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Determination of Village Development Priorities Based on Decision Support System Using the FAHP-WP Method

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***Abstract*--Villages play a strategic role in national development, particularly in improving the quality of life and community welfare. Rengel Village, located in Tuban Regency, East Java, holds significant potential for development. However, decision-making in development through the "Musrenbangdes" (village development planning forum) is often hindered by conflicts of interest between neighborhood units (RT and RW) and the lack of an objective system to assess priorities. Therefore, a Decision Support System (DSS) utilizing the Fuzzy Analytic Hierarchy Process (F-AHP) and Weighted Product (WP) methods is needed to prioritize development. F-AHP determines criterion weights based on relative importance and addresses uncertainty in assessments, while WP ranks alternatives based on these weights. This study involves data collection, calculation of criterion weights, alternative development ranking, system development, and deriving conclusions. The results show that the CR value of 0.033 indicates a good level of consistency in comparisons, yielding the following criterion weights: RPJM (0.331), Urgency Level (0.278), Impact and Benefits (0.237), Regulatory Compliance (0.14), and Budget (0.014). Meanwhile, the alternative development ranking results indicate the following priority order: AP41 (1), AP06 (2), AP33 (3), AP49 (4), AP12 (5), AP40 (6), AP13 (7), AP11 (8), AP43 (9), and AP28 (10).**

***Key words*: Analytic Hierarchy Process Fuzzy; Decision-making; Prioritization; Village development; Weighted Product.**

I. INTRODUCTION

Villages play a strategic role in national development, as the majority of Indonesia's population resides in rural areas and significantly contributes to the country's stability [1]. Village development aims to improve the quality of life and welfare of village communities. The success of village development requires priority analysis and precise decision-making to align with the overall needs of the community. Decision-making is a critical process, but it often becomes complex due to conflicting objectives, numerous options to consider, insufficient clear information, and constantly changing circumstances [2].

Rengel Village, located in Tuban Regency, East Java, is one of the villages with significant development potential. With a population of 9,472 people and abundant natural resources, Rengel Village offers development opportunities in infrastructure, education, healthcare, and creative economy sectors. Development decision-making in Rengel Village is conducted through the Village Development Planning Deliberation (Musrenbangdes). However, this process often takes time due to differing interests among RT and RW representatives, as noted by the village official, Mr. Muhlison. Furthermore, the absence of an objective system to assess the priority of development proposals results in decisions being based more on negotiation than strategic needs. This situation can lead to less effective planning, whereas proper planning is essential to guide sustainable development [3].

To address these challenges, a Decision Support System (DSS) presents a relevant solution. A DSS assists decision-making by providing data-driven analysis to compare various options [4]. Without a DSS, decision-making processes can become inefficient, increase costs, and result in missed opportunities [5]. One of the methods employed is a combination of the Fuzzy Analytical Hierarchy Process (F-AHP) and Weighted Product (WP). The Fuzzy Analytic Hierarchy Process (F-AHP) is a multi-criteria decision-making method that integrates the Analytic Hierarchy Process (AHP) with fuzzy logic to address uncertainty and imprecision in subjective assessments [6]. Meanwhile, the WP method is used to rank development alternatives based on predetermined weights.

The previous research by Purnia et al. (2020) used the Promethee method in a Decision Support System (DSS) to design a web-based information system at BAPPEDA Ciamis Regency, which

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helps rank development priorities efficiently [7]. The Promethee method has the advantage of providing rankings based on clear and structured criteria; however, its limitation lies in its inability to handle uncertainty and subjectivity in data. In this study, a hybrid approach of FAHP and WP is used, where FAHP addresses the weaknesses of AHP in dealing with subjectivity and uncertainty by using fuzzy scales [8]. FAHP has proven to improve assessment accuracy, as demonstrated by Iswara et al. (2018) in determining mustahik with an accuracy of 91.67% [9]. The study by Lubis et al. (2021) showed that the AHP method produces consistent and objective criteria weights, while WP is effective in ranking alternatives, with A134 as the best alternative and A96 as the lowest, with an execution time of 1.27 seconds [10].

Therefore, the combination of FAHP and WP is more adaptive and efficient in determining village development priorities, especially in handling data uncertainty. With the implementation of a Decision Support System, it is hoped that the Rengel Village government can objectively prioritize development according to community needs.

II. Method

This research methodology involves a series of systematic steps designed to address the formulated problems. The process begins with data collection, followed by the calculation of Fuzzy Analytic Hierarchy Process (F-AHP) to determine the weights of each criterion. Subsequently, the Weighted Product (WP) method is applied to rank the development alternatives based on these criteria. Finally, a system is developed to automate the calculations, ensuring faster, more accurate, and transparent decision-making. This methodological approach integrates analytical techniques with system development to provide an objective and efficient solution for prioritizing village development projects. The steps undertaken are summarizes in Fig. 1.

