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Prioritizing micro, small, and medium enterprises assistance areas in West Java using analytical hierarchy process

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ABSTRACT

This study aims to develop a Decision Support System (DSS) to prioritize areas for receiving assistance for Micro, Small, and Medium Enterprises (MSMEs) in West Java Province using the Analytical Hierarchy Process (AHP) and Simple Additive Weighting (SAW) methods. The AHP method is used to determine the importance weight of each criterion based on its priority level, while the SAW method is used to carry out the normalization process, calculate preference values, and rank alternative areas. The criteria used include the number of MSMEs, workforce, financial stability ratio, legality ratio, BPP ratio, digital ratio, and innovation ratio. The results of the study indicate that the system built is able to produce an objective and consistent ranking of priority areas for MSME assistance, as evidenced by the agreement between the results of manual calculations using Microsoft Excel and the results of calculations in the system. Thus, this system is expected to assist relevant parties in making decisions regarding the distribution of MSME assistance in a more targeted and structured manner and rank 27 administrative regions in West Java Province. The results show that the highest-ranked region achieved a preference value of 0.8573, indicating its highest priority for MSME assistance, while the lowest-ranked region obtained a value of 0.5129. These results demonstrate the system's capability to generate consistent and objective rankings. In addition, this study contributes by applying a combined AHP–SAW approach at a regional (macro) level, which is still limited in previous studies, thereby providing a more comprehensive framework for data-driven policy decision-making.

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1. INTRODUCTION

Micro, Small, and Medium Enterprises (MSMEs) are a strategic sector in the national economy, playing a significant role in employment creation and regional economic development. In Indonesia, MSMEs account for more than 99% of total business units and contribute substantially to national employment, making them an important driver of economic growth. In addition to creating jobs, MSMEs also support income distribution and strengthen local economies. Recognizing this importance, the government has prioritized MSMEs through various economic policies and assistance programs, as regulated under Law Number 20 of 2008 concerning Micro, Small, and Medium Enterprises.

In practice, the distribution of MSME assistance programs is influenced not only by individual business characteristics but also by the broader regional conditions in which MSMEs operate (Islam & Gazder, 2023; Lotfipour & Mohtavipour, 2025; Prah & Gajšek, 2024). Each region exhibits distinct characteristics, including the number of MSMEs, labor absorption capacity,

productivity levels, and regional economic stability, all of which contribute to differences in development potential and support needs. These variations indicate that a uniform distribution of assistance may not be effective, as each region requires a tailored approach based on its specific conditions. Therefore, determining priority regions for MSME assistance is essential to ensure equitable economic development, optimize resource allocation, and enhance the effectiveness of government support programs in addressing regional disparities (G et al., 2026; Kabassi et al., 2025a).

One of the main challenges in determining priority regions lies in the complexity of the decision-making process, which involves multiple criteria and is prone to subjectivity when conducted using conventional or manual assessment approaches (Rudiyati et al., 2025; Voutama & Novalia, 2022). These approaches often rely heavily on human judgment without a structured evaluation framework, which can lead to inconsistent results and bias in determining priorities. As a result, such methods are often insufficient to address multi-criteria problems in a consistent, transparent, and objective manner. This condition highlights the need for a systematic, data-driven decision-making framework that is capable of integrating multiple criteria and producing reliable and justifiable outcomes (Abdul Kahar et al., 2026; Harahap et al., 2025).

Most previous studies applying the Analytical Hierarchy Process and Simple Additive Weighting methods have primarily focused on micro-level decision making, such as individual selection, performance evaluation, and small-scale alternative assessment. (Agung Pratama et al., 2024; Rizky Arfani et al., 2023) While these studies have demonstrated the effectiveness of multi-criteria decision-making methods in handling structured decision problems, their application is still largely limited to smaller scopes with relatively simpler data structures. The application of such approaches at the macro level, particularly for regional prioritization using static provincial-scale data with complex and multidimensional characteristics, remains limited (Maimaiti et al., 2025; Shahriar et al., 2026). Therefore there is a need to extend the implementation of these methods to a broader context in order to support more comprehensive and strategic decision-making at the regional level.

