MA THLINE
JOURNAL OF MATHEMATICS AND MATHEMATICS EDUCATION
ISSN 2502-5872 (Print)
ISSN 2622-3627 (Electronic)

Volume 9 Nomor 1, February 2024, 121-140

AHP-TOPSIS: MULTI-CRITERIA DECISION MAKING METHOD WITH HIERARCHICAL WEIGHTING TO DETERMINE PRIORITIES FOR LEAK WORK DRINKING WATER PIPE

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ABSTRACT

This research aims to develop an effective multi-criteria decision making method by paying attention to the validity of the criteria weighting. In previous research, the TOPSIS method was applied to the problem of determining priorities for repairing drinking water pipe leaks by paying attention to four (4) criteria, namely the duration of the complaint, the size of the leak, the leak point, and the distance from the leak point to the location of the officer handling the leak.. The research results show that the TOPSIS method has a simple concept and is able to provide priority recommendations for the order of work based on consumer complaints. However, in this research the results of decision making were considered not optimal because the TOPSIS method for calculating criteria weights did not yet have a hierarchical mediator that guaranteed the validity of the criteria weightings. Therefore, this research tries to combine two methods (AHP-TOPSIS), namely Analytical Hierarchy Process (AHP) and Technique for Order Performance by Similarity to Idea Solution (TOPSIS). AHP is a Multi Criteria Decision Making (MADM) method that can be used to determine criteria weights hierarchically, with a smooth order of levels and considering the relationship between criteria. In this research, AHP was used to obtain criteria weights and TOPSIS to rank priorities for work on drinking water pipe leaks. The research results show that AHP-TOPSIS can produce a more effective and valid rating to help solve the problem of determining priorities for working on drinking water pipe leaks. This solution is the best decision where work priorities are selected based on criteria that are in accordance with service priorities.
Keywords: Pipe Leaks, Priority, AHP, TOPSIS

How to Cite: Muzdalifah, L & Nursiyami, S. (2024). AHP-TOPSIS: Multi-Criteria Decision Making Method With Hierarchical Weighting to Determine Priorities for Leak Work Drinking Water Pipe. *Mathline: Jurnal Matematika dan Pendidikan Matematika*, *9*(1), 121-140. http://doi.org/10.31943/mathline.v9i1.377

PRELIMINARY

A pipe leak is a damaged gap or hole in a pipe line that allows water or air to escape from the pipe. Leaks can occur technically and non-technically (Rinaldy et al., 2021). Pipe leaks can be caused by holes or gaps in connection pipes, rupture of distribution network pipes, poor installation of water meters, and poor pipe installation. PERUMDA Tirta Lestari Drinking Water, Tuban Regency, East Java is a regional public company which operates in the field of supply and clean water services for the people of Tuban. The problem with the company is that pipe leaks are not detected quickly, resulting in delays in work on damaged pipes. Delays in handling pipe leaks have an impact on reducing the supply of clean water which can be detrimental to consumers (Aziza et al., 2020; Nursiyami et al., 2022). Therefore, it is necessary to have a decision-making system for handling leaks that considers various priority conditions, such as the length of the complaint, the size of the leak, the leak point, and the distance from the officer's location to the leak point. Several studies use Multi Criteria Decision Making (MADM) decision model for solving decision problems and optimization problems with various methods such as Technique for Order Performance by Similarity to Idea Solution (TOPSIS), Analytical Hierarchy Process (AHP), Analytic Network Process (ANP), fuzzy, and so on (Y.-W. Du & Gao, 2020; Azza & Dores, 2018; Setiawan, 2018; Nurjanna & Rakhmawati, 2023). The Technique for Order Performance by Similarity to Idea Solution (TOPSIS) method is a method of the Multi Criteria Decision Making (MADM) decision model for solving decision problems practically. This is because the concept is simple and easy to understand, computationally efficient, and has the ability to measure the relative performance of decision alternatives in simple mathematical form (Y.-W. Du & Gao, 2020). The TOPSIS method is based on the concept where the TOPSIS method is able to rank the best selected alternatives not only having the shortest distance from the positive ideal solution, but also having the longest distance from the negative ideal solution (Jumarlis & Mirfan, 2022; Tamba et al., 2019).