A. Data Collection

Data collection in this study was conducted through literature reviews and interviews to obtain relevant and in-depth information related to the research topic.

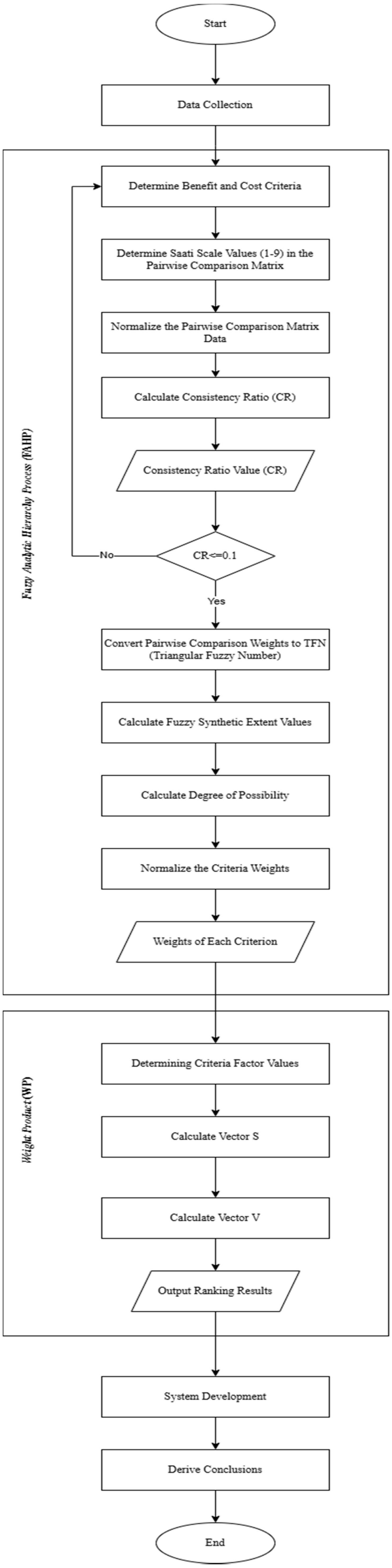

Fig. 1. Research Flow

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The literature review helped to gather existing knowledge, theories, and methodologies related to the research, while interviews were conducted with key stakeholders to gain practical insights and perspectives on the topic. This combination of data collection methods ensured a comprehensive understanding of the subject matter, allowing for more informed analysis and decision-making.

B. *Criteria Weight Calculation Using Fuzzy Analytic Hierarchy Process (FAHP)*

The determination of criteria weights for prioritizing development in Rengel Village was carried out using the Fuzzy Analytic Hierarchy Process (FAHP). This method helps to handle the uncertainty and subjectivity in decision-making by using fuzzy scales. The steps in the calculation process are as follows:

1. Defining Benefit and Cost Criteria
   The criteria in this study are divided into two types: benefit and cost. Benefit criteria prioritize higher values, while cost criteria prioritize lower values.
2. Assigning Saaty's Scale Values (1-9)
   At this stage, a pairwise comparison matrix of the criteria is created using Saaty's 1-9 scale. This scale represents the relative importance between two criteria.
3. Normalizing the Pairwise Comparison Matrix
   Once the pairwise comparison matrix is constructed, the data is normalized to obtain the initial criteria weights. Normalization is performed by dividing each element in the matrix by the total column sum.
4. Calculating the Consistency Ratio (CR)
   If the CR value is less than or equal to 0.1, the matrix is considered consistent, and the calculation can proceed. Conversely, if the CR value exceeds 0.1, the matrix must be revised to ensure the validity of the comparisons.
5. Converting Weights into Triangular Fuzzy Numbers (TFN)
   After confirming consistency, the initial criteria weights are converted into Triangular Fuzzy Numbers (TFN). A TFN comprises three key components—low, medium, and high values—that represent the fuzzy value of each weight. The scale for the Triangular Fuzzy AHP is shown in Table I [7].

TABLE I
Triangular Fuzzy Numbers

Category	Triangular Fuzzy AHP	Triangular Fuzzy AHP Inverse
Equally Important	1,1,1	1, 1, 1
Intermediate Preference	1,2,3	1/3, 1/2, 1
Moderately More Important	2,3,4	1/4, 1/3, 1/2
Intermediate Preference	3,4,5	1/5, 1/4, 1/3
Strongly More Important	4,5,6	1/6, 1/5, 1/4
Intermediate Preference	5,6,7	1/7, 1/6, 1/5
Very Strong More Important	6,7,8	1/8, 1/7, 1/6
Intermediate Preference	7,8,9	1/9, 1/8, 1/7
Extremely More Important	8,9,9	1/9, 1/9, 1/8

The table illustrates various categories of preferences used in Triangular Fuzzy Numbers (TFNs) for Fuzzy Analytic Hierarchy Process (F-AHP). Each category represents the degree of importance or preference between criteria, with corresponding TFNs and their inverses. For example, "Equally Important" is represented by (1, 1, 1) for both the original and inverse comparisons, while "Moderately More Important" is represented by (2, 3, 4) for the original and (1/4, 1/3, 1/2) for the inverse. These values are aggregated and normalized to calculate the criterion weights, ensuring consistent decision-making.

