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# **The Innovation Breakthrough in Digital and Disruptive Era**

# Comparative Analysis of Prediction Results of Decision Support Systems Simple Additive Weighting Method with Preference Selection Index in Determining Scholarship Recipients

Medi Hermanto Tinambunan<sup>1\*</sup>, Djubir R.E. Kembuan<sup>2</sup>, Vivi Peggie Rantung<sup>3</sup>, and Alfiansyah Hasibuan<sup>4</sup>

<sup>1,3,4</sup>Department of Informatics Engineering, Manado State University, Indonesia

<sup>2</sup>Department of Building Engineering Education, Manado State University, Indonesia

**Abstract.** Educational Assistance needs to be a concern because currently the majority of students have the potential and ability but are constrained financially so this needs to be taken seriously by the government, currently, the government through the Ministry of Education has been trying to provide financial assistance in the form of scholarships including achievement improvement scholarships academic. Currently, to get a scholarship, each university certainly gets a limited quota. This is done to provide equal distribution of educational assistance, due to the large difference between the quota obtained and students who need assistance, so it is necessary to provide eligibility selection for students who are entitled to get scholarships. This study took sample data from the 2023 even semester scholarship list at Manado State University, especially in the Informatics Engineering Study Program, then normalized the data to use the SAW and PSI methods. After normalization, calculations were carried out using the SAW and PSI methods. predictions from the two methods will then be tested for the level of accuracy using the confusion matrix method. The result is that the SAW method has an accuracy rate of 98.13% and then the PSI accuracy rate is 97.24% based on the results of the prediction accuracy, the SAW method has a higher accuracy rate than PSI.

## 1 Introduction

The Government of Indonesia through the Ministry of Education, Culture, Research, and Technology has made every effort to always assist every Indonesian student who has academic achievements which are commonly referred to as increasing academic achievement (PPA). This scholarship is given within 1 fiscal year, with a nominal value of Rp. 400,000 every month and paid directly for a study period of 1 semester (six months). Each university will certainly get a different quota of scholarship assistance, at Manado State University every year of course it gets a quota to help students who are less well off financially but excel from an academic aspect, because of the quota system that the University will make criteria as a reference for PPA recipients. The criteria commonly used by the University are the semester being undertaken, student GPA scores, number of dependents of parents, number of siblings, income of parents, number of attendance, and active in organizations. This criterion is used to find out that each student can be indicated to actively participate in academic and organizational activities on campus because besides having financial deficiencies, students are also required to have creativity and a strong intention to continue to excel on campus. In this study, the prediction of decisions was made using two methods, namely, simple additive weighting (SAW) and Preference Selection Index (PSI). SAW is one of the

methods in the Decision Support System which is commonly used to make predictions that can assist in decision making [1]. similarly, the PSI method has a way of working that is almost the same as the SAW method but based on some journal results using the SAW method the prediction results are above 70% while the PSI is not up to 70%, therefore in this research, we will test the accuracy of predictions with using the confusion matrix method this is done to get the most effective method and can be considered in future researchers in predicting PPA scholarship acceptance for students.

## 2 Research Method

### 2.1 Decision Support System

A decision support system, commonly abbreviated as SPK, is an information system aimed at managers or decision-makers to solve a problem [2]. Decision support systems are part of computer-based knowledge management in an organization or agency that can provide information assistance so that a decision can be reached [3].

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\* Corresponding author: [meditinambunan@unima.ac.id](mailto:meditinambunan@unima.ac.id)

## 2.2 Simple Additive Weighting Method

The Simple Additive Weighting method is a weighted sum method. The basis of this method is to search for the weighted sum of the performance ratings for each alternative on all attributes [4]. The SAW method has a process of normalizing the decision matrix into a scale form that can be compared to existing alternative ratings [5]. This method is famous for being the most widely used in determining decisions on problems that have a certain weight on each attribute. The total score will be obtained by adding up all the multiplication results for each rating and the weight for each attribute. The following are the stages in calculating the Simple additive weighting method [6];

$$rij = \frac{\frac{xij}{\max(xij)}}{\frac{\min(xij)}{xij}} \quad (1)$$

Where:

- $rij$  = Normalized performance rating,
- $xij$  = Rows and columns of the matrix.
- $\max(xij)$  = Maximum value of each row and column.
- $\min(xij)$  = Min value of each row and column.

