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An integrated AHP-TOPSIS framework for determination of leading industrial sectors

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An integrated AHP-TOPSIS framework for determination of leading industrial sectors

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A B S T R A C T

This study aims to determine the leading industry in Padang Pariaman Regency, West Sumatera, Indonesia, based on data from the Central Statistics Agency and expert opinion on the Regency Industrial Development Plan. This research combines qualitative and quantitative techniques. This study uses four experts' opinions consisting of three governments and one academician. The criteria and sub-criteria are determined based on the locally adapted National Industrial Development Master Plan. The method used in this study is a combination of the Multi-Criteria Decision Making (MCDM) method, which integrates the Analytical Hierarchy Process (AHP) to calculate the weights and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) to determine the order of priority. The top five leading processing industries were selected: the food industry, the leather/footwear industry, the chemical industry, the apparel industry, and other processing industries.

1. INTRODUCTION

Economic growth is one indicator of success in an area [1]. The economy in West Sumatra Province has tended to increase in recent years. This condition can be seen from the growth of the GRDP (Gross Regional Domestic Product) of West Sumatra Province, which increased from 2010 to 2019 [2]. The Central Statistics Agency noted that the highest cumulative positive GRDP growth occurred in 2019 of IDR 246,422.72 (in billion). Based on data from The Central Statistics Agency knew that the manufacturing sector was in the top five contributors to GRDP of 8.37% in 2019. Nazir et al. [3] explain that the industrial sector plays an essential role in the country's economy. The manufacturing industry sector is one of the leading sectors that causes an increase in the economy [4].

The Indonesian government encourages the growth of the industrial sector. One of the efforts made is to make documents related to industrial development plans for each region. Indonesian central government regulations mandated the Provincial Government to formulate the Provincial Industrial Development Plan, referring to national government regulation 2015-2035. Regulation of West Sumatra Province also mandates the Regent to design Regency/City Industrial Development Plan. Regency/City Industrial Development Plan is used as a policy direction in industrial development by determining the priority industries. Padang Pariaman Regency is one of the areas that will make the Industrial Development Plan.

Currently, there is no scientific research to determine the priority industries in Padang Pariaman. Priority industries or leading industries are needed to determine the policy direction of local and central governments in determining the development strategy of small and medium industries (SMEs). Determining industry priorities in Padang Pariaman Regency facilitates regional development strategies because it is one of the national industrial policies [5]. As a result, regional innovation actors will more readily take policies to increase the added value of their regions through the determination of industry priorities. The development will also be more solvent, and decisions in taking innovation policies will be easier. Innovation actors and investors will also be overwhelming and easy to implement investment. It also increases inter-regional competitiveness. This study was conducted to determine the priority industries in Padang Pariaman Regency based on existing data in the field and the opinion of experts who are considered competent in the development of SMEs in Padang Pariaman.

In identifying priority industries, MCDM (multi-criteria decision making) is used. The method of multi-criteria decision making (MCDM) is intended for decision-making that contains many objectives and conflicting functions [6], [7]. MCDM is used as the method of choice because of this method's ability to make decisions on one choice if the selection process is carried out by more than one decision-making person [8], [9].

Several decision-making methods include AHP, ANP, VIKOR, TOPSIS, VIKOR, SAW, ELECTRE, PROMOTEE, MAUT, and MPE [10]. The decision-making method used in this study is the MCDM method by integrating the Analytical Hierarchy Process (AHP) to calculate the weights and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) to determine the order of priority. This method is known as "Hybrid MCDM" because it combines two methods while maintaining the characteristics of each method. Hybrid MCDM is used in dealing with complex decision-making problems and a combination of several methods contained in MCDM [11], [12].

The AHP method is proposed to determine the leading processing industry in Padang Pariaman Regency because it considers various factors or criteria that influence by assessing weights. Thus, this method quantifies the criteria or sub-criteria through the weight value [13]. As a result, the level of subjectivity in making this decision is reduced. In addition, the AHP method has a hierarchical structure to represent the relationship between the influencing factors, namely criteria and sub-criteria [14]. The relationship between factors is also quantified through pairwise comparisons [15].

Several previous studies have been conducted regarding the use of AHP in determining the priority scale for determining sectors [16]. Rukmana [17] determined the superior potential of the District in Bandung Regency using AHP. Homer [18] determined the Industrial Cluster in Sorong regency's industrial estate based on Delphi Method and AHP.