6. Calculating Fuzzy Synthetic Extent
   This calculation is based on a fuzzy matrix and aims to evaluate the relative superiority among criteria. This value serves as the foundation for subsequent fuzzy analysis steps:

$$S_i = \left(\sum_{j=1}^{m} M_{gi}^{j}\right) \otimes \left[\left(\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^{j}\right)\right]^{-1} \quad (1)$$

Note:
S_i = The fuzzy synthetic extent value for the i-th object.

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∑ = Summation of the values in the column, starting from column 1 in each row of the matrix.
j = Refers to the column index.
i = Refers to the row index.
M = Triangular Fuzzy Number (TFN).
m = Total number of criteria.
g = Parameters of the Triangular Fuzzy Number (TFN), consisting of l (lower limit), m (middle value), and u (upper limit).

7. Calculating the Degree of Possibility

The degree of possibility is used to compare the relative superiority among criteria. It determines to what extent one criterion is considered superior to another under uncertainty. The following equation is used to calculate V:
- If m1 ≥ m2, then V = 1
- If l2 ≥ u1, then V = 0
- Otherwise, V is calculated as:

$$\frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} \quad (2)$$

Note:
V = Degree of Possibility (degree of overlap between fuzzy sets).
l = Lower Limit (the smallest value of a fuzzy set).
m = Middle Value (the most representative value of a fuzzy set).
u = Upper Limit (the largest value of a fuzzy set).

8. Normalizing Criteria Weights

The calculated fuzzy weights are then normalized so that the total weight of all criteria equals 1. This normalization ensures that the final criteria weights are proportional and can be used as input for the WP method:

$$d(A_i) = \frac{d'(A_i)}{\sum_{i=1}^{n} d'(A_i)} \quad (3)$$

Where $d'(A_i) = \min\{V(S_i \geq S_k)\}$.

Note:
$d(A_i)$: Normalized preference for alternative A_i.
$d'(A_i)$: Individual preference value of A_i
Σ $d'(A_i)$: Total preference values of all alternatives.

C. *Ranking Calculation Using the Weighted Product Method*

The Weighted Product (WP) method is used to determine the ranking of alternatives based on preference values obtained from the calculation process. The steps for ranking calculation using the WP method are as follows:

1. Determining Criteria Factor Values

   This step involves determining scale factor values for each criterion to be used in the decision-making process. The chosen scale reflects field conditions for each criterion.

2. Calculating the S Vector

   The WP method evaluates and ranks alternatives based on criteria weights. The first step is calculating the S vector value, which represents the weighted product of each alternative's performance on the criteria. The purpose of calculating the S vector is to aggregate the performance of each alternative across all criteria, giving a comprehensive score that reflects how well each alternative meets the set criteria. This value is used to compare and rank the alternatives, helping to identify the best options based on the established criteria. The first step is calculating the S vector value:

$$S_i = \prod_{j=1}^{n} X_{ij}^{w_j} \quad (4)$$

   where i = 1, 2, …, m

   Note:
   S : Preference of alternatives represented as vector S
   x : Value of the criterion
   w : Weight of the criterion
   i : Alternative
   j : Criterion
   n : Number of criteria

3. Calculating the V Vector

   This step calculates the V vector, which determines the ranking of alternatives. The V vector transforms the S vector values into a scale representing each alternative's relative preference, with higher values indicating better performance. This calculation helps compare alternatives clearly for informed decision-making. The relative preference value of each alternative is calculated using

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the formula:

$$dV_i = \frac{\prod_{j=1}^{n} x_{ij}^{w_j}}{\prod_{j=1}^{n} x_{tj}{*}W_j} \quad (5)$$

Note:
V: Represents the preference of alternatives represented as vector V
x : Value of the criterion
w : Weight of the criterion
i : Alternative
j : Criterion
n : Number of criteria

4. Ranking Output

After completing all calculations, the final result is a ranking of alternatives. The alternative with the highest V vector value is considered the top priority for the development of Rengel Village based on the specified criteria, while the alternative with the lowest V vector value is given the lowest priority. This ranking provides an objective guide for decision-making, ensuring that the development focuses on the most urgent and strategic needs. The purpose of this ranking is to prioritize development projects effectively, directing resources and efforts towards the initiatives that will bring the greatest benefits to the community.

