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A CASE STUDY ON EVALUATING PERSONNEL AND JOBS JOINTLY WITH FUZZY DISTANCE SETS

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In this research, a case study of fuzzy approach on personnel evaluation and job evaluation together was performed. A newer fuzzy distance measurement formula was developed and used to determine fuzzy distances. Although there have been many researches on personel evaluation and job evaluation concepts together, it is not found any research in which these to concepts were examined. Evaluating personel and job together gave some advantages like comparability of data, useness of model and managing the two concepts together. Model gave detailed information on an organization. Results showed that suggested formula and method could be used for small, medium or large companies easily, and allowed to evaluate two concepts together even there are many personel and jobs in an organization.

Keywords: Fuzzy Sets, Personnel Evaluation, Job Evaluation, Human Resources, Human Capital

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1. INTRODUCTİON

Human capital is the most important and useful components for organizations in competition area. To support the organization effectively, management information system (MIS) managers must manage their human resources effectively (Chen et.al., 2005). Making the right decisions about human resources policies can determine success in companies (Cano´ s et al. 2008).

Like successful evaluation in an organization, the probability of a successful and timely completion of a project is also improved when decision makers choose employees with the skill and competency set that best matches the multi-criteria demands of the project (Shipley et al., 2009). Within the realm of project management, it has been demonstrated that a fuzzy logic model could help in the selection of new product introductions (Shipley et al., 1995) because it allows for subjective evaluation by the decision maker under conditions of uncertainty and ambiguity. The decision maker faces similar conditions when selecting project team members (Shipley et al., 2009).

In this research, personnel evaluation and job evaluation processes determined together based on fuzzy set theory, at the beginning of the research, personnel evaluation and job evaluation processes determined separately, current jobs and personnel related to these jobs classified according to their fuzzy distances, grouped in a scale table which was generated in this research, afterwards they compared according to their fuzzy distances and group numbers, and results were discussed.

Results showed that fuzzy approach gave more detailed research opportunity within a job group. With using this method, it is possible to determine whether current personnel are able to work or not, even it is possible to determine position of a personnel in same job group. Thus, some further suggestions were made according to results like education needing of company or staff, amount and quality of educations according to personnel evaluation criteria and job evaluation factors, current position of jobs etc. Three possible personnel position were found and possible positions discussed.

2. METHOD

Let E be a universe set. A fuzzy set A of E is defined by a membership function $\mu_A(x) \rightarrow [0,1]$, where μA(x), $\forall x \in E$, indicates the degree of x in A. Let A+ and A- be positive and negative ideal solution; d+ and d- defined as alternative's distance to positive and negative ideal solution (Jahanshahloo et al., 2006). A triangular fuzzy number A is a fuzzy number with piecewise linear membership function μA defined by (Wang et al., 2007);

$$\mu_A = \begin{cases} \dfrac{x - a_i}{b_i - a_i}, & a_i \le x \le b_i \\ \dfrac{c_i - x}{c_i - b_i}, & b_i \le x \le c_i \\ 0, & otherwise \end{cases} \quad \ldots \quad (1)$$

which can be denoted as a triplet $M_i = (a_i, b_i, c_i)$.

Let $M_i = (a_i, b_i, c_i)$ and $M_j = (a_j, b_j, c_j)$ be two triangular fuzzy numbers, than f (A) fuzzy estimation is explained according to Hamming distance as following (Duin et al., 2006);

$$f(A) = \sum_{x \in E} \left| \mu_i(x) - \mu_j(x) \right| \quad \ldots \quad (2)$$

In this case, the distance between M_i and M_j was defined as below;

$$d(M_i, M_j) = \frac{1}{3}\left[\left|(a_i - a_j)\right| + \left|(b_i - b_j)\right| + \left|(c_i - c_j)\right| \right] \quad \ldots \quad (3)$$

In this study, we have obtained only the distance of alternative solution to positive and negative ideal solutions depending on absolute values. In addition to this, it was required to find whether alternative solution is lower or higher than ideal solutions. Thus, it is possible to decide side situation in addition to distance measurement. For this reason, Formula (2) was developed as below:

$$d(M_i, M_j) = \frac{1}{3}\left[(a_i - a_j) + (b_i - b_j) + (c_i - c_j) \right] \quad \ldots \quad (4)$$

With this equation, place and group number of a current job in scale table could be evaluated successfully. At the end of this step, current jobs within an organization could be easily grouped based on fuzzy distances.

