

## Decision Making and Evaluation System for Employee Recruitment Using Fuzzy Analytic Hierarchy Process

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**ABSTRACT:-** In this fast-changing world, there are also fast-changing industrial and market side. As the great growth of industrial side, many company are seeking for more and more employee. Not only an ordinary and less-skilled employee, but well trained and fit best at their position at industry. It is a big challenge to create a system that help the human resource development in industry to make their work easier without missing an opportunity to get a best employee. Also the objective of this study is to develop a decision making and evaluating system for employee recruitment using fuzzy analytic hierarchy process. The system will firstly, calculate the weight of pairwise comparison generated by administrator. Then, system will retrieve all data about the applicant. Every person, has it's own record in respective curriculum vitae. The system will retrieve only important data such as age, gender, education, work experience, and desired salary. Then, the system will retrieve the condition of desired employee from human resource development department. Every single data on all participant is calculated as a number and the system will compare it with fuzzy analytical hierarchy process (later on will abbreviated as AHP) weight calculated from pair matrix and show a result. The result is in form of rank, which show the fittest applicant to the available job vacancy.

**KEYWORDS:-** fuzzy, analytical hierarchy process, decision support system, evaluation system, recruitment process.

### I. INTRODUCTION

In this fast-changing world, there are also fast-changing industrial and market side. As the great growth of industrial side, many company are seeking for more and more employee. Not only an ordinary and less-skilled employee, but well trained and fit best at their position at industry. Human resource development in an industry, also create more strict selection to ensure the best human resource for their company. Many efforts and money rolled out to feed those manual system on recruiting a new employee with that method. A good employee recruiting strategy is the best way to avoid having recruiting turn into a time-draining, money-sucking activity. We have all run an ad and been inundated with unqualified people who eat up time and resources [1]. It is a big challenge to create a system that help the human resource development in industry to make their work easier without missing an opportunity to get a best employee. Using this new method, human resource development will know which is the worthed applicant and less-worthed applicant and sort them in many order such as their work experience, grade, and majoring.

The method that purposed in this thesis is AHP and Fuzzy Logic. According to Saaty (1980) "It is a systematic decision making method which includes both qualitative and quantitative techniques" [2]. A decision making and evaluating system for employee recruitment able to simplify the work of human resource development on industry. This system will access all applicant data from given curriculum vitae, or by other data that given at personal interview with the human resource development department. This will provide the accuracy of the recruitment progress and also create an evaluating system of all new recruited employee. The evaluating system will have all the data of the employee and make it easier to evaluate an employee.

Evaluation Decision-Making System is a centralized public access portal designed to provide information related to evaluation of a library's services and resources for management and advocacy purposes [3]. By utilizing the AHP and Fuzzy correctly, it show a better results to determining the evaluation score, because the defuzzification method able to overcome the uncertainty factor as we know that the object we will select is human. Fuzzy AHP methodology is flexible and can be used for other sectors with some sector specific characteristics changes. Humans are often uncertain in assigning the evaluation scores in crisp AHP. Fuzzy AHP can capture this difficulty [4].

The primary objective of this study is to develop a decision making and evaluating system for employee recruitment using fuzzy analytic hierarchy process, especially the objectives are :

1. to design a system that decide which applicant to be recruited.
2. to implement a Fuzzy Analytic Hierarchy Process to the system.
3. to test the usability of the created system at recruitment progress.

## II. FIELD SITE STUDY

This study was conducted on Kopkar Citra Bekasi, a company under Telkom Surabaya in Surabaya, East Java. The data obtained from the company is a form of applicant data that applied to the company for a job. The data contain main properties of applicant such as education, major, salary estimation, and more interview result such as motivation, stress tolerance, communication, and initiative. The data obtained from open recruitment conducted by related local company as new job available. The main research methodology to create such system is :

1. Research and study about how companies recruit the new employee.
2. Research about how to make a reliable and stable software or system.
3. Research about how the system will implement the Fuzzy-AHP method.
4. Creating the system using PHP language to easily maintain the data inside the database.
5. Implementing the Fuzzy-AHP method to the system and do some minor test.
6. Test the system to a company, to find the response about the system and repair bug if exist to ensure the system will work properly on long use.