D. System Development

This stage involves developing a web-based system for prioritizing the development of Rengel Village using PHP and MySQL. The system is designed to process data and automatically calculate rankings using the FAHP-WP method.

E. Derive Conclusions

The final stage involves analyzing the calculation results to derive conclusions and provide recommendations. These recommendations are based on the top-ranked alternative obtained from the FAHP-WP process, supporting more effective decision-making.

III. Result and Discussion

This section presents the findings of the study and provides an in-depth discussion of the results obtained through the application of the FAHP-WP method. The analysis focuses on determining the village development priorities based on the established criteria and scale. It also discusses the implications of the calculated preferences and explores how these results can support decision-making in village development planning

A. Data Collection

Data collection in this study was conducted through literature review and interviews. The literature review involved searching for journals, articles, news, and other related sources to obtain theoretical information on village development planning. Additionally, interviews were conducted with Mr. Muhlison, a village official, and the Village Development Work Plan (RKP) team to obtain practical and in-depth information about the village development planning process.

Table II summarizes the data collection on the decision-making process for determining Rengel Village's development priorities. Meetings with representatives of 74 RT/RWs and village officials are held to record and map needs, but the process faces challenges such as debates that cause delays and a deliberation system that is slow and lacks objectivity. Key indicators considered in the decision-making include budget, alignment with the medium-term development plan, urgency, impact, and regulations. Interviews were also conducted to gather data on alternative development plans for Rengel Village and the criteria used in the decision-making process.

TABLE II
Interview Result

No.	Question	Answer
1	How is the decision-making process to determine the development priorities of Rengel Village?	Through a meeting with representatives of RT/RW and village officials, recording and mapping the needs.
2	How is the decision-making process to determine the development priorities of Rengel Village?	74 RT/RWs.
3	Are there any obstacles in determining development priorities?	Yes, debates among representatives delay the process.
4	Is the current deliberation system effective?	No, the process is slow and not objective.
5	What indicators are considered in determining village development?	Budget, Alignment with Village Medium-Term Development Plan, Urgency, Impact, Regulations.

B. Calculation of Criterion Weights with FAHP

1. Determine Criteria and Type of Benefit or Cost

In this section, the criteria for prioritizing the development of Rengel Village are

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determined based on several factors that reflect both costs and benefits. These criteria play a crucial role in evaluating and ranking development projects to ensure that the most urgent and impactful initiatives are prioritized. The following are the criteria and their corresponding types of benefit or cost:

A: Budget (Cost)
M: RPJM (Medium-Term Village Development Plan) (Benefit)
K: Urgency Level (Benefit)
D: Impact or Benefit Level (Benefit)
R: Regulatory Compliance (Benefit)

2. Determine the Value of the Saaty Comparison Matrix (1-9)

The pairwise comparison matrix reflects the preference level between criteria, helping to establish their relative importance in decision-making. This matrix assigns numerical values (1-9) to indicate the intensity of preference, where higher values represent greater importance.

Table III presents the Pairwise Comparison Matrix (Saaty Comparison Matrix), which compares the importance levels between criteria (M, K, D, R, A) in the AHP method. The diagonal values are 1, while other values represent preference levels, such as M being twice as important as K (value 2) and the reverse being 0.5. This matrix is used to calculate the priority weights of each criterion.

TABLE III
Comparison Matrix

	M	K	D	R	A
M	1	2	2	3	3
K	0.5	1	2	2	3
D	0.5	0.5	1	2	3
R	0.333	0.5	0.5	1	2
A	0.333	0.333	0.333	0.5	1

3. Normalize the Matrix

Normalization is done by dividing each element in the pairwise comparison matrix column by the total value of that column. Table IV shows the normalized pairwise comparison matrix, where each element represents the result of dividing the value in the original matrix by the total value of its respective column. This normalization ensures that the sum of each column equals 1, providing a consistent basis for calculating priority weights for each criterion.

TABLE IV
Normalize The Matrix

	M	K	D	R	A
M	0.375	0.462	0.343	0.353	0.25
K	0.188	0.231	0.343	0.235	0.25
D	0.188	0.115	0.171	0.235	0.25
R	0.125	0.115	0.086	0.118	0.167
A	0.125	0.077	0.057	0.059	0.083

4. Calculate Priority Weights by Determining the Eigenvector

The average or priority weight is obtained by summing the elements in each row of the matrix and dividing the result by the total sum of elements in that row. This process is done for all criteria.

Table V shows the priority weights for the criteria M, K, D, R, and A. Each weight is calculated by summing the row values and dividing by the total number of criteria. The AVR/Priorities column represents the final priority weight for each criterion, which will be used to determine the eigenvector.