2.1 Fuzzy Job Evaluation

At this stage of research, a general scale table which has some group numbers and was grouped according to some fuzzy intervals based on work of Turkey Metal Industry Job Grouping System Scale (Mess, 1996) generated (see table below). Depending on quality and variety of characteristic of each job value of each job is different from each other (Gilbert, 2005). It is possible to state that job evaluation is such objective and scientific method that it determines priority of work and job structure by job grouping (Chiaburu, 2006).This table was used for both personnel grouping and job grouping processes. Nine interval groups listed in Turkey Metal Industry Job Grouping System Scale (Mess, 1996) were defined with sub and top fuzzy distances, and distances of fuzzy distance values of job and personnel were compared with this scale. These intervals were numbered as group numbers from 1 to 9 (see table 1). Number of job groups could be changed based on organizational structure. Current jobs or personnel which have less value than top value of a group and higher value than sub value of a group were defined as a member of that group.

Table 1. Job groups, their sub and top values based on fuzzy intervals

Job Group	Sub fuzzy values	Top fuzzy values
1	(0 , 0 , 0)	(300 , 300 , 300)
2	(301 , 301 , 301)	(365 , 365 , 365)
3	(366 , 366 , 366)	(430 , 430 , 430)
4	(431 , 431 , 431)	(495 , 495 , 495)
5	(496 , 496 , 496)	(560 , 560 , 560)
6	(561 , 561 , 561)	(625 , 625 , 625)
7	(626 , 626 , 626)	(690 , 690 , 690)
8	(691 , 691 , 691)	(755 , 755 , 755)
9	(756 , 756 , 756)	(1000 , 1000 , 1000)

At job evaluation step, current job factors and their weight values were determined based on 4 main factors and 12 sub factors of current job as ability, responsibility, effort and job requirements. Results of analytical hierarchy process (Kahraman et al., 2003; Kahraman et al., 2004; Kuo et al., 2002) used by Saaty (Saaty, 1990; Saaty et al., 2007; Fu et al., 2006), converted to certain numbers by Kaufmann, Gupta (Kaufmann et al., 1991). Then Chang's method (Chang, 1996), Liou and Wang's Method (Liou et al., 1992), Abdel-Kader and Dugdale's methods (Abdel-Kader et al., 2001) were used to determine factor weights for each sub factor group, results were compared and evaluated. Table 2 illustrates weight values of job settlement.

Table 2. Job evaluation factor weights

Factors	Point of Factor Weight	Sub Factors	Sub Factor Weight Point
Ability	380	Education or Basic Information	114
		Experience	103
		Skills	89
		Initiative and Finding Remedies	74
Responsibility	280	Machine, Apparatus and Supplies Responsibility	60
		Equipment and Product Responsibility	78
		Production Responsibility	85
		Responsibility of Others' Job Security	57
Effort	150	Mental Effort	45
		Physical Effort	105
Job Requirements	190	Possible Dangers Caused by Job	75
		Labor Conditions	115

For each current job, experts of this job evaluated importance of their job factors as linguistic statements. These linguistic statements and their fuzzy values were given in Table 3.

Table 3. Linguistic and fuzzy values in job evaluation

Linguistic Value	Fuzzy Value
Very Low	(0 ; 0.2 ; 0.4)
Low	(0.2 ; 0.4 ; 0.6)
Medium	(0.4 ; 0.6 ; 0.8)
High	(0.6 ; 0.8 ; 1)
Very High	(0.8 ; 1 ; 1)

Two job groups of Art-Craft, Furnace Shift Responsibility and Glass Production team, were used to demonstrate job evaluation and combination of jobs processes. Fuzzy distance measures and grouping results of Furnace Ship Responsibility were given in Figure 1. Formula (4) was used to determine these values, experts of these jobs were named as critics who gave linguistic values for their jobs. These linguistic values were converted to fuzzy values based on Table 3, than scores were determined as shown in Figure 2.