This study addresses this gap by developing a decision support system to determine priority regions for MSME assistance in West Java Province using regional data from the West Java Central Statistics Agency (BPS) for 2022. The Analytical Hierarchy Process is applied to determine the relative importance of decision criteria, while the Simple Additive Weighting method is used to rank regional alternatives based on preference values. The proposed approach is expected to provide objective, measurable, and systematic recommendations that can support more targeted, transparent, and structured planning and distribution of MSME assistance programs. Based on the identified gap, this study aims to answer the following research question, how can a decision support system integrating AHP and SAW methods be used to objectively determine priority regions for MSME assistance at the regional level.

2. RESEARCH METHOD

This study was conducted to address the problem of determining priority regions for UMKM assistance programs (Bruzzese et al., 2023; Štilić & Puška, 2023). The research methodology integrates the Analytical Hierarchy Process (AHP) to determine the weights of each criterion and a web-based Decision Support System that applies the Simple Additive Weighting (SAW) method to rank alternative regions. This approach aims to support a more effective and objective decision-making process in the implementation of UMKM assistance programs (Abuabara et al., 2025; Restrepo-Tamayo et al., 2025).

The data used in this study were obtained from the West Java Central Statistics Agency (BPS) for the year 2022, consisting of quantitative regional indicators related to MSME conditions. The data are measured using ratio and interval scales, allowing for normalization and comparison across regions. To ensure the validity of the system, the calculation results were compared with manual computations using Microsoft Excel. This validation process aims to verify the accuracy and consistency of the implemented AHP and SAW methods. In the AHP process, expert judgment was used to construct the pairwise comparison matrix. The experts involved have relevant knowledge in MSME development and decision-making processes, ensuring that the weighting results are reliable and justified (Abdullah et al., 2026; Nenzhelele et al., 2023).

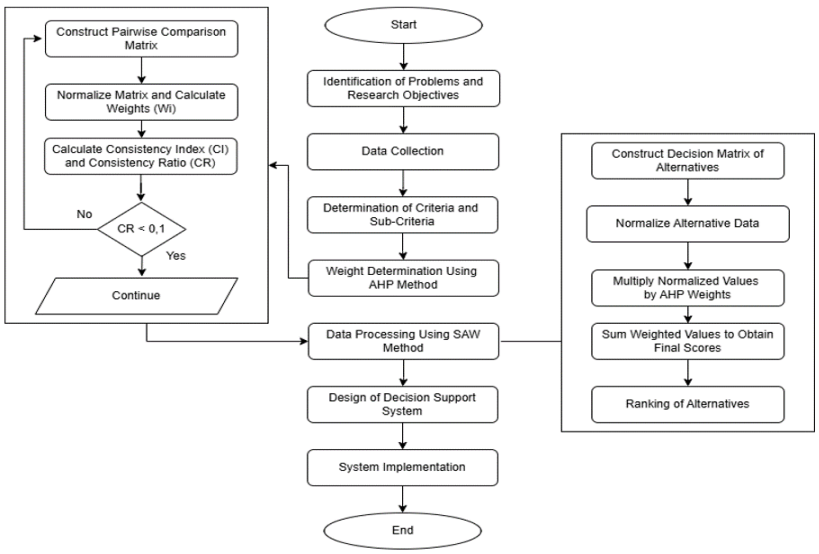

Figure 1. Flowchart of the decision-making process using AHP for criteria weighting and SAW for ranking