TABLE V
Priority Weights

	M	K	D	R	A	AVR/ Prioritas
M	0.375	0.462	0.343	0.353	0.25	0.357
K	0.188	0.231	0.343	0.235	0.25	0.249
D	0.188	0.115	0.171	0.235	0.25	0.192
R	0.125	0.115	0.086	0.118	0.167	0.122
A	0.125	0.077	0.057	0.059	0.083	0.08

5. Calculate the Maximum Eigenvalue

a. Vektor [A]

It is obtained by multiplying the initial matrix by the priority weights (eigenvector), which helps to determine the relative importance of each criterion in the decision-making process. Table VI shows the Eigenvalue calculation results for each criterion in the AHP method. The Eigenvalue is obtained by multiplying the normalized matrix values by the priority weights (eigenvector), such as for criterion M, calculated as 2.666 x 0.357 = 0.952. These results are used to test the

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consistency of the pairwise comparison matrix and ensure the accuracy of the priority weights in decision-making.

TABLE VI
Eigenvalue

Criteria	Normalized Matrix	Priority Weights	*Eigenvalue*
M	2.666	0.357	0.952
K	4.333	0.249	1.079
D	5.833	0.192	1.120
R	8.5	0.122	1.037
A	12	0.080	0.960

b. Lambda Maximum or Maximum Eigenvalue

The maximum or minimum eigenvalue often referred to as lambda max (λmax), is a measure used in methods like AHP (Analytic Hierarchy Process) to assess the consistency of decision-making matrices. It is calculated by finding the eigenvalue of a pairwise comparison matrix. If the matrix is consistent, the maximum eigenvalue will be close to the number of criteria being compared. A lambda max value that deviates significantly from this indicates inconsistency in the judgments, which may require adjustments to improve the reliability of the decision-making process. The total lambda max value for each criterion is the sum of the following values: 0.952 + 1.079 + 1.12 + 1.037 + 0.960 = 5.148

6. Calculate Consistency Index (CI)

The Consistency Index (CI) is used to measure the consistency level in the pairwise comparison matrix.

$$\text{CI} = \frac{\lambda maks - n}{\text{n} - 1} = \frac{5.148 - 5}{5 - 1} = 0.037$$

In this case, the matrix has five criteria, and the largest eigenvalue (λmax) obtained is 5.148. With this calculation, the CI is found to be 0.037. This low CI value indicates that the pairwise comparisons are highly consistent, which is crucial for ensuring the reliability of the decision-making process. The result of this CI calculation will be used next to compute the Consistency Ratio (CR).

7. Calculate Consistency Ratio (CR)

The Consistency Ratio (CR) is used to evaluate whether the level of consistency in the pairwise comparison matrix is acceptable

$$\text{CR} = \frac{CI}{\text{RI}} = \frac{0.037}{1.12} = 0.033$$

The Consistency Ratio (CR) is a measure used to evaluate whether the level of consistency in a pairwise comparison matrix is acceptable. The CR is calculated by dividing the Consistency Index (CI) by the Random Index (RI). The CI value is 0.037, and the RI value is 1.12, resulting in a CR value of 0.033

8. Check the Consistency Ratio (CR)

For the pairwise comparison matrix to be acceptable, the CR value should be less than 0.1 (CR ≤ 0.1). Since the CR value of 0.033 is smaller than 0.1, the matrix is considered consistent, and the weight calculations can be accepted.

9. Convert Comparison Matrix Values to Triangular Fuzzy Numbers

The pairwise comparison matrix, which has passed the consistency ratio test with CR ≤ 0.1, will be converted into Triangular Fuzzy Numbers (TFN) that include lower, medium, and upper values.

Table VII illustrates the process of converting values from the AHP comparison matrix into Triangular Fuzzy Numbers to account for uncertainty in decision-making. In the previous AHP comparison matrix, if a comparison value is 2, its corresponding fuzzy triangular value is (1,2,3), where 1 represents the lower bound, 2 is the middle (most likely) value, and 3 is the upper bound.

10. Calculating Extent Analysis Values

In this stage, the results from the Triangular Fuzzy Numbers (TFN) conversion are used to calculate the extent analysis value for each criterion. This calculation involves the lower, medium, and upper bounds of TFN for each criterion.

