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DECISION SUPPORT SYSTEM FOR THE FEASIBILITY OF GIVING CUSTOMER CREDIT USING TOPSIS AND SAW METHODS (Case Study): SAVE LOAN COOPERATIVE CV. The Source of Prosperous Life

[1]MAHAPUTRA HIDAYAT, [2]MASNURUL, [3]AYU NUR

[1]Informatics Engineering Study Program, Faculty of Engineering

Bhayangkara University – Surabaya

ABSTRACT

Supporting System for Deciding the Feasibility of Providing Credit to Customers with Topsis Method and Simple Additive Weighting Method in CV. Sumber Hidup Prosperous, this research is motivated by the results of a customer who must meet the criteria determined by the cooperative to be able to get credit. In this case cooperatives are required to be able to make decisions quickly and carefully. To realize this it is necessary to have a decision support system (SPK) with the Topsis method and the Simple Additive Weighting method that can solve the problem of decision making with many criteria. The results obtained from this study are the application program of the Decision Support System for Providing Credit to the Customer with the Topsis Method and the Simple Additive Weighting Method in CV. The Source of Prosperous Life. The conclusions of the results of this study have shown a value that is accurate enough to help simplify the process of creditworthiness and report generation.

Keywords: *Decision Support System, Topsis Method and Simple Additive Weighting Method*

1. INTRODUCTION

A cooperative is a business organization that is owned and operated by a group of people for a common interest based on the principle of kinship and one of its activities is providing savings and loan services for its members. Cooperative is a financial institution that has many activities where one of them is serving credit activities. For the sake of smooth lending activities between the bank and the customer, the bank needs to assess and determine prospective customers first before making a decision to accept or reject credit requests. This is done considering the risk of uncollectible loans is quite large. So a customer must meet the criteria set by the bank to get credit.

To realize this, it is necessary to have a Decision Support System (DSS) that can help managers in making decisions, improve data processing, speed up the process and can improve the quality and service of the bank in providing credit.

2. THEORITICAL BASIC

2.1. TOPSIS Method

The TOPSIS method is one of the multi-criteria decision making methods that was first introduced by Yoon and Hwang in 1981. This method is one of the most widely used methods for completing practical decision making.

TOPSIS has the concept where the alternative chosen is the best alternative that has the shortest distance from the positive ideal solution and the farthest distance from the negative ideal solution. The more factors that must be considered in the decision making process, the more difficult it is to make decisions on a problem. Especially if the decision-making effort of a particular problem, besides considering various factors or various criteria, also involves several decision makers.

2.2. Steps to the TOPSIS Method

1. Make a normalized decision matrix.
   $$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}$$
2. $$y_{ij} = W_i r_{ij}$$
3. $$D_i^+ = \sqrt{\sum_{i=1}^{m} \left(y_i^+ - y_{ij}\right)^2}$$

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4. $D_i^- \sqrt{\sum_{i=1}^{m}(y_{ij} - y_i^-)^2}$
5. $v_i = \frac{D_i^-}{D_i^- + D_i^+}$

2.3. Simple Additive Weighting Method

The Simple Additive Weighting method is often also known as the weighted sum method. The basic concept of the SAW method is to find a weighted sum of the performance ratings for each alternative on all attributes.

The SAW method requires the decision matrix normalization process (X) to a scale that can be compared with all available alternative ratings. This method is the most famous and most widely used method in dealing with a Multiple Attribute Decision Making situation.

The SAW method requires the decision maker to determine the weight of each attribute. The total score for the alternative is obtained by adding up all the multiplication results between the rating (which can be compared across attributes) and the weight of each attribute. The rating of each attribute must be dimension free in the sense that it has passed the previous matrix normalization process.

2.4. Simple Additive Weighting completion steps

SAW Completion Steps as follows Determine the criteria that will be used as a reference in making decisions, namely Ci.

1. Determine the suitability rating of each alternative on each criterion.

2. Make a decision matrix based on criteria (Ci), then normalize the matrix based on an equation that is adjusted to the type of attribute (profit attribute or cost attribute) to obtain an normalized matrix R.

