Design of Information System for Acceptance Selection of Prospective Employees Online Using Tahani Fuzzy Logic Method and Simple Additive Weighting (SAW)

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ABSTRACT

This research designed and made an information system of online based job applicant selection system by using Tahani fuzzy logical method and Simple Additive Weighting (SAW). This research is designed due to the job applicant selection system that hasn't been optimized so that the management of an institution as well as a company faces some difficulties and barners in selecting the perfect human resources to be hired. The method applied in this research are Tahani fuzzy logical method and Simple Additive Weighting (SAW) producing web application-based software system that can handle the job applicant selection process by analyzing the data of job application as well as job applicant's data. This kind of system produced some outputs consisting of job-applicant candidate rank, ideal job applicant rank, and also final rank.

Keywords:
Tahani Fuzzy
Simple Additive Weighting (SAW)
Job Applicant Rank
Final Rank

I. Introduction

Human Resources Management (HRM) is an activity that is related to the effort to obtain human resources carried out by a variety of specific activities including the recruitment and selection. The selection process should be managed professionally and effectively in order to obtain a good resource for a longer period of time so that the objectives and the company's success can be achieved.

In Indonesia, the recruitment systems that exist today are still intended for one company alone, cannot serve many companies at once, using the criteria and static weighting, so it can not adjust to fulfill appropriate human resources. For this reason, it need a system that can store, integrate and analyze the data several candidates for some different companies or institutions. An information system will be optimized if the application using measured methods, among these methods are fuzzy logic method and Simple Additive Weighting (SAW).

Tahani fuzzy and Simple Additive Weighting (SAW) methods are used to select candidates by conducting an analysis of the data vacancy and applicant data so as to produce the final ranking. The analyze were performed with the criteria and weighting that is more dynamic, based on the needs of each company. The information system also can help job seekers to obtain information about job vacancies anytime and anywhere.

II. Review of Tahani Fuzzy and Simple Additive Weighting (SAW) method

A. Fuzzy Logic

In 1965, Lotfi A. Zadeh introduced the fuzzy set theory. This theory states that the main component of the most influential is the membership function. Membership function represents the degree of closeness of an object to a particular attribute, whereas in probability theory more emphasis on the use of the relative frequency (Ross, 2005). More detail:

- The basic concept of fuzzy set: Fuzzy logic is able to adapt to changes and uncertainty that accompanies the problem.
- Classical Set (Crisp): Fuzzy set theory is an extension of classical set theory. In the classical set theory, there are only two grades of membership, namely $\mu\bar{A}(x)=1$ for x as members of A; and $\mu\bar{A}(x) = 0$ for x is not a member of A (Kusumadewi, 2006).
- Fuzzy set : If X is a collection of objects denoted generically by x, then a fuzzy set $\bar{A}$ in X is a set of sequential pairs (Kusumadewi, 2006).

$$\bar{A}=\{ (x, \mu\_ \tilde{A}(x)) \mid x\in X \} \quad (1)$$

Where:

$\bar{A}$	:	fuzzy set
$\mu\_\bar{A}(x)$	:	degree of membership
X	:	Objects denoted generically
x	:	Object

With $\mu\bar{A}(x)$ is the degree of membership x which maps X into membership space μ which lies between (0.1).

B. Membership Function

The membership function is a curve that shows the mapping of points of input data into membership values. Membership function has a value in the interval between 0 and 1, which are obtained through the function approach. Some of membership functions used in this study, namely:

a. Triangle curve representation

Fig. 1. Triangle curve representation

Triangular curve is a combination of 2 lines (linear) as shown in Fig. 1.

Membership function:

$$\mu[x] = \begin{cases} 0; & x \le a \text{ atau } x \ge c \\ \frac{(x-a)}{(b-a)}; & a \le x \le b \\ \frac{(b-x)}{(c-b)}; & b \le x \le c \end{cases} \quad (2)$$

Where:

$\mu[x]$: degree of membership set
x : data *crisp*
a : domain bottom value
b : domain maximum value
c : domain top value

b. Shoulder shape curve representation

The shoulder shape curve basically is a trapezoid-shaped curve, but is not fully formed, the shaped like a 'shoulder' or half of a trapezoidal shape. The shoulder shape curve is used to terminate an area of fuzzy variables, the left shoulder moves from right to wrong as well as right shoulder moves from wrong to the right. This shape shown in Fig. 2.

