row and column
Min Xin = minimum value of each row and column
Xin = row and column in the matrix

Where Rin is the normalized performance rating of alternative Ai on attribute Cj; i = 1,2,…m and n = 1,2,…,n.

The preference value for each alternative (Vi) is given as:

$$\mathrm{U}i = \sum_{n}^{m} = 1\ Wn(rin) \qquad (3)$$

Where :

Ui	=	The final score of alternative
Wn	=	Predefined weight
Rin	=	Normalized matrix

A larger Ui value indicates that alternative Ai is preferred.

3. Result and Discussion

As for examples of cases in solving problems using the SAW method, including the following, determining the types of criteria and alternatives, the alternative in this study is in schools looking for students who are entitled to receive educational assistance, the author will use 3 alternatives in the example of calculating the SAW method there are alternative 1 (A1), alternative 2 (A2), and alternative 3 (A3).

Table 10. Match Rating From Initial Data

	C1	C2	C3	C4	C5	C6	C7	C8
A1	800.000	2	3.190	Very Good	Nothing	No father	5	Registered KPS
A2	1.200.000	5	3.420	Enough	Sub-District Level	Students from the orphanage	7	Registered PKH
A3	500.000	9	2.680	Good	District Level	Both parents are still there	0	No getting help

a. Determine the preference weight or the level of importance (W) of each criterion

Table 11. Preference weight or importance level

Kriteria	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**
Rating Kepentingan/Bobot(W)	4	3	3	2	3	4	2	5

b. Create a decision matrix X

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

c. Normalize the decision matrix X by calculating the value of the normalized performance rating (Rij) of the alternative (Ai) on the criteria (Cj) with the following formula.

If the criterion type is profit (*benefit*).

$$Rin = \frac{Xin}{\max(Xin)}$$

If the criterion type is *cost*.

$$Rin = \frac{\min(Xin)}{Xin}$$

By using the above formula to find the normalized matrix value, the following calculation is obtained, as follows:

$$R11 = \frac{\min(4,3,5)}{4} = \frac{3}{4} = 0.75$$

$$R21 = \frac{\min(4,3,5)}{3} = \frac{3}{3} = 1$$

$$R31 = \frac{\min(4,3,5)}{5} = \frac{3}{5} = 0.6$$

$$R12 = \frac{1}{\max(1,3,5)} = \frac{1}{5} = 0.2$$

$$R22 = \frac{3}{\max(1,3,5)} = \frac{3}{5} = 0.6$$

$$R32 = \frac{5}{\max(1,3,5)} = \frac{5}{5} = 1$$

$$R13 = \frac{3}{\max(3,4,2)} = \frac{3}{4} = 0.75$$

$$R23 = \frac{4}{\max(3,4,2)} = \frac{4}{4} = 1$$

$$R33 = \frac{2}{\max(3,4,2)} = \frac{2}{4} = 0.5$$

$$R14 = \frac{5}{\max(5,3,4)} = \frac{5}{5} = 1$$

$$R24 = \frac{3}{\max(5,3,4)} = \frac{3}{5} = 0.6$$

$$R15 = \frac{1}{\max(1,2,3)} = \frac{1}{3} = 0.33$$

$$R25 = \frac{2}{\max(1,2,3)} = \frac{2}{3} = 0.66$$

$$R35 = \frac{3}{\max(1,2,3)} = \frac{3}{3} = 1$$

$$R16 = \frac{4}{\max(4,2,1)} = \frac{4}{4} = 1$$

$$R26 = \frac{2}{\max(4,2,1} = \frac{2}{4} = 0.5$$

$$R36 = \frac{1}{\max(4,2,1} = \frac{1}{4} = 0.25$$
$$R17 = \frac{\min(2,1,5)}{2} = \frac{1}{2} = 0.5$$
$$R27 = \frac{\min(2,1,5)}{1} = \frac{1}{1} = 1$$
$$R37 = \frac{\min(2,1,5)}{5} = \frac{1}{5} = 0.2$$
$$R18 = \frac{\min(5,4,2)}{5} = \frac{2}{5} = 0.4$$
$$R28 = \frac{\min(5,4,2)}{4} = \frac{2}{4} = 0.5$$
$$R34 = \frac{4}{\max(5,3,4)} = \frac{4}{5} = 0.8$$
$$R38 = \frac{\min(5,4,2)}{2} = \frac{2}{2} = 1$$

d. The result of the normalized performance rating value (Rij) forms a normalized matrix (R).

$$R = \begin{bmatrix} 0.75 & 0.2 & 0.75 & 1 & 0.33 & 1 & 0.5 & 0.4 \\ 1 & 0.6 & 1 & 0.6 & 0.67 & 0.5 & 1 & 0.5 \\ 0.6 & 1 & 0.5 & 0.8 & 1 & 0.25 & 0.2 & 1 \end{bmatrix}$$

e. The final result of the preference value (Pi) is obtained from the multiplication and addition of the normalized matrix row elements (R) with the preference weights (W) corresponding to the matrix column elements (W).

$$P1 = (4)(0.75) + (3)(0.2) + (3)(0.75) + (2)(1) + (3)(0.33) + (4)(1) + (2)(0.5) + (5)(0.4) = 15.84$$
$$P2 = (4)(1) + (3)(0.6) + (3)(1) + (2)(0.6) + (3)(0.67) + (4)(0.5) + (2)(1) + (5)(0.5) = 18.51$$
$$P3 = (4)(0.6) + (3)(1) + (3)(0.5) + (2)(0.8) + (3)(1) + (4)(0.25) + (2)(0.2) + (5)(1) = 17.9$$

f. Ranking Process

Table 12. Rangking Result

Ranking	Pi	Name	Value
1	P2	Sekar Sari	18,51
2	P3	Febi Hendrawa	17,9
3	P1	Imam Aminudin Muharom	15,84

The conclusion that can be drawn from table 11 above is that the highest value is in P2. Thus, alternative A2, namely Sekar Sari, is the alternative chosen as the best alternative for prospective recipients of educational assistance.

4. Conclusion

Making a Decision Support System for the selection of education scholarship recipients to calculate student selection with ranking results has been successfully built. The system that has been made refers to the existing problem formulation, namely the system can select students according to the provisions by performing calculations based on the SAW (Simple Additive Weighting) method on FMADM (Fuzzy Multiple Attribute Decision Making). Some conclusions that can be described are that this system aims to assist in selecting students who are eligible for educational assistance. The calculation on the system to perform the selection uses the SAW (Simple Additive Weighting) method. The stages of the system development process in this research are problem identification, system analysis, design, testing, and implementation. The result of the system calculation is the ranking of the highest to the lowest scores and the highest score is the result to get the students who are most deserving of Education Assistance. The system was built only as a tool to provide information to the school as a consideration in making decisions.

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