Implementation of SAW and AHP In Decision-Making Models for Credit Provision in Cooperatives

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Abstract

The research aims to overcome the difficulties in selecting the best members of the Al-Amin Independent Corporation, focusing on the challenges faced in determining the best members in the process of giving credit and payments on time. However, many members fail to meet their obligations or fail to pay their contributions smoothly, leading to credit freezes and decreased cooperative income. The cause of a member's failure to pay quotas has not been identified by the current candidate admission selection system. The methods used are Simple Additive Weighting (SAW) and Analytical Hierarchy Process (AHP) applied in the Decision Support System (DSS) model. The results of the research showed the effectiveness of the SAW method in identifying the best and optimal alternative with the highest value on V2 of 4. The AHP method has successfully determined the priority weight and the level of importance for member selection criteria including Activity (0.50), Savings (0.13), Guarantee (0.09), Loan (0.10), Disbursement (0.10), Time Period (0.07). The research provides insight to decision-makers in cooperatives makes important contributions, especially in the granting of credit, and affirms the importance of objective methods in the selection of members.

Keywords*— DSS, SAW, AHP, Cooperative*

1. INTRODUCTION

A cooperative is a legal entity established by an individual or a cooperative legal entity, with the separation of the assets of its members as capital to run a business, that meets collective aspirations and needs in the economic, social, and cultural fields following the values and principles of the cooperative [1]. Cooperatives have played a significant role in fostering economic development within communities, particularly benefiting small and medium-sized ones [2]. Al-Amin Mandiri Cooperative provides savings and loan services. One of the problems seen is the provision of financial loans to cooperative member customers who do not meet the requirements.

This cooperation has not used a decision support system in the process of lending and only provides loans to customers who are deemed to be able to pay their bills and have warranty conditions that are still worthy of use. The absence of a system that would make it easier for the cooperative to decide to grant the loan caused a delay in time because it had to be considered manually. Besides, Al-Amin Mandiri Corporation itself often suffers losses because customers do not pay on time, which leads to credit clogging. To address the aforementioned challenges, transitioning from a manual system to a decision support system is crucial. This shift aims to streamline the verification process and enable group decision-making capabilities [3].

The process of determining eligibility is a problem that requires many criteria to be assessed, so it requires an approach that can deal with the problem of multi-criteria. Simple Additive Weighting (SAW) and Analytical Hierarchy Process (AHP) can be used as a method of multi-criterion decision-support system [4]. The following research endeavors also incorporated the AHP and TOPSIS techniques, with the inclusion of the SAW method, to assess the extraction of renewable resources in Iran. Various aspects including technical, economic, energy security, and social dimensions were considered, employing diverse sub-criteria [5].

A decision-support system is a decision-making system in a semi-structured and instructed situation, where no one knows exactly how the decision should be taken [6], [7]. A decision support system can be applied in decision-making processes across diverse fields beyond cooperatives, including supplier selection, wedding organizing, project prioritization, motorcycle loan approvals, tuition fee management, and more [8], [9].

Al Amin Mandiri is a cooperative that has a lending facility to rebuild the economy and improve the well-being of its members. All members have the right to apply for loans. The loan application is based on the AHP method, which is a decision-making method that includes a set of criteria and alternatives [10]. The SAW method determines the best alternative by calculating the weight of the performance evaluation of each alternative based on all criteria [11]. Based on the explanation above, this research aims to determine the eligibility of members to obtain credit at the Al-Amin Mandiri Cooperative using the SAW and AHP methods to find the best alternative.

Previous studies have involved comparative analysis of methods in DSS for example, research conducted by Fatkhurrochman in determining recipients of aid for the construction of housing communities that are less able by comparing methods TOPSIS and SAW [12]. Seven criteria were used in this study: the amount of income, the size of land owned, the type of floor and wall of the house, the availability of MCK, education, and employment. After the calculation is done, sensitivity tests are performed on both methods. The research results show that the SAW method is the most optimal with a SAW change value of 14.65% and a TOPSIS change value of 4.02%.

Further related research by Prisa Marga Kusumantara on the selection of online learning media platforms comparing SAW and AHP methods [13]. The criteria set for this research are the use of quotas, strong signal needs, rich features, ease of use, interaction, and multitasking. After that, each method is calculated for each criterion, and after that, the distance between SAW and the Analytical Hierarchy Process (AHP) is measured against the respondent's assessment. The results show that the SAW method is more relevant in this case than the AHP.

The same research by Prisa Marga Kusumantara on the selection of wedding organizers in Surabaya by comparing the SAW and WP methods [14]. Rating, year of birth, price, photo per roll, and food menu variation were the criteria used in this study. After that, calculations are done for each method for each criterion. The calculations show that the SAW method is more relevant in this situation than the WP method, with the SAW rank gap of 78% and the WP of 80%.

The research was conducted to determine the eligibility of members in obtaining credit in the Al-Amin Mandiri Independent Cooperation using the Simple Additive Weighting (SAW) and Analytical Hierarchy Process methods. (AHP). Through the implementation of this decision-support system, it is expected that the cooperative can improve efficiency, reduce the risk of credit clogging, and ensure proper lending to members who meet the established criteria.