As an initial study, researchers used TOPSIS to determine priorities for repairing drinking water pipe leaks based on consumer complaints at Perumda Air Minum Tirta Lestari (Nursiyami, Muzdalifah, & Kurniawati, 2022). The research results show that the TOPSIS method has a simple concept and is able to provide priority recommendations for the order of work based on consumer complaints. However, in this research the results of decision making were considered not optimal because the TOPSIS method for calculating criteria weights did not yet have a hierarchical mediator that guaranteed the validity of the criteria weightings. Therefore, further research is needed in which decision-making methods are used by considering hierarchical weighting of criteria.

The Analytical Hierarchy Process (AHP) method is a method that defines problems, creates a hierarchical structure and determines criteria and alternative choices. Hierarchy is defined as a representation of a complex problem in a multi-level structure where the first level is the goal, followed by the levels of factors, criteria, sub-criteria, and so on down to the last level of alternatives (Azza & Dores, 2018). AHP is a Multi Criteria Decision Making

(MADM) method that can be used to determine criteria weights hierarchically, with a smooth order of levels and considering the relationship between criteria. Several previous studies have succeeded in combining the AHP and TOPSIS methods in decision making (Al Azis et al., 2017; Du & Gao, 2020; Santika & Handika, 2019). Combining the AHP and TOPSIS methods can produce more objective rankings quickly and precisely, by combining the AHP and TOPSIS methods, it can produce better recommendations (Akmaludin & Badrul, 2019; Berdie et al., 2017; Y. W. Du & Gao, 2020; Hanine et al., 2016; Jatiningrum et al., 2022; Santika & Handika, 2019).

The aim of this research is to develop an effective multi-criteria decision making method by paying attention to the validity of hierarchical weighting of criteria. This research uses a combination of the AHP and TOPSIS methods (AHP-TOPSIS) which are applied to the problem of determining priorities for drinking water pipe work. In this case, AHP is used to obtain criteria weights in a hierarchical manner, while TOPSIS is used to make decisions in order of priority for work on drinking water pipe leaks. AHP-TOPSIS is expected to be able to provide priority recommendations for working on pipe leaks at Perumda Air Minum Tirta Lestari effectively and validly.

METHODS

This research is a continuation of previous research (Nursiyami, Muzdalifah, & Kurniawati, 2022). The type of research, criteria and data used are the same. In this research, the AHP-TOPSIS method was used to solve this problem. AHP is used to obtain criteria weights in a hierarchical manner, while TOPSIS is used to make decisions in order of priority for work on drinking water pipe leaks. With hierarchy, a complex problem can be broken down into groups which are then arranged into a form of hierarchy so that the problem will appear more structured and systematic. Hierarchy is often used as a problem solving method compared to other methods because it reaches the deepest sub-criteria and takes into account validity up to the tolerance limit for inconsistencies in various criteria and alternatives chosen by decision making (Rachman, 2019). The TOPSIS steps used are the same as previous research, while the AHP steps in weighting criteria are described as follows:

1) Compile a Pairwise Comparison Matrix

The pairwise comparison matrix describes the relative contribution or influence of each element on the goals or criteria at the level above. Comparisons are made based on the choice or judgment of the decision maker by assessing the level of importance of one element compared to other elements. The results of this assessment are written in pairwise comparison matrices (PCM) (Putra, 2022). The value and definition of qualitative opinions from the Saaty comparison scale are measured using the analysis table as shown in Table 1.

Table 1. Table of Pairwise Comparison Rating Scales (Saaty Scale)

Intensity of Interest	Definition	Explanation
1	Both elements are equally important	Two elements contribute equally to that property
3	One element is slightly more important than the others	Experience and judgment slightly favor one element over the other
5	Elements that are essential or very important compared to other elements	Experience and consideration strongly influence one element over another
7	One element is clearly more important than the others	One element is strongly supported and its dominance has been seen
9	One element is absolutely more important than the other elements	Evidence supporting one element over another has the highest level of confirmation
2,4,6,8	Middle values between two adjacent considerations	When compromise is needed
The opposite	If activity *i* gets one point when compared with activity *j*, then *j* has the opposite value when compared with activity *i*	

The pairwise comparison matrix is arranged as in equation 1.

$$A = [r_{im}] = \begin{bmatrix} 1 & r_{12} & \dots & r_{1n} \\ \frac{1}{r_{12}} & 1 & \dots & r_{2n} \\ \dots & \dots & & \\ \frac{1}{r_{1n}} & \frac{1}{r_{2n}} & \dots & \dots \\ & & \dots & 1 \end{bmatrix} \quad (1)$$

When $A = 1,2 \dots, n =$ criteria index.

