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Application of the AHP-TOPSIS Method

to Determine The Feasibility of Fund Loans

*Penerapan Metode AHP TOPSIS Untuk*

*Menentukan Kelayakan Pinjaman Dana*

Juniar Hutagalung

System Information, STMIK Triguna Dharma

Jl. Pintu Air I/Jend. AH. Nasution No. 73 Medan Johor

[juniarhutagalung77@gmail.com](mailto:juniarhutagalung77@gmail.com)

**Abstract** – This study aims to produce a decision support system (SPK) the feasibility of lending funds as a tool and recommendations for cooperatives with several criteria being the basis for decision making, namely: business ownership status, ability, character, collateral, income, and salary. Implementation of the system uses the Visual Studio 2010 and Microsoft Access 2010 programming languages ​​as a database so that it can provide convenience in making decisions, real and objective assessments so that the results are effective and efficient through the use of two methods, namely AHP to determine the weighting of the criteria and the TOPSIS method in determining to rank The results of the pairwise comparison matrix calculation, the value of CR = 0.03 which indicates that the weight obtained is acceptable and consistent. The combination of AHP and TOPSIS is designed to have precise and fast accuracy and successful implementation as a recommendation for cooperative leaders in making decisions determining the feasibility of applying for a loan of funds. In applications that are designed to produce alternative customer data in sequence starting from the highest preference value 0.7525 (very feasible to get a loan of funds) to the lowest of 0.2704 (not feasible). The results obtained can be accounted for.

**Keywords:** AHP*, Cooperative,* DSS, Loans, TOPSIS

***Abstrak*** *– Penelitian ini bertujuan untuk menghasilkan sistem pendukung keputusan (SPK) kelayakan pemberian pinjaman dana sebagai alat bantu dan rekomendasi bagi pihak koperasi dengan beberapa kriteria menjadi dasar pengambilan keputusan, yaitu : status kepemilikan usaha, kemampuan, karakter, agunan, penghasilan, dan gaji. Implementasi sistem menggunakan bahasa pemrograman Visual Studio 2010 dan Microsoft Access 2010 sebagai database sehingga dapat memberikan kemudahan dalam mengambil keputusan, penilaian yang real dan objektif agar hasilnya efektif dan efesien melalui pemanfaatan dua metode yaitu AHP untuk penentuan bobot dari kriteria-kriteria dan metode TOPSIS dalam penentuan perangkingan. Hasil perhitungan matriks perbandingan berpasangan, nilai CR = 0,03 yang menunjukkan bahwa bobot yang diperoleh dapat diterima dan konsisten. Pengkombinasian AHP dan TOPSIS dirancang agar memiliki akurasi yang tepat dan cepat serta implementasinya sukses sebagai rekomendasi bagi pihak pimpinan koperasi dalam mengambil keputusan menentukan kelayakan pengajuan pinjaman dana. Pada aplikasi yang dirancang menghasilkan data alternatif nasabah secara terurut mulai dari nilai preferensi yang paling tinggi 0,7525 (sangat layak mendapatkan pinjaman dana) hingga terendah 0,2704 (tidak layak). Hasil yang diperoleh dapat dipertanggungjawabkan.*

***Kata Kunci:*** AHP, Koperasi, DSS, Pinjaman, TOPSIS

**INTRODUCTION**

Savings and loan cooperatives are a type of cooperatives in Indonesia that have activities, in essence, providing services in terms of savings and loan funds in the form of money for members of the cooperative as well as the community. XYZ cooperatives is a type of active savings and loan cooperative, which utilizes member savings and then distributes to members/customers again in the form of loans to set up a business or in meeting the cost of living of its customers. Loan types are based on short, medium and long term repayments. However, this often experiences risks and obstacles, including arrears and late payments, and not making advance payments for various reasons from customers. Therefore, cooperatives need a policy in granting loans by setting standards to accept or reject these risks, namely by determining which loans are appropriate according to the criteria needed, including business ownership status, ability to repay loans, customer character, collateral, customer's income, and salary.

Based on the background, that the XYZ cooperatives in the process of selecting proper customers and getting loans is still inaccurate so that it requires computer-based applications and appropriate methods to select several criteria in determining whether or not customers are eligible for loans. Cooperative leaders need a computer-based application and methods that are more precise, accurate, fast and relevant for the customer data collection process to be more directed. The cooperative leader as the decision-maker must have an effective and efficient decision support system to decide whether or not the customer is given a loan within the time frame and conditions provided by the cooperative.

In this study, researchers designed and built a decision support system for lending at the XYZ cooperatives by combining the Analytic Hierarchy Process (AHP) method and Technique For Others Reference by Similarity to Ideal Solution (TOPSIS), which is expected to help in the selection of members/customers which is more appropriate and feasible for receiving loans from the cooperative. The lending needs to take into account the risks that will occur to members because it affects the financial condition of the cooperative as well. For this reason, a computer-based decision support system is needed that can produce output in the form of information quickly related to lending criteria, whether or not a member receives a loan. The existence of a decision support system can provide information based on analysis so that it is more efficient in decision making in an organization (Budiharjo, Agus & A. Muhammad, 2017).

The combination of AHP and TOPSIS is an appropriate method as a recommendation in the selection of free channels to improve the QOS of Radio Networks (Jayakumar L. & Janakiraman S, 2019). The AHP method is more effective for the selection of railroad technical facilities at PT. KAI Diver I Medan (Fifin, 2017). Several combinations of decision support apply the AHP and TOPSIS methods, Combining the AHP-TOPSIS method, it can be concluded that the method used has succeeded in realizing energy cost savings and can be used as recommendations for making decisions precisely, effectively and efficiently (Dhiaa, Haider, Yaarob & Tamer, 2019). To make it easier to determine policies and strategies for the right solution to reverse logistical barriers, a decision support system is implemented by combining the AHP and TOPSIS methods. AHP for determining criteria weights and TOPSIS are used for alternative ranking stages, so that decisions taken are more effective and efficient (Pornwasin & Tossapol, 2018).