## III. BASIC PRINCIPLE OF THIS PAPER

This paper described about how the system will utilize the Fuzzy AHP as a method to make a decision support system and to test the reliability of the system. The goal is to obtain the fittest applicant to be recruited by the company. The applicant's property will be considered by a fuzzy weight by the company is a form of pairwise comparison. The criteria are obtained from administrator decision, as the administrator can input, edit, or delete the criteria according to the company condition. The system will help the work of the human resource department as it helps the selection of new employee.

The general concept of the software is to create a decision of new employee that should be recruited, based on the criteria given by administrator, and or based on the condition given by company. The **Fig. 1** shows the general concept of the software.

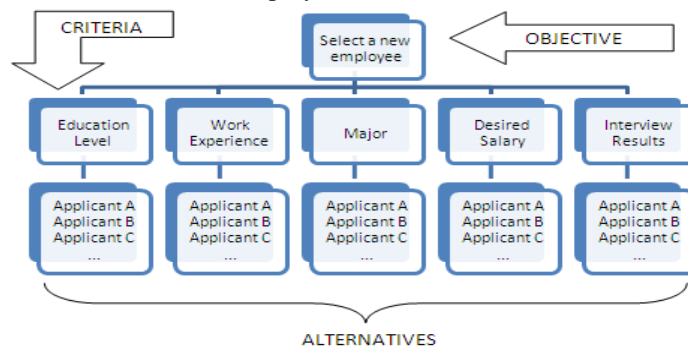


**Figure. 1** The general concept of the software

The concept of the software as the decision making is started with data processing from the database. The data is in form of applicant data and also the pairwise comparison that initiated by the administrator. Then, the program initiating the fuzzy rule set from the number 1 – 9 described in precious chapter. The Fuzzy AHP algorithm then initiated by calculation the weight of criteria from the pairwise comparison. The obtained weight the calculated by the data from applicant in form of alternatives. The applicant with highest score is presented in top of rank that sort all of the calculation in form of rank.

## IV. DESIGN OF FUZZY AHP ALGORITHM

To obtain the best calculation, Fuzzy AHP algorithm need to be designed. As it follow the reality of the condition on the company. Calculation of the system will include Fuzzy Triangular Number set and CoA (Center of Average) defuzzyfication combined with AHP pair matrix of criteria. **Fig. 2** show the diagram of the criteria and alternatives in order to select new employee



**Figure 2.** Diagram of criteria and alternatives

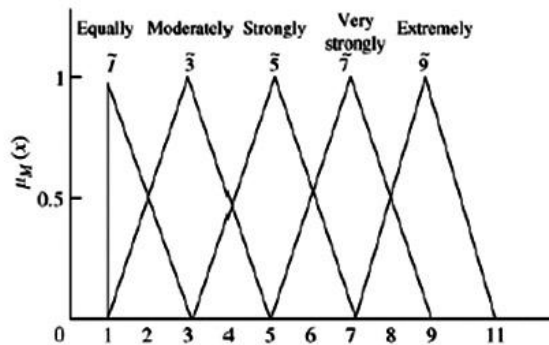
Based on the **Fig. 2**, we can determine that each of criteria are act as superior of each applicant, thus the system is able to sustain Fuzzy AHP algorithm. On previous research Fuzzy AHP has ensured that the relative importance of each criterion and the relative importance of each item in their scale [3].