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TABLE VII
Convert Comparison Matrix Values to Triangular Fuzzy Numbers

	M	K	D	R	A
M	1,1,1	1,2,3	1,2,3	2,3,4	2,3,4
K	0.333, 0.500, 1.000	1,1,1	1,2,3	1,2,3	2,3,4
D	0.333, 0.500, 1.000	0.333, 0.500, 1.000	1,1,1	1,2,3	2,3,4
R	0.250, 0.333, 0.500	0.333, 0.500, 1.000	0.333, 0.500, 1.000	1,1,1	1,2,3
A	0.250, 0.333, 0.500	0.250, 0.333, 0.500	0.250, 0.333, 0.500	0.333, 0.500, 1.000	1,1,1

Table VIII shows the calculation of the extent analysis values derived from the Triangular Fuzzy Numbers (TFN). Each row corresponds to a specific criterion, and the columns represent the lower bound (L), medium value (M), and upper bound (U) of the fuzzy values for that criterion. These values are obtained by aggregating and normalizing the results from the pairwise comparison in the earlier stages of the fuzzy AHP process.

TABLE VIII
Calculating Extent Analysis Values

L	M	U
0.147	0.33	0.675
0.112	0.255	0.54
0.098	0.21	0.45
0.061	0.13	0.293
0.044	0.075	0.158

11. Calculate Degree of Possibility

After calculating the extent analysis values, the next step is to calculate the degree of possibility to determine how much one criterion is considered more important than another. Table IX shows the results of the degree of possibility, which compares the results of the extent analysis with the conditioning in the degree of possibility formula. This value is calculated by comparing the fuzzy extent of each criterion against the others. After obtaining the values from each comparison, the minimum value for each criterion is selected to determine the criterion's weight

TABLE IX
Calculate Degree of Possibility

Criteria	Degree of Possibility	Value	Minimum Value
M	V(S1>=S2)	1	1
	V(S1>=S3)	1	
	V(S1>=S4)	1	
	V(S1>=S5)	1	
K	V(S2>=S1)	0.84	0.84
	V(S2>=S3)	1	
	V(S2>=S4)	1	
	V(S2>=S5)	1	
D	V(S3>=S1)	0.716	0.716
	V(S3>=S2)	0.883	
	V(S3>=S4)	1	
	V(S3>=S5)	1	
R	V(S4>=S1)	0.422	0.422
	V(S4>=S2)	0.592	
	V(S4>=S3)	0.709	
	V(S4>=S5)	1	
A	V(S5>=S1)	0.041	0.041
	V(S5>=S2)	0.204	
	V(S5>=S3)	0.308	
	V(S5>=S4)	0.638	
TOTAL			3.019

12. Determine Criterion Weights

After calculating the degree of possibility, the weight for each criterion is determined based on the minimum value of the degree of possibility. The weights for each criterion are as follows:

A: Budget = 1
M: RPJM (Medium-Term Village Development Plan) = 0.84
K: Urgency Level = 0.716
D: Impact or Benefit Level = 0.422
R: Regulatory Compliance = 0.041

13. Normalize Criterion Weights

The final step is to normalize the criterion weights, which is done by dividing each criterion's weight by the total weight to make sure the total weight equals 1. Table X illustrates the process of normalizing criterion weights. Each criterion (M, K, D, R, A) is assigned an initial weight, which is then normalized by dividing the weight of each criterion by the total sum of all weights. This ensures that the normalized weights add up to 1, allowing for a balanced and proportional representation of each criterion's importance in the evaluation process. For example,

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criterion M has the highest normalized weight (0.331), indicating its greater influence compared to others, while A has the smallest normalized weight (0.014).

TABLE X
Normalize Criterion Weights

	Weight	Normalized Weight
M	1	0.331
K	0.840	0.278
D	0.716	0.237
R	0.422	0.140
A	0.041	0.014

C. *Ranking Calculation with Weighted Product (WP)*

1. Determine Alternatives for Development Plans

There are 51 alternative development plan data entries. Table XI shows 10 representative alternative data entries, which will be evaluated based on the established criteria to determine the most optimal development plan. These alternatives will be assessed using the Weighted Product method to prioritize and select the best options for implementation.

Table XI contains several alternative development plans for Desa Rengel, derived from a total of 51 original data entries. Each development plan is assigned a unique code to facilitate identification and further processing. This code helps differentiate each alternative plan, allowing for a systematic and structured analysis and comparison. These data will later be ranked based on the results of the Weighted Product (WP) calculation to determine the most suitable and optimal development plan alternative.

2. Determine the Scale Values for Each Criterion and Calculate the S and V Vectors

Vector S is calculated by combining the factor values of each criterion with the predetermined weights. The Benefit criteria (RPJM, Urgency, Impact, and Regulatory Compliance) are raised to the power of positive weights, while the Cost criterion (Budget) is raised to the power of negative weights. This ensures that beneficial factors are enhanced, and the cost is minimized.