Weight Derivation via AHP

In this study, criterion weights are derived using the Analytical Hierarchy Process (AHP) through pairwise comparison and consistency evaluation. The weighting process begins by constructing a pairwise comparison matrix (A), where each element aij represents the relative importance of criterion i compared to criterion j (Javadi et al., 2026; Tadić et al., 2025). The priority weight of each criterion is obtained using the following equation:

$$w_i = \frac{\{\sum j \sum a_{(ij)}\}}{\{\sum i \sum j \, aij\}} \quad (1)$$

To test the consistency of the comparison matrix, the following equations are used:

$$CI = \frac{\{\lambda_{(max)} - n\}}{n-1} \quad (2)$$

$$CR = \{CI\}\{RI\} \quad (3)$$

The criterion weights were determined using the Analytical Hierarchy Process (AHP). Pairwise comparisons were conducted to assess the relative importance of each criterion based on expert judgment (Gamal et al., 2026; Guo et al., 2021). The comparison matrix was then normalized to obtain the priority weights. Consistency of the comparisons was evaluated using the Consistency Ratio (CR). The results show that the CR value is below the acceptable threshold of 0.1, indicating that the judgments are consistent and reliable (Mercan & Acıbuca, 2025; Negeri et al., 2025).

Alternative Ranking Using SAW

The Simple Additive Weighting (SAW) method is used to rank 27 regional alternatives based on seven criteria. This method enables a systematic evaluation by considering both the importance of each criterion and the performance of each alternative. Normalization is performed using the following equations if the criteria are classified as benefit, ensuring that higher values represent better performance and can be fairly compared across all alternatives.

$$r_{(ij)} = \left\{\frac{x_{(ij)}}{\{\max(x_{(ij)})\}}\right\} \quad (4)$$

If criteria cost equations:

$$r_{(ij)} = \frac{\{min\,(x_{(ij)})\}}{(x\_(ij))} \quad (5)$$

The preference value is calculated using:

$$V_i = \sum(w_j \times r_{(ij)}) \quad (6)$$

Using the SAW method, 27 alternatives were evaluated by calculating their normalized values and preference scores. The final ranking was based on the highest preference score, which represents the priority level of each alternative (Kabassi et al., 2025b).

3. RESULTS AND DISCUSSIONS

This study uses several criteria to determine priority areas for MSME assistance in West Java Province. These criteria were selected based on MSME-related indicators published by the West Java Central Statistics Agency (BPS) and are used to represent regional economic and business conditions.

Criteria and Sub-Criteria Definition

Criterion 1 is treated as a cost attribute, meaning that lower values are considered more favorable and indicate a lower level of cost or risk. In contrast, criteria 2–6 are treated as benefit attributes, where higher values reflect better performance, greater advantages, or higher levels of importance. Therefore, an increase in the values of criteria 2–6 corresponds to a higher priority level, while for criterion 1, a lower value contributes positively to the overall evaluation.

Table 1. Criteria data for MSME Assistance priority determination

Code	Criteria Name	Type	Weight
C1	Number of MSMEs	Cost	0,0271
C2	MSME Workforce	Benefit	0,0513
C3	Financial Stability Ratio	Benefit	0,1637
C4	Legalization Ratio	Benefit	0,3278
C5	BPP Ratio	Benefit	0,1218
C6	Digitalization Ratio	Benefit	0,1864
C7	Innovation Ratio	Benefit	0,1218

Each criterion is further defined into several sub-criteria to facilitate a more detailed and structured assessment. These sub-criteria act as specific parameters that help break down each criterion into measurable components. Through this approach, raw data values can be systematically converted into standardized ratings, making them easier to compare and process. This standardization is essential before applying the SAW method, ensuring that the evaluation results are more accurate, consistent, and objective.

Table 2. Criteria rating scale

Code	Criteria Name	Scale	Weight
C1	Number of MSMEs	< 10.000	5
		10.000 - 24.999	4
		25.000 – 39.999	3
		40.000 – 59.999	2
		>60.000	1
C2	MSME Workforce	120.000	5
		90.000 – 119.999	4
		50.000 – 89.999	3
		20.000 – 49.999	2
		< 20.000	1
C3	Financial Stability Ratio	> 2.00	5
		1,75 – 1,99	4
		1,50 – 1,74	3
		1,25 – 1,49	2
		<1,25	1
C4	Legalization Ratio	> 8.0	5