2. RESEARCH METHODS

2.1. Data collection method

Data collection was carried out using observations, interviews, and library research. Direct observations focused on the Al-Amin Mandiri cooperative, while interviews were conducted with relevant parties to gain insights into the procedures for credit applications, the required conditions, and the management challenges faced by the cooperative. Additionally, library research was undertaken by reviewing scientific journals and books related to the research themes, serving as valuable references for this study.

To determine the granting of this credit, the multi-criterion decision support system uses the SAW and AHP methods. The SAW method requires the process of normalizing the decision matrix (X) to a scale comparable to all alternative ratings available. The basic idea of this method, namely the multiplication of the elements of the decision matrix (X), is used to determine this granting. For that, case studies should be done to compare which methods are the most effective to give credit to co-operative members.

2.2. Decision Support System (DSS)

A system designed to assist a particular party in making decisions, usually using more than one criterion and consisting of several additional criteria, is called a decision support system and will transform data into information to help in decision-making on specifically semi-structured issues [15]. The interactive nature of the computer management system facilitates the integration process of various components to make decisions [16].

2.3. Simple Additive Weighting (SAW)

The SAW method is one of two methods used in decision support systems. This method gives sequential weights to the criteria and sub-criteria, and then the alternative value data is summed up according to the previously specified weights. This method is often used to solve problems involving multiple processes. The SAW method is also referred to as the method of weighted aggregation [17].

The process performed when using the SAW method is as follows:

a. Determine the criteria to be used for decision-making, which is symbolized by Ci.
b. Evaluate the matching of each alternative based on each criterion.
c. After making a decision matrix based on criteria (Ci), the equation is used to normalize the matrix according to the type of attribute, e.g. profit or cost attributes, so that the normalized matrix R is produced.
d. The anchoring process, which summarizes the proliferation of the normalized matrices R with the weight vector to obtain the best value as the best alternative (Ai) as a solution, produces the final result.

The equation used to perform such normalization is as follows:

$$rij = \begin{cases} \dfrac{xij}{maxij} \\ \dfrac{minij}{xij} \end{cases} \tag{1}$$

Description:
rij = Normalized performance rating
Maxij = Maximum value for each row and columns
Minij = Minimum value of each row and columns
xij = Rows and Columns of the matrix

By *rij* is the normalized performance rating of the alternative Ai on the attribute Cj ; i = 1,2,..., m and j = 1,2...,n. The preference value for each alternative (V) is given equation:

$$Vi = \sum_{j=1}^{n} wj\, rij \tag{2}$$

Description:
Vi = End value of the alternative (A)
Wj = Determined weight (C)
rij = Matrix normalization

2.4. Analytical Hierarchy Process (AHP)

Analytical Hierarchy Process (AHP) is a decision-making method involving several criteria and alternatives [18]. The AHP method breaks a complex situation into its parts, arranges them in a hierarchical order, gives numerical value to subjective consideration of the relative importance of each variable, and synthesizes as consideration and improves the reliability of AHP as a decision-making tool [19].

Analytical Hierarchy Process Analysis (AHP) is used to make decisions in pairs of comparisons consisting of criteria and choices [20]. Here are examples of data analysis used:

a. Determines the relative importance of the current criteria. This analysis process can be used to upgrade the rating of criteria into an Analytical Hierarchy Process-based system. (AHP).
b. Pairwise Comparison: The analysis process is carried out to calculate the comparison of criteria with others. Values can be expressed as equal, moderate, strong, extremely strong, and extreme.
c. Finding Eigenvectors: Finding eigenvectors is used to obtain rankings to use matrix pairs as the basis for calculating the squares of matrix pairs whenever calculations with both are done.
d. Calculating Eigenvectors First: To calculate the eigenvector first, you must sum up rows of already existing rows and then normalize the total value of each row.
e. Determining Alternative Ranking: Alternative rankings are made through pairing comparisons against each criterion. As a consideration in the process carried out line data and information of alternative options (quantitative methods) along with the consideration of experts related to alternative options.

In the context of the Analytical Hierarchy Process (AHP) analysis for decision-making techniques, the calculation involves determining the Consistency Index (CI) using the formula $CI= (\lambda max-n)/n-1$, where λmax is the largest eigenvalue of the pairwise comparison matrix, and n is the number compared. Subsequently, the Consistency Ratio (CR) is calculated using the formula CR = CI/RI, where RI is the Random Index determined by the matrix size. This calculation aims to evaluate the consistency in the decision-making process and ensure that the assessments provided are sufficiently valid. Calculate the CI consistency index, the $CR = (\pi \text{ max} – n)/n-1$, and the CI = CI/RI [19].

3. RESULT AND DISCUSSION

Because of a delay in time, it had to be considered manually, and then compared to find the best method to solve it. Table 1 below shows six (C) criteria used to make decisions on this issue:

Table 1. Criteria

Criteria	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**
Information	Member’s Active Period	Savings	Guarantee	Loans	Installments	Time Period

The criteria listed from C1 to C6, represent key factors used to evaluate borrower profiles. C1 (Member’s Active Period) assesses the duration of an individual's membership, while C2 (Savings) evaluates their financial savings. C3 (Guarantee) examines the type of collateral provided, and C4 (Loans) measures the borrower's loan amount. C5 (Installments) refers to the regular payment amounts made toward the loan, and C6 (Time Period) considers the repayment duration. Together, these criteria provide a comprehensive framework for assessing borrower eligibility and risk.

