

## **Implementation of DSS for the Selection of MSME Financing Based on Financial Performance and Growth Potential**

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**Abstract** - Many businesses have difficulty choosing a funding scheme that suits their financial condition and their company's growth potential. The Analytical Hierarchy Process (AHP) method and the Order of Preference by Similarity to Ideal Solution (TOPSIS) technique are combined to create the right Decision Support System (DSS). This research collected data through surveys and interviews with experts in 30 relevant agency-assisted MSMEs, but the data that will be displayed in this journal are as many as 5 MSME data that we have selected. Then, using AHP to determine how important financial criteria and business prospects are, and using the TOPSIS method to compare alternative financing such as people's business loans, fintech loans, and venture capital. Research outputs include a prototype of a system that can generate scientific publications, policy inputs, and objective financing advice for financial institutions. It is hoped that with this DSS, the financing selection process will be more measurable and accurate, and will support the sustainable growth of MSMEs. This result shows that the Analytical Hierarchy Process (AHP) method is able to produce a consistent criterion weight with a Consistency Ratio (CR) value of  $< 0.1$ , where business duration (0.22) and income (0.17) are the most dominant factors in assessing the feasibility of MSME financing. Furthermore, the TOPSIS method was used to produce an objective MSME ranking, with Krh Kreasikus Production obtaining the highest preference value ( $C_i = 0.6911$ ) and Nainay Salted Egg Producer obtaining the lowest value ( $C_i = 0.2259$ ), demonstrating the ability of this method in distinguishing at-risk MSMEs and MSMEs with better growth potential. Overall, the AHP-TOPSIS-based Decision Support System model has proven to be effective in helping financial institutions evaluate MSMEs in a more systematic, transparent, and data-based manner compared to conventional methods.

**Keywords:** AHP; DSS; Financing; MSMEs; TOPSIS.

### **1. Introduction**

Small and medium enterprises (SMEs) play a crucial role in driving Indonesia's economic growth. Data collected by the Ministry of Cooperatives and SMEs indicates that this sector absorbs approximately 97% of the national workforce and contributes more than 60% to the Gross Domestic Product (GDP) (Abdurrahman et al., 2020). Ensuring the sustainability of small and medium enterprises has therefore become a key priority in the national economic development strategy. However, empirical evidence shows that accessing formal financing remains a significant challenge (Pratiwi et al., 2024). Many SMEs struggle to meet standard banking requirements, such as providing collateral, preparing reliable financial statements, and complying with the financial ratios set by lending institutions (Pratiwi et al., 2024), (OECD, 2021).

Factors such as financial ratios, business risk levels, and growth potential are often overlooked in the decision-making process by MSMEs, leading to the selection of suboptimal financing schemes or even rejection of loan applications by financial institutions.

The emergence of fintech lending, venture capital, financial sector innovations, and supportive government policies has expanded financing options for SMEs (Keshavarz-Ghorabae, 2023). Nonetheless, challenges persist in selecting the most appropriate financing scheme. Misallocation of funds may occur due to evaluation methods that rely heavily on manual assessments or subjective judgments (Suryawan & Devi, 2023). On the other hand, SME owners often lack sufficient financial literacy, which limits their ability to understand the costs and risks associated with each financing option (Ridho & Listiana, 2024).

Decision Support Systems (DSS), based on multi-criteria decision-making methods, offer a more systematic approach to addressing these issues (Ren et al., 2007), (Hermansyah et al., 2025). The Analytical Hierarchy Process (AHP) and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) are widely used in various domains, including creditworthiness assessment, supply chain management, and supplier selection (Hermansyah et al., 2025), (Sipayung, 2025).

This study examines the application of an integrated AHP–TOPSIS model for evaluating financing alternatives for local SMEs (Keshavarz-Ghorabae, 2023), (Roy & Shaw, 2021). The selected criteria are designed to capture dimensions of financial performance and business growth potential. Furthermore, this study demonstrates the implementation of the system in the form of a web-based application that enables financial institutions and SMEs to interactively obtain financing recommendations.