The AHP-TOPSIS method to determine the priority of road improvement, the level of accuracy obtained is not too high due to the implementation of road improvement there are still personal interests in it so that it is not well-targeted in handling road repair (Firdaus, Muhammad & Nurudin, 2018). To produce a more objective ranking and appropriate recommendations for selecting the best prospective employees the AHP-TOPSIS method was applied (Putu & I. Putu, (2019). The AHP-TOPSIS method of accuracy in filling the pairwise comparison matrix will give more accurate results for the recommendation of PC package selection (Bhima, Rekyan. & Nurul, 2018). The describes a decision support system functions to help a manager in terms of decision making in a structured and half-structure so that it is right on target to apply analytical models and existing data (Ahmadi, Sarjon & Jufriadif, 2018). The determination of beneficiaries of the Family of Hope Program uses the AHP and TOPSIS methods with twelve criteria being compared to find the weight values ​​for each of these criteria. System Usability Scale (SUS) test results in this study obtained an average of 82.5 which indicates that this system belongs to the acceptable category (Hasanah, 2016).

The purpose of this study as an alternative is to assist the cooperative in determining the decision to choose a suitable customer to get a loan/credit following the criteria. Conduct an assessment of each criterion for the selection of members/customers who are eligible and make decision support to get members/customers who meet the criteria quickly and accurately.

**RESEARCH METHODOLOGY**

**A. Decision Support System (DSS)**

AHP and GIS are a combination of appropriate methods to determine data spatially and can evaluate coal deposits as an alternative power generation solution that is widely applied to increase the economic potential of mineral reserves and evaluate coal deposits because many factors affect the energy sector. The AHP method determines the weights of each criterion while the ArcGIS application is used to map and evaluate the sustainable exploitation of mineral deposits in the framework and other geospatial data (Nikolas, *et al,* 2019). PYTOPS is a Python-based tool used in the TOPSIS method to determine the best solution from a set of alternatives with certain attributes. The best alternative is chosen based on its Euclidean distance from the ideal solution. Decision support systems using the TOPSIS method are used to solve multi-attribute problems including supply chain logistics, marketing management, environmental management or chemical engineering (Vnay, *et al*, 2019).

A comprehensive and innovative evaluation method is used to analyze the static voltage stability in the electric power system by utilizing EW-AHP and Fuzzy-TOPSIS. Fuzzy-TOPSIS is used to determine the bus voltage rating of the power system as the final result, taking into account the system's functionality and proportionality. The combination of these two methods is an effective approach to determine the weakest buses in the electric power system (Jiahui. Wu, *et al*, 2019). The decision support system is a process or action to achieve one goal or several goals (Christine & Yeremia, 2018). The decision support system is an interactive that can present information, modeling, and manipulation of data that is useful to facilitate decision-makers in making the right decision in semi-structured and unstructured situations (Frieyadie & Surya, 2018). The decision support system can solve unstructured problems by choosing several alternatives and no one knows for sure how the decision is taken but it produces output in the form of flexible, interactive and adaptive information (Oktopanda, 2017).

**B. Analytic Hierarchy Process (AHP)**

The AHP method is used in decision making to deconstruct the complexity site planning and resource management and evaluates the value as a policy recommendation for use and rebuilding because it is a valuable source of human cultural heritage (Hang, Shanting & Chan, 2018). AHP makes it easy to solve complex problems by arranging criteria in a hierarchical manner, so we can determine the weight or priority (Tri, Erly & Bayu, 2019). AHP and FAHP methods are used as recommendations and make it easy for companies to make decisions to solve multi-critical problems, to reduce the risk of loss for bus body manufacturing companies because many parts must be produced in a short time. Risks can occur when different companies work together to make the same product and share profits. With the application of the AHP and FAHP methods, the results are more appropriate because it can increase productivity and reduce the effect of capacity, time and cost of capacity to make parts of a bus body (Suthep & Puntiva, 2019).

The results of the validation test conducted by the AHP method obtained the final value: 3.8 and concluded the system is feasible to be used to improve teacher performance (Sindhu, 2018). The decision support system research to select priority areas for intervention in family planning activities was built based on the website using the AHP-SMART method (Karmila, Tursina & Muhammad, 2019). E-commerce businesses using AHP need to consider websites and trademarks. The investment factor in the brand is the most important thing for forming a trademark (Tayfun, 2017). AHP method is a method for making decisions by deciding without trial and before finding a solution to the existing constraints then systematically arrange the way it works (Eko, 2016).

Below are some AHP principles that must be understood, namely (Muhammad. *et al,* 2018):

1. Decomposition (create a hierarchy)

A complete and complicated system is easy to understand if it has been broken down into the smallest parts.