1. Determine the appropriate criteria for each alternative that can be used to support the decision results, C for criteria.
2. Determine the suitability rating of each alternative.
3. Make a criterion decision matrix then normalize the matrix to get the normalized R matrix.
4. The final result of ranking the sum of the normalized matrix multiplication (R) with the weighted vector to get the largest value will be chosen as the best decision alternative as a solution.
5. The final result of ranking is the sum of 0 normalized R matrices with the weight vector to get the largest value which will be the best alternative. The  $rij$  value is the normalized performance rating of the  $A_i$  alternative on attributes  $C = 1, 2, \dots, m$  and  $j = 1, 2, \dots, m$ . The preference value for each alternative ( $V_i$ ) is given as a formula in the following equation;

$$Vi = \sum_{j=1}^n Wj rij \quad (2)$$

Where:

- $V_i$  = Alternative Final Value
- $W_j$  = determined weight
- $R_{ij}$  = Normalized matrix
- $\min(x_{ij})$  = minimum value of each row and column

The larger value of  $V_i$  indicates that alternative  $A_i$  is the chosen alternative.

## 2.3 Preference Selection Index Method

The Preference Selection Index method is a method used to solve multi-criteria decision-making [7]. The PSI method aims to determine the relative importance of each attribute if there is a problem with the level of

importance of each attribute [8] The PSI method aims to determine the relative relations between attributes if there is a conflict of interest in each attribute [9]. In practice, it is obtained with minimal and simple calculations because it is based on statistical concepts, and this method is used without requiring attribute weights because the PSI method can produce different weight values in its steps [10]. The following are the stages of the procedure for the PSI method [11];

1. Create a decision matrix.

$$Xij = \begin{bmatrix} x11 & x12 & \dots & x1n \\ x21 & x22 & \ddots & x2n \\ \vdots & \vdots & \ddots & \vdots \\ xm1 & xm2 & \dots & xmn \end{bmatrix} \quad (3)$$

2. Normalizing the decision matrix

The following formula is used if the criterion is worth the benefit;

$$Nij = \frac{Xij}{Xjmax} \quad (4)$$

The following formula is used if the criterion is worth the cost;

$$Nij = \frac{Xjmin}{Xij} \quad (5)$$

Where  $X_{ij}$  is the attribute size ( $i = 1, 2, \dots, N$  and  $j = 1, 2, \dots, M$ ).

3. Compute the average of the normalized data

In this step, it means that the normal data value of each attribute is calculated according to the following equation [12];

$$N = \frac{1}{n} \sum_{i=1}^n 1N_{ij} \quad (6)$$

4. Calculating the preference variation value

At this stage, the preference variation value for each attribute is calculated using the following equation formula;

$$\Phi_j = \sum_{j=1}^n [N_{11} - N]^2 \quad (7)$$

5. Determine deviations in preference values.

$$\Omega_j = 1 - \Phi_j \quad (8)$$

6. Determine the weight of the criteria.

$$\omega_j = \frac{\Omega_j}{\sum_{j=1}^m \Omega_j} \quad (9)$$

The total value of all criteria weighting all attributes should be 1, eg  $\sum_{j=1}^m \Omega_j = 1$

7. Calculate the PSI value ( $\theta_i$ )

Then select the preference index value ( $\theta_i$ ) for each alternative using the following equation [13];

$$\theta_i = \sum_{j=1}^m X_{ij} \omega_j \quad (10)$$

The final result with the highest value is the best alternative obtained through a series of stages in the PSI method [14].

## 2.4 Confusion Matrix

The confusion matrix is a classification of the amount of test data that is skewed and the amount of test data that is wrong [15]. The following is a binary classification on the confusion matrix;

**Table 1.** Confusion Matrix

		Prediction Class	
		1	0
Real Class	1	TP	FN
	0	FP	TN

Where;

TP = True Positive

TN = True Negative

FP = False Positive

FN = False Negative

The confusion matrix formula for calculating accuracy, precision, and recall is as follows;

$$accuracy = \frac{TP+TN}{Total} \quad (11)$$

## 3 Result and Discussion

### 3.1 Data Collection

Data collection is an activity carried out to obtain valid and accurate data that can be used as material for discussion and problem-solving. To obtain data for this study, researchers used registration data for PPA scholarship recipients in 2023 with a total of 114 applicants. The following are the criteria used for selecting scholarship recipients;

**Table 2.** Scholarship Selection Criteria

No	Criteria	Value	Symbol	Type
1	Semester	0,1	C1	Benefit
2	GPA	0,25	C2	Benefit
3	Number of siblings	0,1	C3	Cost
4	Number of parental dependents	0,1	C4	Cost
5	Parental income	0,15	C5	Cost
6	Number of attendance	0,1	C6	Benefit
7	Organization	0,2	C7	Benefit

For example, the data that will be used to perform data processing is as follows;

**Table 3.** Criteria Value Range

Criteria	Range	Value
Semester	Semester 2-7	0,2 - 1
GPA	1-4	0,2 - 1
Number of siblings	>1	0,2 - 1
Number of parental dependents	>1	0,2 - 1
Parental income	> Rp. 1.000.000,	0,2 - 1
Number of attendance	1-16	0,2 - 1
Organization	0 until >=1	0,2 - 1