The TOPSIS method is proposed because it ranks alternatives based on the ideal solution. This method is specific because it considers two distances from each alternative: the positive and negative ideal solutions. Thus, this method is very suitable because of the complexity of solving the problem of the longest distance to the negative ideal solution and the shortest distance to the positive ideal solution [19].

The AHP method has a weakness because it is not precise enough to provide an assessment. This condition was solved by adding supporting data in determining the leading industry. In addition, to overcome these shortcomings, the AHP method is usually combined with other MCDM methods, for example, the TOPSIS method. The TOPSIS method requires the weights used from the calculations of other MCDM methods, for example, the AHP method [20]. Thus, combining these two methods is a practical step to overcome the weaknesses between methods.

2. RESEARCH METHODS

The suitable method used to solve problems in determining priority industries in Padang Pariaman Regency Determination is Multi-Criteria Decision Making (MCDM). Many experts developed several methods of Multi-Criteria Decision Making (MCDM). The method used in this study is the integration of AHP and TOPSIS. Analytical Hierarchy Process (AHP) to calculate the weights of criterion and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) to determine the order of priority. The AHP method is a method that uses the

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weighting and ranking of several alternatives. Then the alternative is chosen as the best alternative [21].

The steps in conducting this research are:

Step 1

This step identifies and determines the potential industries in Padang Pariaman through Central Statistics Agency, based on the number of small and medium industries, workers, and production values.

Step 2

The criteria and sub-criteria in determining the leading industry are based on the National Industrial Development Master Plan 2015-2035 and adapt to local needs. There are nine criteria and 16 sub-criteria in this study.

Step 3

This step was collecting expert opinions regarding the weight of each leading industry based on criteria and sub-criteria. Four experts selected in this study that tree came from the government and one from academic fields. The selected expert has a minimum educational qualification of Strata 1, is experienced in industrial development, and the government has the primary task as an industrial instructor.

Step 4

Determine the weight of the sub-criteria for the leading industry using the AHP. Because it evaluates many aspects or criteria that affect weights, the AHP approach determines the primary processing industry in Padang Pariaman Regency. As a result, this method uses the weight value to quantify the criteria or sub-criteria. As a result, there is less subjectivity involved in making this decision.

Step 5

Determine the leading industry using TOPSIS methods. TOPSIS is used to overcome the weakness of the AHP method. TOPSIS can increase inaccuracy in giving assessments. The second questionnaire is spread to Experts, questioner as an alternative assessment for determining priority leading industry.

Table 1. Comparison scale

Value	Perception Level
1	Equally Important
3	A Little More Important
5	A little more is essential enough
7	More Important
9	Absolute More Important
2. 4. 6. 8	Values Between Two Different Values of Consideration

The data in this study consisted of primary data and secondary data. Primary data is obtained from experts consisting of 3 governments and one academician. Secondary data is data obtained from literature studies, textbooks, papers, websites, and others. The AHP questionnaire was designed by comparing two criteria and sub-criteria. The rating scale can be seen in Table 1.

3. RESULTS AND DISCUSSION

3.1. Identification and determine potential industries

Identification is carried out based on secondary data obtained from the Central Statistics Agency, Padang Pariaman data in 2016-2020. Identification helps collect information on secondary data in the industry sector. Currently, there are ten potential industries based on data on the number of small and medium industries, the number of workers, and production values. Furthermore, from the ten potential industries will be determined the leading industries based on expert opinion, experts determine the weight for each criterion and sub-criteria.

3.2. Determine the criteria and sub-criteria

The criteria and sub-criteria in determining the priority industry in Padang Pariaman Regency were selected based on the National Industrial Development Master Plan 2015-2035. The criteria and sub-criteria in the government regulation are adapted to local needs, showed the sub-criteria in Table 2. There are nine criteria and 16 that are indicators of assessing ten potential industries that exist today.

3.3. Collecting expert opinions

The design of the criteria is based on the criteria in the national industrial development master plan (RIPIN). After obtaining the appropriate criteria, fill out a questionnaire to the experts. The questionnaire designed consisted of the AHP questionnaire and the TOPSIS questionnaire. This questionnaire is closed because the answers are in pairwise comparisons, and the answers have been provided. There are two types of questionnaires in this study. The first questionnaire is a questionnaire to determine the criteria' weight and the sub-criteria's weight. The second questionnaire is an alternative assessment questionnaire for determining priority industry. Furthermore, there is an additional suggestion column and a questionnaire validation sheet.