3. The final result is obtained from the ranking process, namely the sum of the multiplications of normalized matrix R with a weight vector so that the greatest value is chosen as the best alternative (Ai) as the solution. The formula for doing the normalization is:

$$\boldsymbol{r_{ij}} = \begin{cases} \frac{\boldsymbol{x_{ij}}}{\boldsymbol{max x_j}} \text{ if j is the attribute(bnefit)} \\ \frac{\boldsymbol{min_{xij}}}{\boldsymbol{x_{ij}}} \text{if j is the attribute (benefit)} \end{cases}$$

Where :

r = normalized performance rating

$\boldsymbol{Max_{ij}}$ = the maximum value of each row and column

$\boldsymbol{Min_{ij}}$ = minimum value of each row and column

$\boldsymbol{X_{ij}}$ **=** rows and columns of the matrix

Where **r** is the normalized performance rating of alternative A on the $\mathbf{C_j}$ attribute; i = 1,2, ... m and j = 1,2, ..., n.

A preference value for each alternative (V_i) is given as: $\boldsymbol{V_i} = \sum_{j=1}^{n} \boldsymbol{W_j r_{ij}}$

V_i = Final value of the alternative

W_j = Predetermined weight

r_{ij} = Matrix normalization

A greater Vi value indicates that Ai alternatives are chosen.

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3. DISCUSSION

This Final Project is entitled "Supporting Systems for Deciding the Feasibility of Providing Credit to Customers Using the Topsis Method and the Simple Additive Weighting (SAW) Case Study Case CV. Sumber Hidup Makmur, in general, is a system that aims to help decision makers choose various alternatives which are the results of processing information obtained or available using decision making models.

To do system planning analysts as implementation in carrying out the retrieval process decision on the eligibility of lending loans on customers use the Topsis method and the Method Simple Additive Weighting (SAW)

Calculation of the Topsis method
Step I Determine the criteria and weight values

Table 3.1 Code criteria

Criteria		Weight
C1	Guarantee	5
C2	Profession	4
C3	Income	3
C4	The number of dependents	2
C5	House Status	1

Table 3.2 Value data for each criterion

C1	
Certificate	3
Car	2
Motorcycle	1

C2	
Captain	6
Director	5
Pedagang	4
Army	3
Police	2
Civil Servants	1

C3	
25 Million	6
15 Million	5
12 Million	4
10 Million	3
8 Million	2
5 Million	1

C4	
Nobody	5
1 Kid	4
2 Kids	3
3 Kids	2
4 Kids	1

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C5	
Boarding House	4
Contract	3
Parent's House	2
Own Home	1

Table 3.3 Some data on credit application

Customer Name	Guarantee	Profession	Income	Number of Dependent Children	Status
Abdul Hadi	BPKB Avanza 2018	Captain	25.000.000	4 Kids	Contract
Abdul Rohman	Certificate	Captain	25.000.000	4 Kids	Boarding House
Abdulah	BPKB Karimun 2017	Army	10.000.000	Nobody	Boarding house
Achmad Dwi	Certificate	Army	10.000.000	1 Kid	Boarding house
Adam Sautin	BPKB APV 2017	Captain	25.000.000	Nobody	Boarding house

From the sample data above we fill in the table below in accordance with the data values or criteria weights for each alternative.