Each alternative is evaluated based on the specified criteria and assigned a rating that reflects its performance level, as presented in Table 2 below :

Table 2. Rating Performance Level

Low (R)	**Enough (C)**	**High (T)**	**Very High (ST)**
0.25	0.5	0.75	1

The scoring system categorizes performance levels into four distinct ratings: Low (R), scored at 0.25, represents the lowest level of performance or suitability; Enough (C), scored at 0.5, reflects a moderate or acceptable performance level; High (T), scored at 0.75, indicates a strong or above-average level of performance; and Very High (ST), scored at 1, signifies the highest level of performance or suitability. This structured approach ensures consistency and clarity in evaluating alternatives across various criteria.

In the next step, each alternative will be given a value or weight based on each criterion that has been set, which covers :

1. Member's Active Period

Table 3 below shows the members' activity in saving money every month:

Table 3. Member's Active Period Criteria

Criteria	Range	Value	Information
Member's Active Period	≤ 1 Year	0.25	Low
	3 Year	0.5	Moderate
	4-5 Year	0.75	High
	≥ 10 Year	1	Very High

The scoring for a Member's Active Period evaluates the duration of membership and assigns a value to reflect the level of experience or engagement. Members with an active period of ≤1 year are scored 0.25 (Low), those active for 3 years receive 0.5 (Moderate), members active for 4–5 years are scored 0.75 (High), and those with an active period of ≥10 years are assigned 1 (Very High). This system provides a clear and structured approach to categorizing members based on their length of active participation.

2. Savings

The amount of the savings is calculated from the amount of savings of the cooperative member applying for borrowing, as shown in Table 4:

Table 4. Shows the criteria for the Amount of Savings

Criteria	Range	Value	Information
Amount of Savings	< Rp. 825.000	0.25	Low
	Rp. 1.200.000-Rp. 4.805.000	0.5	Moderate
	Rp. 5.150.000-Rp. 7.835.00	0.75	High
	≥ Rp 8.7150.000	1	Very High

The scoring for Amount of Savings categorizes members based on their savings range and assigns a corresponding value to reflect their financial level. Savings of less than Rp. 825,000 are scored 0.25 (Low), while savings between Rp. 1,200,000 and Rp. 4,805,000 are scored 0.5 (Moderate). Those with savings between Rp. 5,150,000 and Rp. 7,835,000 are scored 0.75 (High), and savings of Rp. 8,715,000 or more are assigned a value of 1 (Very High). This scoring provides a structured framework to evaluate members' financial standings.

3. Credit Guarantee

Table 5 shows the type of Credit Guarantee provided by the member:

Table 5. Displays Credit Guarantee Criteria

Criteria	Range	Value	Information
Credit Guarantee	Motor Vehicle Certificate	0.5	Moderate
	Car Vehicle Certificate	0.75	High
	House/Land Certificate	1	Very High

The scoring for Credit Guarantee evaluates the type of asset used as collateral and assigns a corresponding value to reflect its level of reliability. A Motor Vehicle Certificate is scored 0.5 (Moderate), a Car Vehicle Certificate is scored 0.75 (High), and a House or Land Certificate is scored 1 (Very High). This scoring system provides a clear and structured way to assess the quality and security of credit guarantees.

4. Loans
Loans seen from the amount of fund borrowing submitted by members of the cooperative are presented in Table 6 below:

Table 6. Specific Criteria for Loans

Criteria	Criterion Value	Criterion Weight	Information
Loans	< Rp. 8.000.000	1	Very High
	Rp. 9.000.000-Rp. 10.000.000	0.75	High
	Rp. 11.00.000-Rp. 14.000.000	0.5	Moderate
	> Rp. 15.000.000	0.25	Low

The scoring for Loans evaluates the loan amount and assigns a Criterion Value and Criterion Weight to indicate the level of financial risk or appropriateness. Loans of less than Rp. 8,000,000 are assigned a Criterion Value of 1 (Very High), those between Rp. 9,000,000 and Rp. 10,000,000 are scored 0.75 (High), loans ranging from Rp. 11,000,000 to Rp. 14,000,000 are scored 0.5 (Moderate), and loans exceeding Rp. 15,000,000 are scored 0.25 (Low). This system provides a structured framework to assess loan amounts based on their associated risk or desirability.

5. Installments
Installments are calculated from the borrower's monthly installment amount, as shown in Table 7:

Table 7. Instalment Criteria

Criteria	Criterion Value	Criterion Weight	Information
Installments	< Rp. 750.000	0.25	Low
	Rp. 835.000	0.5	Moderate
	Rp. 1.000.000	0.75	High
	> Rp 1.500.000	1	Very High

The scoring for Instalments assesses the monthly payment amount and assigns a Criterion Value and Criterion Weight to indicate its financial impact or level of commitment. Installments of less than Rp. 750,000 are scored 0.25 (Low), those equal to Rp. 835,000 are scored 0.5 (Moderate), installments of Rp. 1,000,000 are scored 0.75 (High), and installments exceeding Rp. 1,500,000 are scored 1 (Very High). This system provides a clear and structured approach to evaluating the affordability and significance of installment amounts.

