

Implementation of The Simple Additive Weighting Method in Solving Decision Making Problems (Case Study of Bidikmisi Scholarship Recipient Selection)

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ABSTRACT

Decision making to determine prospective Bidikmisi scholarship recipients is based on various criteria and parameters. In the process, the evaluation of these criteria and parameters often results in various errors. For that we need a system that can eliminate these errors. Computerized-based system is a solution that can overcome these problems. The system can use a variety of methods and depending on each need. For the selection case for Bidikmisi scholarship recipients, the Simple Additive Weighting algorithm is suitable to be applied, considering that from several studies related to the application of this algorithm in supporting decision making, it turns out that it can provide a fast and accurate solution. It is hoped that the results of this research can later be implemented in the selection process for Bidikmisi scholarship recipients at IAIN Palopo so that a list of Bidikmisi scholarship recipients can be obtained quickly and accurately.

Keywords: Decision support system; Simple additive weighting; Scholarship

INTRODUCTION

Decision making is a very important thing for an organization, because it is related to the progress of an organization, and especially because the future of an organization is determined by the decisions made now. (Salusu, 2015). Making decisions is sometimes easy but more often than not it is very difficult. The ease or difficulty of making a decision depends on the number of alternatives available. The more alternatives available, the more difficult it will be to make a decision. The decisions taken have different levels.

In making decisions, whether routine or not, there are two methods used. The first method is the traditional method, where decision making is

based on intuition and habit. The second method is the modern method, where decision making is based on mathematical calculations and the use of modern instruments, such as computers and statistical calculations (Bhudianto, 2015).

Decision Support System (DSS) is a model-based system consisting of procedures in data processing and considerations to assist managers in making decisions. In order to succeed in achieving its objectives, the system must be simple, robust, easy to control, fully adaptable to important matters and easy to communicate with. It also implicitly means that this system must be computer-based and used in addition to one's problem-solving abilities (Turban, 2005). Decision support systems utilize the resources of individuals intellectually with

computer capabilities to improve the quality of decisions. So it is a computer-based support system for management decision making related to semi-structured problems. A decision support system is an interactive, flexible, easy-to-adjust (adaptable) computer based information system that was specifically developed to support the resolution of unstructured problems to improve decision making. (Surya, 2015)

Several studies have shown that with the help of a decision support system can help in the process of making a decision. The research, among others, helps provide recommendations for recipients of the Program Keluarga Harapan (PKH) assistance accurately and quickly. (Purba & Sihotang, 2019). There is also research that helps decision making in determining the amount of employee salaries. (Setiawan et al., 2018) In addition, there is also research that helps individuals in making decisions, such as the decision to choose the right insurance product. (Prasetya et al., 2018)

Scholarships are the provision of financial assistance given to individuals, students for the continuation of education. Scholarships are defined as a form of award given to individuals in order to continue their education to a higher level. The award can be in the form of certain access to an institution or an award in the form of financial assistance. (Saleh, 2017)

One of the government's programs in facilitating access for the public to pursue higher education is by providing tuition assistance through the Bidikmisi scholarship program (Education Fees for Poor Students with Achievements). The legal basis for implementing this program is the Regulation of the Minister of Research, Technology and Higher Education Number 6 of 2019. (RI, 2019) This program as the name implies is only intended for outstanding students who while studying at the high school level have a record of achievement, both academic and non-academic achievements. But it is not enough just to excel, the student must also come from a poor family.

Interest in the Bidikmisi scholarship program annually experiences a significant increase which is not balanced with the quota provided by each

university. Therefore, the competition for scholarships is also getting tougher. Due to the intense competition, the selection process to determine prospective recipients is also felt to be increasingly difficult for universities. The difficulty in making this decision is caused by the many and complex assessments of each criterion. Not to mention the large number of applicants. The difficulty is felt to be even more severe, especially if the assessment process still relies entirely on human power. It is certain that it will take up a lot of time and energy which then the results are not necessarily accurate.

