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Research Original Article

Cooperative Loan Eligibility Determination System Using The Evaluation Based on Distance form Average Solution (EDAS) Method

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Abstract
The rapid development of Decision Support Systems (DSS) has provided significant benefits, especially in supporting decision-making across various fields, including determining credit loan eligibility within cooperatives. Loans involve transactions in which lenders provide funds or assets to borrowers under agreed-upon terms. DSS is essential for enhancing objectivity and reducing the risk of non-performing loans arising from subjective evaluations. This study produces a web-based DSS capable of evaluating the loan eligibility of cooperative members by implementing the Evaluation Based on Distance from Average Solution (EDAS) method, combined with Rank Order Centroid (ROC) weighting. The system analyzes several criteria, such as collateral, membership status, loan amount, loan term, income, remaining loan balance, and payment status. The EDAS method generates a ranking based on eligibility, with alternative N0071 achieving the highest score of 0.907, followed by N0004 with a score of 0.830, and N0019 with a score of 0.762. The results of the system testing indicate that the loan eligibility calculations produced by the system are accurate and consistent with manual calculations, achieving a match of 95%. This ranking simplifies the cooperative's decision-making process. Furthermore, the system accelerates the loan eligibility determination process, enabling cooperatives to serve their members more effectively and efficiently.

Keywords: Decision Support System; Cooperative; Evaluation Based on Distance from Average Solution; Rank Order Centroid.

INTRODUCTION

The advancement of information technology has brought numerous benefits, one of which is in Decision Support Systems (DSS) that support decision-making processes across various fields, including assessing loan eligibility within cooperatives. A loan can be defined as a transaction where the lender provides a certain amount of money or assets to the borrower under mutually agreed terms and conditions [1]. Cooperatives play a vital role in promoting community economies; however, a significant issue is that many still rely on manual methods for assessing loan eligibility, which are often subjective and carry a high risk of credit defaults. According to Law No. 25 of 1992, cooperatives encompass an economic element aimed at enhancing member welfare and a social element based on family principles. According to [2], cooperatives can also be defined as economic organizations consisting of members who have the freedom to join and exit according to applicable regulations. Another challenge is effective credit risk management to ensure financial sustainability and optimal service. This system focuses on a computerized loan eligibility determination system that considers various criteria, such as loan amount, installments, income, and family dependents, to accelerate and optimize the decision-making process within cooperatives.

The study applies the Evaluation based on Distance from Average Solution (EDAS) method to decision analysis in determining cooperative loan eligibility. EDAS addresses issues by calculating the positive and negative ideal distances for each alternative, which are then averaged to yield accurate decisions [3]. A Decision Support System is a computer-based system that uses various methods to produce accurate and targeted decisions [4]. Additionally, weighting is carried out using the Rank Order Centroid (ROC) method to generate weight values for each criterion. The ROC weighting emphasizes prioritizing criteria as the main focus. Applying these methods in loan eligibility selection is

expected to provide more targeted results and support the cooperative's mission of improving the welfare of communities, ultimately contributing to a better economy.

Based on the description above, this study emphasizes member criteria as the primary parameters in determining loan eligibility. Although several studies have addressed this issue, none have combined criteria factors with the Evaluation based on Distance from Average Solution method. Therefore, the proposed title is " Cooperative Loan Eligibility Determination System Using the Evaluation Based on Distance from Average Solution (EDAS) Method." This system is expected to facilitate an accurate and precise eligibility selection process for borrowers at Koperasi Usaha Rakyat (KUR).

LITERATURE REVIEW

In research on decision support systems for loan eligibility assessment, several previous studies have made significant contributions. Based on earlier research conducted by Rivaldy et al. (2023), titled "Designing a Decision Support System for Loan Eligibility in Employee Cooperatives of Perum Jasa Tirta Karya Bhakti Raharja Using the MAUT Method," this study aims to develop a loan eligibility determination system by applying the Evaluation Based on Distance from Average Solution (EDAS) method with the Rank Order Centroid (ROC) approach. The developed system is designed to provide immediate eligibility results once borrowers register to apply for a loan. The advantages of this system include increased transparency in the decision-making process and a reduction in the risk of problematic loans, which are major challenges in current credit assessments. By utilizing data from Koperasi Usaha Rakyat (KUR), this system can not only enhance the accuracy of evaluations but also expedite the loan eligibility assessment process.