2) Data Normalization

Normalizing data is done by dividing the value of each element in the matrix in pairs by the total value of each column. Calculation of the number of columns in the pairwise comparison matrix is carried out using equation 2.

$$\bar{x}_i = r_{1i} + r_{2i} + \cdots + r_{ni} \quad (2)$$

Information:

$\bar{x}$ = Number of variable

i = i-th column variable

n = n-th row variable

r = Pairwise comparison matrix index

Normalization of the pairwise comparison matrix is carried out using equation 3.

$$r_{ij}' = \frac{r_{ij}}{\bar{x}_j} \quad (3)$$

Information:

$\bar{x}$ = Number of variable

i = i-th column variable

j = j-th row variable

r = Pairwise comparison matrix index

r' = Decision matrix normalization

3) Calculate The Eigenvector and Test Its Consistency

The eigenvector value is obtained by multiplying each column of the pairwise comparison matrix then raising it to the power of 1/n (number of attributes) (Irawan, 2019). If the PCM matrix is a consistent matrix (transitive matrix) then there are n eigenvalues that correspond to a vector v which is the priority weight, where n is the size of the matrix and v is the eigenvector; Av = nv. However, if the matrix is not transitive, then the eigenvalue corresponding to a vector will have the largest eigenvalue which is called the maximum eigenvalue (max) whose magnitude will be greater than or equal to the size of the matrix (n); max. The priority weight value is obtained by dividing each attribute eigenvector value by the total eigenvector value. If it is inconsistent then data collection (preferences) needs to be repeated. The eigenvector value in question is the maximum eigenvector value obtained (Kelana et al., 2021).

The following is the equation for calculating priority. Calculations are carried out using equation 4.

$$\bar{x}_i = r_{i1}{}' + r_{i2}{}' + \cdots + r_{in}{}' \quad (4)$$

Keterangan:

$\bar{x}$ = Number of matrix rows

i = i-th row variable

j = j-th row variable

n = n-th column variable

r' = Decision matrix normalization

Then calculate the eigenvector using equation 5.

$$w_i = \frac{\bar{x}_j}{n} \quad (5)$$

Information:

$\bar{x}$ = Number of matrix rows

j = j-th row variable

i = i-th row variable

n = Number of criteria

w = Eigenvectors/ criterion weights

Calculating the weight of the criteria is obtained by multiplying each first column value by the relative priority of the first criterion, the second column value by the relative priority, the second criterion, and so on. The following is the equation for calculating the consistency of the criteria weights. equation to determine the consistency ratio (CR) of the consistency index of a matrix of order n (Budiawan et al., 2022). Calculations are carried out using equation 6.

$$\lambda_{maks} = (w_i \times \bar{x}_i) + \cdots + (w_n \times \bar{x}_n) \quad (6)$$

Information:

λ_{maks} = Maximum lambda

w = Eigenvectors/ criterion weights

$\bar{x}$ = The number of matrix columns in the pairwise comparison matrix

i = i-th variable

n = n-th variable

To calculate the consistency index, calculations are carried out using equation 7.

$$CI = \frac{(\lambda_{maks} - n)}{n - 1} \quad (7)$$

Where:

CI = Consistency Index

λ_{maks} = The largest eigenvalue of a matrix of order n, the maximum λ is obtained by adding up the product of the number of columns and the main eigenvector

To calculate the Consistency Ratio (CI), calculations are carried out using equation 8.

$$CR = \frac{CI}{IR} \quad (8)$$

CR = $Consistency\ Ratio$

CI = $Consistency\ Index$

IR = $Indeks\ Random\ Cosistency$

Tabel 2. *Indeks Random Cosistency*

Matrix Size	***IR***
1	0.00
2	0.00
3	0.58
4	0.90
5	1.12
6	1.24
7	1.32
8	1.41
9	1.45
10	1.49

