

Performance analysis of combination of fuzzy analytic hierarchy process (FAHP) algorithms with preference ranking organization method for enrichment evaluation algorithm (PROMETHEE II) in the ranking process to determine the increase in employee class

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Abstract. In this study conducted a Performance Analysis of the Combination of Fuzzy Analytic Hierarchy Process (FAHP) Algorithm with the Preference Ranking Organization Method for Enrichment Evaluation algorithm (PROMETHEE II) in the ranking process to determine the increase in employee groups. From the results of the experiment the Performance Analysis of Fuzzy Analytic Hierarchy Process (FAHP) Algorithm with the Preference Ranking Organization Method for Enrichment Evaluation algorithm (PROMETHEE II) in the ranking process to determine the increase in the employee class obtained by the average employee considered at 62.31%. Seeing the percentage value considered with the Promethee algorithm (45.33%) lower than the Fuzzy AHP algorithm (79.30%), it can be said that the Combination Fuzzy AHP algorithm with Promethee is more selective in the weighting and ranking process.

1. Introduction

1.1 Analytical hierarchical process (AHP)

AHP is a functional hierarchy with the main input of human perception. This method was developed by Prof. Thomas Lorie Saaty from Wharton Business School in the early 1970s, which was used to search rankings or priority sequences of various alternatives in solving a problem. (Xiulin, SI & Dawei, LI. 2014). Fuzzy AHP method is an analytical method developed from AHP. Although AHP is commonly used in dealing with qualitative and quantitative criteria but Fuzzy AHP is considered better in describing vague decisions than AHP (Igon et al, 2014).

The Dooki, et al (2017) study entitled An Integrated Fuzzy AHP and Fuzzy TOPSIS Approach for Ranking and Selecting of the Chief Inspectors of Banks: A Case Study. In this research hybridization between Fuzzy Analytic Hierarchy Process (FAHP) algorithm and Multiple Attribute Decision Making (MADM) was carried out. The results of this study obtained an average value of Efficiency Rate (ER) of 77.82% with suggestions for improvement so that this method was developed again to obtain a better ER value.

In the research of Wafi, et al (2017) a selection of job tender winners was conducted using the Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE II)

method. In the application, several bidders are considered and choose the best based on the aspects of administration, quality, price and qualifications. In the Promethee II method, several steps are calculated, namely weighting and calculation of the multicriteria preference index for 3 types of preferences, namely, usual, level and quasi and calculations leaving flow, entering flow and netflow. This method has advantages in the ranking process using quantitative and qualitative data. The disadvantage of this method is that it cannot deal with the problem of selecting optimal bidders and requires additional functions. The test results obtained the highest accuracy of 84.21% with the use of the type of preference of usual criterion and quansi criterion. The lowest accuracy value is 63.15% in the use of type criterion preference types. The level of accuracy in testing is largely influenced by the amount of weight used for each criterion and type of preference used. So to improve accuracy, it is proposed to use the PROMETHEE II method by combining it with other methods.

In general, decision making with the AHP Algorithm is based on the following steps (Norhikmah et al. 2013):

1. Define the problem and determine the desired solution, then arrange a hierarchy of problems faced.
2. Determine priority elements
 - a. The first step in determining the priority of an element is to make a comparison of pairs, which is comparing elements in pairs according to the criteria given.
 - b. Pairwise comparison matrices are filled using numbers to represent the relative importance of an element to the other elements.
3. Synthesis

Considerations for pairwise comparisons are synthesized to obtain overall priorities. The things done in this step are:

 - a. Add the values of each column to the matrix
 - b. Divide each value from the column by the corresponding column to obtain the normalization of the matrix.
 - c. Add the values of each row and divide by the number of elements to get the average value.
4. Measuring Consistency

In making decisions, it is important to know how well consistency exists. The things done in this step are as follows:

 - a. Multiply each value in the first column with the relative priority of the first element, the value in the second column with the relative priority of the second element and so on.
 - b. Add up each row
 - c. The results of the sum of rows are divided by the relative priority elements concerned
 - d. Add the quotient above with the number of elements; the result is called λ max
5. Perform calculation of Consistency Index (CI) with the formula:

$$CI = (\lambda_{\max} - n) / \dots\dots\dots (1)$$

Where n = number of elements.
6. Calculate Consistency Ratio (CR) with the formula:

$$CR = CI / IR \dots\dots\dots (2)$$

Where CR = *Consistency Ratio*
 CI = *Consistency Index*
 IR = *Indeks Random Consistency*
7. Check the consistency of the hierarchy.

If the CR value is more than 10%, then the assessment of data judgment must be corrected. But if the Consistency Ratio (CI / CR) is less or equal to 0.1, then the calculation results can be stated correctly.