1. Decision Support System

According to [5], a Decision Support System is a computer-based system designed with a series of specialized programs to aid the decision-making process. This system can be used to solve existing problems with new methods or to apply existing methods to address new problems. In decision-making, it is essential to consider various alternatives to achieve an optimal outcome. Additionally, Decision Support Systems are designed to approach problem-solving for decision-makers and application needs, aiming to generate multiple alternatives with solutions compatible with how computers operate [4].

2. Characteristics of a Decision Support System

According to [6], Decision Support Systems (DSS) have the following key characteristics:

a. Decision Support System (DSS) aids decision-makers in addressing both structured and unstructured problems by providing computer-based information.
b. It integrates data analysis models with data processing and information retrieval functions.
c. DSS is designed for ease of use and operation.
d. It emphasizes high flexibility and adaptability.

3. Evaluation Based on Distance from Average Solution

The EDAS method optimizes alternative data and criteria by normalizing the data. After normalization, the positive and negative distances for each alternative to the ideal solution are calculated. The positive distance indicates how close an alternative is to the best value, while the negative distance measures how far it is from the worst value. The combination of these two distances generates a final score used to rank and assess the eligibility of each alternative in the decision-making process.[7].

4. Rank Order Cetroid (ROC)

The Rank Order Centroid (ROC) method is used to determine criterion weights based on priority order. The first criterion is assigned the highest weight, followed by the second criterion, which has a lower weight than the first but higher than the third, and so on. This process continues until all criteria receive weights according to their priority levels. ROC ensures that more important criteria receive greater weights in the decision-making process [8]. The steps of the ROC method are as follows:

$$W_{km} = \frac{1}{k}\sum_{i=1}^{k}\left(\frac{1}{k}\right) \quad (12)$$

Description:
W = Weighting value of the criterion
K = Number of criteria
I = Value of the alternative $if w_i \geq w_2 \geq \cdots \ldots \ldots \geq w_k then,$

$$W1 = \frac{1+\frac{1}{2}+\frac{1}{3}+\cdots+\frac{1}{k}}{k} \quad (13)$$

$$W2 = \frac{0+\frac{1}{2}+\frac{1}{3}+\cdots+\frac{1}{k}}{k} \quad (14)$$

$$W3 = \frac{0+0+\frac{1}{3}+\cdots+\frac{1}{k}}{k} \quad (15)$$

$$Wk = \frac{0+0+0+\cdots+\frac{1}{k}}{k} \text{ (up to the criterion k)} \quad (16)$$

MATERIALS & METHODS

1. Data Collection

The research process of the EDAS method requires data to calculate the criterion values and weights for each criterion to identify the best alternatives. The data obtained comes from one of the Cooperative Business Units (Koperasi Usaha Rakyat, KUR) located in Pekan Tanjung Pura, Langkat Regency, consisting of a total of 200 data points labeled with the names of members/clients/prospective clients (according to the cooperative's policies). This data will later be converted into values for the predetermined sub-criteria. Below are some of the data used in the calculations.