Fig. 2. Shoulder shape curve representation

Left shoulder membership function:

$$\mu[x] = \begin{cases} 1; & x \leq a \\ \frac{(b-x)}{(b-a)}; & a \leq x \leq b \\ 0; & x \geq b \end{cases} \quad (3)$$

Right shoulder membership function:

$$\mu[x] = \begin{cases} 0; & x \leq c \\ \frac{(x-c)}{(d-c)}; & c \leq x \leq d \\ 1; & x \geq d \end{cases} \quad (4)$$

Where:

$\mu[x]$: degree of membership set
x : data *crisp*
b, c : domain bottom value
a, d : domain maximum value

C. Zadeh Operator

Just like a conventional set, there are some operations that are specifically identified for combining and modifying the fuzzy set. Membership value as part of a two fuzzy sets known as fire strength or α-predicate. This operation uses the basic operators AND and OR in the query process. Recommended alternative is an alternative that has a value of fire strength or level of compliance with selection criteria that have a value above zero to one (Kusumadewi, 2004).

a. AND operator

AND operator interaction associated with operations on the set of α-predicate. This operator is used to retrieve the smallest membership value between elements of the available sets.

$$\mu_{A\cap B} = \min(\mu_A(x), \mu_B(y)) \quad (5)$$

b. OR operator

Operator OR associated with union operation on the set of α-predicate. This operator is used to retrieve the largest membership value between elements of the available sets.

$$\mu_{A\cup B} = \max(\mu_A(x), \mu_B(y)) \quad (6)$$

D. Tahani Fuzzy

Tahani fuzzy describe a fuzzy query processing method, based on the manipulation of language known as SQL. Tahani fuzzy model suitable for use in the process of finding the right and accurate data (Kusumadewi, 2004).

E. Simple Additive Weighting (SAW)

Simple Additive weighting method (SAW) also known as a weighted summation method. The basic concept of SAW is to find weighted summation of the performance rating of each alternative on all attributes (Kusumadewi, 2006). SAW method requires a process of normalizing the decision matrix (X) to a scale which can be compared with all the rating alternatives.

$$r_{ij} = \begin{cases} \frac{x_{ij}}{\text{Max}_i\, x_{ij}}, & \text{with j is benefit attribut} \\ \frac{\text{Min}_i\, x_{ij}}{x_{ij}}, & \text{with j is cost attribut} \end{cases} \quad (7)$$

Where:
r_{ij} : normalization data
x_{ij} : data from *sample* data
i : attribut from *sample* data
j : criteria from *sample* data

Where r_{ij} is the normalized performance rating of A_i alternatives on C_j attribute; i = 1, 2, 3, ..., m and j = 1, 2, 3, ..., n. Preference value for each alternative (V_i) is given as:

$$V_i = \sum_{j=1}^{n} w_j r_{ij} \quad (8)$$

Where:
V_i : Preference value for each alternate applicants
n : Number of alternate applicants
i : alternatif criteria (1 to n)
j : attribut (1 to m)
w : weight preferences
r_{ij} : matrix of sample data that has been normalized

The larger V_i value indicates that the A_i alternative is selected as the best alternative.

III. Research methodology

This study carried out according to the stages following the path shown in Fig. 3.

