Decision Support System for The Program Indonesia Pintar Scholarship using Simple Additive Weighting method

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Submitted : Sep 10, 2022 | **Accepted** : Sep 19, 2022 | **Published** : Oct 3, 2022

Abstract: The Program Indonesia Pintar (PIP) is an educational scholarship from the government for students who lack funds to continue their education, one of which is at the junior high school level. It is still done manually when selecting students who are eligible to receive the PIP scholarship at the junior high school level. This is less efficient because the selection process will take a long to analyze, and the reporting process is not yet computerized. To overcome these problems, a decision support system is needed to assist schools in selecting students who receive PIP assistance. The method used for the development of a decision support system is Simple Additive Weighting (SAW). The choice of this method is because the decision-making process is carried out by searching for the highest alternative from all alternatives so that the assessment is more accurate based on the provisions of the criteria values and preference weights. With the construction of this system, it is expected to be able to provide a solution so that the student selection decision-making process can be carried out quickly and accurately.

Keywords: Decision Support System; Educational; Program Indonesia Pintar; Scholarship; Simple Additive Weighting

1. INTRODUCTION

Education is a conscious and planned effort to create a learning environment and develop students' potential actively so that they can acquire religious knowledge, discipline, character, intelligence, character, and competencies needed by themselves, citizens, nation, and state according to Law no. 20 of 2003. The government's efforts to make education in Indonesia more advanced include the Program Indonesia Pintar (PIP), which is a flagship plan from the government that is shown to ensure the continuation of the education of school-age children from underprivileged or underprivileged families (Zamjani, 2019). These efforts can be supported by a decision support system that provides problem-solving solutions by providing the best alternative to assist the government's efforts to accommodate students who lack funds to continue their education, one of which is at the junior high school education level (or equivalent). A decision support system is also made to support all stages of decision-making, starting with the problem identification stage, selecting significant data, determining the approach for the decision-making process, to the evaluation phase of alternative selection activities (Turnip et al., 2019; Zhou et al., 2021). The decision support system method used is a simple weighting additive, which is a method called the summation of weighting values (Liesnaningsih et al., 2020). The basic concept is to find the sum of the performance ratings on the weighted values of each alternative for all attributes (Dellermann et al., 2019).

PIP scholarships are given to students who meet the criteria required by the government, so a selection process is always carried out so that the recipients of PIP scholarships can meet the criteria and meet the available quota. The selection process still uses manual techniques. This is less effective because the selection process that must be analyzed takes a long time, and the reporting process is not yet computerized. Therefore, a decision support system is needed to make it easier to determine recommendations for students receiving PIP scholarships for decision support makers.

The purpose of this study is to implement the Simple Additive Weighting (SAW) method on a decision support system for the selection of students receiving PIP scholarships, based on six predetermined criteria, namely Kartu Indonesia Pintar (KIP) Recipients (C1), Parent's Income (C2), Parental Dependents (C3), Program Keluarga Harapan (PKH) Participants (C4), Kartu Keluarga Sejahtera (KKS) Holder (C5), Orphan Status (C6).

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JURNAL & PENELITIAN TEKNIK INFORMATIKA
Sinkron : Jurnal dan Penelitian Teknik Informatika
Volume 6, Number 4, October 2022
DOI : https://doi.org/10.33395/sinkron.v7i4.11786
e-ISSN : 2541-2019
p-ISSN : 2541-044X

2. LITERATURE REVIEW

The decision support system is an interactive system designed to help make decisions based on data collection; handling the problem is semi or unstructured (Baswaraj et al., 2018). The decision support system is also made to support all stages of decision-making, starting with the stages of determining the problem, selecting significant data, determining the approach to the decision-making process, to the stage of selecting alternatives. There are four main stages for decision making (Rani et al., 2021; Teniwut & Hasyim, 2021), including The understanding phase (Intelligence) is the process of understanding problems by identifying and reviewing environmental problems that will require provisions based on available data and real, processing data, and conducting tests to make instructions in solving problems that occur so that the hope is to facilitate the search for solutions (Wuryani et al., 2021); The design phase is the process of improving, analyzing, and finding alternative actions or alternative solutions; The selection phase (Choice) is the process of selecting alternative solution proposals in the design phase in order to determine activities by observing criteria (C) based on the achievement goals in the implementation phase; and The implementation phase is the phase of implementing or applying the selected alternative actions to solve the identified problems (Wihartati & Efendi, 2021).