The simple additive weighting method is often also known as the weighted addition method. The basic concept of the simple additive weighting method is to find the weighted sum of the performance ratings for each alternative on all attributes. The simple additive weighting method requires the process of normalizing the decision matrix (X) to a scale that can be compared with all available alternative ratings. (Kusumadewi & Purnomo, 2010) The normalization process can be expressed in the form of a formula as follows :

$$r_{ij} = \begin{cases} \frac{x_{ij}}{\text{Max}_i x_{ij}} & \text{jika j adalah atribut keuntungan (benefit)} \\ \frac{\text{Min}_i x_{ij}}{x_{ij}} & \text{jika j adalah atribut biaya (cost)} \end{cases}$$

Where :

- rij : Normalized performance rating
 - Maximum : Maximum value of each row and column
 - Minimum : Minimum value of each row and column
 - xij : Rows and columns of a matrix
- Where rij is normalized performance rating from alternative Ai in attribute Cj; i=1,2,...,m and j=1,2,...,n.

The preference value for each alternative (Vi) is given with the following formulation:

$$V_i = \sum_{j=1}^n w_j r_{ij}$$

- Vi : Alternative final score
- Wi : Predefined weight
- Rij : Matrix normalization

A larger Vi value indicates that alternative Ai is preferred.

The simple additive weighting method can determine the weight value for each attribute, then proceed with a ranking process that will select the best alternative from a number of alternatives, based on the specified criteria.(Wang, 2019)

Several studies have been conducted to try to overcome the problems that arise due to decision-making problems. Every researcher is competing to produce a theory or method that can be used as a means to help produce an accurate and fast decision. One method that has been studied to solve this problem is the Simple Additive Weighting method.

The research, among others, was conducted by Frieyadie who applied the Simple Additive Weighting method in supporting promotion decisions for promotion. He concluded that the simple additive weighting method could provide recommendations for personnel who really deserve to be promoted to positions.(Frieyadie, 2016). Related research has also been carried out by Mardheni Muhammad, Novi Safriadi, and Narti Prihartini. In their research, they concluded that the simple sdditive weighting method can provide recommendations for priority road improvements based on the required criteria.(Muhammad et al., 2017). Previously, the Simple Additive Weighting method had been studied by Alireza Afshari, Majid Mojahed and Rosnah Mohd Yusoff. Their research resulted in the selection of suitable and appropriate personnel in accordance with the needs.(Afshari et al., 2010). Wakhidatul Fauziah in his research concluded that the simple additive weighting method can help complete and speed up the feasibility report of the computer laboratory of the Sukorejo District Education Unit to the central government compared to the manual method.(Fauiah, 2015). While A.A. Gde A. Putra Ratu Asmara stated that by applying the simple additive weighting method, the system can run optimally and can provide information on prospective students dropping out quickly so that it can assist superiors in making decisions for students affected by dropout.(Asmara, 2016).

With the help of the simple additive weighting method, Muhammad Alfadin Salim managed to quickly determine the nominations for the recipients of home improvement assistance. There are also studies that have proven that using the simple additive weighting method can help provide input in determining the recipients of the supplementary Feeding program for malnourished children, this research was conducted by Maulisa Puspa.(Puspa, 2019). Meanwhile, Ratna Kusumawardani has proven that by using the simple additive weighting method, you can determine road repair priorities.(Kusumawardani & Solichin, 2019)

From some of the research references above, the researchers tried to implement the simple additive weighting method in the case of determining Bidikmisi scholarship recipients. It is hoped that from this research, accurate and fast recommendations for the nomination of Bidikmisi scholarship recipients can be obtained.

With this ranking method, it is hoped that the assessment will be more precise because it is based on predetermined criteria and weights so that it will get more accurate results for who will receive the scholarship..

METHOD

The stages that will be carried out in this research are as follows:

1. Tahapan penelitian
 - a. Problem identification
At this stage, observations were made on the ongoing selection process for Bidikmisi scholarship recipients. From the results of these observations, it turns out that several problems were found. These problems are then inventoried for the next stage.
 - b. Problem formulation
From the results of the problem inventory that has been carried out, then the search for solutions to these problems is carried out. The main solution used is to use a computerized system for problem solving.
 - c. Research design

At this stage, several simulation methods are carried out that will be used in a computerized system to solve the problem. Then from several simulations it was decided to use the simple additive weighting method.

d. Data collection

Some of the data collection techniques used are:

- 1) Observation; by observing the ongoing process from registration to determination.
- 2) Literature study; carried out for the purposes of extracting references to decision support systems, methods and other matters.
- 3) Academic data; This is done by digging up information from the manager regarding the data that will be used as an assessment parameter in the selection process.