6. Time Period
Table 8 shows the time it takes the borrower to repay the loan:

Table 8. Time Period criteria

Criteria	Range	Value	Information
Time Period	10 Months	1	Very High
	15 Months	0.75	Very
	18 Months	0.5	Moderate
	20 Months	0.25	Low

Table 8 above shows scoring for the Time Period evaluates the duration of a given term and assigns a value to represent its level of desirability or appropriateness. A time period of 10 months is scored 1 (Very High), 15 months is scored 0.75 (High), 18 months is scored 0.5 (Moderate), and 20 months is scored 0.25 (Low). This system provides a structured framework for assessing the suitability of time periods based on their length.

The next step before proceeding to the calculation process is that each criterion must be labeled as C1 through C6 and assigned a priority weight based on its level of importance for the requirements. Table 9 below shows the priority weight value for each criterion, known as the initial weight (W).

Table 9. Weighs each criterion

Criteria	C1	C2	C3	C4	C5	C6
Weight	1	1	1	0.75	0.75	0.5

The weighting system assigns values to each criterion based on its relative importance in the evaluation process. C1 (Member's Active Period), C2 (Savings), and C3 (Guarantee) are each given a weight of 1, indicating their very high importance. C4 (Loans) and C5 (Installments) are weighted at 0.75, reflecting their high importance, while C6 (Time Period) is assigned a weight of 0.5, signifying moderate importance. This structured approach ensures that more critical factors have a greater influence on the evaluation, aligning the decision-making process with the priorities of the analysis.

A. SAW Method Manual Calculations

Below is the borrower data that can be seen in Table 10 :

Table 10. Information about Borrowers

Alternative	Criteria					
	C1	C2	C3	C4	C5	C6
Salman	3 Years	Rp. 7.050.000	Motor Vehicle Certificate	Rp. 15.000.000	Rp. 750.000	20 Months
Rani Sorahya	1 Year	Rp. 5.425.000	Land Certificate	Rp. 5.600.000	Rp. 700.000	8 Months
Ali Muzaki	5 Years	Rp. 7.945.000	Land Certificate	Rp. 15.000.000	Rp. 750.000	20 Months
Imam Buchari	4 Years	Rp. 7.825.000	Motor Vehicle Certificate	Rp. 15.000.000	Rp. 750.000	20 Months
Sri Astuti	10 Years	Rp. 8.377.000	Motor Vehicle Certificate	Rp. 14.000.000	Rp. 750.000	20 Months

The table presents a comprehensive evaluation of borrowers based on six criteria: Member's Active Period (C1), Savings (C2), Guarantee (C3), Loans (C4), Installments (C5), and Time Period (C6). These criteria are utilized to assess the financial profiles and loan-related attributes of each borrower systematically. For example, Salman has been a member for 3 years (C1) and possesses savings amounting to Rp. 7,050,000 (C2), and uses a motor vehicle certificate as a guarantee (C3). His loan amount is Rp. 15,000,000 (C4), with monthly installments of Rp. 750,000 (C5) over a repayment period of 20 months (C6). Similarly, Rani Sorahya, who has been a member for 1 year (C1), has savings of Rp. 5,425,000 (C2), provides a land certificate as a guarantee (C3) and has a loan amount of Rp. 5,600,000 (C4) with monthly installments of Rp. 700,000 (C5) over a repayment period of 8 months (C6). These examples illustrate how the criteria are applied to evaluate the borrowers' profiles, providing a structured framework for comparison and analysis.

To ensure consistency and comparability, the raw data is then normalized into a matching rating table as shown in Table 11, where each criterion is assigned a value between 0.25 and 1 based on its relative performance. This normalization process converts qualitative and quantitative data into standardized scores, facilitating a more structured and objective comparison. The matching rating table thus reflects the transformed values, enabling clear identification of strengths and weaknesses across the alternatives. By linking the original criteria to the normalized ratings, this approach ensures that all evaluations align with the predefined scales and priorities.

Table 11. Matching Rating

Alternative	Criteria					
	C1	C2	C3	C4	C5	C6
Salman	0.5	0.75	0.5	0.25	0.5	0.5
Rani Sorahya	0.25	0.75	1	1	0.5	1
Ali Muzaki	0.75	0.75	1	0.25	0.5	0.5
Imam Buchari	0.75	0.75	0.5	0.25	0.5	0.5
Sri Astuti	1	1	0.5	0.5	0.5	0.5

Next, enter it into matrix X using the following formula:

$$X = \begin{bmatrix} x11 & x12 & \cdots & x1j \\ \vdots & \vdots & \vdots & \vdots \\ xi1 & xi2 & \cdots & xij \end{bmatrix} \quad (3)$$

Thus the X result matrix, derived from Formula (3), is presented in Table 11.