The Fuzzy AHP used in this paper is using **Table 1** as the fuzzy global scale :

**Table 1.** Fuzzy global scale

Linguistic Scale	Fuzzy Number	Fuzzy Scale Number
Equal	1	(1,1,3)
Rather Important	3	(1,3,5)
More Important	5	(3,5,7)
Very Important	7	(5,7,9)
Extremely Important	9	(7,9,9)
Equally Not Important	1 <sup>-1</sup>	(1/3,1,1)
Slightly Not Important	3 <sup>-1</sup>	(1/5,1/3,1)
Less Important	5 <sup>-1</sup>	(1/7,1/5,1/3)
Very Less Important	7 <sup>-1</sup>	(1/9,1/7,1/5)
Not Important	9 <sup>-1</sup>	(1/9,1/9,1/7)

**Table 1** also can be represented as **Fig. 3**.



**Figure 3.** Graph of membership function

However, fuzzy numbers must first be defuzzified into Best Non-fuzzy Performance (BNP) value numbers before they can be used for comparison. Thus, the defuzzification of the fuzzy weight of a criterion is done by calculating BNP value of the final weights[4].

The calculation of the Fuzzy AHP is to include the pair matrix based from normal AHP. Each criteria is dependant to each other by mean of priority based on **Table 1**. The **Equation (1)** show the pair matrix of Fuzzy AHP :

$$A = \begin{bmatrix} 1 & a_{12} & a_{1n} \\ a_{21} & 1 & a_{2n} \\ a_{n1} & a_{n2} & 1 \end{bmatrix} \text{ where: } a_{ij} = \begin{cases} 1,3,5,7,9 \\ 1 \\ 1^{-1}, 3^{-1}, 5^{-1}, 7^{-1}, 9^{-1} \end{cases} \dots (1)$$

To obtain the weight of each criteria presented in matrix **A** in **Equation (1)**, we used **Equation (2)** and **Equation (3)** :

$$r_i = a_{i1} \otimes a_{i2} \otimes \dots \otimes a_{in} \dots (2)$$

$$w_i = r_i \otimes (r_i \oplus \dots \oplus r_n)^{-1} \dots (3)$$

Where:

$a_{i1}$  is fuzzy ratio value from criteria 1 until criteria n

$r_i$  is geometrical mean from ratio value of fuzzy criteria i to other criteria

$w_i$  is fuzzy weight from criteria i.

Defuzzification of the weight of each criteria by using Triangular Fuzzy Number Center of Average defuzzification showed on **Equation 4** :

$$w_i = Lw_i + \frac{((Mw_i - Lw_i) + (Uw_i - Lw_i))}{3} \dots (4)$$

Where:

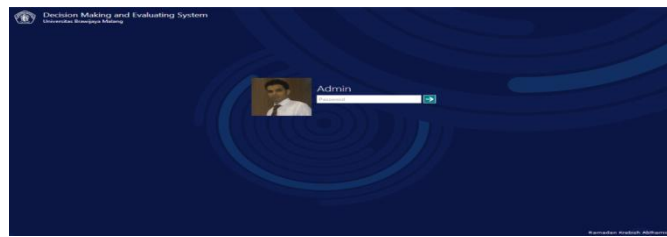
$Uw_i$  is the upper triangular fuzzy number of corresponding criteria- $i$

$Mw_i$  is the middle triangular fuzzy number of corresponding criteria- $i$

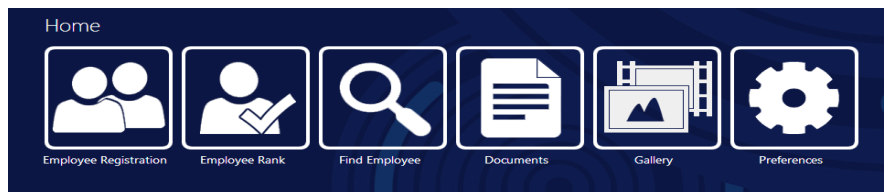
$Lw_i$  is the lower triangular fuzzy number of corresponding criteria- $i$

### V. DESIGN OF SOFTWARE WEBSITE

The design of software website is utilizing PHP language using XAMPP package along with PHPMySQL included. The software function is designed according to the company need, which is flexible as the company are conducting job search according to their job vacancy. Thus, the administrator are free to create, update, and delete the criteria, as well as modifying pairwise comparison. **Fig. 4** is show the autorhization page before entering the main website and the list function homepage of website.