Table 2. Criteria and sub criteria for priority industry sector in Padang Pariaman Regency

Code	Criteria	Code	Sub Criteria
K01	Market Potential	S01	Production Value growth
		S02	Production Volume growth
		S03	Productivity
		S04	Production capacity
		S05	Raw Material Proportion
K02	Job Potential	S06	The number of the worker
		S07	Role in Labor Absorption
		S08	The intensity of Labor Use
		S09	Number of Salaries
K03	National Competitiveness	S10	Sales growth
		S11	Comparative Advantage
		S12	Sales Contribution
K04	Local Added Value	S13	Value Added growth
		S14	Level Use of Raw Materials
K05	Industrial structure	S15	Forward Link
		S16	Backward Link
K06	Technology		
K07	Economic Connectivity		
K08	Food security		
K09	Industrial Equity		

3.4. Determining criteria weights, sub-criteria weights, and final weights using analytical hierarchy process (AHP)

The weight of the criteria is obtained from the expert assessment. There are four experts and produces weights for nine criteria and 16 sub-criteria. Determination of the weight of this criterion used the AHP method. Likewise, the weight of the sub-criteria. Meanwhile, the final weight is obtained from the multiplication of the criteria' and sub-criteria's weights. Thus, weighting each criterion's sub-criteria is necessary because only specific criteria have certain sub-criteria, such as a hierarchical structure. For example, sub-criteria S01 to S05 are certain sub-criteria for criteria K01.

The following are the mathematical stages of the AHP method.

1. Calculate the value of the level of importance. This initial step converts Matrix A (n x n) into a Reciprocal Matrix. The formula can be seen in (1) to (3).

$$\begin{array}{|ccccc|} \hline C & A_1 & A_2 & \dots & A_n \\ A_1 & a_{11} & a_{12} & \dots & a_{1n} \\ A_2 & a_{21} & a_{22} & \dots & a_{2n} \\ .. & \dots & \dots & \dots & \dots \\ A_n & a_{n1} & a_{n2} & \dots & a_{nn} \\ \hline \end{array} \quad (1)$$

$$\frac{W_1}{W_2} = a_{12} \quad (2)$$

$$\begin{array}{|ccccc|} \hline C & A_1 & A_2 & \dots & A_n \\ A_1 & \frac{W_1}{W_1} & \frac{W_1}{W_2} & \dots & \frac{W_1}{W_n} \\ A_2 & \frac{W_2}{W_1} & \frac{W_2}{W_2} & \dots & \frac{W_2}{W_n} \\ \dots & \dots & \dots & \dots & \dots \\ A_n & \frac{W_n}{W_1} & \frac{W_1}{W_2} & \dots & \frac{W_n}{W_n} \\ \hline \end{array} \quad (3)$$

Where A: matrix is a form of pairwise comparison judgment; C: criteria; A: alternative; W: weight value; a: element matrix; and n: index for row or column

2. Perform priority synthesis by adding up the
3. values for each column.
4. Then, each element in the matrix is divided by the number of each column.
5. So, we get the value of the new element and add up each row. This value is called local priority or total priority value.
6. Do the same steps for the other criteria and alternatives.
7. Calculate Consistency Ratio (CR)
   The assessment is acceptable if the CR value is 10%. The formula can be seen in (4) and (5).

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

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$$CR = \frac{C\ I}{R\ I} \quad (5)$$

Where CR: consistency ratio; CI: consistency index; RI: random index; λmax: average eigen value of pairwise comparison matrix; and n: ordo

Pairwise Comparison Matrix consists of expert's opinion in scale (1-9). The matrix is 9 x 9 about criterion to determine the leading industrial sectors. The matrix can be seen in Table 3. After the opinions of all experts regarding the criteria are obtained, the matrix is then normalized. Normalization of this matrix is intended so that the number of assessments for each criterion is 1 (one) or 100%. Matrix normalization can be seen in Table 4. The calculation Normalized Matrix for column K01:

= 1.00 + 0.50 + 0.17 + 0.25 + 0.25 + 0.20 + 0.33 + 1.00 + 3.00

= 6.70

$a_{11} = \frac{1\,80}{6\,80} = 0.15$

Then, calculate the row for K01 in Table 4. until we get 1.69. The priority value for K01 = $\frac{1.69}{9\,80}$ = 0.19

Multiply the pairwise comparison matrix with the priority vector matrix, and we get the weighted sum and eigenvalue in Table 5 to calculate the consistency ratio.