3. METHOD

The method in determining the decision support system used is Simple Additive Weighting (SAW), which is the most frequently used method of Fuzzy MADM and the simplest (Hutahaean et al., 2018; Lismardiana, 2018). The SAW method is called the summation of weighted values. The basic concept is to find the sum of the performance ratings on the weighted values of each alternative for all attributes. Therefore, SAW can also make it easier to make decisions so that they can choose the graduate students who best fit the criteria (C) that have been determined. The SAW requires a normalization process from the decision matrix (X) with a ratio that can be matched with other alternatives. The SAW requires decision makers to assign a weighting to each attribute or criterion (C) (Indriyanti et al., 2019). The Working Procedure of the Simple Additive Weighting Method is shown in Fig. 1.

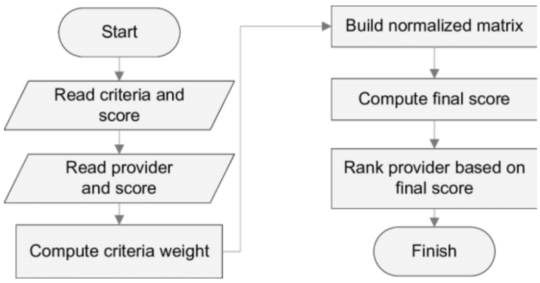

Fig. 1 Working Procedure of the Simple Additive Weighting Method

The Working Procedure of the Simple Additive Weighting Method includes: Determination of the criteria as the basis for making decisions, namely C; Determination of the suitability rating of each alternative (A_i) from each predetermined criterion, the value is obtained from the crisp value; namely i = 1,2,…,m and j = 1,2,…,n; Making a decision matrix based on criteria (C), then normalizing the matrix from the predetermined equation with each type of attribute (benefit/cost) and getting a normalized matrix R; The final result is obtained from the ranking process of the addition of the normalized matrix multiplication R with the weight vector, and the maximum value is obtained for the best alternative solution (A) (Khasanah et al., 2020).

4. RESULT

The following are the steps taken in implementing the Simple Additive Weighting (SAW) method, starting with determining criteria used as a reference for the decision-making of PIP scholarship recipients, as shown in Table 1.

Table 1. Criteria and Sub-Criteria

Criteria	Atribut	Criteria Weight	Sub-Criteria	Sub Criteria Weight
Kartu Indonesia Pintar (KIP) Recipients (C1)	Benefit	0.15 (15%)	Non-Recipient	1
			Recipient	2
Parent's Income (C2)	Cost	0.20 (20%)	<= 500,000 (IDR)	1
			500,000 – 999,999 (IDR)	2
			1,000,000 – 1,999,999 (IDR)	3
			2,000,000 – 4,999,999 (IDR)	4
			5,000,000 – 20,000,000 (IDR)	5

Sinkron : Jurnal dan Penelitian Teknik Informatika
Volume 6, Number 4, October 2022
DOI : https://doi.org/10.33395/sinkron.v7i4.11786
e-ISSN : 2541-2019
p-ISSN : 2541-044X

Criteria	Atribut	Criteria Weight	Sub-Criteria	Sub Criteria Weight
Parental Dependents (C3)	Benefit	0.15 (15%)	1 Child	1
			2 Child	2
			3 Child	3
			4 Child	4
			> 4 Child	5
Program Keluarga Harapan (PKH) Participants (C4)	Benefit	0.15 (15%)	Non-Participant	1
			Participant	2
Kartu Keluarga Sejahtera (KKS) Holder (C5)	Benefit	0.15 (15%)	Non-Holder	1
			Holder	2
Orphan Status (C6)	Benefit	0.2 (20%)	Non-Orphan	1
			Orphan	2

The SAW method recognizes the existence of costs and benefits, determining the total weight if the total number of criteria is 100%. Determination of the value on the weight of the sub-criteria obtained from the crisp value: i = 1, 2, …, m and j = 1, 2, …, n.