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

The following are the normalization calculation results for each criterion (C), which is an essential step in the Simple Additive Weighting (SAW) method to standardize data and enable a fair comparison across all alternatives.

C1

$$\text{r11} = \frac{0.5}{\max(0.5, 0.25, 0.75, 0.75, 1)} = \frac{0.5}{1} = \mathbf{0.5}$$

$$\text{r12} = \frac{0.25}{\max(0.5, 0.25, 0.75, 0.75, 1)} = \frac{0.25}{1} = \mathbf{0.25}$$

$$\text{r13} = \frac{0.75}{\max(0.5, 0.25, 0.75, 0.75, 1)} = \frac{0.75}{1} = \mathbf{0.75}$$

$$\text{r14} = \frac{0.75}{\max(0.5, 0.25, 0.75, 0.75, 1)} = \frac{0.75}{1} = \mathbf{0.75}$$

$$\text{r15} = \frac{1}{\max(0.5, 0.25, 0.75, 0.75, 1)} = \frac{1}{1} = \mathbf{1}$$

C2

$$r21 = \frac{0.75}{max(0.75, 0.75, 0.75, 0.75, 1)} = \frac{0.75}{1} = \mathbf{0.75}$$

$$r22 = \frac{0.75}{max(0.75, 0.75, 0.75, 0.75, 1)} = \frac{0.75}{1} = \mathbf{0.75}$$

$$r23 = \frac{0.75}{max(0.75, 0.75, 0.75, 0.75, 1)} = \frac{0.75}{1} = \mathbf{0.75}$$

$$r24 = \frac{0.75}{max(0.75, 0.75, 0.75, 0.75, 1)} = \frac{0.75}{1} = \mathbf{0.75}$$

$$r25 = \frac{1}{max(0.75, 0.75, 0.75, 0.75, 1)} = \frac{1}{1} = \mathbf{1}$$

C3

$$r31 = \frac{0.5}{\max(0.5, 1, 1, 0.5, 0.5)} = \frac{0.5}{1} = \mathbf{0.5}$$

$$r32 = \frac{1}{\max(0.5, 1, 1, 0.5, 0.5)} = \frac{1}{1} = \mathbf{1}$$

$$r33 = \frac{1}{\max(0.5, 1, 1, 0.5, 0.5)} = \frac{1}{1} = \mathbf{1}$$

$$r34 = \frac{0.5}{\max(0.5, 1, 1, 0.5, 0.5)} = \frac{0.5}{1} = \mathbf{0.5}$$

$$r35 = \frac{0.5}{\max(0.5, 1, 1, 0.5, 0.5)} = \frac{0.5}{1} = \mathbf{0.5}$$

C4

$$r41 = \frac{0.25}{\max(0.25, 1, 0.25, 0.25, 0.5)} = \frac{0.25}{1} = \mathbf{0.25}$$

$$r42 = \frac{1}{\max(0.25, 1, 0.25, 0.25,0.5)} = \frac{1}{1} = \mathbf{1}$$

$$r43 = \frac{0.25}{\max(0.25, 1, 0.25, 0.25,0.5)} = \frac{0.25}{1} = \mathbf{0.25}$$

$$r44 = \frac{0.25}{\max(0.25, 1, 0.25, 0.25,0.5)} = \frac{0.25}{1} = \mathbf{0.25}$$

$$r45 = \frac{0.5}{\max(0.25, 1,025, 0.25,0.5)} = \frac{0.5}{1} = \mathbf{0.5}$$

C5

$$r51 = \frac{0.5}{\max(0.5, 0.5, 05, 0.5,0.5)} = \frac{0.5}{0.5} = \mathbf{1}$$

$$r52 = \frac{0.5}{\max(0.5, 0.5, 05, 0.5,0.5)} = \frac{0.5}{0.5} = \mathbf{1}$$

$$r53 = \frac{0.5}{\max(0.5, 0.5, 05, 0.5,0.5)} = \frac{0.5}{0.5} = \mathbf{1}$$

$$r54 = \frac{0.5}{\max(0.5, 0.5, 05, 0.5,0.5)} = \frac{0.5}{0.5} = \mathbf{1}$$

$$r55 = \frac{0.5}{\max(0.5, 0.5, 05, 0.5,0.5)} = \frac{0.5}{0.5} = \mathbf{1}$$

C6

$$r61 = \frac{0.5}{\max(0.5, 1, 0.5, 0.5,0.5)} = \frac{0.5}{1} = \mathbf{0.5}$$

$$r62 = \frac{1}{\max(0.5, 1, 0.5, 0.5,0.5)} = \frac{1}{1} = \mathbf{1}$$

$$r63 = \frac{0.5}{\max(0.5, 1, 0.5, 0.5,0.5)} = \frac{0.5}{1} = \mathbf{0.5}$$

$$r64 = \frac{0.5}{\max(0.5, 1, 0.5, 0.5,0.5)} = \frac{0.5}{1} = \mathbf{0.5}$$

$$r65 = \frac{0.5}{\max(0.5, 1, 0.5, 0.5,0.5)} = \frac{0.5}{1} = \mathbf{0.5}$$

The following is the result or summary of the calculations for each criterion, which has been compiled into Table 12 :