If the CI/RI value is below 10% then hierarchical consistency is acceptable. If it is above 10%, the assessment data must be corrected. If the CR value <=0.1 then the matrix is said to be consistent. If the CR value>0.1 then the matrix is said to be inconsistent. Consistency is the equality of weight values given between criteria (Jowanka et al., 2022). Repeat steps 3, 4 and 5 for all hierarchical levels (Mahendra et al., 2021). The weighting results in the AHP step are then used to determine work priorities using TOPSIS (Akmaludin & Badrul, 2019; Nursiyami, Muzdalifah, Kurniawati, et al., 2022).

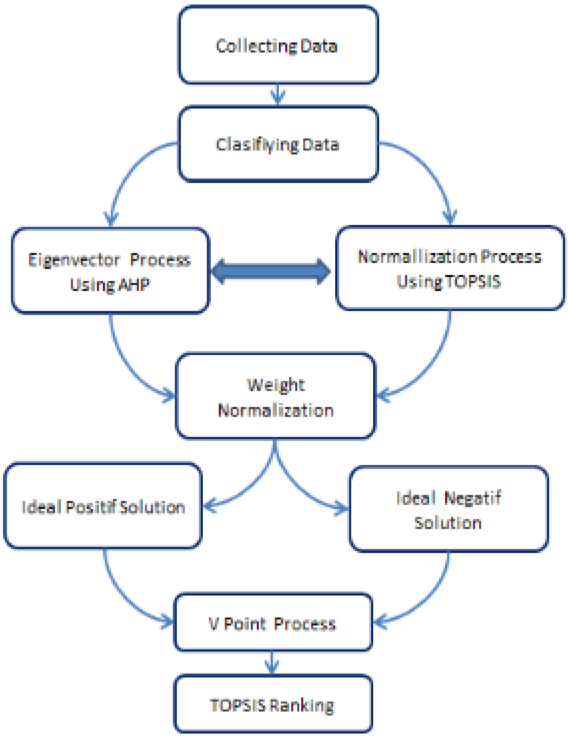

Figure 1. TOPSIS Algorithm Structure

RESULTS AND DISCUSSION

To determine the priority order of work using the AHP TOPSIS method, this research uses data as in previous research (Nursiyami, Muzdalifah, & Kurniawati, 2022). The AHP calculation functions to calculate the priority weights of criteria based on entering the priority scale. If it is consistent after consistent testing of the priority weights then the weights are appropriate and can be used in TOPSIS calculations.

1. Weighting Criteria and Sub-Criteria Using the AHP Method

a. Pairwise Comparison Matrix

Before creating a pairwise comparison matrix, determine the priority scale based on Table 1 of the Saaty Scale. The priority scale is presented in Table 3.

Table 3. Priority Scale

Code	Criteria	Priority Scale
C_1	Complaint Time	1
C_2	Leak Size	5
C_3	Leak Point	3
C_4	Distance	3

The next step is to determine pairwise comparisons between the criteria in matrix form (Table 4). The pairwise comparison values are based on weighting obtained from interviews with the party from PERUMDA Tirta Lestari, Tuban Regency who is responsible for pipe leak complaints and refers to the criteria previously obtained. The diagonal matrix values for comparison of an element with itself and other elements are filled with the weight values in Table 5 of the relative priority criteria and filled with the inverse values, then added up per column.

Table 4. Criteria Comparison Matrix

		C_1	C_2	C_3	C_4
Complaint Time	C_1	1		A Little More important	A Little More important
Leak Size	C_2	Equally Important	1	Very important	Very important
Leak Point	C_3			1	Equally Important
Distance	C_4				1

Table 5. Relative Priority of Criteria

		C_1	C_2	C_3	C_4
Complaint Time	C_1	1	1	3	3
Leak Size	C_2	1	1	5	5
Leak Point	C_3	0.33	0.20	1	1
Distance	C_4	0.33	0.20	1	1
Total		2.66	2.4	10	10

b. Data Normalization

Normalizing the data is done by dividing the value of each element in the paired matrix by the total value of each column using equations 2 and 3. The results of data normalization are presented in Table 6.