Table 1. Data Cooperative

Guarantee	Membershp Status	Income	Loan Amount	Credit Amount	Loan Term	Distance from Residence	Remaining Loan	PS
Motorcycle BPKB	Member	IDR. 3.500.000	IDR. 315.000	12	IDR.325.000	> 10 km	>1,5 jt - 2,5 jt	3
Motorcycle BPKB	Member	IDR. 5.000.000	IDR. 541.000	12	IDR.520.000	> 5 km - 10 km	>1,5 jt - 2,5 jt	3
Motorcycle BPKB	Member	IDR. 5.000.000	IDR. 541.000	12	IDR. 480.000	> 5 km - 10 km	> 3 jt	3
Motorcycle BPKB	Member	IDR. 10.000.000	IDR. 1.008.000	12	IDR. 892.000	> 5 km - 10 km	> 3 jt	3
Motorcycle BPKB	Member	IDR. 2.500.000	IDR. 295.000	12	IDR. 295.000	> 10 km	>1,5 jt - 2,5 jt	3
……..	……..	……..	……..	……..	……..	……..	……..	…….

The data collection technique is carried out to obtain and gather the necessary data/information to achieve the research objectives. Data collection is conducted through observation, which involves directly observing the objects being studied. Additionally, during the observation process, interviews are conducted with sources, specifically the person in charge from the People's Business Cooperative (Koperasi Usaha Rakyat - KUR).

After the data collection process, the results obtained in this research are divided into two types of data:

1. Primary Data: he data obtained consists of 200 borrower records from the cooperative and 9 variables adjusted to the cooperative's needs.
2. Secondary Data: Data from national journals as a source of comparison for the variables to be used.

In this study, data processing is carried out using spreadsheet software Excel to facilitate the analysis and calculation of loan eligibility for cooperative members. After inputting the raw data, the next step is to convert the data into values adjusted according to the predetermined sub-criteria. Subsequently, the data is processed using the EDAS method. Once the calculations are complete, score analysis is performed to determine which alternatives are most eligible for loan approval. The results of this analysis are then presented in the form of tables or graphs, which not only enhance understanding but also provide a visual representation of the evaluation results. Thus, data processing and analysis using the EDAS method through Excel not only yield accurate data but also support more objective and transparent decision-making in the loan approval process within the cooperative environment.

2. System Scheme

The general system scheme for designing a program to determine loan eligibility for cooperative credit provision is as follows:

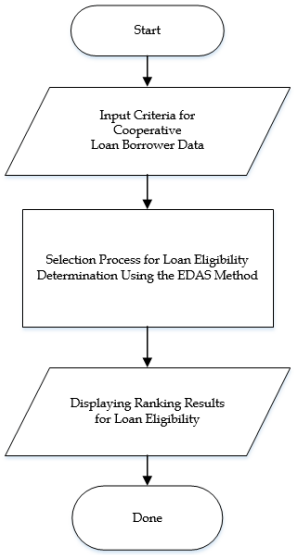


Figure 1. System Scheme

The calculation process of the EDAS method begins by inputting member data, applicants, or new candidates as alternative data, along with criteria that are weighted based on their level of importance using the Rank Order Centroid (ROC) method. Subcriteria for each criterion are also entered according to existing needs. The calculation phase then starts with matrix normalization, followed by the calculation of positive and negative distances (PDA/NDA), and then calculating the final scores to generate rankings from highest to lowest. Based on these rankings, candidates with the highest scores are prioritized for cooperative loan approval, with selection adjusted to the required number of recipients. Data classified as eligible can then be selected for final approval. The stages of the calculation process, along with the formulas, are as follows:

1. Creating a decision matrix:

$$X = [X_{ij}]_{nxm} = \begin{bmatrix} X_{11} & X_{12} & \cdots & X_{1m} \\ X_{21} & X_{22} & \cdots & X_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ X_{n1} & X_{n2} & \cdots & X_{nm} \end{bmatrix} \quad (1)$$