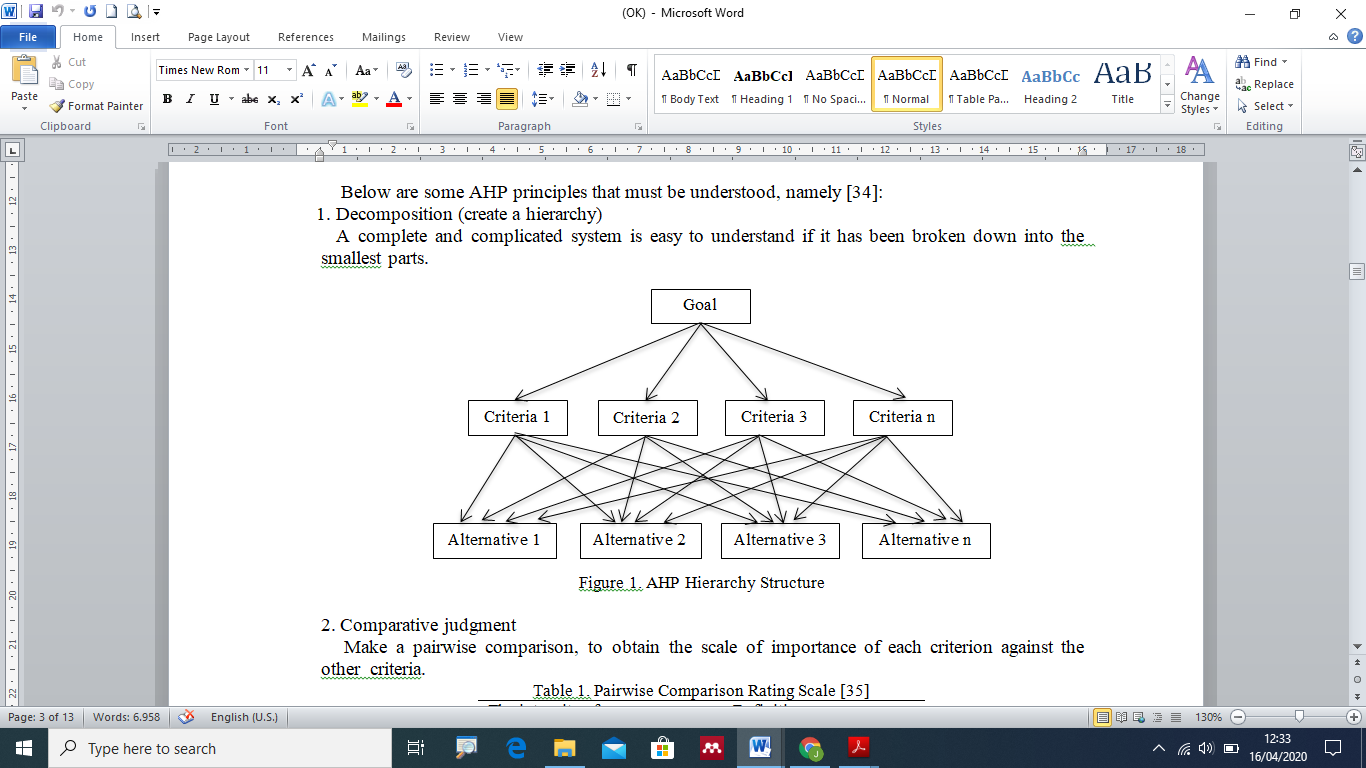


Figure 1. AHP Hierarchy Structure

2. Comparative judgment

Make a pairwise comparison, to obtain the scale of importance of each criterion against the other criteria.

Table 1. Pairwise Comparison Rating Scale

|  |  |
| --- | --- |
| The intensity of  interest | Definition |
| 1  3  5  7  9  2, 4, 6, 8  Inverse | Both elements are equally important  Elements that one a little more important than the other elements  Elements which one is more important than any other element  One element absolutely clearly more important than any other element  One absolutely essential element than other elements  Values between two values adjacent  consideration  If the first activity in the appeal activities got the numbers j, then j has its inverse value Compared with i |

3. Synthesis of priority

4. Logical Consistency

The steps for implementing the AHP method are as follows:

1. Define the problem and determine the solution, then arrange the hierarchy.

2. Determination of element priority.

a. Determine the pair ratio.

b. Make a pairwise comparison matrix.

3. Synthesis, things are done at this stage are:

a. In the matrix add up the values ​​for each column.

b. The value of the column is divided by the total column to produce a normalized matrix, the formula:

........................... (1)

Where:

a = Pairwise comparison matrix

i = matrix row a

j = matrix column a

c. The value of each row is added up and divided by the number of elements to get the average value, the formula:

...................... (2)

Where:

n = Number of criteria

Wi = Average of line I

4. Measuring Consistency, the steps are:

a. The value in the first column and the relative priority of the first element are multiplied, and so on.

b. Each row is added together.

c. From the sum of the rows, the results are

divided among the relative priority elements concerned.

d. The result of the division in point (c) is summed by the number of elements, the result is called lambda (λ) max.

5. Determine the Consistency Index (CI), the formula:

.......... (3)

6. Calculating Consistency Ratio (CR), the formula:

................................. (4)

7. Check the consistency of the hierarchy. If the value is > 10%, then it needs to be improved, if the Consistency Ratio <0.1 then the calculation results are correct.

The value of 0 ≤ ratios ≤ 0.1 is called consistent then the calculation is justified. Below can be used the random index table as follows.

Table 2. Random Index Values ​​(RI)

|  |  |
| --- | --- |
| n | RI |
| 1 | 0 |
| 2 | 0 |
| 3 | 0.58 |
| 4 | 0.90 |
| 5 | 1.12 |
| 6 | 1.24 |
| 7 | 1.32 |
| 8 | 1.41 |
| 9 | 1.45 |
| 10 | 1.49 |
| 11 | 1.51 |
| 12 | 1.48 |
| 13 | 1.56 |
| 14 | 1.57 |
| 15 | 1.59 |

**C. Technique Others Preference by Similarity to Ideal Solution (TOPSIS).**

One of the multi-criteria decision support systems is the TOPSIS method (Dicky Nofriansyah, 2014). The TOPSIS method is an optimization technique used to identify the best combination of parameters optimally for multi-response characteristics and Analysis of Variance (ANOVA) is used to determine the most significant parameters in the overall Multi-object function and it can be concluded that the laser power is very large on the overall Multi-object function (Sampreet, *et al*, 2019). High energy use and severe levels of air pollution caused by winter warming have worsened in China in recent years. The policy of replacing coal-fired boilers with gas fuel for central heating is very important for development in China. To overcome this, the TOPSIS method is used as a recommendation for the government to make the right decisions in improving environmental quality through

energy savings and reducing emissions (Jing, Yaoqi & Xiaojuan, 2019).