Table 12. X Matrix Normalization Results

Alternative	Criteria					
	C1	C2	C3	C4	C5	C6
Salman	0.5	0.75	0.5	0.25	1	0.5
Rani Sorahya	0.25	0.75	1	1	1	1
Ali Muzaki	0.75	0.75	1	0.25	1	0.5
Imam Buchari	0.75	0.75	0.5	0.25	1	0.5
Sri Astuti	1	1	0.5	0.5	1	0.5

Table 12 presents the results of the X Matrix normalization, where each alternative is evaluated against six criteria: C1 (Member's Active Period), C2 (Savings), C3 (Guarantee), C4 (Loans), C5 (Installments), and C6 (Time Period). The normalization process standardizes the raw data, assigning scores between 0.25 and 1 to reflect the performance of each alternative relative to each criterion. For instance, Salman achieves moderate scores across most criteria, with a perfect score of 1 in C5 (Installments), while Sri Astuti demonstrates strong performance with maximum scores in C2 (Savings) and C5 (Installments). This table provides a clear comparison of all alternatives based on normalized values.

Thus, the following normalized matrix (R) is obtained as part of the Simple Additive Weighting (SAW) method, where each alternative is evaluated based on normalized values for the specified criteria, enabling a fair and consistent comparison.

$$R = \begin{bmatrix} 0.5 & 0.75 & 0.5 & 0.25 & 1 & 0.5 \\ 0.25 & 0.75 & 1 & 1 & 1 & 1 \\ 0.75 & 0.75 & 1 & 0.25 & 1 & 0.5 \\ 0.75 & 0.75 & 0.5 & 0.25 & 1 & 0.5 \\ 1 & 1 & 0.5 & 0.5 & 1 & 0.5 \end{bmatrix} \quad (4)$$

Therefore, the final value of each alternative (A) is as follows:
V1 = (1) (0.5) + (1) (0.75) + (1) (0.5) + (0.75) (0.25) + (0.75) (1) + (0.5) (0.5) = 2.9375
V2 = (1) (0.25) + (1) (0.75) + (1) (1) + (0.75) (1) + (0.75) (1) + (0.5) (1) = 4
V3 = (1) (0.75) + (1) (0.75) + (1) (1) + (0.75) (0.25) + (0.75) (1) + (0.5) (0.5) = 3.6875
V4 = (1) (0.75) + (1) (0.75) + (1) (0.5) + (0.75) (0.25) + (0.75) (1) + (0.5) (0.5) = 3.1875
V5 = (1) (1) + (1) (1) + (1) (0.5) + (0.75) (0.5) + (0.75) (1) + (0.5) (0.5) = 3.875

The result from the calculation shows that Rani Sorahya (V2) is the best alternative, with the highest value of 4. This outcome is due to her strong performance across multiple criteria, including Guarantee, Loans, Installments, and Time Period. The high scores in these areas, when combined with the respective weights, contribute significantly to her overall score, making her the top choice in this evaluation using the SAW method.

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B. Weighing steps using AHP methods by organizing hierarchies

In this phase, we will begin to define and weigh criteria, the establishment of criteria has been determined by the co-operatives, and the weighting of the criteria obtained from the outcome of meetings in the Annual Meeting of Members. (RAT). The next step is to create a matrix of comparison pairs into six criteria and four alternatives, namely:

- C = 6 {Credit, Savings, Credit Guarantees, Loans, Repayments, Time Period}
- A = 5 {Salman, Rani Soraya, Ali Muzaki, Imam Buchari, Sri Astuti}

Next, each criterion is given a value as described in Table 13, according to the level of importance and definition. (source : Saaty, 1994).

Table 13. Fundamental Scales for Pair Comparisons

Interest Level	***Definition***	***Explanation***
1	*It's just as important as the others.*	*Two elements contribute equally to that property.*
3	*Moderate its importance with the others*	*Experience and little consideration support one element over the other*
5	*Strong importance with others*	*Experience and consideration strongly support one element over the other.*
7	*It's more important than the others.*	*One element is strongly supported, and its dominance has been seen in practice.*
9	*Extreme/absolute importance over the others*	*The evidence that supports one element over the other has the highest possible level of confirmation.*
2,4,6,8	*A value between two adjacent assessments*	*A necessary compromise between two considerations*
Reciprocal	*Value between two adjacent assessments if element i has one of the above digits compared to j, then j has its opposite value when compared with element i*	

Table 13 presents the fundamental scales for pairwise comparisons, which are used to assess the relative importance of various criteria. This scale ranges from 1 to 9, where 1 indicates that two elements are equally important, and 9 represents the extreme or absolute importance of one element over the other. The scale also includes intermediate values like 3, 5, and 7 to express moderate, strong, and more significant differences in importance, respectively. Additionally, reciprocal values are used when comparing two elements in the opposite direction, ensuring consistency in the comparisons.