Table 3.4 Weighting of each criteria

Customers Name	Guarantee	Profession	Income	Number of Dependent	Status
Abdul Hadi	2	6	6	1	3
Abdul Rohman	3	6	6	1	4
Abdulah	2	3	3	5	4
Achmad Dwi	3	3	3	4	4
Adam Sautin	2	6	6	5	4

Step II Calculate the square of each criterion

Squares for Abdul Hadi :

Guarantee	= 2*2	= 4
Profession	= 6*6	= 36
Income	= 6*6	= 36
Number Of Dependents	= 1*1	= 1
Status	= 3*3	= 9

Squares for Abdul Rohman

Guarantee	= 3*3	= 9
Profession	= 6*6	= 36
Income	= 6*6	= 36
Number of Dependents	= 1*1	= 1

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Status	= 4*4	= 16
Squares for Abdulah		
Guarantee	= 2*2	= 4
Profession	= 3*3	= 9
Income	= 3*3	= 9
Number Of Dependents	= 5*5	= 25
Status	= 4*4	= 16
Squares for Ahmad Dwi		
Guarantee	= 3*3	= 9
Profession	= 3*3	= 9
Income	= 3*3	= 9
Number Of Dependents	= 4*4	= 16
Status	= 4*4	= 16
Squares for Adam Sautin		
Guarantee	= 2*2	= 4
Profession	= 6*6	= 36
Income	= 6*6	= 36
Number Of Dependents	= 5*5	= 25
Status	= 4*4	= 16

Step III Add up the squares of each criterion

Guarantee = 2*3*2*3*2 = 72
Profession = 6*6*3*3*6 = 1.944
Income = 6*6*3*3*6 = 1.944
Number Of Dependents = 1*1*5*4*5 = 100
Status = 3*4*4*4*4 = 768

Amount	72	1.944	1.944	100	768
Root	8.49	44.10	44.10	10	27.72

Step IV Calculate the normalization of each candidate for each of Abdul Hadi's criteria:

R11 = Initial value / square root (Guarantee)
= 2 / 8.49 = 0.24

R12 = Initial value / square root (Occupation)
= 6 / 44.10 = 0.136

R13 = Initial value / square root (Earnings)
= 6 / 44.10 = 0.136

R14 = Initial value / square root (Number of Dependents)
= 1/10 = 0.1

R15 = Initial value / square root (Status)
= 3/27.72 = 0.108

Step V Calculate the normalization of each candidate for each of Abdul Rohman Criteria:

R21 = Initial value / square root (Guarantee)
= 3 / 8.49 = 0.35

R22 = Initial value / square root (Occupation)
= 6 / 44.10 = 0.136

R23 = Initial value / square root (Earnings)
= 6 / 44.10 = 0.136

R24 = Initial value / square root (Number of Dependents)
= 1/10 = 0.1

R25 = Initial value / square root (Status)
= 4 / 27.72 = 0.144

Step VI Calculate the normalization of each candidate for each criterion Abdulah:

R31 = Initial value / square root (Guarantee)
= 2 / 8.49 = 0.24

R32 = Initial value / square root (Occupation)
= 3 / 44.10 = 14.7

R33 = Initial value / square root (Earnings)
= 3 / 44.10 = 14.7

R34 = Initial value / square root (Number of Dependents)
= 5/10 = 0.5

R35 = Initial value / square root (Status)
= 4 / 27.72 = 0.144

Step VII Calculate the normalization of each candidate for each criterion Achmad Dwi:

R41 = Initial value / square root (Guarantee)
= 3 / 8.49 = 0.24

R42 = Initial value / square root (Occupation)
= 3 / 44.10 = 14.7

R43 = Initial value / square root (Earnings)
= 3 / 44.10 = 14.7

R44 = Initial value / square root (Number of Dependents)
= 5/10 = 0.5

R45 = Initial value / square root (Status)
= 4 / 27.72 = 0.144

Step VIII Calculates the normalization of each candidate for each of Adam Sautin's criteria:

R51 = Initial value / square root (Guarantee)
= 2 / 8.49 = 0.24

R52 = Initial value / square root (Occupation)
= 6 / 44.10 = 0.14

R53 = Initial value / square root (Earnings)
= 6 / 44.10 = 0.14

R54 = Initial value / square root (Number of Dependents)
= 5/10 = 0.5

R55 = Initial value / square root (Status)
= 4 / 27.72 = 0.108

So that the normalized decision matrix table

0.24	0.136	0.136	0.1	0.108
0.35	0.136	0.136	0.1	0.144
0.24	14.7	14.7	0.5	0.144
0.24	14.7	14.7	0.5	0.144
0.24	0.14	0.14	0.5	0.108

