

DECISION SUPPORT SYSTEM TO SELECT CANDIDATES FOR LOAN USING TOPSIS

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Abstract

Noticing the development of technology is developing rapidly increasing, companies need information systems that can support decision-making requirement. The existence of a bank's lending activities is certainly one advantage for the bank including also the customers. In need of credit ratings as a material consideration for the prospective customer before the bank decides to accept or reject the request of prospective customers, this is done given the risk of uncollectible big enough. To assist in determining a person's determination would be eligible for a loan then takes a decision support system. This study aims to design and build a Decision Support System for Selecting Candidates for Loan using TOPSIS method. The criteria used in determining the decision, among others, ability to repay, collateral value, duration and status of the house. The benefits of this application are to provide an alternative form of reference to the bank in determining the prospective customer who deserved the loan.

Keywords : Decision Support System, TOPSIS, Selection.

1. Introduction

Credit activity in a bank can give advantage for the customer and the bank itself. In the credit, a selection process is needed to determine the customers who will receive or not receive the loan. The customers who propose the loan are called loan candidates. This process should be done because of the risk of unpaid loan is high. If the bank give the loan carelessly and many customer can't pay the loan, the bank would collapse. PT Bank NTT is one of the banks that face this threat.

The process of selecting the loan candidates in PT Bank NTT is still done manually and sometimes the data is not valid due to human error. Another weakness of the conventional way is at least five whole days was needed to determine the feasibility of a customer to receive a loan. This situation happened because the calculation process for each criteria is done manually. According to the rule of the bank, to have a loan, a customer should fulfill several certain criteria. The calculation itself took longer time when the customers is increased in number. This research is held to answer the problem. PT Bank NTT needed a decision support system to select the loan candidates among customers.

One of the methods to implement the decision support system is TOPSIS (*Technique for Others Reference by Similarity to Ideal Solution*). TOPSIS is expected to search the best alternative based on the predefined criteria. TOPSIS is used in a decision support system to search the best loan candidates because of its ability to recommend loan candidates from several variables of customers. TOPSIS can compute the advantage and disadvantage for several criteria of customers to the decision maker. This research is done by searching the weighted value for each attributes or criteria, then a ranking process is done to determine the optimum alternative or the best loan candidate. In the calculation, TOPSIS used the priority addition of weighted value to adjust the importance of each defined criteria. The method approached

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systematically. It started from the system requirements gathering, and then it went into requirement analysis, application design, implementation, testing till the maintenance. UML (Unified Modelling Language) is also used to design the application. By using UML, the problems will be defined by graphical notation in order to improve the understanding for develop the application (Sommerville,1995).

2. Reference Study

2.1. Research Originality

TOPSIS is a multiple criteria method to identify solutions from a finite set of alternatives based upon simultaneous minimization of distance from an ideal point and maximization of distance from a nadir point. TOPSIS can incorporate relative weights of criterion importance. This paper reviews several applications of TOPSIS using different weighting schemes and different distance metrics, and compares results of different sets of weights applied to a previously used set of multiple criteria data. Comparison is also made against SMART and centroid weighting schemes. TOPSIS was not found to be more accurate, but was quite close in accuracy. Using First-order and second-order metrics were found to be quite good, but the infinite order (Tchebycheff norm, L-1) was found to decline in accuracy (Olson, 2004).

Josowidagdo in this research as a titled: Topsis Method as a Priority determinant Decision Alternative transportation programs. This article presents a model of passenger demand and its relation to supply a railways shuttle services. Five kriteria are used to rank alternatif executive cabin on the train, in which weight for each criteria developed using by the mean arrival rate and services rate the queuing system. The technique for order preference by similarity (TOPSIS) is then used to combine the approach that is applied to parahyangan train having routes from Bandung to Jakarta (Josowidagdo, 2003).

Alroaia and Khosravani in research titled of “Using Topsis Technique To Priority Of Investment In Stock Exchange (The Case Of Tehran Stock Exchange)”. In this paper we use TOPSIS method for solving Multiple Attribute Decision Making (MADM) problems with a finite number of solutions. Based on the defined model what we could find is that the Cement, Lime and Gypsum industry, and Kalsomine are placed the first priority. Similarly, it's recommended that microcredit programs increase their focus on building the entrepreneurial capital of TSE (Alroaia & Alroaia, 2011).

