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Decision Support System for Loan Eligibility using the Simple Additive Weighting (SAW) Method

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Abstract

The Solok City Bakti Husada Employees Cooperative is a non-bank financial institution in the form of a cooperative that serves the needs of its members in lending services with collateral in the form of member savings. The aim of this research is to make it easier for the Bakti Husada Cooperative to determine the suitability of loans to borrowers and to create a Decision Making System using the Simple Additive Weighting (SAW) method which is able to assist the Bakti Husada Cooperative in determining the suitability of loans to borrowers. The data collection method was carried out by direct observation and interviews with employees from the Bakti Husada Cooperative, Solok City. The results obtained are effective in making decisions about loan eligibility at the Bakti Husada Cooperative in Solok City in accordance with the criteria that have been determined in the selection. This result is proven. By using this system, members who apply for a loan get a score that is in accordance with the criteria and weights that have been set and from there it can be seen if there are criteria that are not in accordance with the standard requirements of the member's application for a loan so that members can improve the loan requirements so that Loan applications are accepted by the cooperative. Gusnelawati obtained the calculation results using the SAW method to determine the feasibility of providing loans to cooperatives with a value of 0.9625 and was the 1st Best in making this decision.

Keywords: Loan Feasibility, Decision Support Systems, Simple Additive Weighting, Cooperatives.

1. Introduction

The Bakti Husada Employees Cooperative, Solok City, is a non-bank financial institution in the form of a cooperative that serves the needs of its members in lending services with collateral in the form of member savings with the aim of providing services and convenience for prospective borrowers in their economic needs . Providing loan funds to prospective borrowers must also be approved by the head of the cooperative/cooperative board. This approval generally requires considerations such as conducting an analysis of the prospective borrower's ability to pay. Because each prospective borrower's economic condition is different, you must be careful in making decisions. In determining whether or not a loan recipient is eligible, there must be an assessment of the criteria set as a reference for decision making to avoid the occurrence of bad credit by the prospective borrower which causes losses for the cooperative. So far, decision-making activities at the Bakti Husada Employees Cooperative are still inadequate. The analysis process carried out still uses Microsoft Excel, so it does not rule out the possibility of frequent errors occurring when considering prospective borrower data, loan data and calculation process errors in providing funds.

In previous research conducted by Mubarok, Ade Suherman, Himam Dwipratama, Ramdhani, Yudi, Topiq, and Salman in 2019 with the title Decision Support System for Credit Provision Using the TOPSIS Method. This research explains that the BMT ItQan sharia cooperative is a cooperative with sharia management, providing savings products, financing and sharia financial services. The financing system implemented at the BMT ItQan Sharia Cooperative is still a manual process. Cooperatives provide financing to their members with the provisions of criteria, where the criteria assessment process is still carried out manually, where in determining the provision of financing the calculations are still done using many files manually, if there is a change in data or information then it takes a long time, so that the decision The results produced are still less effective and accurate because sometimes there are several criteria that are not taken into consideration during the assessment process. The solution offered by researchers is a Decision Support System using the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method in weighting credit recipients so that it can provide solutions to existing problems. TOPSIS uses the principle that the selected alternative must have the shortest distance from the positive ideal solution and the longest (furthest) distance from the negative ideal solution from a geometric point of view by using Euclidean distance (the distance between two points) to determine the relative closeness of an alternative to the optimal solution. The results of this

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research are that the decision support system that has been implemented by researchers can make more accurate and objective decisions and produce accurate financing data reports which are very helpful in providing financing to the BMT ItQan Sharia Cooperative [1].

In other research conducted by Supiyandi, Raja Nasrul Fuad, Eko Hariyanto, and Satia Larasati in 2020 with the title Decision Support System for Providing Cooperative Credit Using the Weighted Product Method. This research explains that the TNI Ajendam I/Bukit Barisan member cooperative still contains elements in providing loans that are outside the provisions of the cooperative. Not a few members come to ask to be given a loan, where the management often does not pay attention to the member's ability to repay the loan that will be given , so that a lot of the credit distributed is not on target and results in a lot of outstanding credit or bad credit. The solution offered by researchers is a Decision Support System with the Weighted Product (WP) method, which is a decision making method using a multiplication method to connect attribute ratings, where the rating of each attribute must first be raised to the power of the attribute in question. The results of this Decision Support System research where the implementation of this system shows that the Weighted Product (WP) in the ranking process for granting new customer credit has the same result value, if the method is calculated manually, it is an interactive information system to assist decision making in semi-structured situations and unstructured situations like this[2].