2. Finding the average of alternatives:

$$AV_j = \frac{\sum_{i=1}^{m} rij}{m} \quad (2)$$

3. Finding the average distance from the positive and negative distances. If the criterion type is a benefit, the formula used is as follows:

$$PDA_{ij} = \frac{\max\left(0,(r_{ij} - AV_j)\right)}{AV_j} \quad (3)$$

$$NDA_{ij} = \frac{\max\left(0,(AV_j - r_{ij})\right)}{AV_j} \quad (4)$$

If the criterion type is cost, the formula used is as follows:

$$PDA_{ij} = \frac{\max\left(0,(AV_j - r_{ij})\right)}{AV_j} \quad (5)$$

$$NDA_{ij} = \frac{\max\left(0,(r_{ij} - AV_j)\right)}{AV_j} \quad (6)$$

4. Determining the weighted sum of positive and negative values:

$$SP_1 = \sum_{j=1}^{m} W_j * PDA_j \quad (7)$$

$$SN_1 = \sum_{j=1}^{m} W_j * NDA_j \quad (8)$$

5. Normalizing the positive and negative distances of the alternatives:

$$NSP_i = \frac{SP_i}{Max_i(SP_i)} \quad (9)$$

$$NSN_i = \frac{SN_i}{Max_i(SN_i)} \quad (10)$$

6. Determining the score for each alternative:

$$AS_i = \frac{1}{2}(NSP_i + NSN_i) \quad (11)$$

RESULTS AND DISCUSSION

1. Determination of Criteria and Criterion Weights

The criteria used in the process of determining eligible customers using the EDAS method are as follows:

Table 2. Criteria and Criterion Weights

Code	Name Criteria	Categori	Rank Order Centroid (ROC)	Weight Result
C1	Guarantee	Cost	((1/1)+(1/2)+(1/3)+(1/4)+(1/5)+(1/6) +(1/7)+(1/8)+(1/9))/9	0,314
C2	Membership Status	Benefit	(0+(1/2)+(1/3)+(1/4)+(1/5)+ (1/6)+(1/7)+(1/8)+(1/9))/9	0,203
C3	Income	Benefit	(0+0+(1/3)+(1/4)+(1/5)+(1/6)+ (1/7)+(1/8)+(1/9))/9	0,148
C4	Loan Amount	Cost	(0+0+0+(1/4)+(1/5)+(1/6) +(1/7)+(1/8)+(1/9))/9	0,111
C5	Credit Amount	Cost	(0+0+0+0+(1/5)+(1/6) +(1/7)+(1/8)+(1/9))/9	0,083
C6	Loan Term	Cost	(0+0+0+0+0+(1/6) +(1/7)+(1/8)+(1/9))/9	0,061
C7	Remaining Loan	Cost	(0+0+0+0+0+0+ (1/7)+(1/8)+(1/9))/9	0,042
C8	Distance from Residence	Benefit	(0+0+0+0+0+0+0+ (1/8)+(1/9))/9	0,026
C9	Payment Status	Cost	(0+0+0+0+0+0+0+0+(1/9))/9	0,012
		Total		**1**

Next, to perform the calculation steps in solving the method within the decision support system, weight values are required for each sub-criterion. The table below can be seen for reference:

Table 3. Sub Criteria

Guarantee	**Weight**
Motorcycle BPKB	1
Car BPKB	2
Membership Status	**Weight**
Prospective Customer	1
Customer	2
Member	**3**
Income	**Weight**
IDR. 1.000.0000 – IDR. 1.500.000	1
> IDR. 1.500.000 – IDR. 2.500.000	2
>IDR. 2.500.00 0 – IDR. 3.000.000	3
> IDR. 3.000.000	4
Loan Amount	**Weight**
IDR. 1.000.000 – IDR. 1.500.000	4
>IDR. 1.500.000 – IDR. 2.500.000	3
>IDR. 2.500.000 – IDR. 4.000.000	2
> IDR. 4.000.000	1
Credit Amount	**Weight**
<IDR. 150.000	1
IDR.150.000 - <= IDR.350.000	2
>IDR. 350.000 – IDR. 500.000	3
> IDR. 500.000	4
Loan Term	**Weight**
4 Month	3
6 Month	2
6 Month - 12 Month	1
Remaining Loan	**Weight**
IDR. 0	4
<= IDR. 500.000	3
<= IDR. 1.000.000	2
> IDR. 1.000.000	1
Distance from Residence	**Weight**
> 10 Km	1
> 5 Km - 10 Km	2
< 5 Km	3
Payment Status	**Weight**

Has never applied for a loan	4
Regularly every month, but needs to be reminded	3
Pays regularly every month, but the timing shifts	2
On time, never late	1

Based on the sub-criteria described above, it is necessary to evaluate each criterion using a criteria table to perform calculations. Below is the data resulting from the conversion of alternative data.

