

Performance Analysis of Fuzzy AHP in The Rankings

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Abstract. Analytic Hierarchy Process can solve complex multicriteria problems into a hierarchy. 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 factor level, criteria, sub criteria, and so on down to the last level of the alternative (Saaty, 2008). Selection of employees achievement aims to provide encouragement, dedication, loyalty, professionalism and high motivation to employee performance. In this research, Hierarchical Process Analysis Method is used to search the ranking weight, then used Fuzzy AHP method as a comparison, then tested to get employee performance accuration. Fuzzy AHP is a combination of Hierarchical Process Analysis method with fuzzy concept approach. Fuzzy AHP covers the existing weaknesses in Hierarchical Process Analysis, problems with criteria that have more subjective properties. Final conclusions Fuzzy AHP still get more value than using Hierarchy Analysis Process. The percentage of weight gain is 21%, 8%, 9%, 11%, 14%, 7%, 17%, 15%, 10%, and 14% respectively. The difference of the results obtained is due to the weight difference of each criterion value that exists. Furthermore, the calculation of accuration, test results show Fuzzy AHP method gets accuracy of 72%.

Keywords: Hierarchy Analysis Process, Fuzzy AHP, Accuration

1 Introduction

Analytic Hierarchy Process (AHP) is one of the methods that can be used in decision-making system by considering the factors of perception, preference, experience and intuition. AHP can be to combines personal judgment and values into a logical way. AHP can solve complex multicriteria problems into a hierarchy. A complex problem can be interpreted as the criteria of a multicriteria, the uncertainty of the problem structure, the uncertainty of opinion from the decision maker, the decision-maker of more than one person, and the inaccuracy of available data. According to [1], 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 factor level, criteria, sub criteria, and so on down to the last level of the alternative. With a hierarchy, a complex problem can be broken down into groups that are then organized into a hierarchical form so that the problem will seem more structured and systematic.

According to [2], "Fuzzy AHP to determine the relative weights of evaluation criteria and Fuzzy TOPSIS to rank the alternatives", Fuzzy AHP to determine the relative weighting of evaluation criteria and Fuzzy Topsis to determine the accuracy of the data, whereby the

decision consists of three levels: at the highest level, the purpose of the problem lies on the second level, that is, the Criteria listed, and at the third level, the listed sub criteria; The Topsis method yields Sc1 - Sc4 (0.3333) while for Sc5 (0.2).

While the first Fuzzy Analytic Hierarchy Process requires a pairwise Comparison of criteria and sub criteria to determine its weight. Last level belongs alternative. So the criterion 1 is (0.3333333) and sub criterion 1 (0,425), sub criterion 2 (0,575) and criterion 2 produce (0,6666666) from sub criterion 11 (0,644835), sub criterion 12 (0,244575) and sub criterion 3 (0.11059). This consistent comparison matrix indicates that the previous Sub criterion has fewer values than the normalized priority weighting between the two generates the main criteria and the five sub criteria and their ranking. The results showed that the weight generated using fuzzy topsis alternatives showed inaccurate data, so the solution was selected Fuzzy AHP. According to [2], "Comparison of Fuzzy AHP and Fuzzy TOPSIS Methods for Math Teachers Selection" The incorporation of Fuzzy AHP and Fuzzy Topsis Methods for mathematics teacher selection, where the results show the AHP fuzzy method for teacher selection problems mathematics proposed in a group decision based on AHP fuzzy.

First, the decision maker prepares the questionnaire form and then with other interest sharing performs the pairing comparison. Decision makers use linguistic variables, to evaluate alternative rankings with respect to each criterion and they turn them into triangular fuzzy numbers resulting in three (3) best teachers with the weight of T1 (0.31182), T2 (0.39977) and T3 (0.30968). The T2 alternative that has the highest priority weight is chosen as the best mathematics teacher choice. The alternate ranking sequence with the fuzzy AHP method is $T2 > T1 > T3$.