The decision making the process by using TOPSIS if the factors that are taken into consideration are relatively many, it is relatively difficult in decision making (Al Amin, Ahmad & Osavari, 2017). The decision support system developed using the TOPSIS Method can assist in making decisions in determining the best employees. Based on calculations using the TOPSIS method, it was found that V5 (Employee 5) was the best employee because it had the best value (Hylenarti, 2018). The application of the TOPSIS method is designed to solve measurable problems for the financial feasibility decision support systems so that they are more objective in the assessment results taken (Ade, Himam, Yudi & Salman, 2019). The system produced using the TOPSIS method can recommend the selection of priority areas of stunting treatment experienced by toddlers from the largest preference value to the smallest preference value (Mahmud, Tursina & Yulianti, 2019).

In general, the TOPSIS method procedure follows steps (Dwi & Rostika, 2017):

1. Determine the normalized decision matrix.
2. Calculate the weighted normalized decision matrix.
3. Calculate the ideal and negative ideal solution matrices.
4. Calculate the distance between the values ​​of each alternative with the positive and negative ideal solution matrices.
5. Calculate the preference value for each alternative.

The systematic steps of the TOPSIS method are as follows (Munawir, 2018) :

a. Starting to make a decision matrix that is evaluating alternative m in a decision matrix X based on n criteria, used with the following equation:

..... (5)

b. Determine a normalized decision matrix, it can be used with the following equation:

;

1

2







*m*

*i*

*ij*

*ij*

*ij*

*x*

*x*

*r*

..................... (6)

c. Determine the weighted normalized decision matrix, used with the following equation:

............................... (7)

d. Determine the ideal (A +) and negative (A-) ideal solution matrices, used with the following equation:

) ................ (8)

............. (9)

Where:

maxi yij ; if j atribut benefit

mini yij ; if j atribut cost

mini yij ; if j atribut benefit

maxi yij ; if j atribut cost

e. Calculate the distance of the positive (D +) and negative (D-) ideal solutions.

D + is the alternative distance from the positive ideal solution, used with the following equation:

....... (10)

D- is the alternative distance from the negative ideal solution, used with the following equation:

.... (11)

f. Calculation of preference values ​​(Vi) for each alternative. used with the following equation:

........................... (12)

g. Ranking alternatives by sorting alternatives from the largest Vi value to the smallest value. The best solution if the alternative is the best Vi value.

The focus of this research is to build SPK to determine the feasibility of applying for a loan using the AHP-TOPSIS method to speed up the process and produce an optimal decision value. The research framework begins with identifying problems. Identification of the problem with determining priority weights does not yet exist on the criteria selected to rank to determine the feasibility of submitting a loan then collecting data. The data used in this study are primary data through the process of observation and the relevant sources directly and secondary obtained from the theory or related material under study. The technique used to collect data is done by a literature study, interviews who know the criteria and observations.

The perform analysis criteria and implementation of AHP-TOPSIS to obtain an alternative ranking. AHP method is used for the weighting process then the application of the TOPSIS method is carried out to perform an alternative ranking process. The design of the use case diagram is shown in Figure 2.