The technique for order preference by similarity to ideal solution (TOPSIS) is a technique that can consider any number of measures when seeking to identify solutions close to an ideal and far from a nadir solution. TOPSIS traditionally has been applied in multiple criteria decision analysis. In this article, we propose an approach to develop a TOPSIS classifier. We demonstrate its use in credit scoring, providing a way to deal with large sets of data using machine learning. Data sets often contain many potential explanatory variables, some preferably minimized, some preferably maximized. Results are favorable by a comparison with traditional data mining techniques of decision trees. Proposed models are validated using Mont Carlo simulation (Wu & Olson, 2006).

2.2. TOPSIS Method As A Decision Making Alternative

Decision maker made decision by approaching systematically to problems through data gathering into information process. The information is also added with important factors. Decision support system is a computer based system to recommend a decision by using certain data and model to solve unstructured problems. The purpose of this system is not to replace a manager, but to be a supporting tools for managers to take decisions (Suryadi, 2002).

TOPSIS method is based on a concept where a selected alternative is not only has the closest range from positive ideal solution, but also have the farthest range from negative ideal solution. TOPSIS is one of the methods called MADM (*Multiple Attribute Decision Making*) which is a part of MCDM (*Multi Criteria Decision Making*). TOPSIS consider both of the closest range from positive ideal solution and the farthest range from negative ideal solution by taking the relative proximity from the positive ideal solution. Based on the comparison of relative distance, the alternative priorities arrangement can be achieved. TOPSIS widely used to support the take of decisions practically because of the simple and easy to understand concept. Some other advantages is the efficient computation and the ability to measure relative performance from decision alternatives (Kusumadewi dkk., 2006).

These steps are to do the computation using TOPSIS[7]: 1) Create normalized decision matrix; 2) Create weighted normalized decision matrix by multiplying weight of w_i with the work rating r_{ij} which result as a matrix called y_{ij} ; 3) Determine positive ideal solution matrix (A^+) and negative ideal solution matrix (A^-) based on normalized weight rate y_{ij} ; 4) Determine the value range of alternatives by using positive ideal solution matrix (A^+) and negative ideal solution matrix (A^-); 5) Determine preference value for each alternative (V_i).

3. System Design

The system design of the application is made based on the prior requirements. Figure 1 shows a Use Case diagram which includes user and administrator activities in Decision Support System to Select Loan Candidates.

3.1. Use Case of System

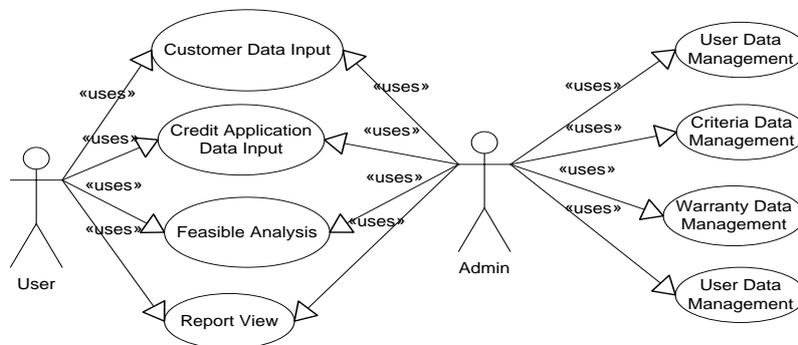


Figure 1. Use Case of System

As shown in Figure 1, user can do several things, such as: input customer's data, input loan application data, process credit feasibility analysis, and view report. On the other side, analysis of credit feasibility is used to analyze loan application whether they are feasible to receive a loan or not. View report has the function to view result data of credit analysis. Admin has privilege to compute by using TOPSIS. Administrator also can inputs criteria data, inputs warranty data, inputs weight value of decision and manages user data.

The implementation of TOPSIS needs some additional views in order to implements the method into the application. These views are value rating view, TOPSIS weight view, TOPSIS matrix view, maximum and minimum view, TOPSIS result view, and report view. According to the explanation before, the DSS Data Analysis Process will be computed so it will produce information that required by the administrator. On the other side, the report view function will display the result of selection. The result will take form as the arranged latest value into ranks

order by maximum value of each customer. The scoring technique of credit application is using four criteria. These criteria are the capability to repay, warranty value, time period, and house status. Each data will be given certain score according to credit application which customer propose for each criteria. The score given is starts from four as the very good score, then three that means good, two that means fair and one that means bad. Total score is the result of the value that has been taken from adding the result of multiplication of value weight and certain criteria score. Table 1 shows the total score of customer. The accepted customer should has score range from 2,0 until 4,0 and when score is less than 2,0 the customer is rejected.