Table 4. conversion of alternative data.

No.	Alternative	C1	C2	C3	C4	C5	C6	C7	C8	C9
1.	N0001	1	3	2	2	2	1	4	1	3
2.	N0002	1	3	2	1	4	1	3	2	3
3.	N0003	1	3	4	1	4	1	4	2	3
4.	N0004	2	3	4	1	4	1	3	2	3
5.	N0005	1	2	2	2	2	1	4	1	3
…	….	….	….	….	….	….	….	….	….	….
200.	N0200	1	1	3	2	3	1	4	1	1

2. Manual Calculation of the EDAS Method

The following are the steps in solving the EDAS method:

1. Using Table 4 and equation (1), the following is obtained:

$$X = \begin{bmatrix} 132221413 \\ 132141323 \\ 134141423 \\ 234141323 \\ 123221413 \end{bmatrix}$$

2. Determining the Average Result
   Calculating the average result by summing the values of each criterion attribute and then dividing by the number of alternatives according to equation (2). The average result (AV) has been specified in Table 4.

Table 5. Average Results

No.	Alternative	C1	C2	C3	C4	C5	C6	C7	C8	C9
1.	A1	1	3	2	2	2	1	3	1	3
2.	A2	1	3	2	1	4	1	2	2	3
3.	A3	1	3	4	1	4	1	3	2	3
4.	A4	2	3	4	1	4	1	2	2	3
5.	A5	1	2	2	2	2	1	3	1	3
…	….	….	….	….	….	….	….	….	….	….
200.	A200	1	1	3	2	3	1	4	1	1
AVG		**1.02**	**2.25**	**2.68**	**1.82**	**2.82**	**1.28**	**1.8**	**1.84**	**2.81**
Total		**204**	**450**	**536**	**364**	**564**	**255**	**360**	**367**	**562**

3. Calculating the Positive Distance from Average Solution (PDAS)
   The following is the manual calculation for finding the Positive Distance from Average Solution (PDAS). Based on Table 4, equation (2), and equation (3), the following is obtained:

Table 6. PDA Results

Alternative	C1	C2	C3	C4	C5	C6	C7	C8	C9
N0001	0.020	0.333	0.000	0.000	0.291	0.216	0.000	0.000	0.000
N0002	0.020	0.333	0.000	0.451	0.000	0.216	0.000	0.090	0.000
N0003	0.020	0.333	0.493	0.451	0.000	0.216	0.000	0.090	0.000
N0004	0.000	0.333	0.493	0.451	0.000	0.216	0.000	0.090	0.000
N0005	0.020	0.000	0.000	0.000	0.291	0.216	0.000	0.000	0.000
……	…..	……	……	……	……	……	……	……	……
N0200	0.020	0.000	0.119	0.000	0.000	0.216	0.000	0.000	0.644

To calculate the negative distance average (NDAS), it is the opposite of the previous process. This is done by

subtracting the criterion attribute values of the alternatives from the average criterion value, and then dividing by the average criterion value according to equation (4).