The Simple Additive Weighting (SAW) method is one of the methods in the Decision Making System. The solution offered by researchers developing this Decision Making System will use the Simple Additive Weighting (SAW) method to solve existing problems in the current system. The Simple Additive Weighting (SAW) method is known as the weighted addition method. The basic concept of the Simple Additive Weighting (SAW) method is to find the weighted sum of the performance ratings for each alternative across all attributes. The SAW method requires a process of normalizing the decision matrix (X) to a scale that can be compared with all existing alternative ratings [3][4][5][6][7].

The SAW method combines two categories of criteria, namely profit criteria and cost criteria, as an important basis for decision making and selecting motorbikes. SAW is an approach that is often used to address practical decision making. From this context, the SAW method is stated to be an effective and practical approach in the evaluation process that helps determine the best motorbike products that are in great demand by the public. This method plays a big role in providing information about various types of motorbikes in Indonesia that meet the criteria expected by consumers [8].

2. Research methodology

The research framework is a sequence of activities that will be carried out in a study. The research will be carried out applying the Simple Addictive Weighting (SAW) method. The SAW method is used to make it easy to make flexible decisions and is widely used because of its simplicity in responding to needs in decision making, so that decisions can be made effectively and efficiently.

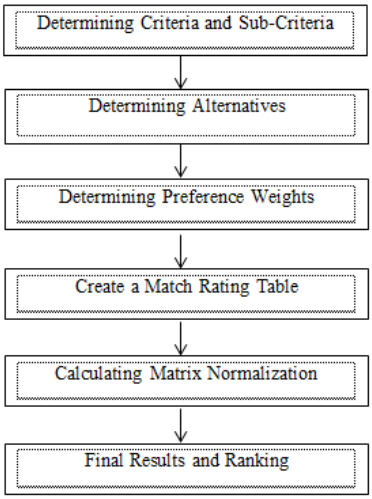

Figure 1. Research Framework

The SAW method requires a process of normalizing the decision matrix (X) to a scale that can be compared with all existing alternative ratings. The SAW method recognizes 2 (two) attributes, namely profit criteria and cost criteria. The following are the steps to complete the SAW method calculation:

1. Determine the criteria and sub-criteria that will be used as a reference in decision making, namely Cj.
2. Determine the alternative, namely Ai
3. Determine the preference weight or level of importance (W) of each criterion.
4. Create a suitability rating table for each alternative for each criterion.
5. Create a decision matrix (X) which is formed from the suitability rating table of each alternative for each criterion. The X value of each alternative (Ai) for each predetermined criterion (Cj), where, i=1,2 , …..m and j=1,2,…..n.
6. Normalizing the decision matrix by calculating the normalized performance rating (rij) value of alternative Ai on criteria Cj. Where Rij is the normalized performance rating value. Xij is the attribute value of each Criteria. Max Xij is the largest value of each criterion i. Min Xij is the smallest value of each criterion I. Max is used in Benefit and Min is used in Cost.
7. The results of the normalized rating values (rij) form a normalized matrix.

8. The final result of the preference value (Vi) is obtained from the sum of the multiplication of the normalized matrix row elements (R) with the preference weights (W) corresponding to the matrix column elements (W). With Vi is the ranking for each alternative. Wj is the weight value of each criterion. rij is the normalized performance rating value. A greater Vi value indicates that alternative Ai is preferred

This method is the most well-known method and is widely used by people in dealing with Multipple Attribute Decision Making (MADM) situations. This method requires the decision maker to determine the weight for each attribute. The total score for an alternative is obtained by adding up all the multiplication results between ratings that can be compared across attributes) weights and each attribute. The rating for each attribute has previously gone through a normalization process. The SAW method is known as the term weighted addition. The basic concept of the SAW method is to find the weighted sum of the performance ratings for each alternative on all attributes. The SAW method requires a process of normalizing the decision matrix (X) to a scale that can be compared with all existing alternative ratings. The formula for carrying out this normalization is as follows:

$$r_{ij} = \left\{\frac{X_{ij}}{Max\, X_{ij}}\right\}$$ if j is the profit attribute

$$r_{ij} = \left\{\frac{Min\, X_{ij}}{X_{ij}}\right\}$$ if j is the cost attribute (cost)

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

Information:

Rij=normalized performance rating value
Xij = attribute value for each criterion
Maxxij = largest value of each criterion
Minxij = smallest value of each criterion
benefit= if the largest value is the best criterion
cost= if the smallest value is the best criterion
Where rij is the normalized performance rating of alternative Ai on attribute Cj; i=1,2,...,m and j=1,2,...,n. The preference value for each alternative (Vi) is given as:

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

Information:

Vi = ranking for each alternative
wj = weight value of each criterion
rij = normalized performance rating value

larger Vi value indicates that alternative Ai is more selected.