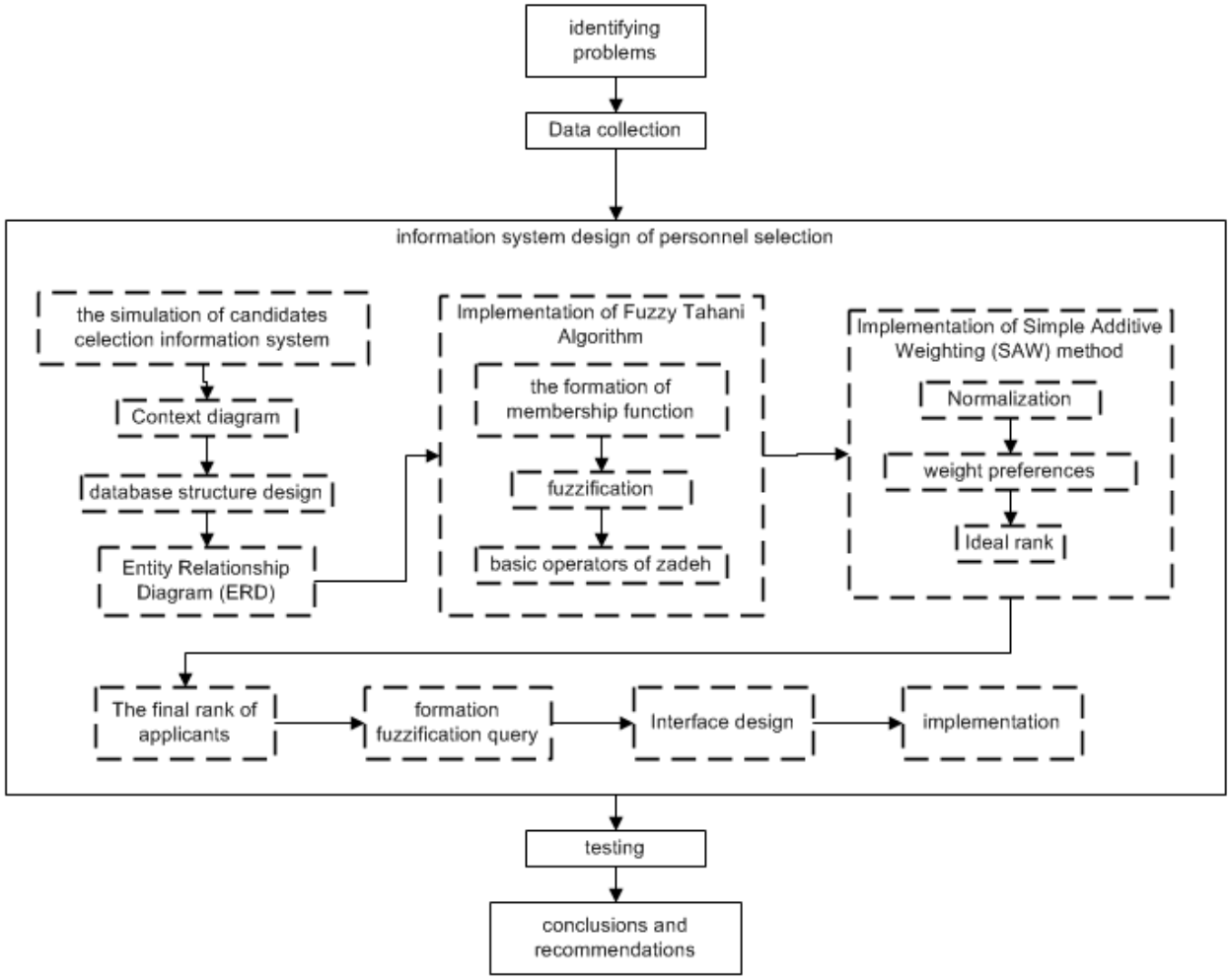

Fig. 3. Research stages

In the simulation shown in Fig. 4 illustrates an outline of the information system of selection of prospective employees use web-based application that involves entities visitors, companies and applicants. In this study, the process of Tahani fuzzy method, called fuzzy database that will become the primary object. Entity involved in the system are entities that have been through the process of registration and verification. Job vacancy information obtained from members of the company while members of the applicants that are interested in the vacancy should complete the form which has been prepared by the system and submit it. Form that must be completed is about the qualification requirements for the job vacancies being offered, the weight of the required qualifications and requirements documents completeness.