Table 7. NDA Results

Alternative	C1	C2	C3	C4	C5	C6	C7	C8	C9
N0001	0.000	0.000	0.254	0.099	0.000	0.000	0.667	0.455	0.068
N0002	0.000	0.000	0.254	0.000	0.418	0.000	0.111	0.000	0.068
N0003	0.000	0.000	0.000	0.000	0.418	0.000	0.667	0.000	0.068
N0004	0.961	0.000	0.000	0.000	0.418	0.000	0.111	0.000	0.068
N0005	0.000	0.111	0.254	0.099	0.000	0.000	0.667	0.455	0.068
……..	…….	…….	…….	…….	…….	…….	…….	…….	…….
N0200	0.000	0.556	0.000	0.099	0.064	0.000	0.667	0.455	0.000

4. Evaluation of Positive Weight Distance (SP) and Negative Weight Distance (SN)
Based on Table 4, using Equation (5), $w_{1=\ 0.314}$ $w_{2=\ 0.203}$ $w_{3=\ 0.148}$ $w_{4=\ 0.111}$ $w_{5=\ 0.083}$ $w_{6=\ 0.061}$ $w_{7=\ 0.042}$ $w_{8=\ 0.026}$. The following is the manual calculation for determining the weighted sum of SP/SN.

Table 8. SP/SN

Alternative	SP	SN
N0001	0.111	0.089
N0002	0.139	0.078
N0003	0.212	0.064
N0004	0.206	0.342
N0005	0.043	0.112
…….	…….	…….
N0200	0.045	0.193
MAX	**0.278**	**0.372**

5. Normalization of Positive Weight Distance (NSP) and Negative Weight Distance (NSN).
The normalization of positive distance (NSP) is obtained from the combined positive weight values, taking the highest value. Each positive distance value for the alternatives is divided by the highest value of the combined weights according to equation (9). The normalization of negative distance (NSN) is obtained from the combined negative weight values, also taking the highest value. Each negative distance value for the alternatives is divided by the highest value of the combined weights according to equation (10). The calculation results can be seen in Table 9.

Table 9. NSP/NSN

Alternative	NSP	NSN
N0001	0.400	0.240
N0002	0.501	0.209
N0003	0.762	0.171
N0004	0.740	0.920
N0005	0.156	0.301
……..	…….	…….
N0200	0.161	0.518

6. Determination of Ascending Score (AS)
The determination of the final score (AS) is done by summing the values of NSP and NSN, according to equation (11). The calculation results can be seen in Table 10.

Table 10. AS Results

Alternative	AS
N0001	0.320
N0002	0.355
N0003	0.467

N0004	0.830
N0005	0.228
…….	……..
N0200	0.339

7. Ranking
The final stage is the ranking of the score values, as shown in Table 11.

Table 11. Ranking Results

Alternative	Value	Rank	Decision
N0071	0.907	1	Eligible
N0004	0.830	2	Eligible
N0019	0.762	3	Eligible
N0033	0.730	4	Eligible
N0064	0.679	5	Eligible
…….	…….	……	……
N0116	0.149	200	ineligible

The following are the EDAS method calculation results for determining loan eligibility for cooperative members. Alternative N0071, with an AS score of 0.907, is the best option, followed by Alternative N0004 with an AS score of 0.830, and N0019 with an AS score of 0.762, and so forth, which can be recommended as the most suitable loan recipients. Based on these rankings, a decision can be made on how many of the most eligible members can be designated as cooperative loan recipients, according to the capacity available to the cooperative.

3. Impelementasi Sistem

The implementation of the system created is as follows in the website interface built:

a. Initial Display Page

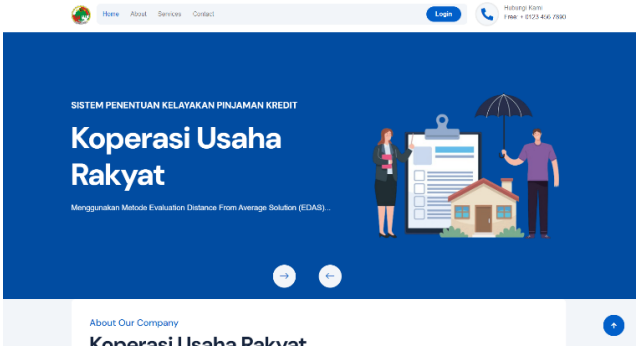


Figure 2. Initial Display Page

The following is the initial display of the decision support system application for determining the feasibility of cooperative loans based on the web.