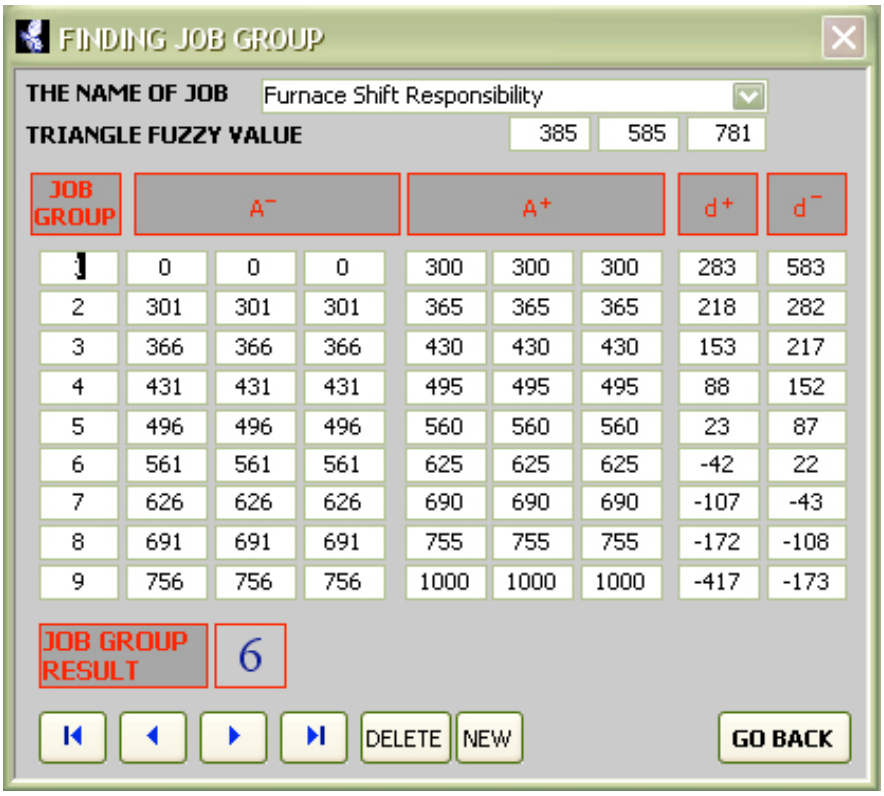

Figure 1. Furnace shift responsibility, critic 1 job evaluation program scene

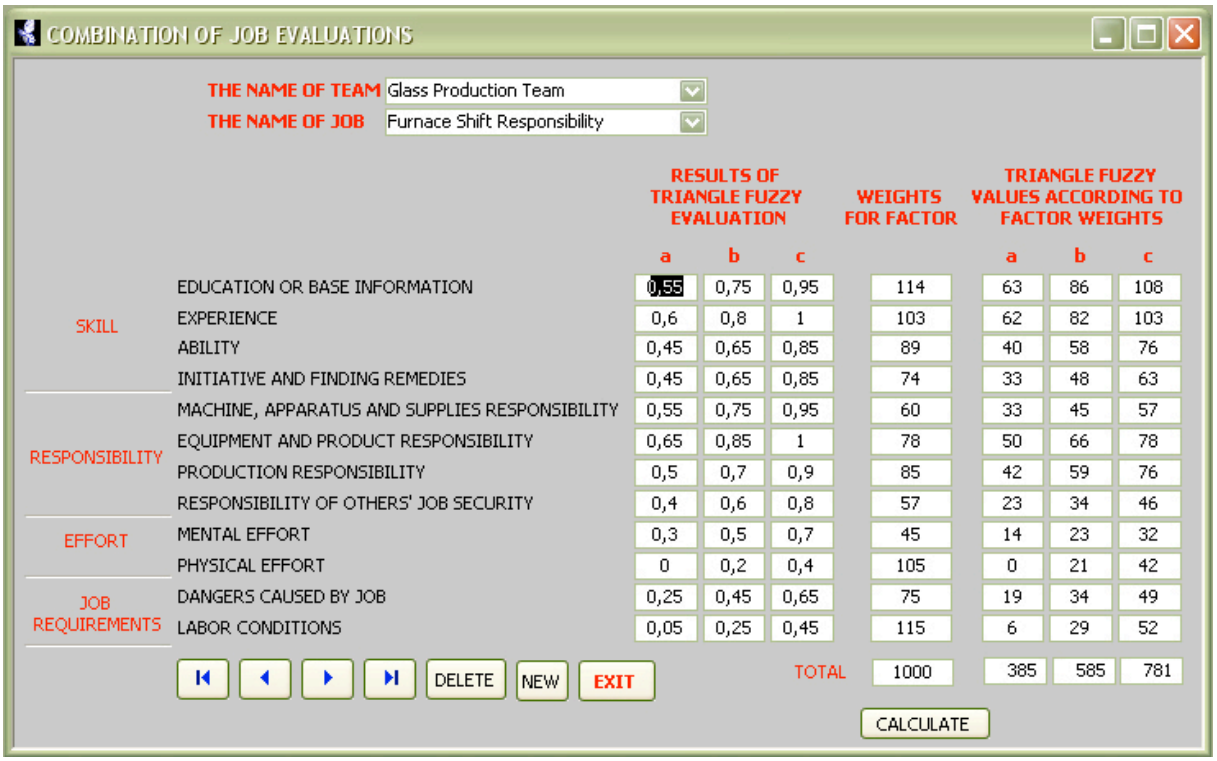

Figure 2. Furnace shift responsibility, combination of job evaluations program scene

2.2 Fuzzy personnel evaluation

Current personnel of each job group were evaluated according to criterias which were determined according to experts linguistic statements (Figure 3), and transformed to triangular fuzzy numbers as shown in Figure 4. After linguistic evaluation of current personnel by experts according to criterias in Figure 3, these evaluations were used to determine triangular fuzzy values of personnel.

These criteria were determined based on job evaluation factors because of their relation with current jobs and using in matching stage. Other some factors could be added to these or neglected from these factors based on experts of human resources and other job specialists. Table 4 gives linguistic and fuzzy values in personnel evaluation which could be used for conversion process.

Afterwards, group number of current personnel were determined according to formula (3), and they compared with job groups. According to defined criteria, linguistic stated values of personnel were determined and these values were converted to personnel fuzzy values based on table 4.

Linguistic statements again converted to triangular fuzzy values, these values were combined, and multiplied by criteria weights. Results were added and final fuzzy values of each current personnel were found. Same processes in finding of job groups of current jobs in generated scale according to distances were applied to fuzzy values of the personnel and they were grouped in same way. Afterwards, they were classified in scale table as group number (Ozdaban et al., 2010).