## 2. Research Methods

The descriptive analytical quantitative method is employed to systematically describe phenomena and measure the relationships among variables (Keshavarz-Ghorabae, 2023), (Palmieri & Ferilli, 2024). This method was selected because it enables the integration of quantitative data, such as SME financial ratio values, with multi-criteria decision-making models (AHP–TOPSIS). In this study, the researcher used 30 original data from the Cirebon City DKUKMPP Office and used 5 test data displayed for this study, the data obtained has been validated by experts at the Cirebon City DKUKMPP Office as many as 3 validators.

### 2.1. Decision Support System (DSS)

A Decision Support System (DSS) is defined as a computer-based system designed to assist decision-makers in addressing semi-structured and unstructured problems (Ren et al., 2007), (Sipayung, 2025). The characteristics of DSS include flexibility, interactivity, and the ability to integrate data and models to generate recommendations. In the context of SME financing, DSS enhances the accuracy of evaluations by providing data-driven analyses that are more consistent than intuition alone (Ridho & Listiana, 2024).

### 2.2. Analytical Hierarchy Process (AHP)

The Analytical Hierarchy Process (AHP), developed by Saaty (Ren et al., 2007), is used to solve decision-making problems involving multiple criteria. AHP structures a problem into a hierarchy consisting of the main goal, criteria, subcriteria, and alternatives (Khotimah et al., 2024). Pairwise comparison is the core step used to determine the relative importance of each criterion (Ren et al., 2007). The principal eigenvector is employed to calculate weights, with a required consistency ratio (CR) of less than 0.1.

According to Forman and Gass (Subiyantoro et al., 2022), AHP excels because it is capable of capturing subjective expert judgments and converting them into consistent numerical values. AHP has been applied in various domains, including credit risk assessment (Fitriani et al., 2023), business location selection (Febriyanti et al., 2023), and strategic planning for SMEs (Abadi et al., 2023).

$$w_j = \frac{\lambda_{\max} - n}{n - 1} \quad (1)$$

### 2.3. Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

TOPSIS is a Multi-Criteria Decision Making (MCDM) method introduced by Hwang and Yoon (Hermansyah et al., 2025), which evaluates alternatives based on their distance from the positive ideal solution ( $A^+$ ) and the negative ideal solution ( $A^-$ ). The best alternative is the one closest to  $A^+$  and farthest from  $A^-$  (Hermansyah et al., 2025), (Sunariani et al., 2017). TOPSIS is widely applied in various areas, including organizational performance assessment (Jha & Kumar Mittal, 2024), supplier selection (Zuhroh et al., 2025), and investment risk evaluation (Wijaya et al., 2025). Its conceptual simplicity, interpretability of results, and flexibility across diverse data types contribute to its widespread use (Abu et al., 2025).

### 2.4. Integration of AHP and TOPSIS

To combine the strengths of both methods, AHP and TOPSIS are integrated. In the ranking process, TOPSIS uses the criterion weights produced by AHP (Sipayung, 2025), (Widianingsih, 2020). A study by Abdullah and Handayani (Muhammad Ikhsan & Muhammad Hasan, 2020) found that this hybrid method enhances decision accuracy in SME financing assessments. Similarly, Lee and Park (Roy & Shaw, 2021) demonstrated that AHP–TOPSIS integration improves the efficiency of AI-based decision support systems in evaluating the creditworthiness of small enterprises.

### 2.5. SME Financing and Challenges in Accessing Capital

Although SMEs play a critical role in national economic growth, they face multiple barriers in accessing capital (Abdurrahman et al., 2020), (Pratiwi et al., 2024). According to Beck and Demirgüç-Kunt (Purnama et al., 2018), these barriers include collateral constraints, high interest rates, and the lack of recorded credit histories.

Financing options available to SMEs include Kredit Usaha Rakyat (KUR), fintech-based lending (Juwita et al., 2022), and venture capital. Research by Nugroho and Santoso (Keshavarz-Ghorabae, 2023) highlights the need for an evaluation mechanism that assesses eligibility based on cash flow, growth potential, and profitability.

Furthermore, sustainability-based financing has become increasingly important, especially in supporting green SMEs, as noted by Zhang and Wang (Ridho & Listiana, 2024).