b. Login Page

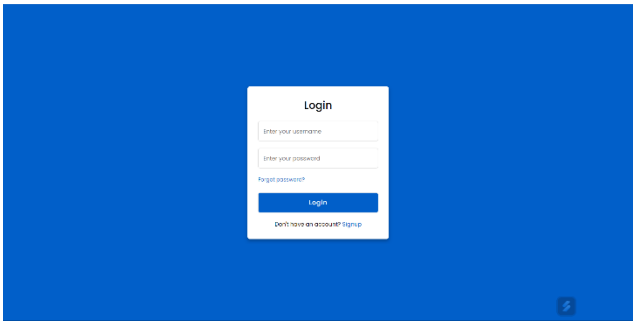


Figure 3. Login Page

The following is the display of the Login page. On this page, the admin or customer can enter their username and password to access the system.

c. Dashboard Page

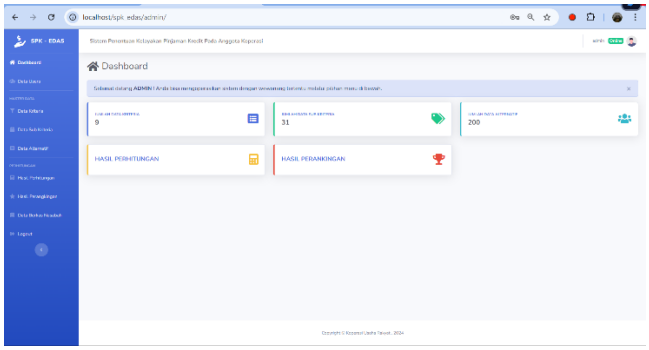


Figure 4. Dashboard Page (Admin)

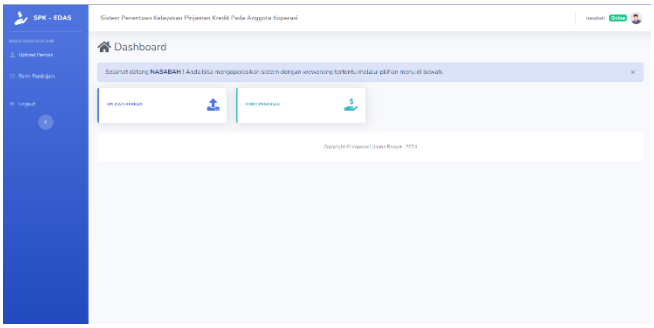


Figure 5. Dashboard Page (User)

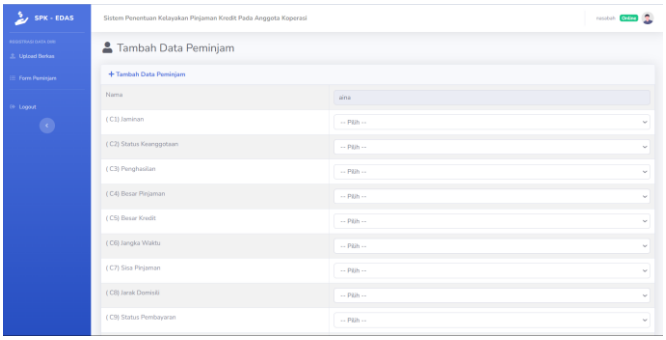
Since the system has 2 user levels, the Dashboard page features 2 displays: one for the admin and one for the user. Each display has different menus due to the different processing functions of the system for each user type

d. Calculation Process Page

Figure 6. Calculation Process Page

The following is the display of the EDAS method process in determining the feasibility of loans for cooperative members. The selected data consists of 200 entries that are labeled with the names of the alternatives or the names of each borrower in the cooperative.

e. ..