In the decision-making process, Table 13 is used to guide the assignment of values in Table 14. Table 14 shows how these pairwise comparisons are applied to evaluate the importance of six criteria: Member's Active Period, Savings, Guarantee, Loan, Installments, and Time Period. Using the scale from Table 13, the relative importance of each pair of criteria is determined and assigned a corresponding value. This comparison helps quantify the significance of each criterion with the others.

Table 14. Matrix Comparison Pairs for Criteria

	Member's Active Period	Savings	Guarantee	Loan	Installments	Time Period
Member's Active Period.	1	5	5	5	5	1
Savings	0,2	1	3	1	1	3
Guarantee	0,2	0,33	1	1	1	3
Loan	0,2	1	0,33	1	1	3
Installments	0,2	1	0,33	1	1	3
Time Period	1	0,33	0,33	0,33	0,33	1
	2,8	8,66	10	9,33	9,33	14

Table 14 displays the matrix of pairwise comparisons, where each value represents the relative importance of one criterion compared to another. For example, the value of 5 in the row "Member's Active Period" compared to "Savings" means "Member's Active Period" is five times more important than "Savings." Similarly, the values of 0.33 or 0.2 indicate lower importance when comparing other criteria. The final row in Table 14 shows the sum of values for each criterion, providing an overall assessment of the criteria's relative importance. These totals are crucial for the next steps in the decision-making process.

The next activity involves calculating the normalization vector properties in the AHP method, which will standardize the values in the pairwise comparison matrix to ensure consistency and facilitate the computation of weighted scores for each criterion.

Calculating Normalization Vector Properties :
A11 = (1*1) + (5*0,2) + (5*0,2) + (5*0,2) + (5*0,2) + (1*1) = 5
A12 = (1*5) + (5*1) + (5*0,33) + (5*1) + (5*1) + (1*0,33) = 21,98
A13 = (1*5) + (5*3) + (5*1) + (5*0,33) + (5*0,33) + (1*0,33) = 28,63
A14 = (1*5) + (5*1) + (5*1) + (5*1) + (5*1) + (1*0,33) = 25,33
A15 = (1*5) + (5*1) + (5*1) + (5*1) + (5*1) + (1*0,33) = 25,33
A16 = (1*1) + (5*3) + (5*3) + (5*3) + (5*3) + (1*1) = 62

A21 = (0,2*1) + (1*0,2) + (3*0,2) + (1*0,2) + (1*0,2) + (3*1) = 4,4
A22 = (0,2*5) + (1*1) + (3*0,33) + (1*1) + (1*1) + (3*0,33) = 5,98
A23 = (0,2*5) + (1*3) + (3*1) + (1*0,33) + (1*0,33) + (3*0,33) = 8,65
A24 = (0,2*5) + (1*1) + (3*1) + (1*1) + (1*1) + (3*0,33) = 7,99
A25 = (0,2*5) + (1*1) + (3*1) + (1*1) + (1*1) + (3*0,33) = 7,99
A26 = (0,2*1) + (1*3) + (3*3) + (1*3) + (1*3) + (3*1) = 21,2

A31 = (0,2*1) + (0,33*0,2) + (1*0,2) + (1*0,2) + (1*0,2) + (3*1) = 3,86
A32 = (0,2*5) + (0,33*1) + (1*0,33) + (1*1) + (1*1) + (3*0,33) = 4,65
A33 = (0,2*5) + (0,33*3) + (1*1) + (1*0,33) + (1*0,33) + (3*0,33) = 4,64
A34 = (0,2*5) + (0,33*1) + (1*1) + (1*1) + (1*1) + (3*0,33) = 5,32
A35 = (0,2*5) + (0,33*1) + (1*1) + (1*1) + (1*1) + (3*0,33) = 5,32
A36 = (0,2*1) + (0,33*3) + (1*3) + (1*3) + (1*3) + (3*1) = 13,19

A41 = (0,2*1) + (1*0,2) + (0,33*0,2) + (1*0,2) + (1*0,2) + (3*1) = 3,86
A42 = (0,2*5) + (1*1) + (0,33*0,33) + (1*1) + (1*1) + (3*0,33) = 5,09
A43 = (0,2*5) + (1*3) + (0,33*1) + (1*0,33) + (1*0,33) + (3*0,33) = 5,98
A44 = (0,2*5) + (1*1) + (0,33*1) + (1*1) + (1*1) + (3*0,33) = 5,32
A45 = (0,2*5) + (1*1) + (0,33*1) + (1*1) + (1*1) + (3*0,33) = 5,32
A46 = (0,2*1) + (1*3) + (0,33*5) + (1*3) + (1*3) + (3*1) = 13,85

A51 = (0,2*1) + (1*0,2) + (0,33*0,2) + (1*0,2) + (1*0,2) + (3*1) = 3,86
A52 = (0,2*5) + (1*1) + (0,33*0,33) + (1*1) + (1*1) + (3*0,33) = 5,09

A53 = (0,2*5) + (1*3) + (0,33*1) + (1*0,33) + (1*0,33) + (3*0,33) = 5,98
A54 = (0,2*5) + (1*1) + (0,33*1) + (1*1) + (1*1) + (3*0,33) = 5,32
A55 = (0,2*5) + (1*1) + (0,33*1) + (1*1) + (1*1) + (3*0,33) = 5,32
A56 = (0,2*1) + (1*3) + (0,33*3) + (1*3) + (1*3) + (3*1) = 13,19