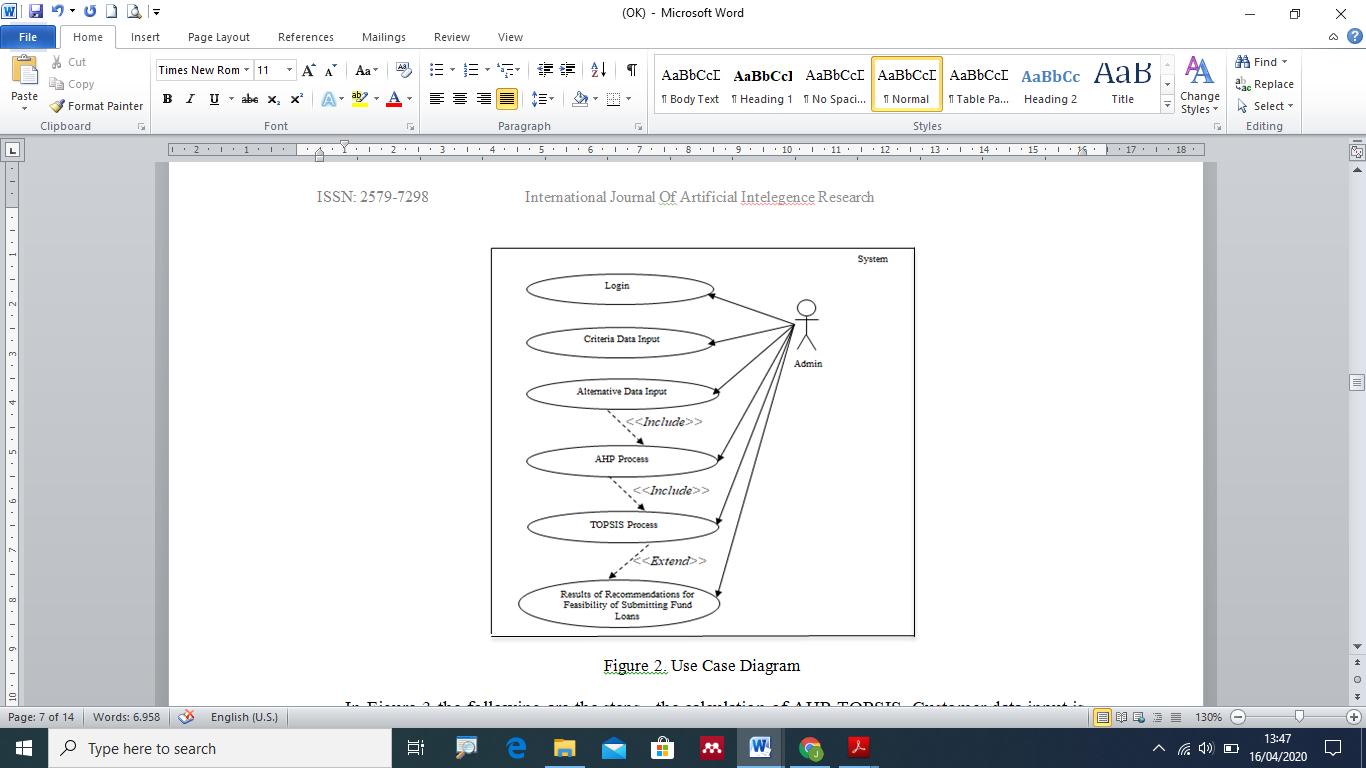


Figure 2. Use Case Diagram

In Figure 3 the following are the steps - the calculation of AHP-TOPSIS. Customer data input is performed as a determinant in the normalized matrix. Furthermore, weights are obtained to determine the ideal and negative ideal solution matrix. From the distance between the values ​​of the solution matrix, the preferences can be determined for each alternative and then ranking. The best solution is an alternative with the largest Vi value.

End

Customer data input

Matrix

normalization

Calculate the matrix

normalized weighted

Calculating positive and negative ideal solutions

Calculate distance

between alternatives

Calculating preferences

every alternative

Alternate ranking

Input from customer master data and data entry

The priority weight of the AHP algorithm

Calculation results are used for

feasibility assessment

Implementation

TOPSIS algorithm

Alternative results with the largest Vi value are the best solutions

Start

Figure 3. AHP-TOPSIS Algorithm Flowchart

**RESULT AND DISCUSSION**

**3.1. Calculation Analysis of AHP Method**

In this study, the determination of the criteria weights utilizes the AHP method, while for the ranking stage is done using the TOPSIS method. The criteria in determining the eligibility of applying for a loan can be seen in table 3. Business Ownership Status (C1), Capability (C2), Character (C3), Collateral (C4), Income (C5), and Salary (C6).