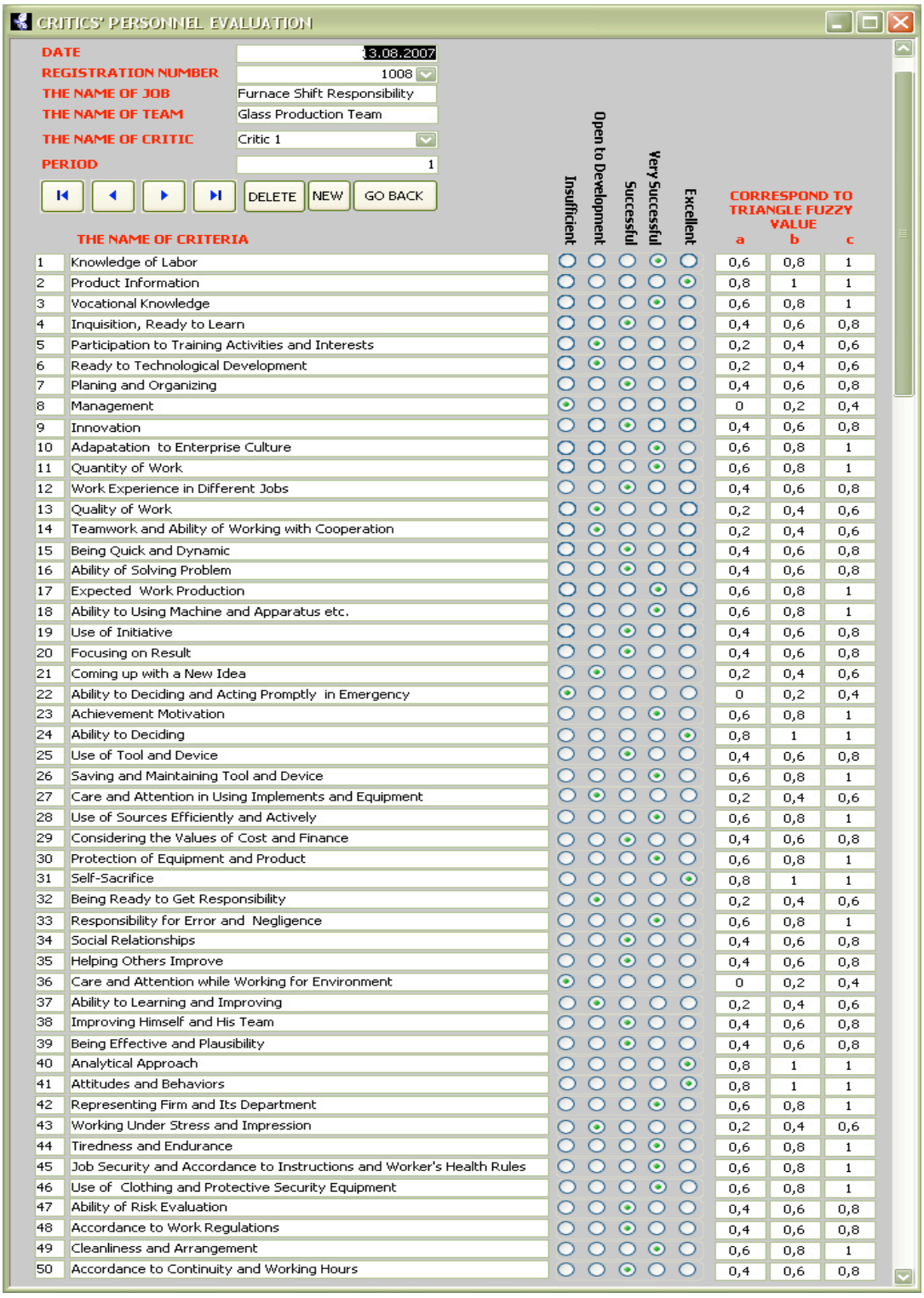

Figure 3. 1008 numbered registered employee who is responsible for furnace shift of program scene evaluated by critic 1