Step IX Make the Normalized Weighted Matrix of Decisions
Formula: Yij = wi.rij

Abdul Hadi 11 = 2 * 0.24 = 0.48
Abdul Hadi 12 = 6 * 0.136 = 0.816
Abdul Hadi 13 = 6 * 0.136 = 0.816
Abdul Hadi 14 = 1 * 0.1 = 0.1
Abdul Hadi 15 = 3 * 0.108 = 0.324
Abdul Rohman 21 = 3 * 0.35 = 1.05
Abdul Rohman 22 = 6 * 0.136 = 0.816
Abdul Rohman 23 = 6 * 0.136 = 0.816
Abdul Rohman 24 = 1 * 0.1 = 0.1
Abdul Rohman 25 = 4 * 0.144 = 0.576
Abdullah 31 = 2 * 0.24 = 0.48
Abdullah 32 = 3 * 14.7 = 44.1
Abdullah 33 = 3 * 14.7 = 44.1
Abdullah 34 = 5 * 0.5 = 2.5
Abdullah 35 = 4 * 0.144 = 0.576
Ahmad Dwi 41 = 3 * 0.24 = 0.72
Ahmad Dwi 42 = 3 * 1.47 = 4.41
Ahmad Dwi 43 = 3 * 1.47 = 4.41
Ahmad Dwi 44 = 4 * 0.5 = 2
Ahmad Dwi 45 = 4 * 0.144 = 0.576
Adam Sautin 51 = 2 * 0.24 = 0.48
Adam Sautin 52 = 6 * 0.14 = 0.84
Adam Sautin 53 = 6 * 0.14 = 0.84
Adam Sautin 54 = 5 * 0.5 = 2.5
Adam Sautin 55 = 4 * 0.108 = 0.432

So the Normalized Decision Matrix is weighted

0.48	0.816	0.816	0.1	0.324
1.05	0.816	0.816	0.1	0.576
0.48	44.1	44.1	2.5	0.576
0.72	4.41	4.41	2.5	0.576
0.48	0.84	0.84	2.5	0.432

Step X Determine the positive ideal solution matrix and the negative ideal solution matrix

The closest value is 1, then it is chosen as a positive ideal solution while the value that is closest to 0, then as a negative ideal solution. The value is taken from the weighted normalized matrix, so that the positive ideal solution matrix and the negative ideal solution matrix are shown in the table

A+	1.05	44.1	44.1	2.5	0.576
A-	0.48	0.84	0.84	0.1	0.324

Step XI Determine the distance between the values of each alternative and the positive ideal solution matrix

$$D_i^+ = \sqrt{\sum_{i=1}^{m}(y_i^+ - y_{ij})^2}$$

Abdul Hadi = $((0{,}48-1.05)^2 + (0.816-44.1)^2 + (0.816-44.1)^2 + (0.1-2.5)^2 + (0.324-0.576)^2) = 0.6225$
Abdul Rahman = $((1.05-1.05)^2 + (0.816-44.1)^2 + (0.816-44.1)^2 + (0.1-2.5)^2 + (0.576-0576)^2) = 0.86568$
Abdullah = $((0{,}48-1.05)^2 + (44.1-44.1)^2 + (44.1-44.1)^2 + (2.5-2.5)^2 + (0.576-0.576)^2) = 0.9876$
Ahmad Dwi = $((0.72-1.05)^2 + (44.1-44.1)^2 + (44.1-44.1)^2 + (2.5-2.5)^2 + (0.576-0576)^2) = 0.5689$
Adam Sautin = $((0.48-1.05)^2 + (0.84-44.1)^2 + (0.84-44.1)^2 + (2.5-2.5)^2 + (0.432-0576)^2) = 0.9872$