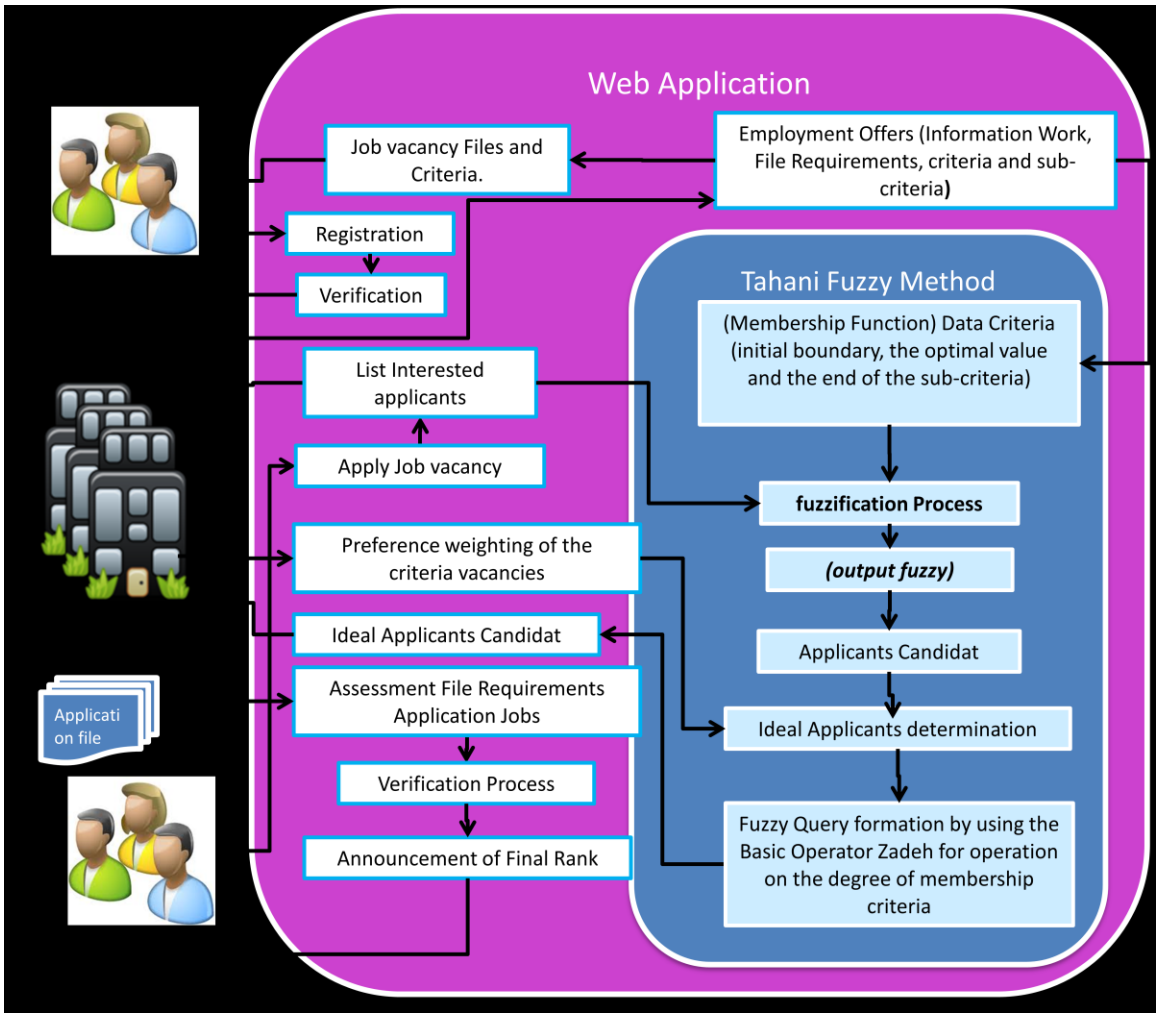

Fig. 4. Simulation of information system for admission selection of prospective employees

Alternative decision is in the form of a list of applicants who have been selected based on the provisions of the system, the weight of the preferences from the members of the company, the comparison criteria for job vacancy and operations defined using Zadeh operation. The decision alternatives are expected to be the basis for decision making by companies. Then the system will announce the ranking of applicants who have been verified by the company as a final announcement.

Implementation of Tahani fuzzy algorithm for selection process of prospective employees and its result is an output of the system shown in Fig. 5.