The best ranking weights are obtained using several criteria. Factors that support performance include Worker-made Needs, Ability, Complexity, Commitment, Feedback, Attitudes to each activity, Perseverance, Obedience and Have clear standards. The closer to the value of the given criterion the better the result.

According to [3], "Decision Support Systems for Selection of Performing Employees Based on Performance using the Analytic Hierarchy Process Method" produces 10 outstanding employees based on their performance. The results of the total weight calculation of each alternative using AHP and Fuzzy AHP, and from CR (Consistency Ratio), both results show consistent results by using AHP Alternative A Weight (0.1596), B (0.6349) and C (0.2055), while using the Fuzzy AHP alternative employee A (0.4869), B (0.3561) and C (0.1570). So based on AHP calculation, the choice of candidates from the highest score to lowest are candidates B, C, and A. While the calculation of Fuzzy AHP, obtained the sequence A, B and C. Based on the research descriptions, the authors looked at some of the differences in increasing the accuracy as well as the specified weights. According to (Ridyanningtias 2013), the measure of employee performance is one important factor. If you can not measure it, it causes difficulties in managing management. The effect of performance measurement has a major impact on existing human resource activities. Several performance appraisal methods, consisting of Graphic Rating Scale Method, Method of Behavioral Valuation Scale, Management Method Based on Goal (Gibson, 1994).

For that the authors conclude that differences in processing and development procedures studied by previous researchers can be appointed as a reference in analyzing this research topic, which to obtain good accuracy data using weighting criteria that will be analyzed using Fuzzy AHP in improving the accuracy of AHP techniques can applied to get a better accuracy, therefore the authors make a study with the title "Performance Analysis Of Fuzzy Analytic Hierarchy Process In The Rangking."

2. Methods

This research, several important points of AHP and fuzzy AHP are briefly described, among others, the data used derived from questionnaires and interviews. Of the 150 questionnaires distributed, only 100 questionnaires were returned. Furthermore, for interviews that are used as resource persons namely the chairman of Prodi, lppm chairman and chairman of the foundation of earth finance persada. Research conducted since years ago.

2.1. AHP

Analytic Hierarchy Process (AHP) defined as a representation of a complex problem in a multi-level structure where the first level is the goal, followed by the factor level, criteria, sub criteria, and so on down to the last level of the alternative [4]. AHP requires the selection of alternative values in pairwise comparisons because it has the nature of uncertainty and should be reconsidered in many pairwise comparison assessments (Yu, 2002).

The problem solving process using AHP method is described as follows:

1. For each value in the first column multiplication must be done with relative priority columns on the first element, then the value in the second column must be multiplied by the relative priority column of the second element. Do so until the first column and relative priority columns on the th menu.
2. Add each row.
3. Furthermore the result of the sum of rows divided by relative priority elements.
4. Sum it up with the number of elements used.
5. Next, calculate the consistency index (CI) using the formula
$$CI = (\lambda_{max} - n) / (n-1)$$
6. After the CI value is obtained, divide by Consistency Ratio (CR) using the formula:
$$CR = CI / RI.$$

2.2. Fuzzy AHP

Decision-making models need to tolerate ambiguity because uncertainty is a common feature in many decision-making issues (Yu, 2002). Because decision makers often provide uncertain answers rather than exact values, the transformation of a qualitative preference to an approximate point may not make sense.

This decision-making is obtained by several stages. By using the Structure Hierarchy then obtained goals / goals to be achieved, the criteria used and alternatives. Structure The hierarchy used can be seen in figure 1.