$\partial_{m\ a\ x}$ = Average the Elements in Eigen Value

$\partial_{m\ a\ x} = \frac{10,26 + 9,76 + 9,77 + 12,60 + 9,62 + 9,\ 60 + 9,67 + 9,82 + 9,85}{9,00}$

$\partial_{m\ a\ x} = 10,10$

CI = $\frac{\partial_{m\ a\ x} - n}{n-1} = \frac{10,10 - 9}{9-1} = 0,14$

RI = 1.45 (for a matrix size of 9 [19])

CR = $\frac{\text{CI}}{\text{RI}} = \frac{0.14}{1.45} = 0.09 \leq 0.10$

Table 3. Pairwise comparison matrix

Code	K01	K02	K03	K04	K05	K06	K07	K08	K09
K01	1.00	2.00	6.00	4.00	4.00	5.00	3.00	1.00	0.33
K02	0.50	1.00	4.00	1.00	2.00	3.00	1.00	0.33	0.25
K03	0.17	0.25	1.00	0.20	0.50	1.00	0.33	0.14	0.13
K04	0.25	1.00	5.00	1.00	3.00	4.00	2.00	0.50	6.00
K05	0.25	0.50	2.00	0.33	1.00	1.00	1.00	0.20	0.17
K06	0.20	0.33	1.00	0.25	1.00	1.00	0.50	0.17	0.14
K07	0.33	1.00	3.00	0.50	1.00	2.00	1.00	0.25	0.20
K08	1.00	3.00	7.00	2.00	5.00	6.00	4.00	1.00	1.00
K09	3.00	4.00	8.00	0.17	1.00	7.00	5.00	1.00	1.00
Sum	**6.70**	**13.08**	**37.00**	**9.45**	**18.50**	**30.00**	**17.83**	**4.59**	**9.22**

Table 4. Normalized matrix

Code	K01	K02	K03	K04	K05	K06	K07	K08	K09	Sum	Priority Vector
K01	0.15	0.15	0.16	0.42	0.22	0.17	0.17	0.22	0.04	1.69	0.19
K02	0.07	0.08	0.11	0.11	0.11	0.10	0.06	0.07	0.03	0.73	0.08
K03	0.02	0.02	0.03	0.02	0.03	0.03	0.02	0.03	0.01	0.22	0.02
K04	0.04	0.08	0.14	0.11	0.16	0.13	0.11	0.11	0.65	1.52	0.17
K05	0.04	0.04	0.05	0.04	0.05	0.03	0.06	0.04	0.02	0.37	0.04
K06	0.03	0.03	0.03	0.03	0.05	0.03	0.03	0.04	0.02	0.28	0.03
K07	0.05	0.08	0.08	0.05	0.05	0.07	0.06	0.05	0.02	0.51	0.06
K08	0.15	0.23	0.19	0.21	0.27	0.20	0.22	0.22	0.11	1.80	0.20
K09	0.45	0.31	0.22	0.02	0.05	0.23	0.28	0.22	0.11	1.88	0.21
Sum	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	9.00	1.00

Table 5. Calculation of λ(eigen value)

Weighted Sum	Eigen Value
1,93	10,26
0,79	9,76
0,23	9,77
2,13	12,6
0,4	9,62
0,29	9,6
0,55	9,67
1,96	9,82
2,06	9,85

The calculation of the consistency index value and the random index value for sub-criteria is the same as the calculation for criteria. Table 6 and Table 7 explain the result calculation of the consistency index value and the random index value for the criteria and sub-criteria.

Table 6. Consistency ratio for criteria

λ_{max}	CI	RI	CR	Conclusion
10.10	0.14	1.45	0.09	Consistent Data

Table 7. Consistency ratio for sub-criteria

Code	λ_{max}	CI	RI	CR	Conclusion
K01 (n = 5)	5.05	0.01	1.12	0.01	Consistent Data
K02 (n = 4)	4.01	0.00	0.89	0.00	Consistent Data
K03 (n = 3)	3.01	0.00	0.58	0.01	Consistent Data
K04 (n = 2)	2.00	0.00	0.00	0.00	Consistent Data
K05 (n = 2)	2.00	0.00	0.00	0.00	Consistent Data