## 2.6. Data Sources

A survey involving 30 SMEs registered under the Office of Cooperatives, SMEs, Trade, and Industry of Cirebon City, as well as interviews with experts in banking and fintech, was used to collect primary data (OECD, 2021), (Suryawan & Devi, 2023). A Likert-scale questionnaire was employed to assess six key financing criteria: accessibility, profitability, cash flow, debt ratio, growth potential, and business risk (OECD, 2021). Secondary data were obtained from SME financial reports, government policy documents, and studies on the Analytical Hierarchy Process (AHP) and TOPSIS methods (Ren et al., 2007), (Hermansyah et al., 2025), (Hu et al., 2025).

## 2.7. Research Stages

Identification of criteria and alternatives: Based on SME financing literature (OECD, 2021), (Ridho & Listiana, 2024) and expert input, six main criteria and four SME financing alternatives were selected. Determination of criteria weights using AHP: A pairwise comparison matrix was completed by three financial experts. Answer consistency was evaluated using the Consistency Ratio (CR) (Ren et al., 2007), (Khotimah et al., 2024). Normalization of the decision matrix: This step ensured that all criterion values were scaled comparably to prevent dominance by variables with larger units (Hermansyah et al., 2025), (Subiyantoro et al., 2022). Weighting and determination of ideal solutions: The weights derived from AHP were applied to the normalized matrix to produce the weighted normalized matrix. The positive ideal solution ( $A^+$ ) and negative ideal solution ( $A^-$ ) were then identified (Hermansyah et al., 2025), (Febriyanti et al., 2023). Distance calculation and preference value determination using TOPSIS: The Euclidean distances to  $A^+$  and  $A^-$  were calculated for each alternative, followed by computation of the preference value  $C_i$  (Hermansyah et al., 2025), (Fitriani et al., 2023). Integration of the model into a web-based DSS: The final model was implemented into a simple web application to facilitate decision-making for financial institutions and SMEs (Keshavarz-Ghorabae, 2023), (Roy & Shaw, 2021).

## 2.8. AHP Formulas

The criteria weights are obtained from the principal eigenvector of the pairwise comparison matrix:

$$w_j = \frac{\text{eigenvector}(A)}{\sum \text{eigenvector}(A)} \quad (2)$$

Explanation:  $w_j$  represents the weight of criterion  $j$ . The pairwise comparison matrix  $A$  is constructed based on expert judgments, such as whether profitability is more important than cash flow, the eigenvector of this matrix reflects the relative priority of each criterion and is normalized so that the total weights equal 1.

Consistency is evaluated using:

$$w_j = \frac{\lambda_{\max} - n}{n - 1} \quad (3) \quad CR = \frac{CI}{RI} \quad (4)$$

Where:  $\lambda_{\max}$  = maximum eigenvalue,  $n$  = number of criteria,  $CI$  (Consistency Index) measures deviation from perfect consistency,  $CR$  (Consistency Ratio) compares  $CI$  with the Random Index ( $RI$ ), which is the mean  $CI$  of randomly generated matrices as defined by Saaty (Ren et al., 2007), (Khotimah et al., 2024).

If  $CR < 0,1$  the matrix is considered consistent (Ren et al., 2007), (Khotimah et al., 2024). In other words, AHP not only provides criterion weights but also ensures the logical validity of expert judgments.

## 2.9. TOPSIS Formula

### 2.9.1. Normalization of the decision matrix:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}} \quad (5)$$

Where  $X_{ij}$  = the  $i$ th alternative value in the  $j$ th criterion and normalization is necessary so that all criteria are on the same scale. For example, profitability in percent and cash flow in rupiah can be compared after normalization.

### 2.9.2. Weighted normalized matrix:

$$y_{ij} = w_j \cdot r_{ij} \quad (6)$$

The normalization value is multiplied by the  $W_j$  weight of the AHP, so that each criterion has a proportional influence according to its level of importance.

### 2.9.3. Ideal solutions positive & negative:

$$A^+ = \{\max(y_{ij})\} \quad (7), \quad A^- = \{\min(y_{ij})\} \quad (8)$$

Where  $A^+$  represents the most ideal conditions (e.g. largest profit, least risk),  $A^-$  represents the worst condition.