Code	Criteria Name	Scale	Weight
		5,0 – 7,99	4
		3,0 – 4,99	3
		1,0 – 2,99	2
		< 1.0	1
C5	BPP Ratio	> 8.0	5
		5,0 - 7,99	4
		3,0 – 4,99	3
		1,0 – 2,99	2
		< 1.0	1
C6	Digitalization Ratio	> 75	5
		60 – 74,99	4
		45 – 59,99	3
		35 – 44,99	2
		< 35	1
C7	Innovation Ratio	> 20	5
		15 – 19,99	4
		10 – 14,99	3
		5 – 9,99	2
		<5	1

Table 1 presents the sub-criteria and rating scales for each criterion. The rating values range from 0 to 1, where higher values indicate better performance of a region with respect to the corresponding criterion. The rating scale is determined based on the distribution of data obtained from BPS West Java. Based on the defined criteria and their respective weights, each alternative was evaluated using data obtained from the West Java Central Statistics Agency (BPS) for 2022. A total of 27 alternatives, representing regions in West Java Province and labeled A1 to A27, were evaluated based on the defined criteria. The evaluation results are presented in Table 3.

Table 3. Decision matrix of alternatives based on criteria

Code	Alternatives Name	C1	C2	C3	C4	C5	C6	C7
A1	Bogor Kota	2	5	4	5	3	3	5
A2	Sukabumi Kota	2	4	4	5	2	5	4
A3	Cianjur	3	3	4	5	2	4	4
A4	Bandung Kota	2	4	3	5	4	2	5
A5	Garut	1	5	3	5	2	5	5
A6	Tasikmalaya	1	4	5	2	1	5	1
A7	Ciamis	3	3	2	5	2	5	1
A8	Kuningan	4	2	3	5	3	4	3
A9	Cirebon Kota	4	3	5	5	4	3	2
A10	Majalengka	3	4	5	3	1	5	1
A11	Sumedang	4	3	3	5	1	4	1
A12	Indramayu	4	2	4	5	3	4	4
A13	Subang	4	2	2	5	2	5	1
A14	Purwakarta	4	2	3	5	4	4	2
A15	Karawang	4	2	4	5	2	3	3
A16	Bekasi Kota	4	2	2	5	2	3	5
A17	Bandung Barat	4	2	4	5	3	4	2
A18	Pangandaran	3	3	3	2	1	5	1
A19	Bogor	5	1	3	5	5	2	5
A20	Sukabumi	5	1	3	5	5	4	5
A21	Bandung	4	3	5	5	4	1	4
A22	Cirebon	5	1	4	5	3	2	2
A23	Bekasi	5	2	4	5	3	2	4
A24	Depok	4	2	5	5	4	2	4
A25	Cimahi	5	1	5	5	5	3	3
A26	Tasikmalaya	3	3	3	5	3	4	2
A27	Banjar	5	1	2	5	4	4	1

The alternatives used in this study consist of 27 administrative regions, including regencies and cities in West Java Province. These alternatives are evaluated based on the defined criteria and sub-criteria using MSME data published by BPS West Java.

Normalization

After assigning rating values to each alternative, the next step is data normalization using the Simple Additive Weighting (SAW) method to ensure comparability among alternatives.