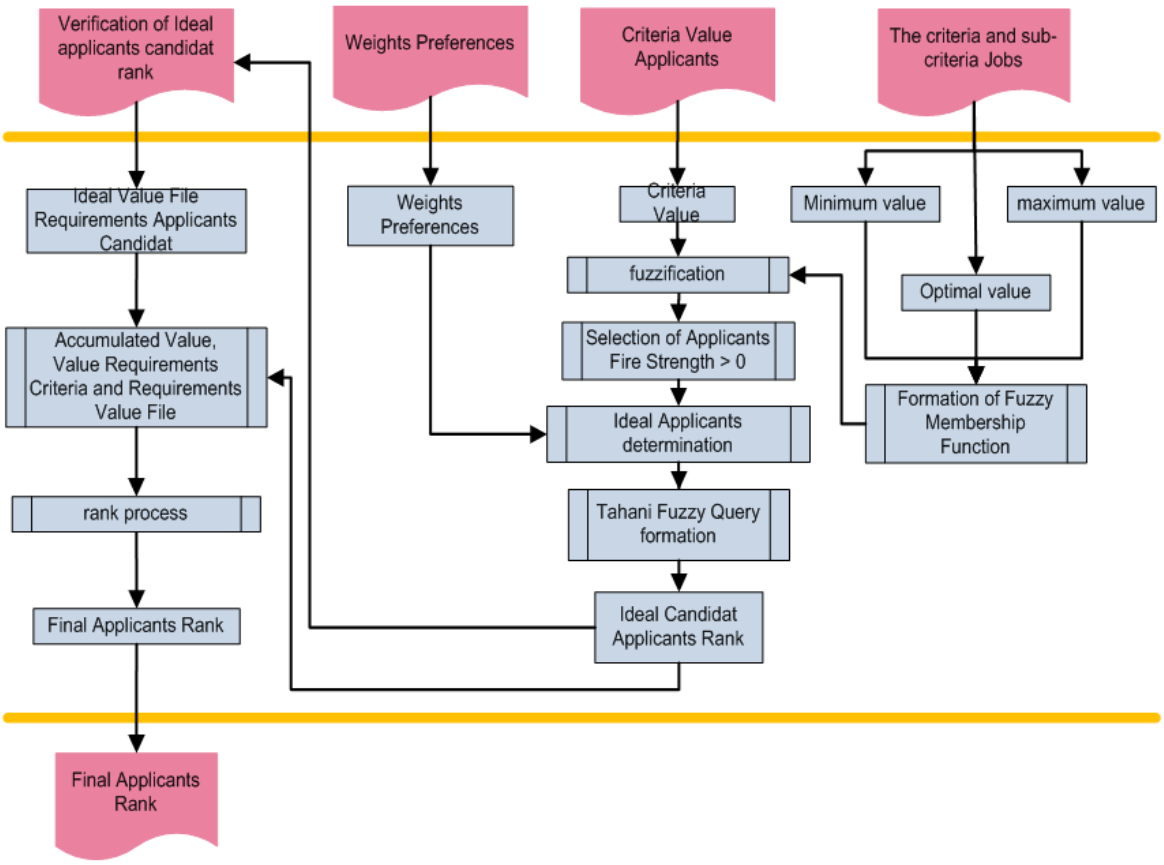

Fig. 5. Fuzzification process flow diagram of Tahani models of personnel selection system

Fuzzification process starting from the stage of data sub-criteria for job openings that have minimal value, optimal value and maximum value of each of the criteria on the requirements of the proposed jobs. From these minimum value, optimal value and maximum value, then being processed to form the membership function of sub-criteria and criteria for job openings. This membership functions then became the rule base for fuzzification process.

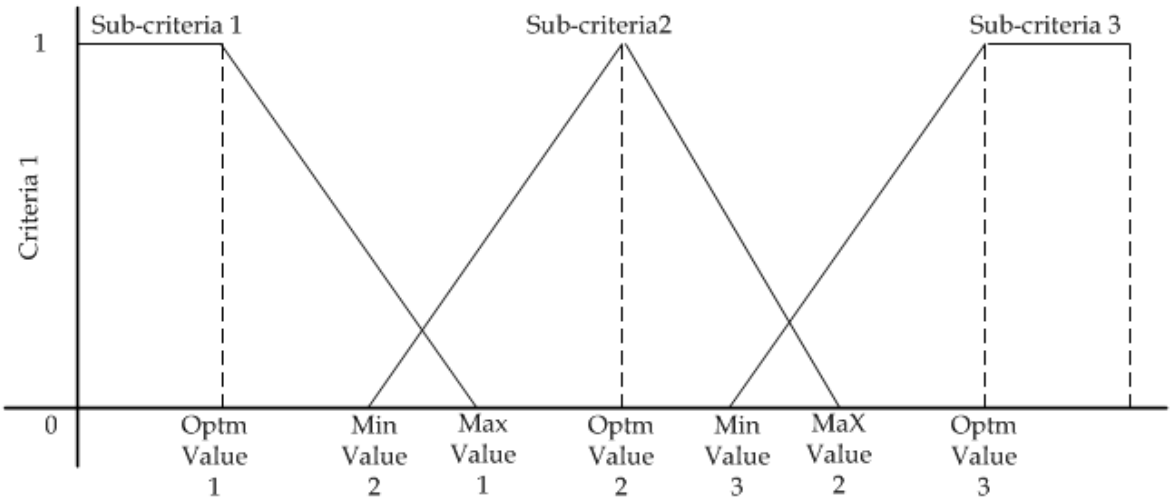

Fig. 6. Shoulder shape curve and triangle curve representation of membership function

Minimum value, the optimal value and the maximum value of the sub-criteria will determine the function of the shoulder shape representation and the triangle shape representation that will be used to form the membership

function of each criteria. The membership function that can be generated from the input of these criteria is shown in Fig. 6 and 7.