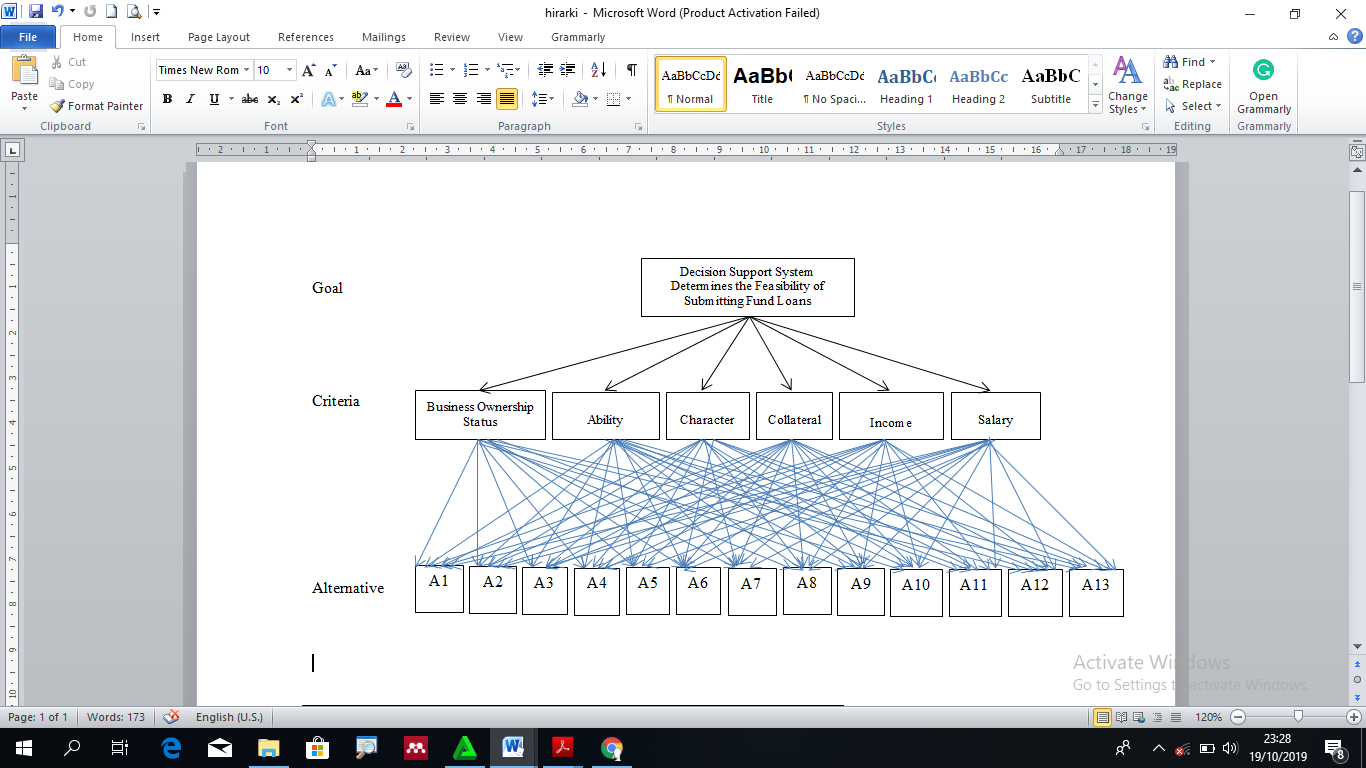


Figure 4. Hierarchical Structure for Applying for a Loan

After determining the criteria, then the value or weight of each criterion is made for each alternative, the next step is to conduct an analysis of the system being made, the results or system output is information about the value of alternative customers that are feasible or not to get a loan and the criteria they have to serve as recommendations for cooperatives so that they can easily and quickly make decisions for customers who are eligible for loans.

Table 3. Pairwise Comparison Matrix

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Criteria | C1 | C2 | C3 | C4 | C5 | C6 |
| C1  C2  C3  C4  C5  C6 | 1  2  1/3  1/4  1/5  1/5 | 1/2  1  1/3  1/3  1/3  1/3 | 3  3  1  1/2  1/3  1/3 | 4  3  2  1  1/2  1/1 | 5  3  3  2  1  2 | 5  3  3  1  1/2  1 |

The number data contained in table 4 is obtained from table 1 which is a comparison scale table of criteria values. Table 6 is the decimal value of the numeric data in table 3.

Table 4. Calculation Results in Decimal Form

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Criteria | C1 | C2 | C3 | C4 | C5 | C6 |
| C1  C2  C3  C4  C5  C6 | 1  2  0.33  0.25  0.20  0.20 | 0.50  1  0.33  0.33  0.33  0.33 | 3  3  1  0.50  0.33  0.33 | 4  3  2  1  0.50  1 | 5  3  3  2  1  2 | 5  3  3  1  0.50  1 |
| Total | 3.98 | 2.83 | 8.17 | 11.50 | 16.00 | 13.50 |

After the number of columns is determined, the next step of the numbers in table 6 is divided by the number of columns, resulting in a normalized matrix. In column C1, divide row C1 by the number of columns C1 = 1 / 3.98 = 0.25

And so on until C6, the results are in table 5.

Table 5. Normalized Pairwise Comparison Matrices

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Criteria | C1 | C2 | C3 | C4 | C5 | C6 |
| C1  C2  C3  C4  C5  C6 | 0.25  0.50  0.08  0.06  0.05  0.05 | 0.18  0.35  0.12  0.12  0.12  0.12 | 0.37  0.37  0.12  0.06  0.04  0.04 | 0.35  0.26  0.17  0.09  0.04  0.09 | 0.31  0.19  0.19  0.13  0.06  0.13 | 0.37  0.22  0.22  0.07  0.04  0.07 |
| Total | 1 | 1 | 1 | 1 | 1 | 1 |

Next look for the priority weight scale, through the calculation of the average row in table 5, for example the following calculation: C1 = (0.25 + 0.18 + 0.37 + 0.35 + 0.31 + 0.37) / 6 = 0.30

Calculations are carried out until C6, so we get the priority table in table 6 below.

Table 6. Priority Weight Scale

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crite  ria | | C1 | | C2 | C3 | C4 | | C5 | | | C6 | No. Rows | Priority | |
| C1  C2  C3  C4  C5  C6 | 0.25  0.50  0.08  0.06  0.05  0.05 | | 0.18  0.35  0.12  0.12  0.12  0.12 | | 0.37  0.37  0.12  0.06  0.04  0.04 | | 0.35  0.26  0.17  0.09  0.04  0.09 | | 0.31  0.19  0.19  0.13  0.06  0.13 | 0.37  0.22  0.22  0.07  0.04  0.07 | | 1.83  1.89  0.91  0.53  0.35  0.49 | 0.30  0.32  0.15  0.09  0.06  0.08 |
| Total | | 1 | | 1 | 1 | 1 | | 1 | | | 1 | 6 | 1 | |

The consistency matrix is ​​shown in table 7, examples of calculations are as follows:

C1 = (1 \* 0.30) + (0.50 \* 0.32) + (3 \* 0.15) + (4 \* 0.09) + (5 \* 0.06) + (5 \* 0.08) = 1, 97.

The calculation is done until C6, so we get the consistency matrix table in table 7 below.

Table 7. Consistency Matrix

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Criteria | | C1 | | C2 | C3 | C4 | | C5 | | C6 | Priority | Product | |
| C1  C2  C3  C4  C5  C6 | 1  2  0.33  0.25  0.20  0.20 | | 0.50  1  0.33  0.33  0.33  0.33 | | 3  3  1  0.50  0.33  0.33 | | 4  3  2  1  0.50  1 | | 5  3  3  2  1  2 | 5  3  3  1  0.50  1 | 0.30  0.32  0.15  0.09  0.06  0.08 | 1.97  1.91  0.96  0.54  0.36  0.50 |

Next, determine the consistency of the vector. This is done by dividing the number of consistency matrices in Table 7 with the weighted values ​​obtained, namely table 6. For example 1.97 / 0.30 = 6.57, so the vector consistency is as follows:

Table 8. Vector Consistency

|  |  |  |  |
| --- | --- | --- | --- |
| Criteria | Vector Priority | Product | Vector Consistency |
| C1  C2  C3  C4  C5  C6 | 0.30  0.32  0.15  0.09  0.06  0.08 | 1.97  1.91  0.96  0.54  0.36  0.50 | 6.57  5.97  6.40  6.00  6.00  6.25 |
| Total |  |  | 37.19 |

Principle of Consistency:

From table 10 we can calculate the value of lambda (λ) max, CI and CR with the formula in equations (1), (2), and (3) whose results are:

1. λ max = Number of Vector Consistency / Number of Criteria

λ max = 37.19 / 6 = 6.20

2. CI = (λmax-n) / (n-1)

= (6.20-6) / (6-1) = 0.04

3. CR = CI / IR (Random Index Table)

= 0.04 / 1.24 = **0.03**

Because the CR value <0.1, the results are concluded to be consistent and acceptable. From the AHP calculation above we get the results from the value of preference weights (W) or criteria weights. Where the value of the number of rows for each element is divided by the number of matrix sizes.