Table 8. The weighting of the criteria and sub-criteria for AHP

Code	Subcriteria	Subcriteria Weight of Each Level	Total Subcriteria Weight of Each Level	Code	Criteria	Criterion Weight	Final Weight
S01	Production Value growth	16.90%	100.00%	K01	Market Potential	12.84%	2.17%
S02	Production Volume growth	12.06%					1.55%
S03	Productivity	29.95%					3.84%
S04	Production capacity	17.08%					22.19%
S05	Raw Material Proportion	24.01%					3.08%
S06	The number of the worker	4.39%	100.00%	K02	Job Potential	11.82%	0.52%
S07	Role in Labor Absorption	28.88%					3.41%
S08	The intensity of Labor Use	24.85%					2.94%
S09	Number of Salaries	41.49%					4.95%
S10	Sales growth	64.18%	100.00%	K03	National Competitiveness	4.51%	2.90%
S11	Comparative Advantage	9.44%					0.43%
S12	Sales Contribution	26.38%					1.19%
S13	Value Added growth	79.56%	100.00%	K04	Local Added Value	12.69%	10.10%
S14	Level Use of Raw Materials	20.44%					2.59%
S15	Forward Link	88.52%	100.00%	K05	Industrial structure	8.34%	7.38%
S16	Backward Link	11.48%					0.96%
				K06	Technology	4.98%	4.98%
				K07	Economic Connectivity	10.31%	10.31%
				K08	Food security	14.20%	14.20%
				K09	Industrial Equity	20.31%	20.31%

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As the value from Table 6 and Table 7 for CR is less than 0,10, the judgments are acceptable [21]. Based on calculations obtained data consistent for the criteria and sub-criteria, continued to the following calculation. The final weight is obtained from the multiplication of the criteria' and sub-criteria's weights. The weight of each sub-criteria for each level is used for the final weight. The weighting of the criteria and sub-criteria results can be seen in Table 8.

3.5. Determining the leading industry using the technique for order preference method by similarity to ideal solution (TOPSIS)

The selection of priority industry alternatives is assessed based on primary data (from experts) using questioner and secondary data from Central Statistics Agency. The selection of this alternative uses the TOPSIS method. The weight used is derived from the final weight calculation in the AHP method.

There are 20 main criteria used in identifying leading industries using the TOPSIS method. The main criteria used in TOPSIS are a combination of the criteria and sub-criteria of the AHP S01-S16 and K06-K09 methods as shown in Table 8. 18 The main criteria were given by the expert using a scale of 1-9. The two main criteria were obtained from Central Statistics Agency data. The main criteria taken from the Central Statistics Agency are growth in production value (S01) and number of workers (S06) because data are available. Growth in production value and number of workers in the top 9 classes because the scale used for assessing other data (expert data) is also 1-9.

Furthermore, for each industry, the main criteria for production are value growth and the number of workers weighted according to their class. The matrix of expert data and the Central Statistics Agency data for ten industries can be seen in Table 9. The next step is the TOPSIS calculation.

The following are the mathematical steps or the mathematical stages of the TOPSIS method.

1. Normalize the decision matrix.
   Ai (Alternative) and Ci (Criteria) ratings are required. The following formula is in (6).

$$r_{ij} = \frac{X_{ij}}{\sqrt{\sum_{i=1}^{m} X_{ij}^2}} \quad (6)$$

   Where r_{ij}: decision normalization matrix; Xij: weight criterion j on alternative i; i: alternative i. $i = 1. 2. .... m$; and j: criteria j. $j = 1. 2. .... n$
2. Normalize the weighted decision matrix.
   Y matrix and other formulas can be seen in (7) and (8).

$$\begin{bmatrix} y_{11} & y_{12} & y_{1j} \\ y_{21} & y_{22} & y_{2j} \\ y_{i1} & y_{i2} & y_{ij} \end{bmatrix} \quad (7)$$

$$y_{ij} = w_j \,.\, r_{ij} \quad (8)$$

   Where w_j: weight criterion j; and y_{ij}: matrix element
3. Create a positive ideal solution matrix and a negative ideal solution matrix which can be seen in equations (9) to (10).

$$A^+ = (y_1^+ . y_2^+ . .... y_i^+) \quad (9)$$

$$A^- = (y_1^- . y_2^- . .... y_i^-) \quad (10)$$

   Where A: matrix; y_j^+: *max if j profit. min If j cost*; and y_j^-: *max if j cost. min If j profit*
4. Determine the distance between the ideal solution matrix and the value of each alternative. The formula can be seen in (11) and (12).

$$D_i^+ = \sqrt{\sum_{i=1}^{n} \left(y_i^+ - y_{ij} \right)^2} \quad (11)$$

$$D_i^- = \sqrt{\sum_{i=1}^{n} \left(-y_i^- + y_{ij} \right)^2} \quad (12)$$

   Where i: 1. 2. .... m; y_j^+: elements of the positive ideal solution matrix; and y_j^-: elements of the negative ideal solution matrix
5. Determine the preference value of each alternative.
   The alternative priority is chosen from the more considerable V_i value. The formula in (13).

$$V_i = \frac{D_i^-}{D_i^- + D_i^+} \quad (13)$$

   Where i: 1. 2. .... m; V: preference value; and D: distance
   Based on the RC+ value, industry ranking is carried out as shown in Table 10.