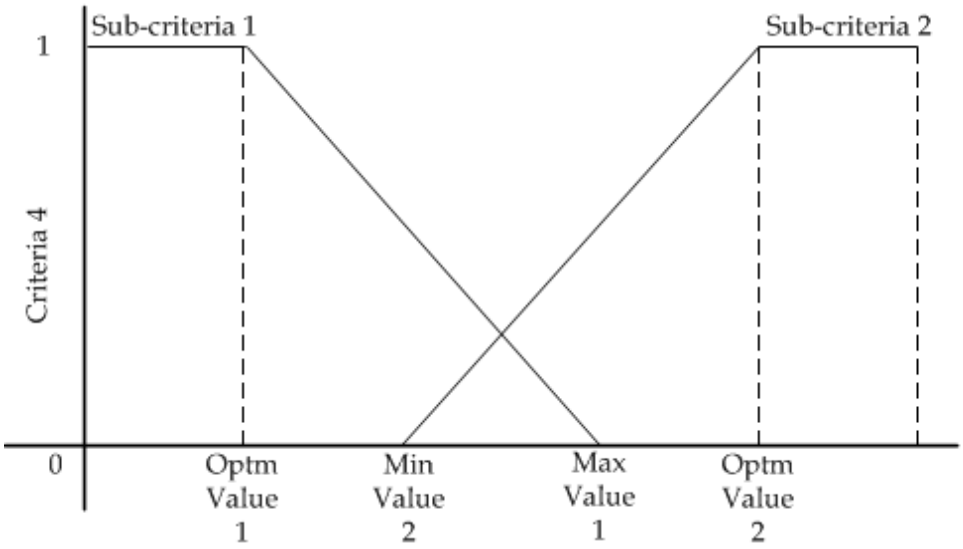

Fig. 7. Shoulder shape representation of membership function

Left shoulder representation of the membership function refers to the equation 2, namely:

$$\mu\text{Criteria}[x] = \begin{cases} 1, & x \leq \text{Noptm} \\ \frac{\text{Nmax} - x}{\text{Nmax} - \text{Noptm}}, & \text{Noptm} \leq x \leq \text{Nmax} \\ 0, & x \geq \text{Nmax} \end{cases}$$

Membership functions of triangular representation referring to equation 1, namely:

$$\mu Criteria[x] = \begin{cases} 0, & x \leq Nmin \; atau \; x \geq Nmax \\ \frac{x - Nmin}{Noptm - Nmin}, & Nmin \leq x \leq Noptm \\ \frac{Noptm - x}{Nmax - Noptm}, & Noptm \leq x \leq Nmax \end{cases}$$

And, right shoulder representation of the membership function refers to the equation 3, namely:

$$\mu\text{Criteria}[x] = \begin{cases} 0, & x \leq \text{Nmin} \\ \frac{x - \text{Nmin}}{\text{Noptm} - \text{Nmin}}, & \text{Nmin} \leq x \leq \text{Noptm} \\ 1, & x \geq \text{Noptm} \end{cases}$$

Based on the definition of the equations above, then designed some standard values of criteria that are dynamic for each job as shown in Table 1.

Table 1. Standar Value of Criteria

No	Criteria Sub-Criteria	Interval		
		Min Value	Optimal Value	Max Value
1	Age (years)			
11	Young		20	25
12	Middle-aged	23	28	33
13	Old	31	36	
2	Work Experience (years)			
21	Short		1	3
22	Long enough	2	4	6
23	Long	5	7	9
24	The longest	8	10	

3	GPE			
31	Acceptable		2.75	3.25
32	Good	3	3.5	3.75
33	Excellent	3.5	4	
4	Body Height			
41	Acceptable		150	154
42	Medium	152	156	160
43	Ideal	158	162	166
44	Very Ideal	164	168	
5	TOEFL			
51	Good		375	425
52	Very Good	400	450	500
53	Excellent	475	550	

Inferencing process which involves the rule base of all the sub-criteria of the previous process, is used to filter criteria values of each applicant based on his/her fire strength value. The output is called a fuzzy value.

IV. Result and Discussion

For system performance testing purposes, this study takes the sample data from the company's CV. Eka Karya Utama. Vacancies information that will be entered into the system is required qualifications of prospective employees. Member companies enter data to the system in the form of required documents and other data in accordance with the available vacancies

Furthermore, a number of applicant data entered as crisp input for each criteria of the vacancies. Degree of membership for each criteria was calculated based on the data that has been entered. Table 2 shows the data of applicants for each criteria.

Table 2. *Sample data, applicants criteria values*

No	Applicant	Criteria				
		Age	Work Experience	GPE	Body Height	TOEFL
1	Wiwin Ningsih	28	2	2.98	158	399
2	Sapril Yansah	23	1.5	3.88	165	400
3	Beti Yuliartati	29	4	4	160	450
4	Feni Malani	20	1	2.88	153	400
5	Kanti Subandi	29	2.5	3.3	155	420
6	Rima Handoko	23	5	3,2	164	430
7	Aris Pristyawati	25	3.5	3.55	157	460
8	Muhajirin	24	1.5	3.68	172	480
9	Dessy Ramadhianty	22	2	3.78	159	410
10	Nazwa Wawan	27	4	3.65	162	500
11	Muhammad Hamidun	25	7	3	165	400
12	Wawan	24	2.7	2.77	170	350

Applicant data is then fed into the scope of membership function to obtain a degree of membership as shown in Table 3.