Table 9. Weighting Matrix of All Normalized Criteria

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Criteria | C1 | C2 | C3 | C4 | | | C5 | C6 | | No. Rows | | Weight Value | |
| C1  C2  C3  C4  C5  C6 | 0.25  0.50  0.08  0.06  0.05  0.05 | 0.18  0.35  0.12  0.12  0.12  0.12 | 0.37  0.37  0.12  0.06  0.04  0.04 | | 0.35  0.26  0.17  0.09  0.04  0.09 | 0.31  0.19  0.19  0.13  0.06  0.13 | | | 0.37  0.22  0.22  0.07  0.04  0.07 | 1.83  1.89  0.91  0.53  0.35  0.49 | 0.30  0.32  0.15  0.09  0.06  0.08 | |
| Total | 1 | 1 | 1 | 1 | | | 1 | 1 | | 6 | | 1 | |

**3.2. Calculation Analysis of TOPSIS Method**

Analysis of calculations with the SPK TOPSIS method is a calculation analysis to find the value of the solution then obtained alternative ranking. The role of the TOPSIS method is to determine alternative ranking. In the TOPSIS method, the weighted importance of the values ​​that become criteria is the result of the Eigen (priority) obtained from the weight calculation in the AHP method. Following is a weight table of the criteria along with the cost/benefit value:

Table 10. Cost and Benefits Matrix and Determination

|  |  |  |
| --- | --- | --- |
| Criteria | Weight (w) | Cost/Benefit |
| C1  C2  C3  C4  C5  C6 | 0.30  0.32  0.15  0.09  0.06  0.08 | Benefit  Benefit  Benefit  Benefit  Benefit  Benefit |

The determination of the ranking of matches for each alternative and each criterion from 1 to 5 is shown in table 11 below:

Table 11. Match Value Ranking for Each Alternative

and Every criterion

|  |  |
| --- | --- |
| Value | Description |
| 1  2  3  4  5 | Very Inadequate  Not feasible  Decent enough  Worthy  Very decent |

Next make a decision matrix, seen in table 12.

Table 12. Value weighting interests of each Prospective Customer

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Criteria | | | | | | |
| Alternative | C1 | C2 | C3 | C4 | C5 | | C6 |
| Customer 1  Customer 2  Customer 3  Customer 4  Customer 5  Customer 6  Customer 7  Customer 8  Customer 9  Customer 10  Customer 11  Customer 12  Customer 13 | 5  4  2  5  4  5  3  2  5  4  4  3  1 | 3  4  2  4  1  2  3  5  2  4  2  3  5 | 4  5  1  4  5  3  4  1  4  2  4  3  5 | 2  2  4  1  4  4  2  4  5  3  3  4  4 | | 4  3  3  3  5  4  4  3  2  4  2  3  1 | 5  2  3  2  4  3  5  5  4  1  5  4  1 | |

Next create a normalized decision matrix R to reduce the data interval, so that the implementation of the TOPSIS method is easy and saves memory use. Calculations using alternative values ​​of one criterion divided by the square root of the sum of each alternative per criterion.

Table 13. Normalized Decision Matrix

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Alternative |  | | | | | |
| C1 | C2 | C3 | C4 | C5 | C6 |
| Customer 1  Customer 2  Customer 3  Customer 4  Customer 5  Customer 6  Customer 7  Customer 8  Customer 9  Customer 10  Customer 11  Customer 12  Customer 13 | 0.36  0.29  0.14  0.36  0.29  0.36  0.21  0.14  0.36  0.29  0.29  0.21  0.07 | 0.25  0.33  0.16  0.33  0.08  0.16  0.25  0.41  0.16  0.33  0.16  0.25  0.41 | 0.29  0.37  0.07  0.29  0.37  0.22  0.29  0.07  0.29  0.14  0.29  0.22  0.37 | 0.16  0.16  0.32  0.08  0.32  0.32  0.16  0.32  0.40  0.24  0.24  0.32  0.32 | 0.33  0.25  0.25  0.25  0.41  0.33  0.33  0.25  0.16  0.33  0.16  0.25  0.08 | 0.37  0.15  0.22  0.15  0.30  0.22  0.37  0.37  0.30  0.07  0.37  0.30  0.07 |

Next determine the normalized decision matrix weighted Y, with the formula:

Vij = WJ \* rij

The results of the normalized decision matrix calculation are weighted in the following table 14.