2. Data analysis

Data analysis was carried out after the research stage was carried out. In this data analysis, what is done in the study is to analyze data from the stages of research that have been carried out, namely analyzing the system testing questionnaire used in the study.

3. System development

At this stage, the system is developed using the prototyping method. What is meant by prototyping technique is rapid system development and testing of working models (prototypes) of new applications through repeated and interactive processes commonly used by information systems experts and business experts. Prototyping is also called rapid application design (RAD) because it simplifies and speeds up system design.

There are several stages in the prototyping technique, which are as follows:

a. Data collection

Users and developers together define the format of the entire software. Define all requirements, and outline the system to be made.

b. Build Prototype

Build prototypes by making temporary designs that focus on presenting to users (eg by creating input and output formats). In this stage, the Simple Additive Weighting method is integrated into the system that is being built.

c. Prototype evaluation

This evaluation is carried out by the user whether the prototype that has been built is in accordance with the wishes of the user.

d. Coding system

In this stage the agreed prototype is translated into the appropriate programming language.

e. System testing

After the system has become a ready-to-use software, it must be tested before use. This test is carried out using several methods, including White Box, Black Box, Base Path.

f. System evaluation

Users evaluate the finished system as expected, if approved then proceed to the next step.

g. Using the System

Software that has been tested and accepted by users is ready to use.

4. Testing and implementation

What is done at this stage is to implement the results of the research conducted. In the implementation of this software, the things that will be done include inputting data for all Bidikmisi scholarship applicants, input criteria, input criteria weights, calculating each alternative.

RESULT and DICUSSION

This study uses data sourced from student data for the 2017 IAIN Palopo Bidikmisi scholarship applicants, for the purposes of this research the data used is applicant data on the SPAN-PTKIN registration path. The number of student applicants is 162 people.

After the required data is available, then the system development begins. System development is carried out using prototyping techniques, namely by directly building the

system and then after it is finished, it is immediately executed while looking at and observing potential errors that may arise. The system is built using the PHP programming language, while for data management using the MariaDB application.

In designing this system there are several things that become the main concern, namely the implementation of the simple additive weighting method into the system, interface design, and database design.

1. Implementation of simple additive weighting method.

After all input data has been filled into the system, the core stage of the system before producing output in the form of ranking recommendations is the process of calculating each criterion and sub-criteria using the simple additive weighting method. There are 14 (fourteen) criteria in this system and each of these criteria has another sub-criterion. The weight calculation process is carried out by calculating the weight of each criterion combined with the calculation of the value of each sub-criterion.

Based on the steps in the simple additive weighting method described above, the following describes the implementation of these stages in the system.

- a. Determine the criteria that will be used as a reference in making decisions, namely C1 to C14.
- b. Determine the suitability rating of each alternative.

- c. Make a decision matrix based on the criteria (C_i), then normalize the matrix based on the equation that is adjusted to the type of attribute (benefit or cost) so that a normalized matrix is obtained.
- d. Perform the ranking process, which is multiplying the normalized matrix by the weight vector.

All applicant student data is filled in according to the respective criteria and sub-criteria. The data is then converted into values according to the values described in the criteria table. The conversion process is carried out automatically by the system by taking into account the determination that has been made. After the data is converted into values, then the data normalization is carried out. This process is the process of calculating the entire matrix from the first row and column to the last row and column. Next is the ranking process. This process is done by multiplying the criteria weights with the normalized matrix data. The data in the attachment is the result of the process of determining the list of scholarship recipients recommended by the system.

2. Interface design

This system is designed as a web-based system, namely a system that runs by being called through a web browser. With this technique, the system does not need to be compiled into an executable application and can be run on a network if the system is placed on the server side.



Figure 1. Display of System Start

At the beginning of the system when successfully called, a welcome page will be displayed. To enter the system, you are required to login by entering your username and password.

If the login is accepted, then it is directed to the system with the following display.



Figure 2. Inside the System Display

The entire interface is designed in such a way that it is easy to use and can be directly operated even by a layman.