Table 2. Degree of Membership

No	Applicant	degree of membership			Degree of membership				Degree of membership			Degree of membership				Degree of membership		
		Age Criteria			Work Experience Criteria				GPE Criteria			Body Height				TOEFL		
		Young	Middle-aged	Old	Short	Long enough	Long	The Longest	Acceptable	Good	Excellent	Acceptable	Medium	Ideal	Very Ideal	Good	Very good	Excellent
1	Wiwin Ningsih	0	0,5	0	0,5	0	0	0	0,54	0	0	0	0,5	0	0	0,52	0	0
2	Sapril Yansah	0	0,5	0	0,75	0	0	0	0	0	0,76	0	0	0,3	0,25	0,5	0	0
3	Beti Yuliartati	0	0,3333	0	0	1	0	0	0	0	1	0	0	0,5	0	0	1	0
4	Feni Malani	0,6	0	0	1	0	0	0	0,74	0	0	0,25	0,25	0	0	0,5	0	0
5	Kanti Subandi	0	0,3333	0	0,25	0,3	0	0	0	0,6	0	0	0,75	0	0	0,1	0,4	0
6	Rima Handoko	0	0,5	0	0	0,5	0	0	0,1	0,4	0	0	0	0,5	0	0	0,6	0
7	Aris Prasetyawati	0	1	0	0	0,8	0	0	0	0,8	0,1	0	0,75	0	0	0	0,8	0
8	Muhajirin	0	0,75	0	0,75	0	0	0	0	0,3	0,36	0	0	0	1	0	0,4	0,667
9	Dessy Ramadhianty	0,2	0,25	0	0,5	0	0	0	0	0	0,56	0	0,25	0,3	0	0,3	0,2	0
10	Nazwa Wawan	0	0,6667	0	0	1	0	0	0	0,4	0,3	0	0	1	0	0	0	0,333
11	Muh. Hamidun	0	1	0	0	0	1	0	0,5	0	0	0	0	0,3	0,25	0,5	0	0
12	Wawan	0	0,75	0	0,15	0,4	0	0	0,96	0	0	0	0	0	1	1	0	0

The criteria values that have been selected are processed further to rank the applicants. These data will be indexed based on the criteria in the vacancy which was then called the candidate ranked applicants based on the applicant's fire strength. Table 4 shows the candidate rank of applicants who have a fire strength value > 0.

Table 4. List of Candidate Rank

No	Applicant	Fuzzy Output					Fire Strength Value
		Age	Work Experience	GPE	Body Height	TOEFL	
1	Aris Pristyawati	1	0	0,8	0	0,8	0,8
2	Beti Yuliartati	0,33	0	0	0,5	1	0,5
3	Rima Handoko	0,5	0	0,4	0,5	0,6	0,5
4	Kanti Subandi	0,33	0,25	0,6	0	0,4	0,33
5	Muhajirin	0,75	0,75	0,28	0	0,4	0,28
6	Dessy Ramadhianty	0,25	0,5	0	0,25	0,2	0,2

Ideal applicants are ranked carried out through the process of calculating the value of the criteria of applicants with the preferences of the company's weight. The method used for this calculation is a multi-criteria selection model using Simple Additive weighting.

Data normalization process conducted in accordance with equation 8, for example, to the first data:

$$r_{11} = \frac{25}{\max\{25; 29; 23; 29; 24; 22\}} = \frac{25}{29} = 0{,}86207$$
$$r_{12} = \frac{3{,}5}{\max\{3{,}5; 4; 5; 2{,}5; 1{,}5; 2\}} = \frac{3{,}5}{5} = 0{,}70000$$
$$r_{13} = \frac{3{,}55}{\max\{3{,}55; 4; 3{,}2; 3{,}3; 3{,}68; 3{,}78\}} = \frac{3{,}55}{4} = 0{,}88750$$
$$r_{14} = \frac{157}{\max\{157; 160; 164; 155; 172; 159\}} = \frac{157}{172} = 0{,}91279$$
$$r_{15} = \frac{460}{\max\{460; 450; 430; 420; 480; 410\}} = \frac{460}{480} = 0{,}95883$$