After the Vi value is obtained, ranking is carried out, so that we can find out the best alternative which will be used as a guide for decision making.

3. Results and Discussion

3.1 *Simple Additive Weighting* (SAW) Method Calculation

1. Determining Criteria and Sub-Criteria

At this stage, the decision support system uses the Simple Additive Weighting (SAW) method by setting 4 criteria that have been determined in collecting data from interviews and direct observation at the Bakri Husada Cooperative, Solok City, which can be seen in table 1 below.

Table 1. Criteria

No	Code	Criteria
1	C1	Loan Amount
2	C2	Length of Loan
3	C3	Paid with
4	C4	Member Status

Understand the sub-criteria used to measure various aspects of the main criteria. In the sub-criteria table the sub-criteria relate to each main criterion along with its classification and associated values. Sub-criteria are an important component in the assessment process that helps us in giving weight to the alternatives being evaluated. Determining the criteria that will be used as a benchmark in decision making. Here the weights and categories for each criterion are explained. After that, convert the data according to the specified values. The following is a sub-criteria table containing the assessment variables for each criterion.

Table 2. Sub Criteria Table

Criteria	Sub Criteria	Mark
Loan Amount	100,000 to 5,000,000	1
	>5,000,000 to 20,000,000	2
	>20,000,000 to 40,000,000	3
	>40,000,000 to 60,000,000	4
Length of Loan	1 to 12 months	1
	13 to 24 months	2
	25 to 36 months	3
	37 to 60 months	4
Paid with	But	3
	Wages	4
Member Status	Not active	3
	Active	4

2. Determining Alternatives

The data is then used in the context of decision making, ranking, or evaluating alternatives depending on relevant criteria or factors. This table provides initial information about the entities or individuals that will be

evaluated or compared in an analysis or decision-making process, can be seen in Table 3 below:

Table 3. Alternative Data

Code	Criteria
A1	Gusnelawati
A2	Vera Rosalina
A3	Loli Alfia
A4	Anita Amelia Suriadi
A5	Princess Nurfadillah Sari
A6	Joni Hendrik
A7	Indra Yani
A8	Riri Afridanti
A9	Yulfira
A10	Rami Zainal

In this study, 10 (ten) alternatives were used as objects to be assessed. The alternatives used are coded A1 to A10.

3. Determining Preference Weights

Identify the preference weight given to each criterion based on the type of variable, whether it is criteria that provide benefits or criteria that provide costs. This preference weight will be used to calculate the final value and ranking of alternatives. By understanding this preference weight table, we can determine the relative importance of each criterion in decision making, which can be seen in Table 4.

Table 4. Preference Weight Values

Criteria	Variable Type	Weight
C1	Benefits	40 %
C2	Benefits	25%
C3	Benefits	15%
C4	Benefits	20%

4. Create a Match Rating Table

The suitability rating table presented below is important information in the evaluation process using the SAW (Simple Additive Weighting) method to calculate the final value and ranking of alternatives. This table lists the assessment or suitability rating given to each alternative based on existing criteria. Suitability ratings reflect the extent to which each alternative meets or conforms to each criterion. By understanding the suitability rating table, you can proceed to the calculation steps in the SAW method and determine the best alternative based on the assessment that has been given. Provides a suitability rating value for each alternative for each criterion in the predetermined data conversion table. Here it has been explained in table 2 that there are values 1 to 4 for each weight. Continue by entering data obtained from the cooperative which will be used as alternative data.