Table 14. Weighted Normalized Decision Matrix

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Alternative |  | | | | | |
| C1 | C2 | C3 | C4 | C5 | C6 |
| Customer 1  Customer 2  Customer 3  Customer 4  Customer 5  Customer 6  Customer 7  Customer 8  Customer 9  Customer 10  Customer 11  Customer 12  Customer 13 | 0.11  0.09  0.04  0.11  0.09  0.11  0.06  0.04  0.11  0.09  0.09  0.06  0.02 | 0.08  0.11  0.05  0.11  0.03  0.05  0.08  0.13  0.05  0.11  0.05  0.08  0.13 | 0.04  0.06  0.01  0.04  0.06  0.03  0.04  0.01  0.04  0.02  0.04  0.03  0.06 | 0.01  0.01  0.03  0.01  0.03  0.03  0.01  0.03  0.04  0.02  0.02  0.03  0.03 | 0.02  0.02  0.02  0.02  0.02  0.02  0.02  0.02  0.01  0.02  0.01  0.02  0.01 | 0.03  0.01  0.02  0.01  0.02  0.02  0.03  0.03  0.02  0.01  0.03  0.02  0.01 |

Next determine the value of positive and negative ideal solutions, based on equations 8 and 9.

Table 15. Results of the Positive (A +) and Negative (A -) Solution

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | | | | | |
| Alternative | | C1 | C2 | C3 | C4 | C5 | C6 |
| Customer 1  Customer 2  Customer 3  Customer 4  Customer 5  Customer 6  Customer 7  Customer 8  Customer 9  Customer 10  Customer 11  Customer 12  Customer 13 | | 0.11  0.09  0.04  0.11  0.09  0.11  0.06  0.04  0.11  0.09  0.09  0.06  0.02 | 0.08  0.11  0.05  0.11  0.03  0.05  0.08  0.13  0.05  0.11  0.05  0.08  0.13 | 0.04  0.06  0.01  0.04  0.06  0.03  0.04  0.01  0.04  0.02  0.04  0.03  0.06 | 0.01  0.01  0.03  0.01  0.03  0.03  0.01  0.03  0.04  0.02  0.02  0.03  0.03 | 0.02  0.02  0.02  0.02  0.02  0.02  0.02  0.02  0.01  0.02  0.01  0.02  0.01 | 0.03  0.01  0.02  0.01  0.02  0.02  0.03  0.03  0.02  0.01  0.03  0.02  0.01 |
| (A+) | | 0.11 | 0.13 | 0.06 | 0.04 | 0.02 | 0.03 |
| (A-) | | 0.02 | 0.03 | 0.01 | 0.01 | 0.01 | 0,01 |

To get the values ​​in table 16 calculated using equations 10 and 11.

Table 16. Results Distance between weighted values ​​of each alternative to the ideal positive solution (D +) and

Negative (D -)

|  |  |  |  |
| --- | --- | --- | --- |
| D+ | | D- | |
| Customer 1 (D1+)  Customer 2 (D2+)  Customer 3 (D3+)  Customer 4 (D4+)  Customer 5 (D5+)  Customer 6 (D6+)  Customer 7 (D7+)  Customer 8 (D8+)  Customer 9 (D9+)  Customer 10 (D10+)  Customer 11 (D11+)  Customer 12 (D12+) Customer 13 (D13+) | 0.0574  0.0447  0.1144  0.0447  0.1081  0.0842  0.0728  0.0806  0.0824  0.0556  0.0860  0.0728  0.0927 | Customer 1 (D1-)  Customer 2 (D2-)  Customer 3 (D3-)  Customer 4 (D4-)  Customer 5 (D5-)  Customer 6 (D6-)  Customer 7 (D7-)  Customer 8 (D8-)  Customer 9 (D9-)  Customer 10 (D10-)  Customer 11 (D11-)  Customer 12 (D12-) Customer 13 (D13-) | 0.1118  0.1140  0.0424  0.1232  0.3287  0.0979  0.0818  0.1126  0.1024  0.1063  0.0830  0.0781  0.1166 |

Next, determine the value of the proximity of each alternative to the ideal solution using equation 12.

Table 17. Ranking of TOPSIS decisions

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Alternative | Score | | | Information | |
| Customer 5 (V5+)  Customer 4 (V4+)  Customer 2 (V2+)  Customer 1 (V1+)  Customer 10 (V10+)  Customer 8 (V8+)  Customer 13 (V13+)  Customer 9 (V9+)  Customer 6 (V6+)  Customer 7 (V7+)  Customer 12 (V12+)  Customer 11 (V11+)  Customer 3 (V3+) | | 0.7525  0.7338  0.7183  0.6608  0.6566  0.5828  0.5571  0.5541  0.5376  0.5291  0.5176  0.4911  0.2704 | Very decent  Very decent  Very decent Worthy  Worthy  Not feasible  Not feasible  Not feasible  Not feasible  Not feasible  Not feasible  Not feasible  Not feasible | |

Table 18. Feasibility Value Measurement Tables

|  |  |
| --- | --- |
| Appropriateness | Information |
| >= 0.7000 | Very decent |
| 0.6000-0.6999 | Worthy |
| <= 0.5999 | Not feasible |

**CONCLUSION**

This research was created to assist the cooperative leadership in determining the feasibility of applying for a loan of funds, where measurements are not only taken from customer data but are taken and considered from many factors. Resolution of these problems using two methods for determining the eligibility of customers who apply for loans, namely the AHP method to determine the weight value that will be used to determine the initial input in the TOPSIS method and use the TOPSIS method for ranking alternatives so that they are able to make decisions more effectively, efficiently and right as a recommendation for the cooperative.

The combination of the AHP-TOPSIS method was successfully applied to the SPK determining whether or not the customer made a loan application and could be applied by examining various objects but must theoretically understand the AHP and TOPSIS method algorithms. From the calculation of the pairwise comparison matrix, the value of CR = 0.03 shows that the weight obtained is acceptable and consistent, with the criteria: business ownership status, ability to repay loans, character, collateral, income, and customer salary. The ranking results use the TOPSIS method after being sorted where the highest value is Customer 5 = 0.7525 (Very Eligible to get a loan of funds) and the lowest value is Customer 3 = 0.2704 (Not Eligible).

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