**Figure 4.** Autorhization page of software website



**Figure 5.** Homepage list function of software website

The site has navigation to travel between menu beside from goind to Home first. The navigation is placed on top right of the site.



**Figure 6.** Navigation between pages

Employee registration menu consist of the function of adding an employee from admin side. The menu can be accessed my clicking the icon that presented above. The data of the employees are presented in a form that contain main data such as, name, address, gender, birth date, and birth place. The advanced menu can be accessed by pressing the “pencil” icon on the left side of every employee. The Edit menu is contain all of the private data of the employee. Admin can edit the data according to the result of the interview or anything. Admin can also delete the data of employee by clicking the “trash” icon.

The employee rank menu is used to check the overall data of the employee in a form. The form is also used as consideration for interview or another needs. Employee rank menu can be accessed by pressing the icon menu.

Find employee menu is the main function of the website. The function is to select a new employee according to criteria that decided before. The flow of the function is described in **Fig. 7** :



**Figure 7.** Find Employee function sequence

Find employee menu will select new employee from the employee database and match the criteria before initiating calculation. The calculation will be conducted if administrator has performed all criteria check and selected a job type. Then, the process of Fuzzy AHP will selecting the most fit applicant to become the new employee.

Documents contain all the history, review, and all activity that has been initiated by administrator. The documents menu also show the trending of all finding result by job type. Document can be accessed by pressing the icon menu on homepage.

Preferences contains all function to create new criteria, edit criteria, edit the priority of criteria and delete criteria. The main interface of the preferences menu is a set of table that contains all used criteria, sorted by means of priority. The company we working with, has a flexible terms on recruiting new employee, so the program must be flexible also. The preferences function must be able to fulfill the needs, so we make a function where administrator are able to edit the criteria, create new criteria, or delete existing criteria.

Documentation contains all gallery from the making of the software. Also contain the picture of the company condition as showed on **Fig. 8** and **Fig. 9**.

**Figure 8.** Example of registration form of new applicant

Criteria	Description	Priority	Option
Education	Formal educational achievements	1	[edit] [delete]
Major	Major of formal latest education	2	[edit] [delete]
Experience	Previous job experience related / not related to applied job	3	[edit] [delete]
Salary estimation	Salary that employee wants	4	[edit] [delete]
Course	Course or informal educational experience	5	[edit] [delete]
Motivation	Motivation for applying the job (obtained from interview)	6	[edit] [delete]
Tolerance of Stress	Tolerance of stress to works (obtained from interview)	7	[edit] [delete]
Communication	Communication skill of the employee (obtained from interview)	8	[edit] [delete]
Initiative	Initiative skill to think and make a decision (obtained from interview)	9	[edit] [delete]

**Figure 9.** Criteria table of software website

## VI. FUZZY AHP CALCULATION

The calculation of the Fuzzy AHP conducted in two function. First, in Preferences function, when administrator save the pairwise comparison. The software will calculate the weight of every criteria using **Equation (1)**, **Equation (2)**, **Equation (3)**, and **Equation (4)**. The output of the calculation is in a form of criteria weight table. Using the value Equal as all value in pairwise comparison, will show the result of calculation showed in **Fig. 10**.

Weight of the Criteria

Criteria	Weight
Education	48.150 %
Major	18.519 %
Experience	8.642 %
Salary Estimation	5.350 %
Course	4.252 %
Motivation	3.887 %
Tolerance of Stress	3.765 %
Communication	3.724 %
Initiative	3.710 %

Show calculation

Figure 10. Weight of criteria result using all Equal as pairwise comparison value

By using the scheme that we obtain from company, the result is shown in Fig. 11.