Table 9. Expert data and the Central Statistics Agency data matrix

Matriks	S01	S02	S03	S04	S05	S06	S07	S08	S09	S10	S11	S12	S13	S14	S15	S16	K06	K07	K08	K09
A01	5.00	6.75	7.00	7.25	7.25	5.00	6.25	6.75	6.25	6.25	5.75	5.75	5.75	6.00	8.75	5.75	5.25	5.75	3.75	4.00
A02	9.00	9.00	9.00	8.50	8.75	4.00	8.75	8.75	8.50	8.50	7.75	8.25	7.75	7.75	7.25	7.25	7.25	7.50	9.00	7.25
A03	2.00	6.50	5.75	7.00	7.25	4.00	7.25	7.75	5.75	6.50	5.00	6.50	6.50	5.75	6.75	5.25	5.50	4.50	3.25	4.75
A04	5.00	5.75	4.25	6.50	6.50	4.00	5.75	5.75	5.75	6.50	6.00	6.00	6.50	5.75	6.75	5.25	6.00	5.00	3.25	4.25
A05	1.00	7.50	6.50	7.00	8.00	8.00	7.00	7.00	6.50	6.50	6.50	6.50	6.00	8.00	7.00	7.00	6.25	6.25	7.25	6.75
A06	3.00	5.00	5.25	5.00	4.00	4.00	3.75	4.25	3.75	4.00	4.25	4.50	5.00	4.25	8.00	5.25	5.00	4.50	3.25	3.75
A07	1.00	8.00	7.25	7.00	6.75	3.00	6.75	6.75	5.75	8.00	7.00	7.25	6.50	6.25	8.25	5.25	5.50	6.50	3.25	5.75
A08	1.00	6.50	5.75	5.75	6.75	9.00	5.75	5.75	4.75	5.25	6.25	5.75	6.75	7.25	6.75	6.75	6.75	5.75	5.75	5.25
A09	1.00	6.00	5.25	5.75	4.75	3.00	5.75	5.50	5.00	5.50	6.00	5.50	5.50	5.50	5.50	5.50	5.50	5.50	5.00	5.50
A10	1.00	7.00	6.25	6.50	7.00	4.00	6.00	5.75	5.25	5.75	5.25	5.25	5.50	6.00	7.00	7.00	6.25	5.75	4.25	5.00

Table 10. Ranks of leading industry in Padang Pariaman Regency

D^+	D^-	RC^+	*Rank*	Industry
0.006	0.091	0.942	1	Food industry
0.029	0.064	0.686	2	Leather. Leather Goods. and Footwear Industry
0.051	0.040	0.437	3	Chemical Industry and Chemical Goods
0.061	0.032	0.341	4	Other Processing Industries
0.075	0.033	0.304	5	Apparel Industry
0.069	0.024	0.259	6	Wood manufacture and woven goods made of bamboo, rattan, and the like
0.080	0.021	0.207	7	Non-Metal Minerals Industry
0.079	0.020	0.203	8	Furniture Industry
0.084	0.016	0.162	9	Textile industry
0.089	0.006	0.067	10	Metal Goods Industry

The top five leading processing industries were selected: the food industry, leather industry, chemical industry, apparel industry, and other processing industries. Furthermore, the ranking is carried out again based on the details of each leading processing industry and selected the top five in each industry. The results of this ranking consider the number of small and medium industries (SMEs); comprehensive human resources; the ratio of labor and number of SMEs; production value; and the increase and decrease in the graph for the number of SMEs, the number of workers, and the value of production (the results of the forecast and the gradient value).

From the results of research that has been carried out by combining quantitative data and expert opinions, the five largest processing industries are priorities for development, namely: the food industry, the leather/footwear industry, the chemical industry, the apparel industry, and other processing industries. The selection of this industry is based on the value of preference or RC^+ (Relative Closeness). The highest value is 0.942 for the food industry. The food industry includes the bread and cake industry, chip industry, coconut cooking oil industry, rice milling, milling industries, and other developing industries.