Table 5. Suitability Ratings

Alternative	C1	C2	C3	C4
A1	4	4	3	4
A2	1	2	4	4
A3	1	2	4	4
A4	1	2	4	4
A5	2	2	4	4
A6	2	2	4	4
A7	4	3	3	4
A8	2	3	3	4
A9	2	2	4	4
A10	1	1	4	4

5. Perform Matrix Normalization

After determining the criteria that are worth profits and costs and having converted the data, the normalization process can be carried out, and a normalized matrix is obtained

$$R = \begin{bmatrix} 1 & 1 & 0.75 & 1 \\ 0.25 & 0.5 & 1 & 1 \\ 0.25 & 0.5 & 1 & 1 \\ 0.25 & 0.5 & 1 & 1 \\ 0.5 & 0.5 & 1 & 1 \\ 0.5 & 0.5 & 1 & 1 \\ 1 & 0.75 & 0.75 & 1 \\ 0.5 & 0.75 & 0.75 & 1 \\ 0.5 & 0.5 & 1 & 1 \\ 0.25 & 0.25 & 1 & 1 \end{bmatrix}$$

Normalization is used to address variations in the scale or range of values that may appear in a matrix, allowing a fairer comparison between alternatives. This normalization step is key in producing more accurate and relevant results when we want to compare alternatives based on predetermined preference criteria.

6. Calculating Final Scores and Rankings

After the normalization results are obtained, the next step is to determine the vector V value.

$v1 = (0.4 * 1) + (0.25 * 1) + (0.15 * 1) + (0.2 * 1) = 0.9625$

$v2 = (0.4 * 0.25) + (0.25 * 0.5) + (0.15 * 1) + (0.2 * 1) = 0.575$

$v3 = (0.4 * 0.25) + (0.25 * 0.5) + (0.15 * 1) + (0.2 * 1) = 0.575$

$v4 = (0.4 * 0.25) + (0.25 * 0.5) + (0.15 * 1) + (0.2 * 1) = 0.575$

$v5 = (0.4 * 0.5) + (0.25 * 0.5) + (0.15 * 1) + (0.2 * 1) = 0.675$

$v6 = (0.4 * 0.5) + (0.25 * 0.5) + (0.15 * 1) + (0.2 * 1) = 0.675$

$v7 = (0.4 * 1) + (0.25 * 0.75) + (0.15 * 0.75) + (0.2 * 1) = 0.9$

$v7 = (0.4 * 1) + (0.25 * 0.75) + (0.15 * 0.75) + (0.2 * 1) = 0.9$

$v8 = (0.4 * 0.5) + (0.25 * 0.75) + (0.15 * 0.75) + (0.2 * 1) = 0.7$

$v9 = (0.4 * 0.5) + (0.25 * 0.5) + (0.15 * 1) + (0.2 * 1) = 0.675$

$v10 = (0.4 * 0.25) + (0.25 * 0.25) + (0.15 * 1) + (0.2 * 1) = 0.5125$

Based on the results of these calculations, the final result is obtained , namely the Vector (V) value for

determining the best poor family. The final results can be seen from Table 6.

Table 6. Final V Value Results

No	Code	Name	Value (V)
1	A1	Gusnelawati	0.9625
2	A2	Vera Rosalina	0.575
3	A3	Loli Alfia	0.575
4	A4	Anita Amelia Suriadi	0.575
5	A5	Princess Nurfadillah Sari	0.675
6	A6	Joni Hendrik	0.675
7	A7	Indra Yani	0.9
8	A8	Riri Afridanti	0.7
9	A9	Yulfira	0.675
10	A10	Rami Zainal	0.5125

From the final results table for the V value above, the final results and decisions on the names of recipients of poor family aid funds can be obtained as in table 8.

Table 8. Final Results and Decisions

No	Name	Score (V)	Rank	Decision
1	Gusnelawati	0.9625	1	Best 1
2	Indra Yani	0.9	2	Best 2
3	Riri Afridanti	0.7	3	Best 3
4	Princess Nurfadillah Sari	0.675	4	Best 4
5	Joni Hendrik	0.675	5	Best 5
6	Yulfira	0.675	6	Best 6
7	Vera Rosalina	0.575	7	Best 7
8	Loli Alfia	0.575	8	Best 8
9	Anita Amelia Suriadi	0.575	9	Best 9
10	Rami Zainal	0.5125	10	Best 10

From the table above, it can be seen that Gusnelawati obtained the highest score (0.9625) and was ranked at the top (Best 1), so she could be considered the best recipient of aid funds. Furthermore, Indra Yeni and Riri Afridanti were ranked second and third, respectively with scores of 0.9 and 0.7. And so on until alternative 10.

4. Conclusion

2The decision-making system and calculation method using Simple Additive Weighting (SAW) can help determine which families are entitled to become recipients of Poor Family Assistance Funds (PKH) based on predetermined weights and criteria. The use of a SAW-based decision making system in selecting recipients of aid funds for poor families has the potential to provide a more efficient and objective solution in distributing aid to families in need. The SAW method helps in calculating the final value for each alternative based on certain criteria, thereby enabling a more informed decision.

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