Table 6. Normalization of Criteria Values

		$\boldsymbol{C_1}$	$\boldsymbol{C_2}$	$\boldsymbol{C_3}$	$\boldsymbol{C_4}$	**Amount**
Complaint Time	C_1	0.375	0.417	0.300	0.300	1.392
Leak Size	C_2	0.375	0.417	0.500	0.500	1.792

		C_1	C_2	C_3	C_4	Amount
Leak Point	C_3	0.125	0.083	0.100	0.100	0.408
Distance	C_4	0.125	0.083	0.100	0.100	0.408
Total		1	1	1	1	4

The next step is to construct a value matrix and eigenvector for each of the criteria Complaint Time (C_1), Leak Size (C_2), Leak Point (C_3), dan Distance (C_4). Priority calculations are obtained using equation 4, while eigenvector calculations use equation 5. The calculation results are presented in Table 7.

Table 7. Criteria Weights (Eigen Value)

		C_1	C_2	C_3	C_4	Amount	Priority	*Eigen Value*
Complaint Time	C_1	0.375	0.417	0.300	0.300	1.392	1	0.348
Leak Size	C_2	0.375	0.417	0.500	0.500	1.792	1	0.448
Leak Point	C_3	0.125	0.083	0.100	0.100	0.408	1	0.102
Distance	C_4	0.125	0.083	0.100	0.100	0.408	1	0.102
Total		1	1	1	1	4	4	1

To find out whether the consistency ratio (CR) is accepted or rejected, it is necessary to calculate using equation 6-8.

$$\lambda_{maks} = (0.348 \times 2.66) + (0.448 \times 2.4) + (0.102 \times 10) + (0.102 \times 10)$$

$$= 4.044$$

$$CI = \frac{(4.044 - 4)}{4 - 1} = 0.015$$

$$CR = \frac{CI}{IR} = \frac{0.015}{0.90} = 0.016$$

Because CR 0.016 < 0.1, it can be said that the consistency ratio of the calculations is acceptable. So the calculation is valid and the weights obtained for each criterion are as in Table 8.

Table 8. Criteria Weights

Criteria		Weights
Complaint Time	C_1	0.348
Leak Size	C_2	0.448
Leak Point	C_3	0.102
Distance	C_4	0.102

Table 9. Complaint Time of Priority Scale (C_1)

Code	Sub Criteria	Priority Scale
SC_{11}	0 Day	3
SC_{12}	1 Day	3

Table 10. Priority Scale for Leak Size $(\boldsymbol{C_2})$

Code	Sub Criteria	Priority Scale
SC_{21}	Substandard Water / improvements	1
SC_{22}	Water Not Flowing	5
SC_{23}	Pipe leak	7

Table 11. Priority Scale for Leak Size $(\boldsymbol{C_3})$

Code	Sub Criteria	Priority Scale
SC_{31}	V1	3
SC_{32}	V2	3
SC_{33}	V3	3
SC_{34}	V4	3
SC_{35}	V5	3
SC_{36}	V6	3
SC_{37}	V7	3
SC_{38}	V8	3
SC_{39}	V9	3
SC_{310}	V10	3

After calculating the weight of the criteria, then calculate the weight of the sub-criteria using the same steps of multiplying the weight of the sub-criteria by the weight of the criteria as follows. The calculation of sub-criteria weights is basically the same as the calculation of criteria. So the author only displays the priority scale per sub-criteria (Table 9-12) and the calculation results (Table 13). The validity of this calculation result has been checked with the consistency ratio value ($CR < 0,1$) being accepted.