This page directs users to fill out a form containing criteria data that will be used to assess loan eligibility. Users will enter the required data in each field according to the information provided by the loan applicants/members/clients.

f. Feasibility Evaluation Results Page

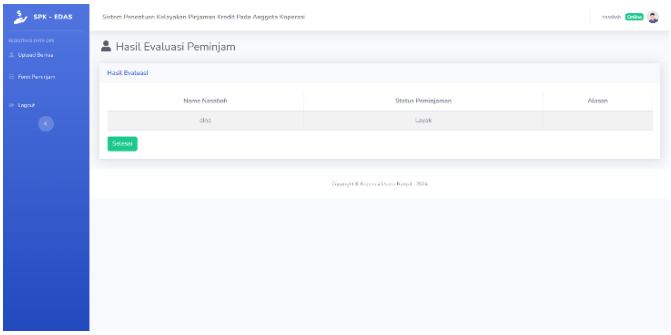


Figure 7. Eligible Evaluation Results

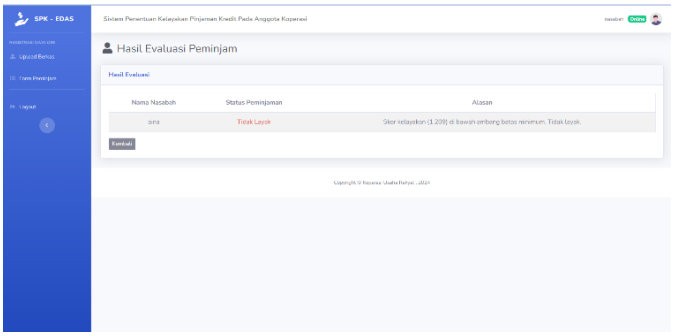


Figure 8. Ineligible Evaluation Results

The page above displays the results of the feasibility evaluation. After the loan applicants fill out the criteria upload form, the results indicating whether the applicant is eligible or not will appear. If eligible, they can automatically apply for a loan; if not, they can fill out the criteria form again.

g. Ranking Results

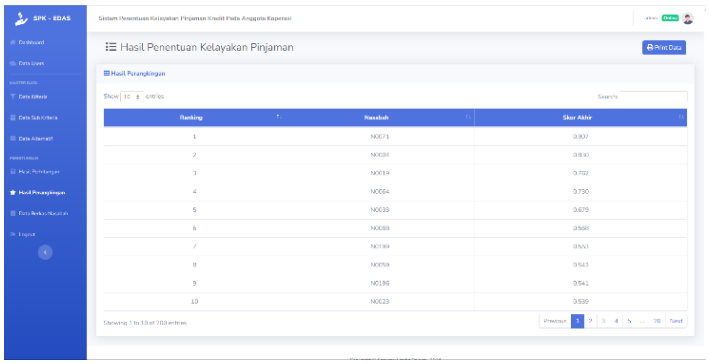


Figure 9. Ranking Results

From the results and discussion presented above, it can be concluded that Alternative N0071 is the best alternative with a final score (AS) of 0.907, followed by Alternative N0004 with a score of 0.830, and so on. Thus, from the ranking results, it can be seen which alternatives have the highest ranking and can be prioritized as eligible candidates for cooperative credit loan recipients.

CONCLUSIONS

The decision support system that has been developed successfully assists in the evaluation process of loan eligibility for cooperative members. This system enables a more objective and efficient evaluation by considering various relevant criteria in determining loan eligibility. Based on direct observations, the criteria that influence this research include collateral, membership status, loan amount, credit amount, loan term, remaining loan balance, distance from residence, and payment status. Thus, this system provides a useful tool for cooperatives to make more informed and fair decisions in granting credit loans to their members. From the data used, the calculation results conclude that Alternative N0071, with an AS score of 0.907, is the best alternative, followed by Alternative N0004 with an AS score of 0.830, and N0019 with an AS score of 0.762, and so on, allowing for recommendations on who should be prioritized as the most eligible loan credit recipients. The results of the system testing indicate that the loan eligibility calculations produced by the system are accurate and consistent with manual calculations, achieving a match of 95%. The EDAS method allows for a more accurate measurement of each alternative (in this case, loan credit applications) based on the distance from the average solution, both in terms of benefits and costs.

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