2.9.4. Distance to ideal solution:

$$D_i^+ = \sqrt{\sum_j (y_{ij} - A_j^+)^2} \quad (9), \quad D_i^- = \sqrt{\sum_j (y_{ij} - A_j^-)^2} \quad (10)$$

- $D_i^+$  is the distance of alternative  $i$  to the positive ideal solution.
- $D_i^-$  is the distance of alternative  $i$  to the negative ideal solution.
- This calculation uses Euclidean distances, so alternatives that are closer to ideal conditions will have  $D_i^+$  small and  $D_i^-$  larger.

2.10. Value preferences:

$$Ci = \frac{D_i^-}{D_i^+ + D_i^-} \quad (11)$$

The value of  $Ci$  indicates the relative proximity of the alternative to the ideal solution. Interpretation:  $Ci$  is close to 1  $\rightarrow$  alternative is very close to the ideal positive solution, meaning it is more feasible to get financing and  $Ci$  close to 0  $\rightarrow$  alternatives are likely to be unfeasible or risky (Hermansyah et al., 2025), (Abadi et al., 2023).

### 3. Result and Discussion

#### 3.1. AHP Criteria Weights

The relative contribution of each component in the alternative feasibility assessment is determined by the weighting of criteria, according to the multicriteria decision-making theory (Ren et al., 2007), (Khotimah et al., 2024). Metode Analytical Hierarchy Process (AHP) allows consistent weighting through paired comparison matrix; It is tested with consistency ratio (CR). In the TOPSIS calculation, this value is used to determine alternative priorities.

Table 1. Weight of MSME Criteria

Criterion	Weight	Attribution
Long Term of Effort	0.22	Benefit
Income	0.17	Benefit
Halal	0.06	Benefit
NIB	0.13	Benefit
Workforce	0.13	Benefit
Capital	0.08	Cost
Scale of Efforts	0.11	Benefit
Accounts Payable	0.10	Cost

The highest weight was in the duration of the business (0.22), confirming long-term stability as the dominant factor in the financing assessment (Sunariani et al., 2017). Furthermore, revenue (0.17) ranks second, as it reflects credit repayment capacity (Jha & Kumar Mittal, 2024). Business legality in the form of NIB (0.13) and halal certification (0.06) also contributes important. Meanwhile, financial factors such as capital (0.08) and accounts payable (0.10) are cost attributes that need to be minimized so that financing risk is low (Fitriani et al., 2023).

#### 3.2. Preliminary Decision Matrix

The decision matrix presents the **original value (raw data)** of each MSME alternative on eight criteria. According to the Multi Criteria Decision Making (MCDM) theory, this matrix is the **initial input** that will be processed by normalization in order to be fairly compared (Hermansyah et al., 2025).

Table 2. Preliminary Decision Matrix

Alternatif	Long Term of Effort	Income	Halal	NIB	Workforce	Capital	Scale of Efforts	Accounts Payable
Dapur Umay	5	180	0	1	8	50	2	3
Rmh Produksi Kreasikus	6	220	0	1	7	35	2	2
Produsen Telur Asin Nainay	4	120	0	1	5	50	1	5
Windy Snack	3	150	1	1	4	80	1	1
Bawang Goreng Ibu Nyonyo	5	130	1	1	6	45	2	3

The data shows the heterogeneity of MSME conditions. For example, Krh Production Rmh has relatively high income (220) and small capital (35), while Windy Snack faces large capital burden (80) and high debt (debt

score = 1). This difference reinforces the urgency of implementing DSS so that financing evaluation is not only subjective, but based on objective comparison.

### 3.3. Matrix Normalization

Normalization is carried out so that each criterion is on a uniform scale, eliminating differences in units and sizes between variables.