Fuzzy AHP is an extension of AHP by combining it with Fuzzy logic theory. In Fuzzy AHP, Fuzzy ratio scale is used to indicate the relative strength of the factors in the relevant criteria. So, a Fuzzy decision matrix can be formed. The final values of alternatives are also presented in Fuzzy numbers. Fuzzy AHP method is an analytical method developed from AHP. Although AHP is commonly used in handling qualitative and quantitative criteria but Fuzzy AHP is considered better in describing decisions that are vague than AHP. The steps for solving Fuzzy AHP are as follows;

- a. Make a hierarchical structure of the problem to be solved and determine the comparison of the paired matrices between the criteria and the scale of TFN (Tringular Fuzzy Number).
- b. Determine the value of the priority Fuzzy synthesis (Si) with the formula:

$$Si = \sum_{j=1}^m M_i^j \times \frac{1}{\sum_{i=1}^n \sum_{j=1}^m M_i^j} \dots\dots\dots (3)$$

- c. Determine the value of vector (V) and the value of Defuzzification Ordinate (d').

$$d'(A1) = \min V (S1 \geq Sk), \text{ for } k = 1, 2, \dots n; k \neq i$$

For $k = 1, 2, \dots n; k \neq i$

- d. Calculation of vector weight values:

$$W' = (d'(A1), d'(A2), \dots, d'(An))T$$

- e. Normalization of fuzzy vector weight values (W)

The normalized vector weight value is like the following formula:

$$W = (d(A1), d(A2), \dots, d(An))T$$

Where W is a non-Fuzzy number. The formulation of normalization is:

$$D(A_n) = \frac{d'}{\sum_{i=1}^n d'(An)} \dots\dots\dots (4)$$

In order to obtain a useful scale when comparing two elements, a comprehensive understanding of the elements that are compared and their relevance to the variables or objectives studied, in the scale of interest, is used as a scale benchmark transformed in the triangular Fuzzy number shown in Table 1.

Table 1. Chang Scale Scales for Comparison of Criteria Scale (Baharsyah et al, 2016)

AHP scale	Fuzzy scale	Fuzzy Invers scale	Description
1	(1,1,1)	(1,1,1)	Equally important
2	(1,2,3)	(1/3,1/2,1)	A little more important
3	(2,3,4)	(1/4,1/3,1/2)	The scale between is a little more and more important
-	-	-	-

1.2 PROMETHEE II Method

PROMETHEE is one of the Multi Criteria Decision Making (MCDM) methods which mean making a determination or sorting in a multicriteria analysis, this method is known because the concept is efficient and simple, in addition to solving problems related to

multicriteria, this method is also very easy to applied than other methods (Wafi et al, 2017). The calculation stages of the Promethee method are as follows:

1. Determine the threshold value

In calculating the threshold value, the veto formula is used to determine the value of p and q, where the veto formula can be used and to calculate the threshold value used in equation 5.

$$\text{Preference (p)} = v - \dots\dots\dots (5)$$

Where:

v = Veto Threshold

q = indifferent

2. Determine the type of preference function criteria to be used

a. Types of Ordinary Criteria (Usual Criterion Type)

This criterion does not differ between criteria a and criteria b if $f(a) = f(b)$, if the value of each criterion in each alternative has a different value, then decision makers have an absolute preference to determine the best alternative. Equation 2.6 shows the usual criteria / type I.

$$H(d) = \begin{cases} 0 & \text{if } d \leq 0 \\ 1 & \text{if } d > 0 \end{cases} \dots\dots\dots (6)$$

Where: H (d) = function difference between alternative criteria values, d = difference in criterion value $\{d = f(a) - f(b)\}$

Type of Quasi Criteria (Quasi Criterion Type)

These types of criteria have two alternatives that have the same preference which as long as the difference or value of H (d) of each alternative does not exceed the q value and if the difference in calculation for each alternative is above q then absolute preference forms occur. Equation 2.7 shows the quasi / type II criteria

$$H(d) = \{(0 \text{ If } d \leq q) / (1 \text{ If } d > q)\} \dots\dots\dots (7)$$

Where H (d) = the function of the difference between alternative criteria values, d = the difference in the criteria value $\{d = f(a) - f(b)\}$ and q = the value of a significant influence of a criterion

c. Type of Level Criteria (Level Criterion Type)

The magnitude of the indifference threshold (q) number and preference threshold (p) tendency can only be determined by simulation. If d is between the q and p values, it can be concluded that the preference condition is weak ($H(d) = 0.5$). The following is the Level / type IV Criteria Equation

$$H(d) = \begin{cases} 0 & \text{IF } d \leq q \\ \frac{1}{2} & \text{IF } q < d \leq p \\ 1 & \text{IF } d > p \end{cases} \dots\dots\dots (8)$$