Weight of the Criteria

Criteria	Weight
Education	61.658 %
Motivation	20.409 %
Experience	9.019 %
Communication	6.213 %
Major	2.519 %
Salary Estimation	0.176 %
Initiative	0.002 %
Course	0.002 %
Tolerance of Stress	0.001 %

Show calculation

Figure 11. Weight of criteria using pairwise comparison value obtained from company

The related matrix calculation from result from Fig. 11 using formula from Equation (1), Equation (2), Equation (3), and Equation (4) is showed below.

Fuzzy Comparison Table

[[1.000][1.000][3.000]]	[[1.000][1.000][3.000]]	[[1.000][1.000][3.000]]	[[1.000][3.000][5.000]]
[[1.000][1.000][3.000]]	[[1.000][1.000][3.000]]	[[3.000][5.000][7.000]]	[[1.000][1.000][3.000]]
[[1.000][3.000][5.000]]			
[[0.333][1.000][1.000]]	[[1.000][1.000][3.000]]	[[1.000][3.000][5.000]]	[[1.000][1.000][3.000]]
[[1.000][3.000][5.000]]	[[1.000][1.000][3.000]]	[[1.000][3.000][5.000]]	[[0.333][1.000][1.000]]
[[0.200][0.333][1.000]]			
[[0.333][1.000][1.000]]	[[0.200][0.333][1.000]]	[[1.000][1.000][3.000]]	[[1.000][1.000][3.000]]
[[1.000][3.000][5.000]]	[[1.000][3.000][5.000]]	[[1.000][3.000][5.000]]	[[1.000][1.000][3.000]]
[[1.000][3.000][5.000]]			
[[0.200][0.333][1.000]]	[[0.333][1.000][1.000]]	[[0.333][1.000][1.000]]	[[1.000][1.000][3.000]]
[[0.333][1.000][1.000]]	[[1.000][1.000][3.000]]	[[1.000][1.000][3.000]]	[[1.000][1.000][3.000]]
[[1.000][1.000][3.000]]			
[[0.333][1.000][1.000]]	[[0.200][0.333][1.000]]	[[0.200][0.333][1.000]]	[[1.000][1.000][3.000]]
[[1.000][1.000][3.000]]	[[0.333][1.000][1.000]]	[[0.333][1.000][1.000]]	[[0.143][0.200][0.333]]
[[0.200][0.333][1.000]]			

[[0.333][1.000][1.000]] [[1.000][1.000][3.000]] [[3.000][5.000][7.000]]	[[0.333][1.000][1.000]] [[1.000][1.000][3.000]] [[3.000][5.000][7.000]]	[[0.200][0.333][1.000]] [[5.000][7.000][9.000]] [[3.000][5.000][7.000]]	[[0.333][1.000][1.000]] [[5.000][7.000][9.000]] [[3.000][5.000][7.000]]
[[0.143][0.200][0.333]] [[1.000][1.000][3.000]] [[3.000][5.000][7.000]]	[[0.200][0.333][1.000]] [[0.111][0.143][0.200]] [[3.000][5.000][7.000]]	[[0.200][0.333][1.000]] [[1.000][1.000][3.000]] [[3.000][5.000][7.000]]	[[0.333][1.000][1.000]] [[0.111][0.143][0.200]] [[3.000][5.000][7.000]]
[[0.333][1.000][1.000]] [[3.000][5.000][7.000]] [[3.000][5.000][7.000]]	[[1.000][1.000][3.000]] [[0.111][0.143][0.200]] [[3.000][5.000][7.000]]	[[0.333][1.000][1.000]] [[5.000][7.000][9.000]] [[3.000][5.000][7.000]]	[[0.333][1.000][1.000]] [[1.000][1.000][3.000]] [[3.000][5.000][7.000]]
[[0.200][0.333][1.000]] [[1.000][3.000][5.000]] [[1.000][1.000][3.000]]	[[1.000][3.000][5.000]] [[0.143][0.200][0.333]] [[1.000][1.000][3.000]]	[[0.200][0.333][1.000]] [[0.143][0.200][0.333]] [[1.000][1.000][3.000]]	[[0.333][1.000][1.000]] [[0.143][0.200][0.333]] [[1.000][1.000][3.000]]