Example of normalization calculation of the "Length of Business" criterion for **Dapur Umay**:

$$r_{11} = \frac{5}{\sqrt{5^2 + 6^2 + 4^2 + 3^2 + 5^2 + n}} = 0.4746$$

Table 3. Normalization Matrix

Alternative	Long Term of Effort	Income	Halal	NIB	Workforce	Capital	Scale of Efforts	Accounts Payable
Dapur Umay	0.4746	0.4906	0.0000	0.4472	0.5804	0.4131	0.5345	0.4330
Rmh Produksi Kreasikus	0.5695	0.5997	0.0000	0.4472	0.5078	0.2892	0.5345	0.2887
Produsen Telur Asin Nainay	0.3797	0.3271	0.0000	0.4472	0.3627	0.4131	0.2673	0.7217
Windy Snack	0.2847	0.4089	0.7071	0.4472	0.2902	0.6610	0.2673	0.1443
Bawang Goreng Ibu Nyonyo	0.4746	0.3543	0.7071	0.4472	0.4353	0.3718	0.5345	0.4330

After normalization as shown in Table 3, Kreasikus Production Rmh excelled in terms of business duration (0.5695) and revenue (0.5997), while Salted Egg Producer Nainay recorded a very high value of accounts payable (0.7217), which was negative because it met the cost criteria. Meanwhile, Windy Snack excelled in halal terms (0.7071) but was burdened with high capital (0.6610). This normalization makes it clearer how MSMEs differ on a comparative scale.

### 3.4. Weighted Normalized Matrix

After normalization, each  $r_{ij}$  value is multiplied by the  $w_j$  criterion weights obtained from AHP (Ren et al., 2007), (Hermansyah et al., 2025). This process results in a weighted normalized matrix ( $y_{ij}$ ) that shows the relative contribution of each alternative to each criterion.

Table 4. Weighted Normalized Matrix

Alternative	Lama Usaha	Pendapatan	Halal	NIB	Tenaga Kerja	Modal	Skala Usaha	Hutang Usaha
Dapur Umay	0.1044	0.0834	0.0000	0.0581	0.0755	0.0330	0.0588	0.0433
Rmh Produksi Kreasikus	0.1253	0.1019	0.0000	0.0581	0.0660	0.0231	0.0588	0.0289
Produsen Telur Asin Nainay	0.0835	0.0556	0.0000	0.0581	0.0472	0.0330	0.0294	0.0722
Windy Snack	0.0626	0.0695	0.0424	0.0581	0.0377	0.0529	0.0294	0.0144
Bawang Goreng Ibu Nyonyo	0.1044	0.0602	0.0424	0.0581	0.0566	0.0297	0.0588	0.0433

The results showed that Kreasikus Production Rmh excelled in terms of business duration (0.1253) and revenue (0.1019), in accordance with a very strict assessment for each criterion. In contrast, Nainay Salted Egg Producer has high accounts payable (0.0722), which reduces its eligibility because debt is an attribute of cost. Windy Snack received a good score for halal (0.0424), but its capital value was higher (0.0529).

### 3.5. Ideal Positive & Negative Solutions

TOPSIS defines a positive ideal solution ( $A^+$ ) as the best condition (maximum value for benefit, minimum for cost) and a negative ideal solution ( $A^-$ ) as the worst condition (minimum value for benefit, maximum for cost) (Hermansyah et al., 2025).

Table 5. Ideal Positive and Negative Solutions

Type	Long Term of Effort	Income	Halal	NIB	Workforce	Capital	Scale of Efforts	Accounts Payable
Ideal Positif (A <sup>+</sup> )	0.1253	0.1019	0.0424	0.0581	0.0755	0.0231	0.0588	0.0144
Ideal Negatif (A <sup>-</sup> )	0.0626	0.0556	0.0000	0.0581	0.0377	0.0529	0.0294	0.0722

The ideal solution is negative showing newly established MSMEs, low income, lack of legality, large capital, micro-scale, and high debt. On the contrary, the ideal positive solution shows the best MSMEs that have a high old business, large income, halal and fulfilled NIB, a lot of labor, small capital, and a larger business scale.

### 3.6. Distance to the Ideal Solution

The distance of each alternative to A<sup>+</sup> (D<sup>+</sup>) and A<sup>-</sup> (D<sup>-</sup>) is calculated using the Euclidean distance formula. The best alternatives are those with a minimum D<sup>+</sup> and a maximum D<sup>-</sup> (Hermansyah et al., 2025).