Step XII Distance Ideal Negative Solution

$$D_i^- = \sqrt{\sum_{i=1}^{m}(y_{ij} - y_i^-)^2}$$

Abdul Hadi = $((0.48-0.48)^2 + (0.816-0.84)^2 + (0.816-0.84)^2 + (0.1-0.1)^2 + (0.324-0.576)^2) = 0.3246$

Abdul Rahman = $((1.05-0.48)^2 + (0.816-0.84)^2 + (0.816-44.1)^2 + (0.1-0.1)^2 + (0.576-0576)^2) = 0.9987$

Abdullah = $((0{,}48-0.48)^2 + (44.1-0.84)^2 + (44.1-0.1)^2 + (2.5-2.5)^2 + (0.576-0.576)^2) = 0.798$

Ahmad Dwi = $((0.72-0.48)^2 + (44.1-0.84)^2 + (44.1-0.48)^2 + (2.5-2.5)^2 + (0.576-0576)^2) = 0.778$

Adam Sautin = $((0.48-1.05)^2 + (0.84-44.1)^2 + (0.84-44.1)^2 + (2.5-2.5)^2 + (0.432-0.324)^2) = 0.5598$

Step XIII Determine the preference value for each alternative $v_i^+ = \frac{D^-}{D_i^- + D_i^+}$

Abdul Hadi = 0.3246 / 0.3246 + 0.6225 = 1.6225
Abdul Rohman = 0.9987 / 0.9987 + 0.86568 = 1.8656
Abdullah = 0.798 / 0.798 + 0.9876 = 1.9876
Ahmad Dwi = 0.778 / 0.778 + 0.5689 = 1.5689
Adam Sautin = 0.5598 / 0.5598 + 0.9872 = 1.9872

Based on the final value of the TOPSIS method process, the lecturer who gets a loan is Abdulullah.

Abdullah	1.9876
Adam Sautin	1.9872
Abdul Rohman	1.8656
Abdul Hadi	1.6225
Achmad Dwi	1.5689

Calculation of the SAW method
Step I Determine the criteria and weight values

Table 3.5 Code criteria

Criteria		Weight	
C1	Guarantee	5	0,35
C2	Profession	4	0,2
C3	Income	3	0,2

Table 3.6 Value data for each criterion

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Table 3.2 Value data for each criterion

C1	
Certificate	3
Car	2
Motorcycle	1

C2	
Captain	6
Director	5
Trader	4
Army	3
Police	2
Civil Servants	1

C3	
25 Million	6
15 Million	5
12 Million	4
10 Million	3
8 Million	2
5 Million	1

C4	
Tidak Ada	5
1 Anak	4
2 Anak	3
3 Anak	2
4 Anak	1

C5	
Boarding House	4
Contract	3
Parent's Hose	2
Own House	1

Table 3.7 Some data on loan submission

Customer Name	Guarantee	Profession	Income	Number Of Dependents	Status
Abdul Hadi	BPKB Avanza 2018	Captain	25.000.000	4 children	Contract
Abdul Rohman	Sertifikat	Captain	25.000.000	4 chikdren	Boarding House
Abdulah	BPKB Karimun 2017	Army	10.000.000	No Child	Boarding House
Achmad Dwi	Sertifikat	Army	10.000.000	1 child	Boarding House
Adam Sautin	BPKB APV 2017	Captain	25.000.000	No Child	Boarding House

Customer Name	Guarantee	Profession	Income	Number of Dependents	Status
Abdul Hadi	2	6	6	1	3
Abdul Rohman	3	6	6	1	4
Abdulah	2	3	3	5	4

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Achmad Dwi	3	3	3	4	4
Adam Sautin	2	6	6	5	4

From the sample data above we fill the table below in accordance with the data values or criteria weights for each alternative

Step II makes normalization of the X matrix from the data taken from the table above.

$$\begin{vmatrix} 2 & 6 & 6 & 1 & 3 \\ 3 & 6 & 6 & 1 & 4 \\ 2 & 3 & 3 & 5 & 4 \\ 3 & 3 & 3 & 4 & 4 \\ 2 & 6 & 6 & 5 & 4 \end{vmatrix}$$