The next stage is determining the suitability rating for each alternative to each criterion, as shown in Table 2.

Table 2. Determining the Suitability Rating

Alternative (A_i)	Criteria					
	C1	C2	C3	C4	C5	C6
Student 1	2	1	2	2	1	1
Student 2	2	1	5	2	1	2
Student 3	2	1	1	1	2	1
Student 4	1	1	1	1	1	2
Student 5	1	5	1	1	1	1
Student 6	2	1	1	2	1	1
…	…	…	…	…	…	…
Student 1,155	2	1	2	2	1	1

The determination of the suitability rating for each alternative to each criterion is then modeled into fuzzy numbers and then converted to Crips numbers. The value for each alternative A_i on each criterion that has been set. The sample data used amounted to 1,155 data for rating the suitability of each criterion from students receiving PIP scholarships

The third stage is making a decision matrix based on criteria. Normalization of the matrix is carried out based on the equation determined by the type of attribute (benefit or cost), and the normalized matrix R is obtained (Hutahaean et al., 2018), as shown in Fig. 2-4.

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

Fig. 2 Decision Matrix

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$$r_{11} = \frac{2}{\max[2,2,2,1,1,2,2]} = \frac{2}{2} = 1$$
$$r_{21} = \frac{\min[1,1,1,1,5,1,1]}{1} = \frac{1}{1} = 1$$
$$r_{31} = \frac{2}{\max[2,5,1,1,1,1,1]} = \frac{2}{5} = 0{,}4$$
$$r_{41} = \frac{2}{\max[2,2,1,1,1,2,2]} = \frac{2}{2} = 1$$
$$r_{51} = \frac{1}{\max[1,1,2,1,1,1,2]} = \frac{1}{2} = 0{,}5$$
$$r_{61} = \frac{2}{\max[1,2,1,2,1,1,1]} = \frac{1}{2} = 0{,}5$$

Fig. 3 Matrix Normalization

$$r = \begin{bmatrix} 1 & 1 & 0{,}4 & 1 & 0{,}5 & 0{,}5 \\ 1 & 1 & 1 & 1 & 0{,}5 & 1 \\ 1 & 1 & 0{,}2 & 0{,}5 & 1 & 0{,}5 \\ 0{,}5 & 0{,}3 & 0{,}2 & 0{,}5 & 0{,}5 & 0{,}5 \\ 0{,}5 & 0{,}2 & 0{,}2 & 0{,}5 & 0{,}5 & 0{,}5 \\ \dots & \dots & \dots & \dots & \dots & \dots \\ 1 & 1 & 0{,}2 & 1 & 1 & 0{,}5 \end{bmatrix}$$

Fig. 4 Matrix Transformation

Furthermore, ranking is obtained from the normalized matrix equation (r_{ij}) with preference weighting (W). The ranking process is based on the weight value W = (0.15, 0.2, 0.15, 0.15, …, 0.2). Test results using the calculation of the Simple Additive Weighting (SAW) method are shown in Table 3.

Table 3. Test Result

Alternative (A_i)	Atribut (Criteria)						Result
	C1 = $\frac{X_{ij}}{max\ X_{ij}}$	C2 = $\frac{min\ X_{ij}}{X_{ij}}$	C3 = $\frac{X_{ij}}{max\ X_{ij}}$	C4 = $\frac{X_{ij}}{max\ X_{ij}}$	C5 = $\frac{X_{ij}}{max\ X_{ij}}$	C6 = $\frac{X_{ij}}{max\ X_{ij}}$	$\sum_{j=1}^{n} Wi\ r_{ij}$
Student 1	1	0,74	0,4	1	0,5	0,5	0,74
Student 2	1	0,93	1	1	0,5	1	0,93
Student 3	1	0,71	0,2	0,5	1	0,5	0,71
Student 4	0,5	0,42	0,2	0,5	0,5	0,5	0,42
Student 5	0,5	0,40	0,2	0,5	0,5	0,5	0,40
…	…	…	…	…	…	…	…
Student 1,155	1	0,78	0,2	1	1	0,5	0,78

The final results obtained from the ranking are all normalized matrix multiplications R with weight vectors, and the maximum value will be chosen as the best alternative solution (A)

5. DISCUSSIONS

As for effectiveness testing, comparing decisions based on the calculation results of the SAW method with manual decisions made by decision-makers is shown in Table 4.