### 3.2 Simple Additive Weighting Method Prediction Process

In this method, the next step is to normalize the data according to the range of data in Table 4. Following are the results of data normalization; Furthermore, the normalization of the R matrix is carried out based on the criteria of benefits and costs, along with the results of the normalization of the R matrix;

$$R = \begin{bmatrix} 0,4 & 1 & 0,5 & 0,2 & 0,3 & 0,8 & 0,5 & 1 \\ 0,4 & 0,8 & 0,5 & 0,2 & 0,2 & 0,2 & 0,5 & 1 \\ 1 & 0,6 & 0,4 & 0,2 & 0,5 & 1 & 1 & 1 \\ 1 & 0,4 & 0,8 & 0,4 & 0,2 & 0,2 & 0,4 & 0,5 \\ 1 & 0,4 & 0,4 & 0,4 & 0,3 & 0,3 & 0,2 & 0,5 \\ 1 & 1 & 0,8 & 0,4 & 0,25 & 0,2 & 0,8 & 0,5 \\ 1 & 0,4 & 0,8 & 0,6 & 0,5 & 0,3 & 0,2 & 0,1 \\ 1 & 0,4 & 0,8 & 0,6 & 0,2 & 1 & 1 & 1 \\ 1 & 1 & 0,8 & 0,4 & 0,2 & 0,25 & 1 & 1 \\ 1 & 0,4 & 0,4 & 1 & 1 & 0,2 & 0,8 & 1 \end{bmatrix}$$

After that, the ranking is carried out by multiplying it with the weight of the criteria, the results of the ranking are as follows;

**Table 4.** Ranking Results SAW

Rating	Alternative	Student Name	Value
1	8	Grison Yonathan Albrisen Pelanginang	0,77
2	9	Daniel Sengkey	0,69
3	3	Gita Sibarani	0,68
4	10	Jonatan injil watung	0,65
5	1	Depita Wati sitanggang	0,59

6	6	Claudia Pither	0,575
7	4	Yodia Gracia Pelle	0,47
8	2	Claudya Tuuk	0,46
9	7	Ridho Junior Songgigilan	0,42
10	5	Meiman Pasrah Harefa	0,38

### 3.3 Preference Selection Index Method Prediction Process

The stages in this method are to normalize the matrix and then look for the normalized average performance and determine the value of the preference variation after that, determine the deviation of the preference value, then determine the preference value of the selection index, as follows;

**Table 5.** Ranging Results PSI

Rating	Alternative	Value
1	08	0,639986
2	010	0,614684
3	07	0,609414
4	01	0,533142
5	06	0,493277
6	09	0,479689
7	02	0,476274
8	03	0,471355
9	04	0,438783
10	05	0,382798

### 3.4 Confusion Matrix

After testing using the simple additive weighting method and the preference selection index method, then testing the level of prediction accuracy will be carried out using the confusion matrix, the classification results can be seen in the following table;

**Table 6.** Method Test Result

No	Student Name	Reality Result	SAW Result	PSI Result
1	Grison Yonathan Albrisen Pelanginang	L	L	L
2	Daniel Sengkey	L	TL	L
3	Gita Sibarani	L	L	L
4	Jonatan injil watung	L	TL	TL
5	Depita Wati sitanggang	TL	TL	TL
6	Claudia Pither	L	L	L
7	Yodia Gracia Pelle	TL	TL	L
8	Claudya Tuuk	L	L	L
9	Ridho Junior Songgigilan	L	L	L
10	Meiman Pasrah Harefa	L	L	L

From the results of the comparison above TL Failed while L is Passed, then calculations will be carried out to test the level of accuracy of each method, the following is the result of the classification confusion matrix;

**Table 7.** SAW Confusion Matrix Classification

		Prediction Class	
		1	0
Real Class	1	6	2
	0	0	2

$$Akurasi = \frac{TP + TN}{TP + TN + FN + FP} \times 100\%$$

$$Akurasi = \frac{6 + 99}{6 + 99 + 2 + 0} \times 100\% = 98,13\%$$

**Table 8.** PSI Confusion Matrix Classification

		Prediction Class	
		1	0

Real Class	1	7	1
	0	1	1

$$Akurasi = \frac{7 + 99}{7 + 99 + 1 + 2} \times 100\% = 97,24\%$$

#### 4 Conclusion

based on the results of predictive calculations between simple additive weights and the Preference selection index method, a difference of 0.89% is obtained between the two methods, where the accuracy of SAW predictions is greater than PSI because SAW prediction results have an accuracy rate of 98.13% while PSI has an accuracy of 97.24% so that the conclusion that can be drawn is a weighted method. Simple addition has better accuracy than the PSI method according to the criteria that have been determined by the background of the problem. This research certainly has limitations and certainly requires input and suggestions for further development, because it is not the only method in decision support systems, one of which needs to be developed further by normalizing it using fuzzy numbers.

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