in order to obtain the normalized matrix R as follows:

$$R = \begin{bmatrix} 0{,}86207 & 0{,}70000 & 0{,}88750 & 0{,}91279 & 0{,}95833 \\ 1{,}00000 & 0{,}80000 & 1{,}00000 & 0{,}93023 & 0{,}93750 \\ 0{,}79310 & 1{,}00000 & 0{,}80000 & 0{,}95349 & 0{,}89583 \\ 1{,}00000 & 0{,}50000 & 0{,}82500 & 0{,}90116 & 0{,}87500 \\ 0{,}82759 & 0{,}30000 & 0{,}92000 & 1{,}00000 & 1{,}00000 \\ 0{,}75862 & 0{,}40000 & 0{,}94500 & 0{,}92442 & 0{,}85417 \end{bmatrix}$$

The preference of the company's weight is W = (30, 2, 3, 160, 450), which respectively show a preference for age, work experience, GPA, height and TOEFL.

Ranked applicants determined through calculation refers to the equation 9 to choose the ideal alternative applicants. Results of the selection preference value for each V_i is:

$V_1 = (30 * 0{,}86) + (2 * 0{,}70) + (3 * 0{,}89) + (160 * 0{,}91) + (450 * 0{,}96) = 607{,}22$
$V_2 = (30 * 1{,}00) + (2 * 0{,}80) + (3 * 1{,}00) + (160 * 0{,}93) + (450 * 0{,}94) = 605{,}31$
$V_3 = (30 * 0{,}79) + (2 * 1{,}00) + (3 * 0{,}80) + (160 * 0{,}95) + (450 * 0{,}90) = 583{,}88$
$V_4 = (30 * 1{,}00) + (2 * 0{,}50) + (3 * 0{,}83) + (160 * 0{,}90) + (450 * 0{,}88) = 571{,}41$
$V_5 = (30 * 0{,}83) + (2 * 0{,}30) + (3 * 0{,}92) + (160 * 1{,}00) + (450 * 1{,}00) = 638{,}19$
$V_6 = (30 * 0{,}76) + (2 * 0{,}40) + (3 * 0{,}95) + (160 * 0{,}92) + (450 * 0{,}85) = 558{,}68$

Ideal applicants ranking are shown in Table 5, after the result of the calculation is converted to two-digit precision.

Table 5. Ideal Applicants Ranking

No	Applicant	Ideal Ranking
1	Muhajirin	63,82
2	Aris Pristyawati	60,72
3	Beti Yuliartati	60,53
4	Rima Handoko	58,39
5	Kanti Subandi	57,14
6	Dessy Ramadhianty	55,87

The assessment of administrative requirements is rights of the company based on documents submitted by the applicant. Assumptions of valuation used for each required document is if the documents exist, the default value is 100, but if not then the default value is 0, as shown in Table 6.

Table 6. assessment of administrative requirements

No	Applicant	Required Document						Mean Value
		CV	Academic Certificate	Academic Transcript	TOEFL	ID Card	Photo	
1	Aris Prasyetia	100	100	100	100	100	100	100,00
2	Beti Yuliartati	100	0	100	0	100	100	66,67
3	Rima Handoko	100	100	100	100	0	100	83,33
4	Kanti Subandi	100	100	100	100	100	0	83,33
5	Muhajirin	0	100	0	0	100	100	50,00
6	Dessy Ramadhianty	0	0	100	100	100	100	66,67

The accumulated value of applicants consisting of recapitulation ideal value and administrative value, shown in Table 7.

Table 7. Applicant Final Score

No	Pelamar	Ideal Score	Adm. Score	Final Score
1	Aris Pristyawati	60,72	100,00	80,36
2	Beti Yuliartati	60,53	66,67	63,60
3	Rima Handoko	58,39	83,33	70,86
4	Kanti Subandi	57,14	83,33	70,24
5	Muhajirin	63,82	50,00	56,91
6	Dessy Ramadhianty	55,87	66,67	61,27

Table 7 shows that the three best candidates have a final value 80.36, 70.86 and 70.24 respectively. And as the output of the selection system of prospective employees is an ordered list of applicants based on their final score.

V. Conclusion

Tahani fuzzy method and Simple Additive Weighting can be applied in information system for selection of prospective employees online. This system can help and make a recommendation for the company to select applicant online. The system is able to make the rule base based on qualifications in job vacancies refers to the given value of minimum, optimum and maximum.

Although the system has been successfully providing recommendations for the company, but it is advisable to document the assessment process is also done through fuzzification process so that the final score for the ranking of applicants can be performed fully automatically.

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