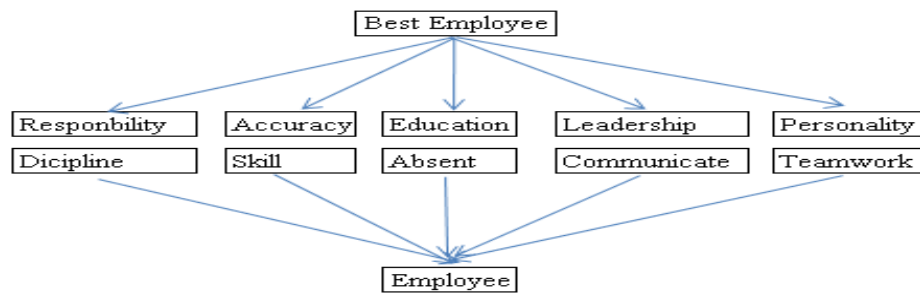


Figure 1 Hierarchy Structure

Fuzzy AHP procedure follows the rules steps by:

1. Creating a Hierarchy Structure
2. Create a Triangular Fuzzy Number (TFN);
3. Determining the value of fuzzy systesis (S_i):
4. Determining the value of vector (V) and Defuzzify Ordinate value (d');
5. Normalization of fuzzy vector weight values (W) Normalized vector weight values;
6. Conduct a comparison of data accuracy on AHP and Fuzzy AHP;

3. Result

This research used survey method with field data collecting technique 150 respondents and interviewed to 3 resource persons namely chairman of Prodi, Chairman of LPPM and Chairman of Bina Bumi Persada Foundation. Of the 150 questionnaires distributed, only 100 questionnaires were returned. Research conducted since January until December 2016. The stages of this study started from data collection, data processing, problem formulation, testing stages and data analysis described in the form of diagrams in Figure 2.

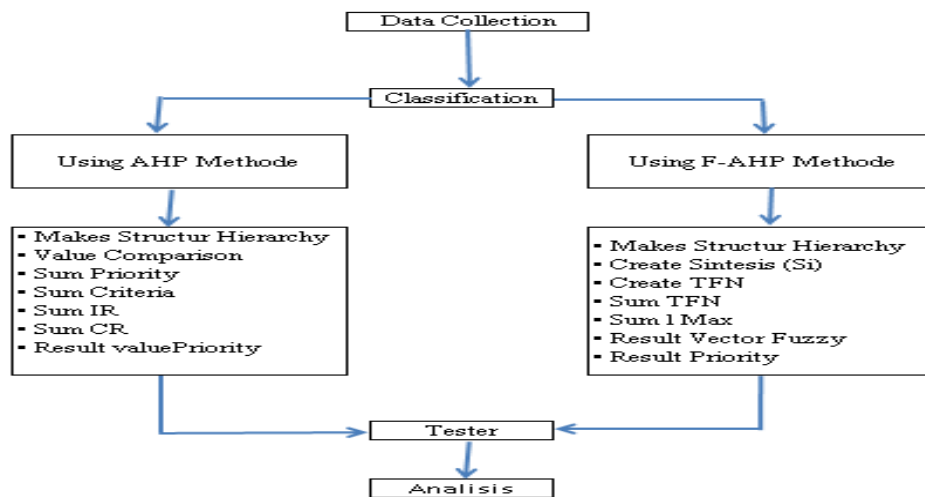


Figure 2. Flow Diagram

Data from respondent survey questionnaires using AHP and Fuzzy AHP methods are as follows:

Using AHP methods

The first stage is the comparison of criteria and alternatives, and the calculation of the weight of the value needs to be done. Thus, evaluation criteria according to the main objectives and evaluation of alternative criteria should be realized. The next step, after all these evaluation procedures, the alternative weights can be calculated. In the second step, this weight is used for AHP calculations for final evaluation. Comparison matrix for criteria. Table 1.

Table1. Value Matriks Comparison.