Table 1.
Total Score of Customer

Range	Status
$\geq 2,0 - 4,0$	Accepted
$< 2,0$	Rejected

Theses steps is to score the credit criteria in order to get the total score:

a. Capability to Repay Scoring

In this scoring for the capability to repay, Bank will review the monthly income of the customer. The regulation of PT Bank NTT about the capability to repay is the monthly payment is less or equal to 75% customer's monthly income. i means interest rate. Interest rate is decided by PT Bank NTT is about 19%. The method to determine interest rate is annuity. This method arrange the amount of principal payment and the interest which should be paid, so that the payment is flat and similar every month. Based on it, so a customer whose payment more than 0.75 of his or her income will only get one point and rejected in the capability to repay scoring. However if the monthly payment is less than 0.25 of his or her income, the score will be four and greatly recommended to receive loan. The capability to repay scoring is shown in Table 2.

Table 2.
Capability to Repay Scoring

Num	Range	Score
1	$< 0,25$	4
2	$0,25 - 0,50$	3
3	$0,50 - 0,75$	2
4	$> 0,75$	1

b. Warranty Value Scoring

The minimum condition in warranty value scoring is 5,0 from warranty value and i is the interest rate. Liquidity value is a value which is determined by a bank to determine the amount of loan that can be given to a customer. Liquidity that has been determined by PT Bank NTT is 80%. Based on the formulation that bank has made, if the warranty value is more than 5,0 of loan value then it only has one point and will be rejected. Otherwise, if the warranty value is less than 1,8 of loan value, the score is four and recommended to get the loan. Table 3 shows the range and score of warranty value.

Tabel 3.

Warranty Value Scoring

Num	Range	Score
1	< 1,8	4
2	1,8 – 3,4	3
3	3,4 – 5,0	2
4	> 5,0	1

c. Time Period Scoring

The longer time period of the loan, the score given is higher. Table 4 shows the scoring for time period that proposed by customer. 36 month will get four points, 24 month will get three points, 12 months will get two points and 6 months will get only one point.

Table 4.

Time Period Scoring

Num	Period	Score
1	36 month	4
2	24 month	3
3	12 month	2
4	6 month	1

d. House Status Scoring

The scoring for the house status is the orientation about the ownership status of customer's house when he or she propose a loan. If the house is owned by the customer, then the score is four. If the house is a company's official house, then the score is three. If the house is still in credit, so the score is two, and other status will only get one point. Table 5 shows the house status scoring.

Table 5.

House Status Scoring

Num	Criterion	Score
1	Self-Owned	4
2	Company	3
3	Credit	2
4	Other	1

4. Implementation and System Testing

The testing is done by using two methods, they are manual testing and system testing to make sure the system that has been built is run according to the TOPSIS method procedures. If the manual testing and the system testing shows the similar results, then the system succeeded to use TOPSIS method to select customers who feasible to get credit. System testing uses customer's data who propose credit application PT Bank NTT that were gotten from credit department. Manual testing is done with the equality formula of TOPSIS method. Suppose the customer's data that will be selected can be seen in Table 6.

Table 6.
Credit Applicants

Name	Proposed Loan	Time Period	Income	Warranty	House Status
Corry	10.000.000	36	1.800.000	40.000.000	Parents
Achmad	30.000.000	36	2.750.000	60.000.000	Self-Owned
Farra	15.000.000	24	4.000.000	14.000.000	Self-Owned
Mat B	14.000.000	24	2.250.000	16.000.000	Self-Owned
Eduard	25.000.000	36	4.500.000	23.000.000	Self-Owned

Based on data of Table 6, the TOPSIS formula is implemented to be a recommendation in order to select the customer who is feasible to get a loan. To determine the feasible customer, the calculation of each criteria should be done, they are capability to repay scoring, warranty value scoring, time period scoring and house status period. As an example, we'll calculate data of a customer named Corry to get score for capability to repay. The steps are:

- Calculate the monthly principal payment

$$\text{Principal payment} = \frac{10.000.0}{36} = 277.777,8$$

- Calculate the interest

$$\text{Interest} = 10.000.000,00 \times 19\% \times (30/360) = 158.333,3$$

- Calculate monthly payment

$$\text{Monthly Payment} = 277.777,8 + 158.333,3 = 436.111,1$$

- Calculate the capability to repay

$$\text{Capability to repay} = \frac{436.1}{1.800.0} = 0.243$$

Based on the calculation result about the capability to repay of the customer named Corry, the result shows that the value of payment is 0,243 that means four points for capability to repay scoring. This points is based on Table 2. The calculation is done to each customer who apply loan until all of the capability to repay result is calculated. The next step is to get the warranty value of customer. The steps are:

- Calculate total loan,

$$\text{Total loan} = 10.000.000,00 \times 19\% \times 24 = 68.400.000,00$$

- Calculate Warranty Value

$$\text{Warranty Value} = 40.000.000,00 \times 80\% = 32.000.000,00$$

- Calculate Value

$$\text{Value Range} = \frac{68.400.0}{32.000.0} = 2.138$$

Based on the calculation about warranty value for the customer named Corry, the result is 2,138. It means the score is three based on Table 3. The calculation is done to each customer who apply loan until all of the warranty value result is calculated. Next is time period scoring. Based on table 4, the result of time period scoring for each customer is shown in Table 6.

Table 6.
Example of Time Period Scoring

Alternative	Time Period	Score
Corry	36 month	4
Achmad	36 month	4
Farra	24 month	3
Mat B	24 month	3
Eduard	36 month	4

Finally, the house status scoring is calculated. Based on table 5, the result of house status scoring for each customer is shown in Table 7.

Table 7.
Example of House Status Scoring

Alternative	House Status	Score
Corry	Parent-owned	1
Achmad	Self-owned	4
Farra	Self-owned	4
Mat B	Self-owned	4
Eduard	Self-owned	4

The next phase after all criteria result is calculated is make the match rate for each alternative (customer) on each criterion as shown in Table 8.

Table 8.
Match Rate for Each Alternative in Each Criterion

Alternative	Criterion			
	C ₁	C ₂	C ₃	C ₄
Corry	4	3	4	1
Achmad	3	2	4	4
Farra	4	1	3	4
Mat B	3	2	3	4
Eduard	4	1	4	4

C₁ is for capability to repay, C₂ is for warranty value, C₃ is for time period and C₄ is for house status. After getting the match rate for each alternative in each criterion, the next phase is determine the decision weight to each criteria. The decision weight given can be seen in Table 9.

Tabel 9.
Decision Weight

Criterion	Decision Weight
Capability to Repay	Very Good
Warranty Value	Good
Time Period	Good
House Status	Fair

Based on Table 9, the decision weight can be written as: $W = 4$ (very good), 3 (good), 3 (good), 2 (fair). Next, a calculation is done by using TOPSIS method like following steps:

1. Create normalized decision matrix:

$$|x_1| = \sqrt{4^2 + 3^2 + 4^2 + 3^2} = 8.124038405$$

$$r_{11} = \frac{4}{8.12403} = 0.492365964, \text{ etc.}$$

Normalized Matrix R obtained:

$$R = \begin{bmatrix} 0.492365964 & 0.688247202 & 0.492365964 & 0.124034 \\ 0.369274473 & 0.458831468 & 0.492365964 & 0.496138 \\ 0.492365964 & 0.229415734 & 0.369274473 & 0.496138 \\ 0.369274473 & 0.458831468 & 0.369274473 & 0.496138 \\ 0.492365964 & 0.229415734 & 0.492365964 & 0.496138 \end{bmatrix}$$

2. Create weighted and normalized decision matrix (matrix Y):

$$y_{11} = w_1 r_{11} = (4) (0.492365) = 1.969463856$$

$$y_{12} = w_2 r_{12} = (3) (0.688247) = 2.064741605$$

Matrix Y obtained:

$$Y = \begin{bmatrix} 1.969463856 & 2.064741605 & 1.477097892 & 0.248069 \\ 1.477097892 & 1.376494403 & 1.477097892 & 0.992277 \\ 1.969463856 & 0.688247202 & 1.107823419 & 0.992277 \\ 1.477097892 & 1.376494403 & 1.107823419 & 0.992277 \\ 1.969463856 & 0.688247202 & 1.477097892 & 0.992277 \end{bmatrix}$$

3. Determine positive ideal solution matrix (A^+) and negative ideal solution (A^-) based on weighted and normalized rate y_{ij} .