TABLE XI
Alternatives for Development Plans

Code	Aternative Names for the Development Plans of Rengel Village
AP01	Repair of the bridge near Pondok Al Khoirot (Depression)
AP02	Repair of Gang Walet road
AP03	Repair of roads damaged by rainwater flow and drainage/sanitation in Gang Yatim north of the mosque, which floods during heavy rain or household water discharge
AP04	Installation of convex mirrors in Gang Tirtomoyo
AP05	Construction of drainage from behind the village hall to the east of Pak Pos
AP06	Construction of retaining walls along the edge of Serut Cemetery to Gempol (TPT)
AP07	Installation of heat protection at RW 04 community hall, such as blinds or canopies, to shield posyandu activities from the heat (blinds and canopies)
AP08	Gradual construction of a gate (gapura) in RW 04
AP09	Construction of RW 03 community hall
AP10	Repair of the road from the west direction of Purboyo Bridge to the main road

The determination of each criterion is critical as it reflects their importance in the decision-making process. The S-vector represents the overall performance of the alternatives, while the V-vector, obtained by normalizing the S-vector, allows for easy comparison and ranking of alternatives, ensuring objective and informed decision-making. Example:

$SAPO2 = 1^{10.331} \times 3^{0.278} \times 3^{0.237} \times 2^{0.14} \times 2^{-0.014}$
$= 1.9215$

Vector V is obtained by normalizing the S values for each alternative against the total sum of all S values. Example:

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$$VAPO2 = \frac{SAP02}{\sum s} = \frac{1.9215}{78.4439} = 0.0245$$

Table XII shows the scale values for each criterion used in evaluating alternatives: M, K, D, R, and A. Each alternative is assigned scale values based on these criteria, which are then calculated to produce the S Vector and V Vector. The S Vector represents the total score calculated using a specific method, while the V Vector is the normalized result of the S Vector, indicating the relative priority of each alternative. Alternatives with higher V Vector values are considered superior in this evaluation.

TABLE XII
Scale Values for Each Criterion and Calculate the S and V Vectors

Code	Criteria					S Vector	V Vector
	(M)	(K)	(D)	(R)	(A)		
AP01	0	2	3	2	1	0	0
AP02	1	3	3	2	2	1.9215	0.0245
AP03	0	3	3	2	1	0	0
AP04	1	2	2	3	1	1.6666	0.0212
AP05	1	3	3	2	2	1.9215	0.0245
AP06	1	4	3	3	2	2.2031	0.0281
AP07	0	1	3	1	1	0	0
AP08	1	3	2	1	2	1.5841	0.0202
AP09	1	2	2	2	1	1.5594	0.0199
AP10	1	3	3	2	2	1.9215	0.0245

3. Ranking of Village Development Priorities

The alternatives are ranked by sorting the V values from the largest to the smallest, where the highest V value represents the most prioritized alternative. Table XIII displays the top 10 ranked results out of 51 alternative development projects in Rengel Village, which have been prioritized based on specific criteria to address the village's most urgent and impactful needs. The ranking is determined by the V-values, where higher V-values indicate higher priority, resulting in the order shown in the table.

TABLE XIII
Ranking of Village Development Priorities

Rank	Code	Alternative Names for the Development Plans of Rengel Village	V Vector
1	AP41	Procurement of a large fogging machine for dengue/DBD prevention in RW 05	0.0287
2	AP06	Construction of retaining walls along the edge of Serut Cemetery to Gempol (TPT)	0.0281
3	AP33	Construction of concrete drainage covers from Mr. Mulyono's house to the main road	0.0265
4	AP49	Drainage construction from Mr. Purnomo's house (RT 02) to the back of Mr. Sunarto's house	0.0265
5	AP12	Rehabilitation of Gang Pesantren road	0.0264
6	AP40	Repair of the bridge in front of Al Karomah Mushola (RT 03)	0.0262
7	AP13	Drainage construction in front of Pesantren Cemetery	0.0259
8	AP11	Repair of retaining walls or river normalization from DAM Purboyo to DAM Santren	0.0255
9	AP43	Construction of RW 06 community hall	0.025
10	AP28	Relocation of the waste channel in front of Mrs. Tutik's shop to directly flow into the Ngerong drainage/main road drainage (to eliminate water sediment causing odors)	0.0247