Table 12. Distance Priority Scale (C_4)

Code	Sub Criteria	Priority Scale
SC_{41}	0 – 2	3
SC_{42}	3 – 5	3
SC_{43}	6 – 8	3
SC_{44}	9 – 11	3

Table 13. Sub Criteria Weights

Criteria and Sub Criteria			Final Weight Value Criteria
Complaint Time	0 day	SC_{11}	0.250
	1 day	SC_{12}	0.750
Leak Size	small	SC_{21}	0.074
	medium	SC_{22}	0.283
	big	SC_{23}	0.643
Leak Point	V1	SC_{31}	0.220
	V2	SC_{32}	0.173
	V3	SC_{33}	0.140
	V4	SC_{34}	0.116
	V5	SC_{35}	0.097
	V6	SC_{36}	0.080
	V7	SC_{37}	0.066
	V8	SC_{38}	0.054
	V9	SC_{39}	0.043
	V10	SC_{310}	0.033
Distance	0 – 2	SC_{41}	0.543

Criteria and Sub Criteria			Final Weight Value Criteria
	3 – 5	SC_{42}	0.262
	6 – 8	SC_{43}	0.140
	9 – 11	SC_{44}	0.055

2. Determining Leak Repair Priorities Using TOPSIS

Determining leak repair priorities uses the results of AHP calculations and data conversion using the TOPSIS method. From the daily leakage data from January 1 2022 to April 5 2022, a conversion of the weighting data from the alternatives to the criteria presented in Table 14 was carried out.

Table 14. Suitability of data conversion from alternatives to criteria

No		C_1	C_2	C_3	C_4
1.	A1	0.261	0.127	0.008	0.055
2.	A2	0.261	0.288	0.01	0.027
3.	A3	0.261	0.288	0.01	0.027
4.	A3	0.261	0.033	0.01	0.027
...	…	…	…	…	…
176.	A57	0.261	0.288	0.01	0.027
Result Sum		7.199993027	6.217566347	0.107202035	0.32900347

Normalization of the decision matrix is carried out by dividing each value in the decision matrix by the value of the divisor obtained from the square root of each row of criteria. The results of the normalization of the decision matrix and the weighted normalized matrix are presented in Table 15 and Table 16.

Table 15. Normalization of Decision Matrix

No	Alternative Route	C_1	C_2	C_3	C_4
1.	A1	0.036250035	0.020425998	0.074625449	0.16717149
2.	A2	0.036250035	0.046320374	0.093281811	0.082066
3.	A3	0.036250035	0.046320374	0.093281811	0.082066
4.	A3	0.036250035	0.005307543	0.093281811	0.082066
...	…	…	…	…	…

No	Alternative Route	C_1	C_2	C_3	C_4
176.	A57	0.036250035	0.046320374	0.093281811	0.082066

$$R = \begin{bmatrix} 0.036250035 & 0.020425998 & 0.074625449 & 0.16717149 \\ 0.036250035 & 0.046320374 & 0.093281811 & 0.082066 \\ 0.036250035 & 0.046320374 & 0.093281811 & 0.082066 \\ 0.036250035 & 0.005307543 & 0.093281811 & 0.082066 \\ \dots & \dots & \dots & \dots \\ 0.036250035 & 0.046320374 & 0.093281811 & 0.082066 \end{bmatrix}$$

Table 16. Weighted Normalized Matrix

No	Alternative Route	C_1	C_2	C_3	C_4
1.	A1	0.18125018	0.10212999	0.149250898	0.835857
2.	A2	0.18125018	0.23160187	0.186563623	0.41033
3.	A3	0.18125018	0.23160187	0.186563623	0.41033
4.	A3	0.18125018	0.02653771	0.186563623	0.41033
…	…	…	…	…	…
176.	A57	0.18125018	0.23160187	0.186563623	0.41033

The rule for calculating the value of positive and negative ideal solutions is that for a positive ideal solution, if the attribute of the criteria is benefit, the value taken is the max value of each criterion, if the attribute is cost, the value taken is the min value and for the negative ideal solution The opposite condition applies if the attribute is benefit/cost then the min value is taken, if the attribute is cost then the max value is taken. Then the distance between the value of each alternative and the positive and negative ideal solution matrix (D) is calculated. The calculation results can be seen in Table 17 and Table 18. Then the ranking is carried out starting from the highest preference value, the ranking results can be seen in Table 19.