COMBINATION OF PERSONNEL EVALUATIONS

REGISTRATION NUMBER: 1008
LAST EVOLUATION DATE: 13.08.2007
PERIOD: 1
EVALUATED DATE: 13.08.2007

DELETE | NEW | GO BACK

	RESULTS OF TRIANGLE FUZZY EVALUATION a	b	c	WEIGHTS FOR CRITERIA	TRIANGLE FUZZY EVALUATIONS ACCORDING TO CRITERIA WEIGHTS a	b	c
Knowledge of Labor	0,60	0,80	0,93	15	9	12	14
Product Information	0,47	0,67	0,80	19	9	12	15
Vocational Knowledge	0,60	0,80	1,00	17	10	14	17
Inquisition, Ready to Learn	0,60	0,80	0,93	20	12	16	19
Participation to Training Activities and Interests	0,53	0,73	0,87	20	11	15	18
Ready to Technological Development	0,47	0,67	0,80	23	11	15	18
Planing and Organizing	0,47	0,67	0,87	16	7	11	14
Management	0,27	0,47	0,67	18	5	8	12
Innovation	0,27	0,47	0,67	16	4	7	11
Adapatation to Enterprise Culture	0,67	0,87	1,00	18	12	16	18
Quantity of Work	0,47	0,67	0,87	17	8	11	15
Work Experience in Different Jobs	0,27	0,47	0,67	18	5	9	12
Quality of Work	0,40	0,60	0,80	15	6	9	12
Teamwork and Ability of Working with Cooperation	0,47	0,67	0,87	14	7	9	12
Being Quick and Dynamic	0,46	0,67	0,87	15	7	10	13
Ability of Solving Problem	0,47	0,67	0,80	15	7	10	12
Expected Work Production	0,53	0,73	0,93	15	8	11	14
Ability to Using Machine and Apparatus etc.	0,53	0,73	0,93	15	8	11	14
Use of Initiative	0,33	0,53	0,73	15	5	8	11
Focusing on Result	0,40	0,60	0,80	12	5	7	10
Coming up with a New Idea	0,33	0,53	0,73	11	4	6	8
Ability to Deciding and Acting Promptly in Emergency	0,20	0,40	0,60	11	2	4	6
Achievement Motivation	0,27	0,47	0,67	12	3	6	8
Ability to Deciding	0,67	0,87	1,00	12	8	11	12
Use of Tool and Device	0,33	0,53	0,73	23	8	12	17
Saving and Maintaining Tool and Device	0,67	0,87	1,00	20	13	17	20
Care and Attention in Using Implements and Equipment	0,33	0,53	0,73	17	6	9	13
Use of Sources Efficiently and Actively	0,47	0,67	0,87	30	14	20	26
Considering the Values of Cost and Finance	0,40	0,60	0,80	26	10	15	21
Protection of Equipment and Product	0,60	0,80	0,93	23	14	18	21
Self-Sacrifice	0,80	1,00	1,00	28	22	28	28
Being Ready to Get Responsibility	0,33	0,53	0,73	28	9	15	21
Responsibility for Error and Negligence	0,53	0,73	0,93	29	15	21	27
Social Relationships	0,53	0,73	0,87	14	8	10	12
Helping Others Improve	0,40	0,60	0,80	21	8	13	17
Care and Attention while Working for Environment	0,20	0,40	0,60	22	4	9	13
Ability to Learning and Improving	0,47	0,67	0,80	11	5	7	9
Improving Himself and His Team	0,33	0,53	0,73	12	4	6	9
Being Effective and Plausibility	0,53	0,73	0,93	11	6	8	10
Analytical Approach	0,73	0,93	1,00	11	8	11	11
Attitudes and Behaviors	0,53	0,73	0,87	28	15	20	24
Representing Firm and Its Department	0,53	0,73	0,93	27	15	20	25
Working Under Stress and Impression	0,27	0,47	0,67	23	6	11	15
Tiredness and Endurance	0,40	0,60	0,80	27	11	16	21
Job Security and Accordance to Instructions and Worker's Health Rules	0,53	0,73	0,93	28	15	21	26
Use of Clothing and Protective Security Equipment	0,60	0,80	1,00	25	15	20	25
Ability of Risk Evaluation	0,40	0,60	0,80	22	9	13	18
Accordance to Work Regulations	0,27	0,47	0,67	50	13	23	33
Cleanliness and Arrangement	0,47	0,67	0,87	24	11	16	21
Accordance to Continuity and Working Hours	0,60	0,80	0,93	41	25	33	38
			TOTAL	1000	462	662	836

Figure 4. 1008 numbered registered employee's grouping evaluation program scene

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Table 4. Linguistic and fuzzy values in personnel evaluation

Linguistic Value	Fuzzy Value
Insufficient	(0 ; 0.2 ; 0.4)
Open to Development	(0.2 ; 0.4 ; 0.6)
Successful	(0.4 ; 0.6 ; 0.8)
Very Successful	(0.6 ; 0.8 ; 1)
Excellent	(0.8 ; 1 ; 1)

2.3 Matching Evaluated Personnel Groups with Evaluated Current Job Groups

After determining job and personnel groups, these groups were compared. As shown in Figure 5, group number of personnel in Furnace Shift Responsibility was found in group 7, and group number of job was found as group 6. It means that current personnel have higher group number and could be promoted. It also alerts a waste of human capital.