X1	X2	X3	X4	X5	X6	X7	X8
1	3	5	5	3	5	1	3
0,33	1	5	7	5	3	3	1
0,14	0,20	1	3	1	1	2	3
0,11	0,14	0,33	1	2	1	0,3	1
0,14	0,20	1,00	0,50	1	3	2	0,33
0,20	0,33	1,00	1,00	0,33	1	0,2	0,75
1,00	0,33	7,00	0,33	0,50	5,00	0,2	0,5
0,33	1,00	21,00	27,00	0,50	15,00	3,00	1
3,73	6,21	12,16	21,53	20,36	20,33	9,73	10,58

Calculate value matrix is normalized as follows:

$$X1 = (1 / 7,2), (0,3 / 7,2), (0,3 / 7,2), (2 / 7,2), (2 / 7,2), (0,2 / 7,2), (1 / 7,2)$$

$$X2 = (3 / 12,2), (1 / 12,2), (0,5 / 12,2), (0,3 / 12,2), (3 / 12,2), (0,33 / 12,2), (3 / 12,2)$$

$$X3 = (3 / 13), (2 / 13), (1 / 13), (0,5 / 13), (0,5 / 13), (3 / 13), (2 / 13), (1 / 13)$$

$$X8 = \begin{pmatrix} 3/8,3 \\ 1/8,3 \\ 1/8,3 \\ 0,5/8,3 \\ 1/8,3 \\ 0,3/8,3 \\ 0,5/8,3 \\ 1/8,3 \end{pmatrix}$$

Alternative weights are calculated with AHP then the weight of this value can be used on F-AHP. Thus, the AHP methodology should begin in the first step. Thus, the initialized normalized decision matrix can be used as a reference which can be seen in table 2.

Table2. Normalized Matriks values.

X1	X2	X3	X4	X5	X6	X7	X8
0,268	0,483	0,247	0,232	0,147	0,246	0,103	0,284
0,089	0,161	0,411	0,325	0,246	0,148	0,308	0,095
0,089	0,032	0,082	0,139	0,049	0,049	0,206	0,284
0,054	0,023	0,027	0,046	0,098	0,049	0,034	0,095
0,089	0,032	0,082	0,023	0,049	0,148	0,021	0,031
0,054	0,054	0,082	0,046	0,016	0,049	0,021	0,071
0,268	0,054	0,041	0,141	0,246	0,246	0,103	0,047
0,089	0,161	0,027	0,046	0,149	0,066	0,206	0,095
1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000

After obtaining the value of the matrix, then determine the priority of choice (Synthesis of Priority) is done by calculating the Priority Evaluation Value which includes:

- Calculates a factor value in a table column.
- Calculating the value of factors in the table used scales 1 through 9 that refer to table 3. Rating Scale.
- Divide each factor value in a column by the total value of the calculation per column.
- Calculates the average value of a row by calculating the value of a factor per row.

Table 3. Results Amount and Priority

Goal	Amount	Prioritaty
X1	2,009	0,270
X2	1,782	0,157
X3	0,930	0,033
X4	0,426	0,057
X5	0,475	0,084
X6	0,393	0,029
X7	1,145	0,103
X8	0,839	0,266

The result of the average value of the line above is known that the priority of responsibility has the highest value, that is 0.270 but can not be set as the criteria value chosen before determining the consistency ratio level.

Next calculate the Consistency Ratio (CR), ie evaluate the consistency level of the assessment given in the pairwise comparison stage. Determine CR using the Weighted Sum Vector formula, ie by multiplying the result of the mean value of the row by each factor value in the Pairwise comparison table. To determine the value of consistency vector by dividing the value of weighted sum vector with the average value of result of Consistency Vector:

Table 4. Consistency Vector Results

X1	8,858 / 0,295	9,153
X2	5,192 / 0,205	5,397
X3	0,328 / 0,050	0,378
X4	0,522 / 0,067	0,590
X5	0,912 / 0,093	1,005
X6	0,195 / 0,044	0,238
X7	1,593 / 0,118	1,711
X8	1,908 / 0,128	2,036

Next Calculate the value of Consistency Index (CI) and lamda. The lamda value λ is the average value of the Consistency Vector.

$$\lambda = 9,153 + 5,397 + 0,378 + 0,590 + 1,005 + 0,238 + 1,711 + 2,036 / 8$$

$$= 2,564$$

lamda value is obtained, next step calculates the CI value.

$$CI = (2,564 - 8) / (8 - 1) = - 5,436 / 7 = - 0,7765$$

Last count CR value (Consistency Ratio). CR value is used to see the final result of whether the search criteria and alternatives in accordance with the given provisions. If the value of CR <0.10, then decision making is considered consistent, but if the alternative value is greater or inconsistent then it needs to be recalculated to get a consistent value.