Table 4. Normalization results of alternatives

Code	Alternatives Name	C1	C2	C3	C4	C5	C6	C7
A1	Bogor Kota	0,50	1	0,80	1	0,60	0,60	1
A2	Sukabumi Kota	0,50	0,80	0,80	1	0,40	1	0,80
A3	Cianjur	0,33	0,60	0,80	1	0,40	0,80	0,80
A4	Bandung Kota	0,50	0,80	0,60	1	0,80	0,40	1
A5	Garut	1	1	0,60	1	0,40	1	1
A6	Tasikmalaya	1	0,80	1	0,40	0,20	1	0,20
A7	Ciamis	0,33	0,60	0,40	1	0,40	1	0,20
A8	Kuningan	0,25	0,40	0,60	1	0,60	0,80	0,60
A9	Cirebon Kota	0,25	0,60	1	1	0,80	0,60	0,40
A10	Majalengka	0,33	0,80	1	0,60	0,20	1	0,20
A11	Sumedang	0,25	0,60	0,60	1	0,20	0,80	0,20
A12	Indramayu	0,25	0,40	0,80	1	0,60	0,80	0,80
A13	Subang	0,25	0,40	0,40	1	0,40	1	0,20
A14	Purwakarta	0,25	0,40	0,60	1	0,80	0,80	0,40
A15	Karawang	0,25	0,40	0,80	1	0,40	0,60	0,60
A16	Bekasi Kota	0,25	0,40	0,40	1	0,40	0,60	1
A17	Bandung Barat	0,25	0,40	0,80	1	0,60	0,80	0,40
A18	Pangandaran	0,33	0,60	0,60	0,40	0,20	1	0,20
A19	Bogor	0,20	0,20	0,60	1	1	0,40	1
A20	Sukabumi	0,20	0,20	0,60	1	1	0,80	1
A21	Bandung	0,25	0,60	1	1	0,80	0,20	0,80
A22	Cirebon	0,20	0,20	0,80	1	0,60	0,40	0,40
A23	Bekasi	0,20	0,40	0,80	1	0,60	0,40	0,80
A24	Depok	0,25	0,40	1	1	0,80	0,40	0,80
A25	Cimahi	0,20	0,20	1	1	1	0,60	0,60
A26	Tasikmalaya	0,33	0,60	0,60	1	0,60	0,80	0,40
A27	Banjar	0,20	0,20	0,40	1	0,80	0,80	0,20

The normalization results demonstrate that the SAW method effectively balances differences in measurement scales across all criteria, allowing each indicator to be evaluated on a comparable basis. By transforming the original values into normalized scores, the method ensures that no single criterion disproportionately influences the outcome due to scale differences.

As a result, the final regional ranking reflects proportional contributions from all indicators, creating a more objective and fair evaluation process. This approach enables decision-makers to identify priority areas for MSME assistance more accurately, as the ranking is based on a comprehensive assessment that considers all relevant factors in a balanced manner.

Preference Value Calculation and Ranking

The normalized values are multiplied by the criterion weights obtained from the AHP method to calculate preference values, reflecting the relative importance of each criterion in the decision-making process. These weighted values are then summed to produce the final score for each alternative, which serves as the basis for ranking the priority of MSME assistance areas in a systematic and transparent manner.

Table 5. Decision matrix of alternatives based on criteria

Alternatives Code	Alternatives Rank	Preference Value (Vi)	Rank
A1	Bogor Kota	0,8573	1
A2	Sukabumi Kota	0,8425	2
A3	Cianjur	0,8389	3
A4	Bandung Kota	0,8338	4
A5	Garut	0,8243	5
A6	Tasikmalaya	0,821	6
A7	Ciamis	0,8047	7
A8	Kuningan	0,8018	8
A9	Cirebon Kota	0,8004	9
A10	Majalengka	0,7828	10
A11	Sumedang	0,7768	11
A12	Indramayu	0,7766	12
A13	Subang	0,7734	13
A14	Purwakarta	0,7704	14
A15	Karawang	0,7626	15
A16	Bekasi Kota	0,7608	16
A17	Bandung Barat	0,7467	17
A18	Pangandaran	0,736	18
A19	Bogor	0,7199	19

Alternatives Code	Alternatives Rank	Preference Value (Vi)	Rank
A20	Sukabumi	0,7179	20
A21	Bandung	0,6997	21
A22	Cirebon	0,6994	22
A23	Bekasi	0,6777	23
A24	Depok	0,6744	24
A25	Cimahi	0,6538	25
A26	Tasikmalaya	0,5766	26
A27	Banjar	0,5129	27

The ranking results indicate that regions such as Bogor Kota and Sukabumi Kota occupy the highest positions due to their strong performance across key criteria, particularly in legalization ratio, digitalization, and workforce absorption. These indicators reflect better readiness and capacity in utilizing MSME assistance effectively. On the other hand, regions with lower rankings tend to have weaker performance in multiple criteria, indicating the need for more fundamental support and development strategies. Compared to previous studies that mainly focus on micro-level decision-making, this study provides a broader perspective by applying multi-criteria analysis at the regional level. This approach enables policymakers to allocate resources more strategically based on comprehensive regional evaluations. Practically, the results of this study can support government institutions in designing more targeted MSME assistance policies by prioritizing regions with higher readiness levels, while also identifying regions that require more intensive development programs.