Step III After that normalization X is made to normalization R, so as to obtain the normalization result of matrix R as follows:

$$\begin{vmatrix} 0{,}66666667 & 1 & 1 & 1 & 0{,}75 \\ 1 & 1 & 1 & 1 & 1 \\ 0{,}66666667 & 0{,}5 & 0{,}5 & 0{,}2 & 1 \\ 1 & 0{,}5 & 0{,}5 & 0{,}25 & 1 \\ 0{,}66666667 & 1 & 1 & 0{,}2 & 1 \end{vmatrix}$$

Step IV Next is made the matrix W * R multiplication and the sum.
The results obtained from the multiplication and the sum will get the best alternative. Here are the results of ranking:

Abdul Hadi = (0.66666667 * 0.35) + (1 * 0.35) + (0.66666667 * 0.35) + (1 * 0.35) + (0.66666667 * 0.35) = 1.4

Abdul Kohman = (1 * 0.2) + (1 * 0.2) + (0.5 * 0.2) + (0.5 * 0.2) + (1 * 0.2) = 0.8

Abdullah = (1 * 0.2) + (1 * 0.2) + (0.5 * 0.2) + (0.5 * 0.2) + (1 * 0.2) = 0.8

Achmad Dwi = (1 * 0.15) + (1 * 0.15) + (0.2 * 0.15) +

(0.25 * 0.15) + (0.2 * 0.15) = 0.3975

Adam Sautin = (0.75 * 0.1) + (1 * 0.1) + (1 * 0.1) + (1 * 0.1) + (1 * 0.1) = 0.55

The results of the above calculation the authors can conclude the results by ranking Vi value of the smallest largest value, so that Abdul Hadi received a loan

Abdul Hadi	1,4
Abdul Kohman	0,8
Abdullah	0,8
Adam Sautin	0,3975
Achmad Dwi	0,55

4. IMPLEMENTATION

In this section, the author will explain the workings of the application program that the author has designed, which is as follows:

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4.1. Interface Implementation Results

Implementation of the interface is the overall system display if the system is first run, then the user is asked to log in to enter a username and password. Then the user's data will be verified whether the data exists or not in the database. If the user data is valid, then the user will be switched to the main menu form and if not, then the user will be warned and the user will be asked to re-enter his username and password which will appear as shown below.

Figure 4.1 *Form Login*

4.2. Display Main Page Form

After logging in successfully, it will appear to the main page or also called the home page.

Figure 4.2 *Main Menu Home*

The Data Display Menu consists of:
a. Add Data functions to add customers.
b. Change customer data functions to change customer data.
c. Erase customer data functions to delete customer data
d. Search functions to make it easier to search customer data.
e. Show entire display the large amount of data that is desired.

4.3. Display Analyst Graph Results

Figure 5.4 is an implementation and shows the results of customer analyst graphs received by using 2 methods, namely the SAW method and the TOPSIS method.

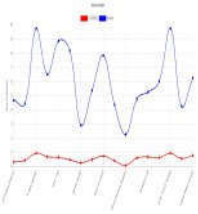

Figure 4.3 *Analyst Graphic Results*

4.4. Display Analyst Results

In Figure 5.3 is the implementation and show whether or not the customer analyst results are accepted using 2 methods, namely the SAW method and the TOPSIS method.

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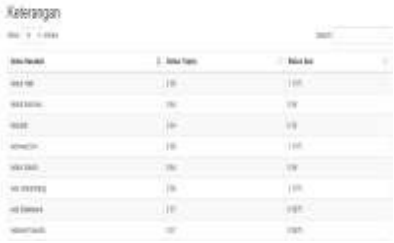

Figure 4.4 *Analyst Results*

5. CONCLUSION

From the research of the trial results of the Topsis method and the SAW method the number of customers received 250 in the Topsis method and the SAW Method as many as 70% of the total number of 175 people, the number of customers not received was 75 people.

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