Table 4. Effectiveness Testing

Alternative (A_i)	SAW Decisions	Manual Decisions	Result
Student 1	Recipient	Recipient	Accordance
Student 2	Recipient	Recipient	Accordance
Student 3	Recipient	Recipient	Accordance
Student 4	Recipient	Recipient	Accordance
Student 5	Non-Recipient	Recipient	Non- Accordance
…	…	…	…
Student 1,155	Non-Recipient	Non-Recipient	Accordance

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$$\text{Percentage of decision results} = \frac{\text{Accordance Results}}{\text{Total}} = \frac{8}{10} = 0{,}8 = 80\% \qquad (1)$$

Based on the results in Table 4, the results between decisions using SAW and manual decisions taken by decision makers then, the percentage which is then calculated according to the accuracy obtained is 80%.

The results of the analysis of the Simple Additive Weighting (SAW) method have been implemented in the design of a decision support system for the Program Indonesia Pintar Scholarship, shown in Fig. 5-6.

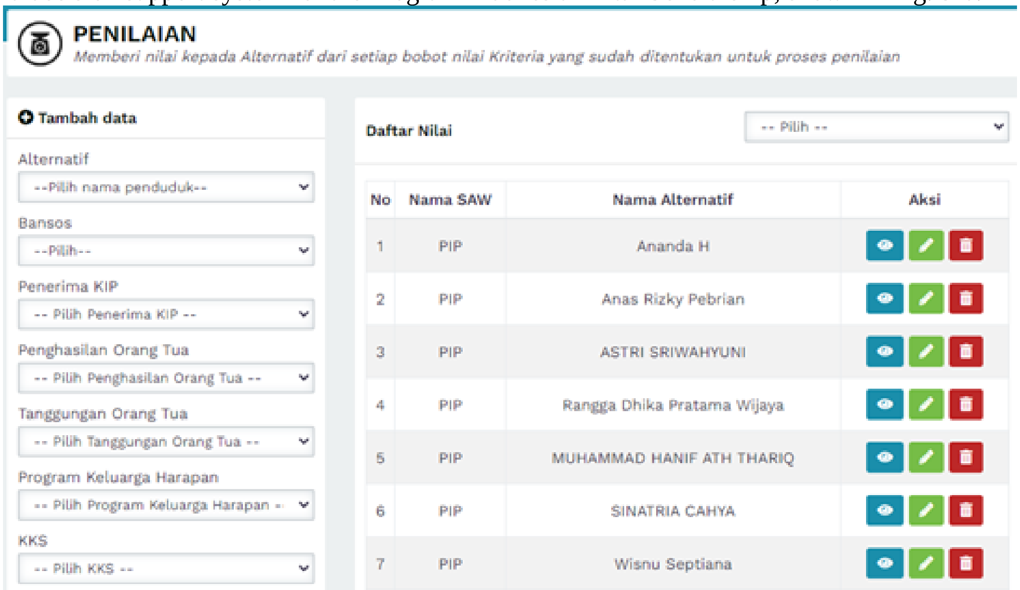

Fig. 5 Display the Assessment Page Using the Simple Additive Weighting Method

Fig. 6 Display the Ranking Page

6. CONCLUSION

Based on the results of the study, it was concluded that the application of Simple Additive Weighting to the decision support system can provide the best final result based on the largest value obtained so that it can determine the recipients of the Smart Indonesia Program scholarships with an accuracy rate of 80%. This decision support system can be useful for school staff in accelerating the process of selecting recipient students so that it is more effective and efficient.

7. ACKNOWLEDGMENT

The authors wish to acknowledge Institut Teknologi Garut, which supports and funds this research publication.

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Sinkron : Jurnal dan Penelitian Teknik Informatika
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p-ISSN : 2541-044X

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