The second highest industry is the leather/footwear industry, with a preference value of 0.686. including footwear for daily use, leather and artificial leather goods industry for personal use. and repair of footwear and leather goods. Furthermore, the chemical industry and chemical goods are the third-highest, with a preference value of 0.437. This industry consists of other fertilizer industries and soap and household cleaning materials. Other processing industries are the fourth-highest industry with a preference value or RC^+ value of 0.3641. namely motorcycle repair and maintenance services, jewellery goods industry from precious metals not for personal use, imitation jewellery industry, special design services, and handicraft industries. Then, the apparel industry has a preference value of 0.304, including the embroidery or embroidery industry, textile apparel equipment industry, textile

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convection industry, tailoring, custom-made clothing industry, and knitted apparel industry.

MCDM is a decision-making method to determine the best alternative from several alternatives based on specific criteria [22]. This research has integrated AHP and TOPSIS to determine priority industries in Padang Pariaman Regency. Because it is not exact enough to assess, the AHP approach has a flaw. This problem was handled by including additional information into choosing the leading industry. In addition. the AHP approach is frequently used with other MCDM methods. This study using the TOPSIS method to solve these flaws. The TOPSIS approach requires the weights used in AHP methods' calculations. As a result, merging these two strategies is a practical step toward overcoming the shortcomings of each method. Industries are selected based on several criteria. Criteria are usually in the form of measures, rules, or standards used in decision-making.

4. CONCLUSION

This research has used decision-making techniques using the AHP and TOPSIS methods to select leading industries in Padang Pariaman Regency. Based on the identification and analysis that has been done, there are ten priority industries. This industry is determined based on the number of SMEs, the number of workers, and data on production values. From the results of research that has been carried out by combining quantitative data and expert opinions, the five largest processing industries are priorities for development, namely: the food industry, the leather/footwear industry, the chemical industry, the apparel industry, and other processing industries. This leading industry can be the basis to design Industrial Development Plan of the Padang Pariaman Regency.

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REFERENCES

[1] X. Bai. J. Chen. and P. Shi. “Landscape urbanization and economic growth in China: Positive feedbacks and sustainability dilemmas.” *Environ. Sci. Technol.*. vol. 46. no. 1. pp. 132–139. Jan. 2012. doi: 10.1021/es202329f.

[2] Badan Pusat Statistik Kabupaten Padang Parimanan. “*Kabupaten Padang Pariaman Dalam Angka 2020*.” 2020. Available: https://padangpariamankab.bps.go.id/publication/2020/04/27/66eb65a6a2d046b577c18ab5/kabupaten-padang-pariaman-dalam-angka-2020.html.

[3] M. S. Nazir. M. M. Nawaz. and U. J. Gilani. “Relationship between economic growth and stock market development.” *African J. Bus. Manag.*. vol. 4. no. 16. pp. 3473–3479. 2010. Available: https://academicjournals.org/journal/AJBM/article-abstract/229B23621149.

[4] D. Su and Y. Yao. “Manufacturing as the key engine of economic growth for middle-income economies.” *J. Asia Pacific Econ.*. vol. 22. no. 1. pp. 47–70. Jan. 2017. doi: 10.1080/13547860.2016.1261481.

[5] S. Suharman. M. Nugroho. M. W. M. Asha. and H. W. Murti. “Inovasi. Teknologi dan Peningkatan Daya Saing Industri.” *Pros. Semin. Nas. Has. Litbangyasa Ind. II*. vol. 1. no. 1. pp. 137–148. 2018. Available: http://litbang.kemenperin.go.id/pmbp/article/view/4469.

[6] E. K. Zavadskas and Z. Turskis. “Multiple criteria decision making (MCDM) methods in economics: An overview.” *Technol. Econ. Dev. Econ.*. vol. 17. no. 2. pp. 397–427. 2011. doi: 10.3846/20294913.2011.593291.

[7] C. Kahraman, *Fuzzy Multi-Criteria Decision Making: Theory and Applications with Recent Developments*. Springer US, 2008. Available: https://books.google.co.id/books?id=s2GOmBVdXYoC.

[8] M. Aruldoss. T. M. Lakshmi. and V. Prasanna Venkatesan. “A Survey on Multi Criteria Decision Making Methods and Its Applications.” *Am. J. Inf. Syst.*. vol. 1. no. 1. pp. 31–43. 2013. Available: http://pubs.sciepub.com/ajis/1/1/5/.

[9] M. L. Bell, B. F. Hobbs, and H. Ellis, “The use of multi-criteria decision-making methods in the integrated assessment of climate change: implications for IA

practitioners," *Socioecon. Plann. Sci.*, vol. 37, no. 4, pp. 289–316, 2003, doi: 10.1016/S0038-0121(02)00047-2.