Table 5. Consistency Test Results.

Criteria	Amaks	CI	CR	Ket
X1	8,858	2,564	- 0,550	Consisten
X2	2,088	0,844	-0,938	Consisten
X3	1,665	0,904	-1,005	Consisten
X4	1,583	0,916	-1,018	Consisten
X5	1,652	0,906	-1,007	Consisten
X6	1,670	0,904	-1,004	Consisten
X7	1,758	0,891	-0,990	Consisten
X8	1,831	0,881	-0,979	Consisten

4. Discussion

Next determine the pairwise comparison matrix subcriteria. The final result can be seen in figure 4

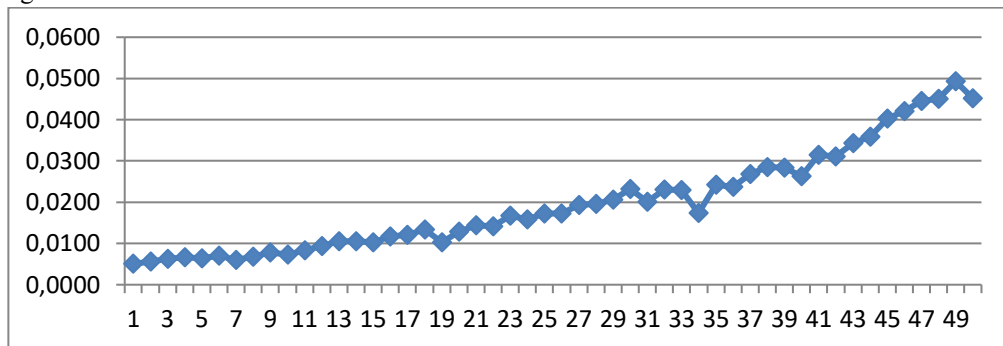


Figure 4 . Graph Result of Matrices.

From the result matrix above, then obtained the final value for best ranking using AHP method can be seen in table 6.

Table 6. Employee Value Results

Goal	Mean Value	Rank
K41	0,0314	10
K42	0,0310	9
K43	0,0343	6
K44	0,0359	8
K45	0,0402	4
K46	0,0420	5
K47	0,0445	3
K48	0,0450	7
K49	0,0493	1
K50	0,0452	2

Using the F-AHP method first stage, the criteria and the weight of the alternative importance must be compared. For that, there must be a linguistic term and an equivalent fuzzy number that shows the size of the comparison. The terms of linguistic comparison and the equivalent fuzzy numbers considered in this journal. By following the steps and calculations of the F-AHP procedure, a ranking of strategies is obtained.

Table 7. Number of Fuzzy numbers.

L	M	U	ΣL	Σm	Σu
1	1	1	3	3	3
¼	1/3	1	3/12	4/12	1/12
1/3	½	1	2/6	3/6	1
1	1	1	3	3	3
1	1	1	3	3	3
1/3	½	1	2/6	3/6	1
1	1	1	1	1	1
1/3	½	1	2/6	3/6	1

The data used using the AHP method on the first test with the first 10 samples resulted in total (0.0050, 0.0057, 0.0060, 0.0067, 0.0064, 0.0070, 0.0060, 0.0067, 0.0079 and 0.0074), then the second test resulted (0.0083, 0.0093, 0.0105, 0.0102, 0.0107, 0.0117, 0.0121, 0.0133, 0.0103 dan 0.0129). there is a slight increase until finally on the fifth test it produces (0.0315, 0.0311, 0.0344, 0.359, 0.0420, 0.04 02, 0.0466, 0.0451, 0.0493 and 0.0452).