Validation of System Calculation Results

To verify the accuracy of the developed system, a comparison was conducted between the calculation results generated by the system and manual calculations performed using Microsoft Excel to ensure that the implemented algorithms function correctly and produce consistent outputs. The comparison results, as presented in Table 6, indicate that the system-generated values align with the manual calculations, demonstrating that the system is accurate, reliable, and suitable for supporting decision-making in determining the priority of MSME assistance areas.

Table 6. Comparison of preference values and rankings between excel and system calculations

No	Alternatives Code	Preference Value (Excel)	Rank (Excel)	Preference Value (System)	Rank (System)	Consistency
1	A1	0,8243	5	0,8243	5	Consistent
2	A2	0,8425	2	0,8425	2	Consistent
3	A3	0,8004	9	0,8004	9	Consistent
4	A4	0,7704	14	0,7704	14	Consistent
5	A5	0,8389	3	0,8389	3	Consistent
6	A6	0,5766	26	0,5766	26	Consistent
7	A7	0,6997	21	0,6997	21	Consistent
8	A8	0,7608	16	0,7608	16	Consistent
9	A9	0,8018	8	0,8018	8	Consistent
10	A10	0,6538	25	0,6538	25	Consistent
11	A11	0,6777	23	0,6777	23	Consistent
12	A12	0,821	6	0,821	6	Consistent
13	A13	0,6744	24	0,6744	24	Consistent
14	A14	0,7626	15	0,7626	15	Consistent
15	A15	0,736	18	0,736	18	Consistent
16	A16	0,7179	20	0,7179	20	Consistent
17	A17	0,7734	13	0,7734	13	Consistent
18	A18	0,5129	27	0,5129	27	Consistent
19	A19	0,7828	10	0,7828	10	Consistent
20	A20	0,8573	1	0,8573	1	Consistent
21	A21	0,7768	11	0,7768	11	Consistent
22	A22	0,7199	19	0,7199	19	Consistent
23	A23	0,7766	12	0,7766	12	Consistent
24	A24	0,8047	7	0,8047	7	Consistent
25	A25	0,8338	4	0,8338	4	Consistent
26	A26	0,7467	17	0,7467	17	Consistent
27	A27	0,6994	22	0,6994	22	Consistent

The consistency between the preference values and rankings generated by the system and those obtained through Microsoft Excel calculations confirms the correctness of the AHP–SAW implementation. This result demonstrates that the proposed decision support system is capable of

performing accurate multi-criteria computations, thereby reducing potential calculation errors and enhancing the reliability of regional prioritization outcomes.

System Interface Implementation

Implementation of a decision support system that has been developed through a user interface and is designed to automate the AHP and SAW calculation process and provide an intuitive platform for users to manage criteria, process data, and display ranking results.

Figure 2. Main interface of the decision support system

Figure 2 shows the main interface of the developed decision support system. This interface serves as the entry point for users to access system features, including criteria management, data processing, and result ranking. The layout is designed to support efficient navigation and ease of use. Additionally, the interface provides a clear overview of available functions, enabling users to interact with the system more effectively.

Figure 3. Criteria and weight management interface

Figure 3 illustrates the interface used to manage criteria and their corresponding weights derived from the AHP method. Through this interface, users can view and update criteria data, which directly affects the calculation process. This feature ensures flexibility in adjusting decision parameters when needed. Moreover, it allows users to maintain the relevance and accuracy of the evaluation by updating criteria according to current conditions.