[10] H. Akay and M. Baduna Koçyiğit. "Flash flood potential prioritization of sub-basins in an ungauged basin in Turkey using traditional multi-criteria decision-making methods." *Soft Comput.*. vol. 24. no. 18. pp. 14251–14263. Sep. 2020. doi: 10.1007/s00500-020-04792-0.

[11] R. Raei and M. Bahrani Jahromi. "Portfolio optimization using a hybrid of fuzzy ANP. VIKOR and TOPSIS." *Manag. Sci. Lett.*. vol. 2. no. 7. pp. 2473–2484. Oct. 2012. doi: 10.5267/j.msl.2012.07.019.

[12] A. Sanayei. S. Farid Mousavi. and A. Yazdankhah. "Group decision making process for supplier selection with VIKOR under fuzzy environment." *Expert Syst. Appl.*. vol. 37. no. 1. pp. 24–30. Jan. 2010. doi: 10.1016/j.eswa.2009.04.063.

[13] S. Unver and I. Ergenc. "Safety risk identification and prioritize of forest logging activities using analytic hierarchy process (AHP)." *Alexandria Eng. J.*. vol. 60. no. 1. pp. 1591–1599. Feb. 2021. doi: 10.1016/j.aej.2020.11.012.

[14] M. Punniyamoorty. P. Mathiyalagan. and G. Lakshmi. "A combined application of structural equation modeling (SEM) and analytic hierarchy process (AHP) in supplier selection." *Benchmarking*. vol. 19. no. 1. pp. 70–92. Feb. 2012. doi: 10.1108/14635771211218362.

[15] A. Görener. K. Toker. and K. Uluçay. "Application of Combined SWOT and AHP: A Case Study for a Manufacturing Firm." *Procedia - Soc. Behav. Sci.*. vol. 58. pp. 1525–1534. Oct. 2012. doi: 10.1016/j.sbspro.2012.09.1139.

[16] E. Suroso, W. Satyajaya, H. Al Rasyid, and T. P. Utomo, "Kajian penentuan komoditas unggulan dalam pengembangan teknologi agroindustri rakyat di Kabupaten Tulang Bawang," *Inov. Pembang. J. Kelitbangan*, vol. 4, no. 01, pp. 22–36, 2016. Available: https://jurnal.balitbangda.lampungprov.go.id/index.php/jip/article/view/6.

[17] A. N. Rukmana. R. Amaranti. and M. A. Shakira. "Penetapan Potensi Unggulan Kecamatan Di Kabupaten Bandung." *J. Res. Technol.*. vol. 6. no. 1. pp. 23–32. 2020. Available: https://www.journal.unusida.ac.id/index.php/jrt/article/view/137.

[18] E. N. Homer, A. D. Wicaksono, and F. Usman, "Penentuan Jenis Klaster industri di Kawasan Industri Arar Kabupaten Sorong Berdasarkan Metode Delphi dan Analytical Hierarchi Process (AHP)," *Indones. Green Technol. J.*, vol. 5, no. 1, pp. 16–23, 2016. Available: https://igtj.ub.ac.id/index.php/igtj/article/view/159.

[19] B. Vahdani. S. M. Mousavi. and R. Tavakkoli-Moghaddam. "Group decision making based on novel fuzzy modified TOPSIS method." *Appl. Math. Model.*. vol. 35. no. 9. pp. 4257–4269. Sep. 2011. doi: 10.1016/j.apm.2011.02.040.

[20] F. Torfi. R. Z. Farahani. and S. Rezapour. "Fuzzy AHP to determine the relative weights of evaluation criteria and Fuzzy TOPSIS to rank the alternatives." *Appl. Soft Comput. J.*. vol. 10. no. 2. pp. 520–528. 2010. doi: 10.1016/j.asoc.2009.08.021.

[21] T. L. Saaty and L. G. Vargas, *Models, Methods, Concepts & Applications of the Analytic Hierarchy Process*, vol. 175. Boston, MA: Springer US, 2012. doi: 10.1007/978-1-4614-3597-6.

[22] J. qiang Wang. Y. xi Cao. and H. yu Zhang. "Multi-Criteria Decision-Making Method Based on Distance Measure and Choquet Integral for Linguistic Z-Numbers." *Cognit. Comput.*. vol. 9. no. 6. pp. 827–842. 2017. doi: 10.1007/s12559-017-9493-1.

http://dx.doi.org/10.30656/jsmi.v5i2.3823