Having obtained value on AHP method, then forwarded using Fuzzy AHP method. The first experiment consisted of 10 samples, the first test yielded the total (0.250, 0.457, 0.363, 0.467, 0.364, 0.270, 0.160, 0.670, 0.379 and 0.274), then the second test resulted (0.283, 0.393, 0.405, 0.202, 0.407, 0.317, 0.321, 0.133, 0.213 and 0.129). there is a slight increase but not stable, the test is repeated until finally on the fifth test it produces (0.415, 0.319, 0.344, 0.529, 0.290, 0.202, 0.618, 0.451, 0.593 and 0.952).

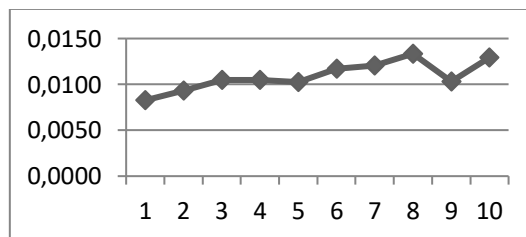


Figure 5. Image display The first Test Phase uses the AHP method

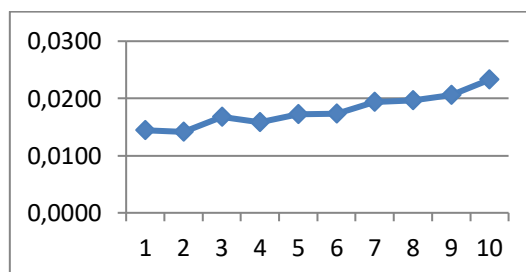


Figure 6. The image view of the Fifth Testing Stage using the AHP method

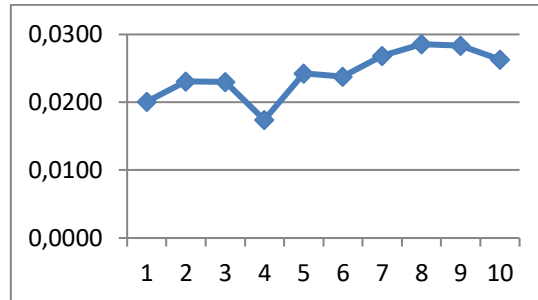


Figure 7. Graphical display First Test Phase using F-AHP

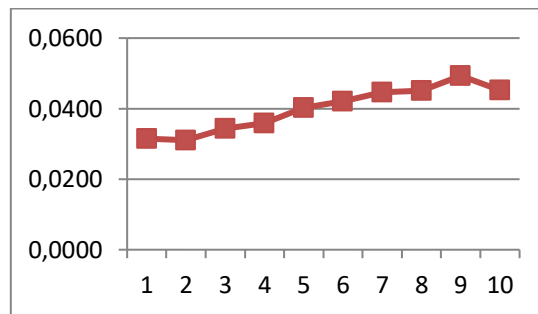


Figure 8. Graphical Views of the Fifth Testing Stage using the F-AHP method.

From the previous test results, then obtained the final value for the best ranking using F-AHP method can be seen in table 8.

Table 8. Employee Value Accuracy Results

Goal	Average	Rank
K41	0,4142	10
K42	0,4105	9
K43	0,4434	6
K44	0,4595	8
K45	0,5027	4
K46	0,5206	5
K47	0,5453	3
K48	0,5507	7
K49	0,5949	1
K50	0,5529	2

Table 8 can be seen that the highest value obtained by employee to 49 with value (0,5933) compared with other employees.

5. Conclusion

The results of decision making accuracy analysis using Fuzzy AHP show that there is a good accuracy improvement when using Fuzzy AHP method compared using AHP. The best employee rank value generated using the AHP method is 0.0493 or 49.3%. Furthermore, conducted several times testing to find accuracy using Fuzzy AHP method, it increased to 0,5949 or equal to 59,4%. Thus it can be said that by using the method of Fuzzy AHP to find the accuracy of decision making to find the best employees rank can be used as a solution as an alternative.

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