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D. System Development

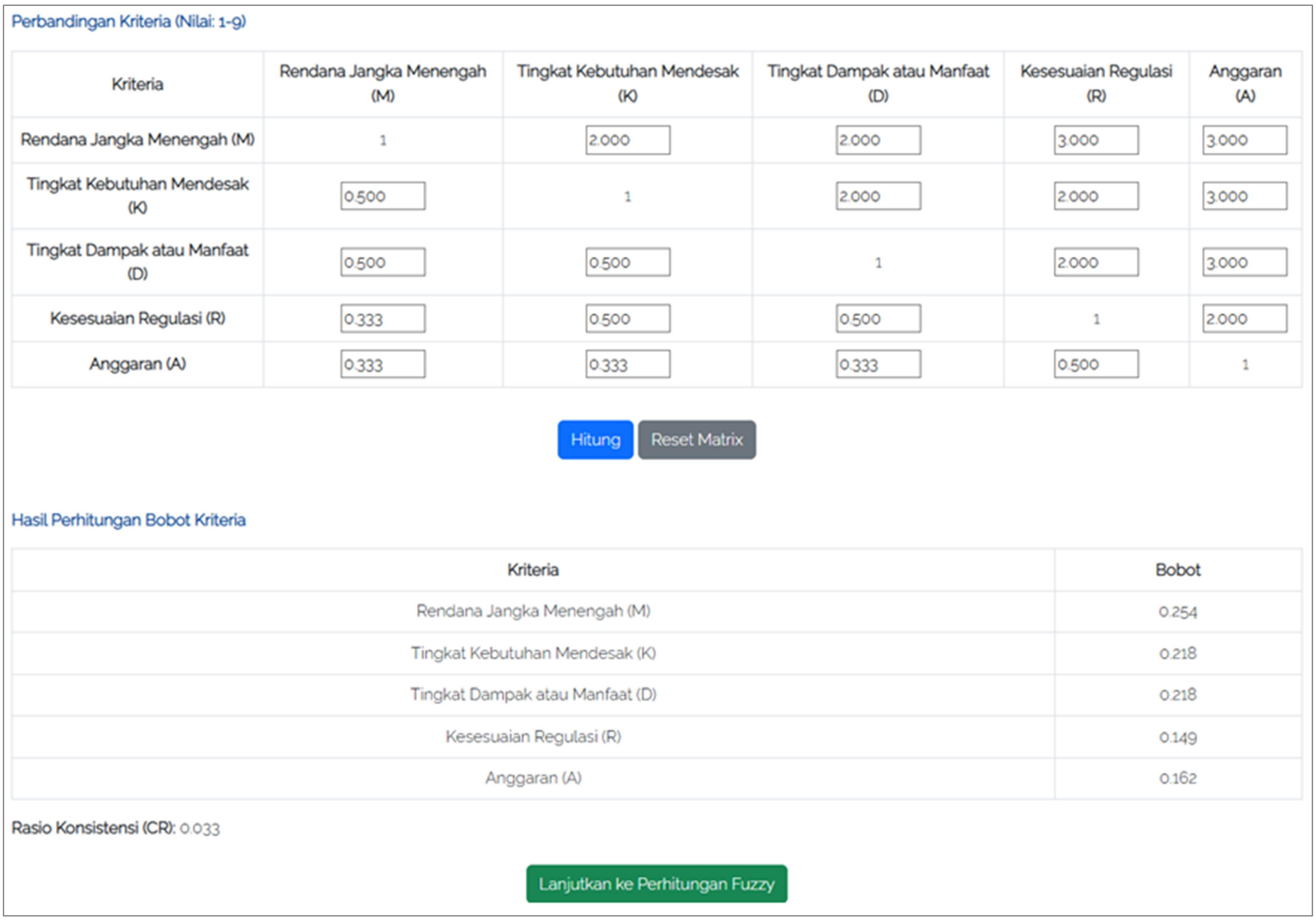

Fig. 2. System of Village Development Priorities

Fig. 2 provides a general overview of the system used for calculating criterion weights. This system is designed to be quite complex, featuring functionalities for inputting alternatives, comparison scales, evaluation years, criteria, and ultimately generating rankings based on the calculated weights. At this stage, the focus is on illustrating the process of criterion comparison using the Fuzzy AHP method, including calculating the consistency ratio (CR) to ensure the assessments are consistent. The system then proceeds to the calculation and ranking stage using the Weighted Product (WP) method, providing a priority order for decision-making in village development.

IV. CONCLUSION

The Decision Support System (DSS) based on the Fuzzy Analytic Hierarchy Process (FAHP) and Weighted Product (WP) methods provides an objective solution for determining the priority of development in Rengel Village. With a Consistency Ratio (CR) value of 0.033, the system demonstrates a good level of consistency in criterion comparisons. The resulting criterion weights show that RPJM has the highest weight (0.331), followed by Urgency Level (0.278), Impact and Benefits (0.237), Regulatory Compliance (0.14), and Budget (0.014). The alternative development ranking results in the following priority order: AP41 (1), AP06 (2), AP33 (3), AP49 (4), AP12 (5), AP40 (6), AP13 (7), AP11 (8), AP43 (9), and AP28 (10).

The integrated priority determination for Rengel Village's development, using a web-based system, allows automatic calculation and ranking. This system facilitates quick, accurate, and transparent access and data processing, as well as decision-making. Furthermore, the use of modern technology in this system supports sustainable village development in a more efficient and effective manner.

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