Where:

H (d) = the function of the difference in the value of each criterion between alternatives

d = difference in criteria value $\{d = f(a) - f(b)\}$

p = value for preference tendency as well

q = value of significant influence criteria

3. Calculating the Amount of Multi Criteria Preference Index Value

The value of the multicriteria preference index is calculated according to the weighting conditions for each of Pi's preference criteria and functions like the following equation.

$$\pi_{ij} = \pi(a_i, a_j) = \sum_{k=1}^q P_k(a_i, a_j) \cdot W_i \dots\dots\dots (9)$$

Where: $P_k(a_i, a_j)$ is the result of a calculation using the preference type formula, W_i = Weight of each criterion.

4. Calculating the direction of preference calculated according to the leaving flow index value (θ^+), entering flow (θ^-) and net flow.

a. Value Leaving Flow

The value of Leaving Flow is obtained according to the following equation:

$$\theta^+(a) = \frac{1}{n-1} \sum x \varepsilon \varphi(a, x) \dots\dots\dots (10)$$

Where:

$\Phi(a, x)$ = preference value a better than value x

n = number of alternatives

$\sum x \varepsilon \varphi$ = alternative values from the preference table are summed horizontally

b. Entering Flow Value

Equation 2.9 shows the formula to get the entering flow value.

$$\theta^-(a) = \frac{1}{n-1} \sum x \varepsilon \varphi(x, a) \dots\dots\dots (11)$$

Where:

$\varphi(x, a)$ = preference value x is better than value a

n = number of alternatives

$\sum x \varepsilon \varphi$ = alternative values from the preference table are summed vertically

c. Net Flow Value

Net Flow value is obtained from the results of the reduction of leaving flow values with entering flow values as in equation 2.10.

$$\theta(a) = \theta^+(a) - \theta^-(a) \dots\dots\dots (12)$$

Where:

$\theta^+(a)$ = Formula for leaving flow (Promethee I)

$\theta^-(a)$ = Formula for entering flow (Promethee I)

$\theta(a)$ = Formula for net flow (Promethee II)

2. Findings and Discussions

1. Test for consistency

The consistency of paired assessments is evaluated by calculating Consistency Ratio (CR). When setting if the CR ≤ 0.1 , the assessment results are said to be consistent.

$$CI = (\lambda_{\max} - n) / n \dots\dots\dots (13)$$

$$CR = CI / IR \dots\dots\dots (14)$$

Where is CR = Consistency Ratio

CI = Consistency Index

IR = Random Consistency Index

$$CR = -0.66540905 / 1.11 = -0.59946$$

The matrix with code A1 obtained $CR < 0.1$, this means that the assessment obtained from the assessment is consistent. For other employee paired matrix calculations, it is done in the same way as the A1 paired matrix.

3. Fuzzy AHP Combination Algorithm with PROMETHEE II

The calculation using the Combination method is to enter the value data for each criterion for each employee's group increase and identify the weight values for each sub-criterion of each criterion and its parameters. The ranking is based on NetFlow values as in Table 2.

Table 2.Combination Ranking Results

Code	Employee	<i>Leaving Flow</i>	<i>Entering Flow</i>	<i>Net flow</i>	Ranking
A2	Aprilina	7.6156	1.21045	6.40515	1
A3	Sandy	6.26342	3.25385	3.00957	2
A1	Husni	5.09235	2.4348	2.65755	3
A5	Panda	2.04232	6.4002	-4.35788	4
A4	Denis	0.27967	7.99407	-7.7144	5

4. Discussion

At this stage, the software built is used as a tool to compare the accuracy of the Fuzzy AHP algorithm with the Fuzzy AHP Combination algorithm with Promethee. For the results with the Fuzzy AHP algorithm employees that are worth considering for group increase are those whose Final Values > 70 are 119 people while for Promethee's algorithm is the value of Net Flow > 0 which is as many as 68 people.

5. Conclusion

From the results of the experiment the Performance Analysis of Fuzzy Analytic Hierarchy Process (FAHP) Algorithm with the Preference Ranking Organization Method for Enrichment Evaluation algorithm (PROMETHEE II) in the ranking process to determine the increase in the employee class obtained by the average employee considered at 62.31%. Seeing the percentage value considered with the Promethee algorithm (45.33%) lower than the Fuzzy AHP algorithm (79.30%), it can be said that the Combination Fuzzy AHP algorithm with Promethee is more selective in the weighting and ranking process.

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