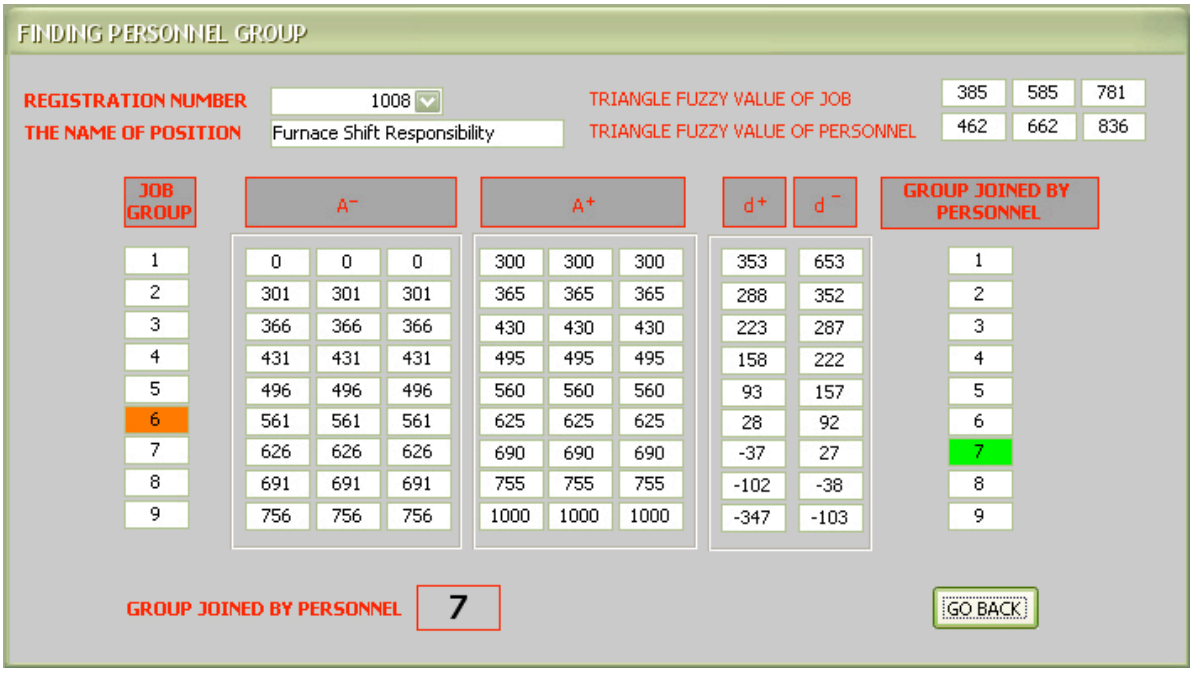

Figure 5. Program scene of group which is joined by 1008 numbered registered employee

Table 5 illustrates other personnel who have higher group numbers than their current jobs. They could be seen as promoted personnel. At this situation, this alert means that these personnel may be used in higher levels of organization. As competition increases among the markets, an organization has to use its human resources efficiently. In this frame, it may be a useful and economical tool for both organizations and human resources experts.

Table 5. Calculating of 1008 numbered registered personnel's job concerned with promotion

Discussed Work about Promotion	Value of Work	Job Groups	d^+	d^-
Press production manufacturing operatorship 1	(363,563,763)	6	-90	-21
Blowing press production manufacturing operatorship 1	(366,566,766)	6	-87	-18
Blend shift responsibility	(442,642,829)	7	-15	54
Furnace technicianship	(482,682,845)	7	3	86

A^- = (385,585,781), A^+ = (462,662,836)

3. CONCLUSION

In job and personnel evaluation, from fuzzy distance measurement was used to reach required results many steps of model such as determining groups, conforming the situation of personnel, studying on sub criteria in terms of defining improving and training necessities, displaying labors oriented promotion. Here, the distance between triangle fuzzy numbers according to Hamming distance was considered. However, in confirmation of studied model, only the value of distance of alternative to positive and negative ideal solution depending on absolute value was obtained. But, besides this, in study, the need for defining of which side of ideal solutions that alternative solution was shown. In this way, it might be possible to reach distance measurement's side. Also, in terms of being developed of model, alternative solution ways could be developed considering distance measurement like euclidian, manhattanian etc. which are other distance measurement methods in different studies.

Model outputs also allow workers to evaluate themselves, and it allows drawing career maps of workers by reflecting workers. It also gives an advantage of information to organization about workers' career map, so organizations know their personnel skills in any case of empty positions. Thus, suggested model answers the requirements of organization by classifying its workers. Outputs of model also could be used for providing job environment satisfaction in an organization by using linguistic statements instead of mathematical statements.

Suggested model also could be used for small, middle or large companies, and for management strategies in service and production industries. Managers could use model outputs to determine their managerial concepts or overall behaviors of organizations.

By evaluating and using of classification opportunities provided by suggested model, classifier could easily make effective communications with personnel, and the model also provides this useful tool for human resources experts.

Finally, it could be said that this research has some additions to literature as a developed newer formula of fuzzy distance measurement, examining of personnel and job evaluation together, and suggested model also provides a clear view to extreme group differences in absolute logic method.

For further researches, it may be a literatural source and further researches could be performed according to personnel parameters, linguistic criteria or other specific details. Computer-based software was developed to perform calculations within this research, more general and effective computer software could be developed at this area.

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BIOGRAPHICAL SKETCH

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