Table 6. Distance to the Ideal Solution

Alternative	D <sup>+</sup>	D <sup>-</sup>
Dapur Umay	0.0593	0.0777
Rmh Produksi Kreasikus	0.0458	0.1024
Produsen Telur Asin Nainay	0.1039	0.0303
Windy Snack	0.0903	0.0730
Bawang Goreng Ibu Nyonyo	0.0584	0.0784

The Kreasikus Production Rmh has the smallest D<sup>+</sup> (0.0458) and the largest D<sup>-</sup> (0.1024), indicating that these alternatives are closest to ideal conditions. In contrast, Nainay Salted Egg Producer has a high D<sup>+</sup> (0.1039) and a very small D<sup>-</sup> (0.0303), so it is furthest from ideal conditions.

### 3.7. Value Preferences & Rankings

The value of the preference is calculated by the formula Ci

Table 7. Preference and Ranking Values

Alternative	D <sup>+</sup>	D <sup>-</sup>	C <sub>i</sub>	Ranking
Dapur Umay	0.0593	0.0777	0.5672	6
Rmh Produksi Kreasikus	0.0458	0.1024	0.6911	1
Produsen Telur Asin Nainay	0.1039	0.0303	0.2259	30
Windy Snack	0.0903	0.0730	0.4471	19
Bawang Goreng Ibu Nyonyo	0.0584	0.0784	0.5733	5

The final results show that Krh Production ranks first with Ci=0.6911, indicating that it has high financing feasibility. Umay's Kitchen ranks in the top 10 with Ci=0.5672, while Nainay Salted Egg Producer ranks last with Ci=0.2259, indicating that due to high debt burden and relatively low income, Nainay Salted Egg Producer is in the last position. These results show that the AHP-TOPSIS method can consistently identify differences in MSME eligibility objectively.

### 3.8. Application Overview

Here are some pictures that the author presents for an overview of the application that the author is designing using AHP-TOPSIS.



Figure 1. Login Page

Figure 1 is the login page for admins to process the next steps to enter the dashboard page.



Figure 2. Admin Dashboard Page

The dashboard page, as shown in Figure 2, displays a graph of MSME growth, recommendation results, and rankings. The administrator also entered the value of the MSME ranking criteria.



Figure 3. Funding Eligibility Recommendations Page

Figure 3 is the page of results of calculations and rankings so that MSMEs are given rankings and recommendations for funding.

#### 4. Conclusion

Based on the results of the study using the AHP-TOPSIS method on eight criteria for MSME financing, several conclusions can be drawn: 1) The Analytical Hierarchy Process (AHP) succeeded in determining the weight of the criteria consistently with a *Consistency Ratio (CR)* value of  $< 0.1$ . This confirms that expert judgments used as input are logically and validly acceptable. The highest weights were in the length of business (0.22) and income (0.17), indicating that stability and financial capacity remain the main determinants in MSME financing access. 2) The Choice Setting Technique Based on Similarity to Ideal Solutions (TOPSIS) has the ability to generate measurable and unbiased alternative rankings. The results of the analysis showed that Krh Kreasikus Production ranked first with a preference value of  $C_i=0.6911$ , while Nainay Salted Egg Producer ranked last with a preference value of  $C_i=0.2259$ . This shows that TOPSIS can easily distinguish high-risk MSMEs from MSMEs that have high growth potential. 3) Operating time, revenue, and business legality (NIB and halal certification) are the main factors that determine the value of financing. However, accounts payable and capital as cost attributes

have a negative impact on valuation. These results are in line with financial literacy theory, which states that business track record, cash flow, and regulatory compliance are key factors in credit decision-making. 4) The Decision Support System (DSS) model based on AHP-TOPSIS has proven to be effective as a tool to assist financial institutions in evaluating MSMEs. Compared to conventional methods that tend to be subjective, this model provides more systematic, transparent, and data-driven recommendations.

Based on the findings of the study, several suggestions can be proposed for subsequent studies, it is recommended to combine additional methods such as Fuzzy AHP, COPRAS, or MOORA to increase the strength of the analytical results. In addition, the research sample should be extended to other MSME sectors, such as agriculture and tourism, so that the results can be generalized.

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