Table 17. Positive and Negative Ideal Solution Values

	Complaint Time	Leak Size	Leak Point	Distance
Atribute	Benefit	Cost	Cost	Benefit
A^{+}MAX	0.06041673	0.02653771	0.093281811	0.212764

	Complaint Time	Leak Size	Leak Point	Distance
A^{-}MIN	0.18125018	0.23160187	0.055969087	0.835857

Table 18. Distance of Positive and Negative Ideal Solutions

No	Jalan	D+	D-
1.	A1	0.64163326	0.15957589
2.	A2	0.32308818	0.4451163
3.	A3	0.32308818	0.4451163
4.	A3	0.24966911	0.49008145
…	…	…	…
176.	A57	0.32308818	0.4451163

Continue by searching for the preference value for each alternative (V_i) as in Table 19.

Table 19. Preference Values

Alternative Route	Values
A1	0.199169
A2	0.579424
A3	0.579424
A3	0.662496
…	…

A larger V_i value indicates that alternative A_i is preferred. From the calculation of AHP-TOPSIS V_3 it is shown that A_3 was chosen as the priority for processing pipe leak complaints by PERUMDA Tirta Lestari Drinking Water, Tuban Regency, Branch IV Semanding with a value of 0.662496 with a complaint duration of 0 days, small leak size, leak point on Clean TPA Road, and distance traveled 4 km from the location of the leak officer. Below is a table of preference values and alternative rankings of priority work on daily leak complaints from January 1 2022 to April 5 2022 which are used as shown in Table 20.

Table 20. Priority Ranking for Pipe Leak Work

Alternative Route	Value	Rangking	Rangking Per Day
V1	0.199169	176	2
V2	0.579424	112	3
V3	0.579424	112	3
V3	0.662496	38	1
V4	0.68245	27	1
V5	0.579424	112	2
V2	0.579424	112	2
V6	0.579424	112	2
V7	0.64385	64	2
V1	0.645157	58	1
V1	0.580855	73	3
V8	0.579424	112	1
V9	0.66897	28	1
V10	0.653446	55	2
…	…	…	…
V57	0.579424	112	1

In Table 20, the rows in gray and white are signs to distinguish daily leak complaints that come to the admin of pipe leak complaints from PERUMDA Air Minum Tirta Lestari, Tuban Regency, the results of the processing carried out by the AHP-TOPSIS method have been arranged based on the priority order of processing the complaints. leakage. On the first and second days (January 1 and January 2 2022) the same priority order was produced as previous research using the TOPSIS method only (Nursiyami, Muzdalifah, & Kurniawati, 2022). Meanwhile, on the third day, differences began to be seen where in previous research the priority order was V7 (JL. Mastrip V fork east of the house facing north) - V1 (Perum Karang Indah BD/07) - V1 (Perum Karang Indah Blok BC/38). Meanwhile, in this research, the priority order was obtained V1 (Perum Karang Indah BD/07) - V7 (JL. Mastrip V fork east of the house facing north) - V1 (Perum Karang Indah Blok BC/38). There appears to be a difference that in research using the TOPSIS method alone, the priority order for working on pipe leaks is only based on the size of the leak. This is in line with the input criteria weights used in the research. Meanwhile, using the AHP-TOPSIS method, the priority order results represent the attractive force of connectedness due to the use of pairwise comparisons in weighting criteria. Likewise for the priority order on day 5 and others. This shows that the AHP-TOPSIS method can produce a more effective and valid rating to help solve the problem of determining priorities for working on drinking water pipe leaks. This solution is the best decision where work priorities are selected based on criteria that are in accordance with service priorities.

CONCLUSION

From the results of the processing and discussions that have been carried out, it is concluded that the AHP TOPSIS method provides priority recommendations for the order of work based on four (4) criteria. AHP-TOPSIS can produce a more effective and valid rating to help solve the problem of determining priorities for working on drinking water pipe leaks. This solution is the best decision where work priorities are selected based on criteria that are in accordance with service priorities.

For further research, it is hoped that we can use the AHP-TOPSIS method in more varied and representative problem cases so that we can more clearly see the effectiveness and validity of the AHP-TOPSIS method. Furthermore, decision-making methods can also be developed that suit real needs and conditions in the field, such as combining the AHP method with the Topsis-2N method which uses a preference technique based on similarity to the ideal solution.

ACKNOWLEDGMENT

We would like to express our thanks to Perumda Air Minum Tirta Lestari, Tuban Regency, which has agreed to be a research site and provide the data needed for this research.

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