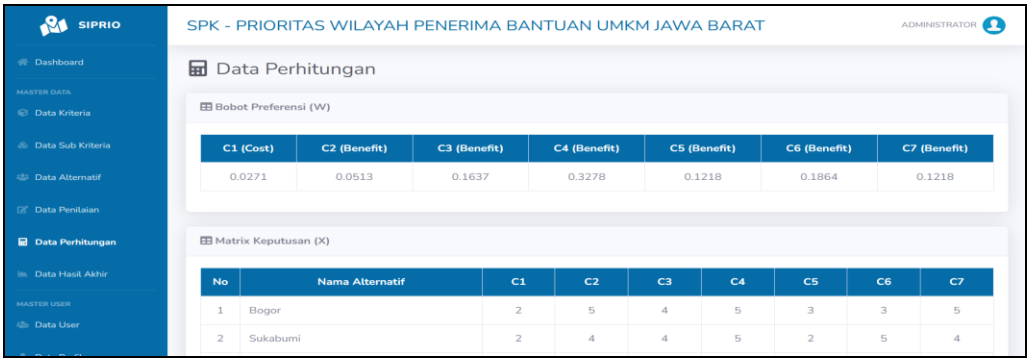

Figure 4. Calculation process interface

Figure 4 shows the calculation process interface of the developed decision support system. This page displays the automated computation results based on the AHP–SAW methods, including normalization values, weighted scores, and preference values for each alternative. Through this interface, users can directly observe how the system processes data and produces ranking results objectively and consistently. Furthermore, this interface enhances transparency by clearly presenting each stage of the calculation process.

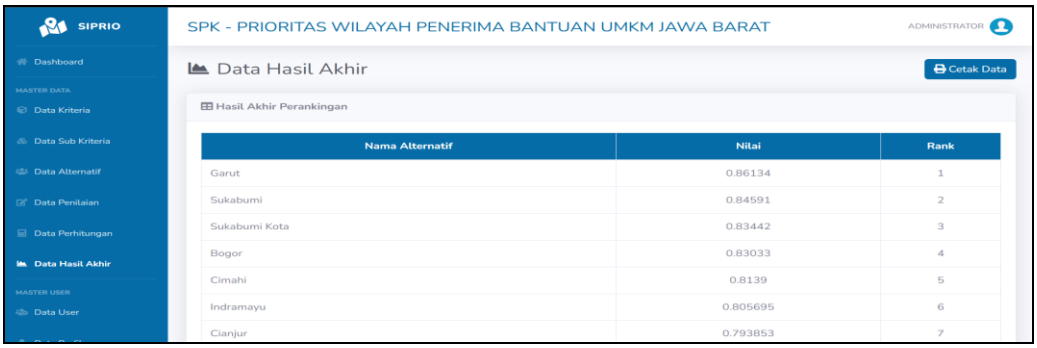

Figure 3. Ranking results generated by the system

Figure 5 presents the ranking results produced by the system using the SAW method. The interface displays the preference values and priority order of each alternative, labeled from A1 to A27, allowing users to easily identify which alternatives have higher or lower priority levels. These results provide decision-makers with a clear overview of priority areas for MSME assistance, supporting more informed and data-driven decisions. Additionally, the ranking output is presented in a structured and easy-to-read format, enabling users to interpret the results quickly and accurately.

4. CONCLUSION

This study successfully developed a web-based decision support system for determining priority areas for MSME assistance in West Java Province using the AHP and SAW methods. The AHP method was applied to derive the weights of decision criteria, while the SAW method was used to calculate preference values and rank 27 alternative regions based on data from the West Java Central Statistics Agency (BPS) for 2022. The system was able to produce consistent and objective ranking results, as validated by the comparison between system calculations and manual calculations using Microsoft Excel. The implementation of this system is expected to assist relevant stakeholders in making more structured, transparent, and data-driven decisions in the distribution of MSME assistance. The main contribution of this study lies in the implementation of a combined AHP–SAW approach at the regional level, which provides a systematic and data-driven framework for prioritizing MSME assistance areas. This approach enhances decision-making by integrating multiple criteria into a consistent evaluation model. In practical terms, the system can assist policymakers in determining priority regions more objectively, improving the effectiveness and fairness of MSME assistance distribution.

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