3. Database design

In running this system, all data is managed by a database system with the following table structure:

a. Alternative Table:

No	Name	Type
1	id_alternatif	int (11)
2	nama	varchar (50)
3	alamat	varchar (50)
4	gender	enum ('L','P')

Table 1. Alternative Table

b. Criteria Table:

No	Name	Type
1	id_kriteria	int (11)
2	kode	varchar (10)
3	nama	varchar (50)
4	atribut	enum ('benefit','cost')
5	Bobot	float

Table 2. Criteria Table

c. Value Table:

No	Name	Type
1	id_alternatif	int (11)
2	id_subkriteria	int (11)

Table 3. Value Table

d. SUB-CRITERION Table :

No	Name	Type
1	id_subkriteria	int (11)
2	id_kriteria	int (11)
3	nama	varchar (50)
4	nilai	float

Table 4. SUB-CRITERION Table

e. User Table:

No	Name	Type
1	id_user	int (11)

2	nama	varchar (50)
3	username	varchar (50)
4	password	varchar (50)

Table 5. User Table

4. Implementation of the simple additive weighting method into the system

The simple additive weighting method has several stages in its operation. These stages are carried out sequentially and structured, while the stages are as follows:

- a. Selection criteria; used to determine / reference in assessing the scholarship recipients to be selected.
- b. Criteria value; scoring against predetermined criteria.
- c. Criteria weighting; awarding the value of conformity to the recommendation criteria for

scholarship recipients. The value is determined by the decision maker.

- d. Rank; perform calculations against the criteria with the weight of the suitability of the criteria.
- e. The chosen alternative; is the final stage of ranking, where students who are recommended will be selected as alternative choices.

In connection with the stages above, the following will describe the criteria, sub-criteria and weighting of each variable.

a. Parent's income criteria, attribute: cost, weight: High

NO	NAME OF SUB-CRITERION	VALUE
1	$X \geq 3.000.000$	2.5
2	$2.000.000 < X < 3.000.000$	5
3	$1.000.000 < X \leq 2.000.000$	7.5
4	$X \leq 1.000.000$	10

Table 6. Attribute Criteria Table

b. Criteria for the number of dependents, attribute: benefit, weight: High

NO	NAME OF SUB-CRITERION	VALUE
1	1 kid	0
2	2 kids	2.5
3	3 kids	5
4	4 kids	7.5
5	5 kids	10

Table 7. Dependents Criteria Table

c. Criteria for the house, attribute: benefit, weight: High

NO	NAME OF SUB-CRITERION	VALUE
1	Luxury	1
2	Not luxury	5

Table 8. House Criteria Table

d. Semester 1 ranking criteria, attribute: benefit, weight: Very High

NO	NAME OF SUB-CRITERION	VALUE
1	Outside Rank 10	0

2	Rank 4 - 10	1
3	Rank 3	5
4	Rank 2	7.5
5	Rank 1	10

Table 9. Semester 1 Criteria Table

The criteria for ranking this semester are repeated until the 6th semester ranking (as many as semesters at SMA/SMK/MA).

e. Non-academic achievement criteria, attribute: benefit, weight: High

NO	NAME OF SUB-CRITERION	VALUE
1	Non-OSIS Management	0
2	OSIS Management	2.5
3	Chief of OSIS	5

Table 10. Non-Academic Achievement Criteria

f. National level competition criteria, attribute: benefit, weight: High

NO	NAME OF SUB-CRITERION	VALUE
1	N/A	0
2	Outside of Big 3	1
3	3 rd place	5
4	2 nd place	7.5
5	1 st place	10

Table 11. National Level Competition Table

The criteria for the national level competition are repeated at the provincial and district/city levels.

g. Electricity bill criteria, attribute: benefit, weight: High

NO	NAME OF SUB-CRITERION	VALUE
1	> 1300 VA	0
2	1300 VA	5
3	900 VA	7.5
4	450 VA	10

Table 12. Electricity Bill Criteria Table

CONCLUSION

Based on the research that has been done, it can be concluded that the Simple Additive Weighting method can be implemented in solving

decision-making cases to produce recommendations for prospective Bidikmisi scholarship recipients quickly and accurately.

For development purposes, follow-up of this research is needed, including:

- a. Trying to implement the simple additive weighting method can be tested in other decision-making cases.
- b. rying to combine the simple additive weighting method with other methods in solving decision-making case.

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