Calculate positive ideal solution (A^+):

$$y_1^+ = \max \{1.969463856; 1.477097892; 1.969463856; 1.477097892; 1.969463856\} \\ = 1.969463856, \text{ etc.}$$

Based on the calculation, the results is:

$$A^+ = \{1.969463856; 2.064741605; 1.477097892; 0.992277877\}$$

Calculate negative ideal solution (A^-):

$$y_1^- = \min \{1.969463856; 1.477097892; 1.969463856; 1.477097892; 1.969463856\} \\ = 1.477097892, \text{ etc.}$$

Based on the calculation, the results is:

$$A^- = \{1.477097892; 0.688247202; 1.107823419; 0.248069469\}$$

4. Determine the value range of alternatives by using positive ideal solution matrix (A^+) and negative ideal solution matrix (A^-).

Range between weighted value of each alternative from positive ideal solution:

$$D_1^+ = \sqrt{(1.969463856 - 1.969463856)^2 + (2.064741605 - 2.064741605)^2 + (1.477097892 - 1.477097892)^2 + (0.248069469 - 0.992277877)^2}$$

$$= 0.744208408, \text{ etc.}$$

Range between weighted value of each alternative from negative ideal solution:

$$D_1^- = \sqrt{(1.969463856 - 1.477097892)^2 + (2.064741605 - 0.688247202)^2 + (1.477097892 - 1.107823419)^2 + (0.248069469 - 0.248069469)^2}$$

$$= 1.507821183, \text{ etc.}$$

5. Determine preference value for each alternative (V_i).

Calculate the vicinity of each alternative from ideal solution:

$$V_1 = \frac{1.507821183}{0.744208408 + 1.50782} = 0.669538797, \text{ etc.....}$$

Based on the calculation result, the maximum value is V_1 and the minimum value is V_3 , in other words, customer named Corry is in the top rank, and customer named Farra is in the fifth rank. Ranked calculation result can be seen in Table 10.

Table 10.
TOPSIS Calculation Result Rank

Rank	Name	Preference Value
1	Corry	0.669538797
2	Achmad	0.560415243
3	Mat B	0.523329676
4	Eduard	0.412313132
5	Farra	0.385043053

System Testing is done by selecting the customer that can be seen on Table 6 using DSS application that had been built in the research. One of the most important processes in the application is customer's credit application data input. Data will be used as the source of computation by using TOPSIS method. After the computation is done, the result will be shown as can be seen in Figure 2. The preference value result in Figure 2 is similar to the value result in Table 10, so it can be concluded that the calculation in the system is well done.

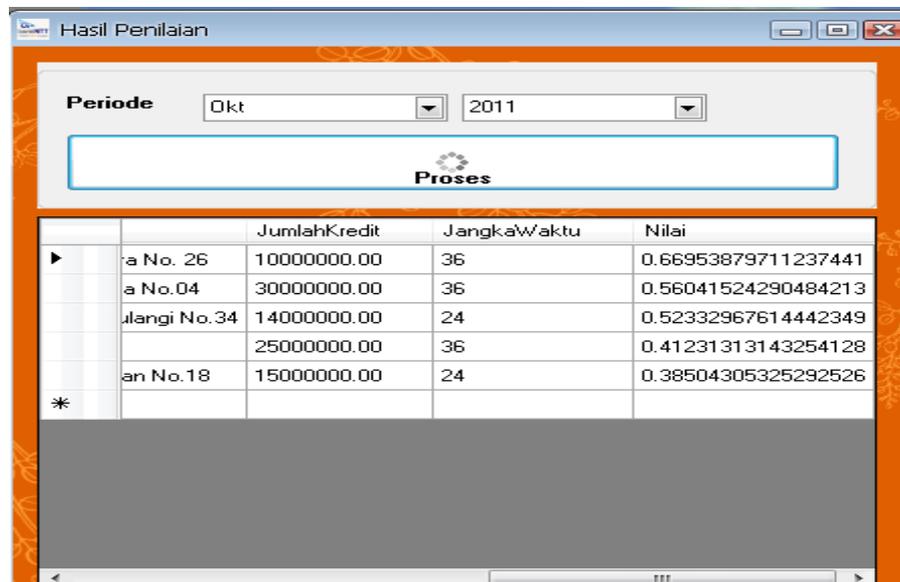


Figure 2. Scoring Result

5. Conclusion

Based on research and discussion that has been done about DSS application to select candidates for loan using TOPSIS in PT Bank NTT, some conclusion can be taken. First, DSS application needs criteria to determine the feasibility of customer who apply a loan. Second, the result of each criterion scoring become the base input to the next step of TOPSIS in creating

normalized matrix. Third, TOPSIS method can be used to select the best alternative or the best customer to be given a loan by ranking the customer according to the data. Finally, the manual and system testing produce the similar result to prove that the method can be computerized well.

6. References

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