A61 = (1*1) + (0,33*0,2) + (0,33*0,2) + (0,33*0,2) + (0,33*0,2) + (1*1) = 2,26
A62 = (1*5) + (0,33*1) + (0,33*0,33) + (0,33*1) + (0,33*1) + (1*0,33) = 6,42
A63 = (1*5) + (0,33*3) + (0,33*1) + (0,33*0,33) + (0,33*0,33) + (1*0,33) = 6,86
A64 = (1*5) + (0,33*1) + (0,33*1) + (0,33*1) + (0,33*1) + (1*0,33) = 6,65
A66 = (1*5) + (0,33*1) + (0,33*1) + (0,33*1) + (0,33*1) + (1*0,33) = 6,65
A66 = (1*1) + (0,33*3) + (0,33*3) + (0,33*3) + (0,33*3) + (1*1) = 5,96

Table 15 Summarizes the value of the row, and then performs the summary of the line.

Table 15. Summary value

Line	Aggregation	Results
1	5 + 21,98 + 28,63 + 25,33 + 25,33 + 62	168,27
2	4,4 + 5,98 + 8,65 + 7,99 + 7,99 + 21,2	56,21
3	3,86 + 4,65 + 4,64 + 5,32 + 5,32 + 13,19	36,98
4	3,86 + 5,09 + 5,98 + 5,32 + 5,32 + 13,85	39,42
5	3,86 + 5,09 + 5,98 + 5,32 + 5,32 + 13,19	38,76
6	2,26 + 6,42 + 6,86 + 6,65 + 6,65 + 5,96	34,8
	Total	374,44

The normalized vector Eigenvalues are generated by dividing the sum of each row by the total, as presented in Table 16 below.

Table 16. Normalized Eigenvector Values

Eigen Vektor	Number per row /Total	Contribution Weight
Eigen Vektor 1	168,27 / 374,44	0,44
Eigen Vektor 2	56,21 / 374,44	0,15
Eigen Vektor 3	36,98 / 374,44	0,09
Eigen Vektor 4	39,42 / 374,44	0,10
Eigen Vektor 5	38,76 / 374,44	0,10
Eigen Vektor 6	34,8 / 374,44	0,09

This process results in the calculation of the normalization vector, which reflects the relative importance of each criterion in the decision-making process. The values derived from this normalization are crucial for the subsequent step, where the proper values for comparison criteria are calculated. These values, which are shown in Table 17 below, provide an updated set of weights that will be used to evaluate and compare the alternatives more accurately in the decision model.

Table 17. Normalization vector proper values for comparison criteria

	Member's Active Period	Savings	Guarantee	Loan	Installments	Time Period	
Member Active Period	5	21,98	28,63	25,33	25,33	62,00	168,27
Savings	4,4	5,98	8,65	7,99	7,99	21,2	56,21
Guarantee	3,86	4,65	4,64	5,32	5,32	13,19	36,98
Loan	3,86	5,09	5,98	5,32	5,32	13,85	39,42
Installments	3,86	5,09	5,98	5,32	5,32	13,19	38,76
Time Period	2,26	6,42	6,86	6,65	6,65	6,96	34,8
							374,44

After obtaining the Normalization Vector's Own Value for comparison criteria, the next stage will be to calculate the consistency ratio (CR).

a) Determining the Maximum Eigenvalue

eMaks = (2,8*0,44) + (8,66*0,15) + (10*0,09) + (9,33*0,10) + (9,33*0,10) + (14*0,09) = 6,55

b) Calculating the consistency index (CI)
CI = (eMaks – n) / (n – 1)
CI = (6,55 – 6) / (6 – 1) = 0,11
If the CR value is < 0.1 then the data and calculations are consistent, but if the CR values are > 0.1, then the recalculation needs to be done.

c) Calculating the consistency ratio (CR)
CR = 0,11 / 1,24 = 0,08870
From the calculation of the CR value, a CR value < 0.1 is obtained, which informs the consistency of the calculations. Thus, the priority weight or Vector eigenvalue obtained can be used in this study.

4. CONCLUSION

The implementation of the SAW and AHP methods for the decision-making process in granting credit to the Al-Amin independent cooperation demonstrates a complementary relationship between both methods. The SAW method provides a clear ranking of alternatives based on the highest value (V2 = 4), allowing for the selection of the best member. On the other hand, the AHP method contributes by assigning priority weights to each criterion, such as Activity (0.44), Savings (0.15), Guarantee (0.09), Loans (0,10), Instalment (0,10), and Time Periode (0,09) which helps determine the relative importance of each factor in the decision-making process. Together, these methods ensure a structured and well-informed approach to selecting the best member. To further improve decision-making accuracy, the cooperative can refine the criteria weights from AHP, integrating regular updates to reflect changing conditions and feedback. Moreover, expanding the analysis to include risk assessment models within the SAW and AHP framework could strengthen decision-making by addressing potential risks, making the overall process more robust and reliable.

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