Geometric Average

[[3.000][45.000][127,575.000]]  
[[0.022][9.000][3,375.000]]  
[[0.067][27.000][16,875.000]]  
[[0.007][0.333][243.000]]  
[[0.000][0.007][3.000]]  
[[0.556][81.667][5,103.000]]  
[[0.000][0.002][0.840]]  
[[0.185][25.000][793.800]]  
[[0.000][0.008][2.778]]

Defuzzyfication

[0.61657481131475]  
[0.025192923174979]  
[0.090191871310149]  
[0.0017605078483154]  
[2.330417943735E-5]  
[0.20409358684233]  
[1.1966997307169E-5]  
[0.062127454809114]  
[2.3573523623592E-5]

-----  
[[3.837][188.018][153,971.418]]

Geometric Weight

[[0.782][0.239][0.829]]  
[[0.006][0.048][0.022]]  
[[0.017][0.144][0.110]]  
[[0.002][0.002][0.002]]  
[[0.000][0.000][0.000]]  
[[0.145][0.434][0.033]]  
[[0.000][0.000][0.000]]  
[[0.048][0.133][0.005]]  
[[0.000][0.000][0.000]]

**VII. CONCLUSION AND RESULT**

The result of the software in a form of rank and sort all the applicant in order from most fittest applicant to less fittest applicant. **Fig. 12** shows the rank table from software website.

Name	Criteria									Total Score
	Education	Major	Experience	Salary Estimation	Course	Motivation	Tolerance of Stress	Communication	Initiative	
Rahman Naufal	2,959.560	17.635	459.979	1,179,541.700	0.000	428.597	0.030	211.234	0.090	1,183,620.000
Bintang Luthfi	2,959.560	30.231	450.960	1,144,331.500	0.000	346.960	0.028	180.170	0.083	1,148,300.000
Henry Auffa Wardoyo	2,836.245	17.635	459.979	1,126,726.400	0.000	346.960	0.028	180.170	0.083	1,130,570.000
Zainudin Rifqi	2,836.245	17.635	459.979	1,091,516.200	0.000	346.960	0.028	180.170	0.083	1,095,360.000
Haikal Rizal Fuadi	2,959.560	20.154	459.979	1,056,306.000	0.000	346.960	0.028	180.170	0.083	1,060,270.000
M.Aldo Wicaksono	2,836.245	30.231	450.960	1,056,306.000	0.000	346.960	0.028	180.170	0.083	1,060,150.000
Ridho Maulana Dani	2,836.245	27.712	450.960	1,056,306.000	0.000	346.960	0.028	180.170	0.083	1,060,150.000
Ayana Sabrina	2,774.588	22.674	450.960	1,056,306.000	0.000	346.960	0.028	180.170	0.083	1,060,080.000

**Figure 12.** Rank table from software website

Based on above study and the result from **Fig. 12**, Fuzzy AHP can be used for Decision Support System to find new employee. By observing the company needs, we can make a software that fulfill the company needs and adjusted from the condition of the company. Fuzzy can be used as algorithm to improve AHP algorithm so the software is more better and precise to the goal.

The calculation obtained from the **Equation (1), Equation (2), Equation (3), and Equation (4)** is able to determine the best applicant. By using the membership function described in **Table 1**, the weighting of the criteria is optimum because it can diverse the most important criteria to the less important criteria. That proved on the large gap between Education and other criteria, based on test of weighting using pairwise comparison obtained from company.

The system went well on the company because it's provide flexibility on determining criteria, pairwise comparison, flexibility to modify applicant data, and good data serving.

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