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HUMAN RESOURCES MANAGEMENT FUZZY DECISION MODEL

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Abstract

Human Resource Management fuzzy model is presented in this paper. The model is an attempt to minimise subjective value judgement in the process of recruitment and selection. The model comprises three levels of hierarchy of which lower levels of decision-making processes are relevant. Lower levels relate to deterministic approach to assign purposes of the job vacancy and attributes that have probabilistic-possibilistic approach.

Keywords: fuzzy variables, membership function, worth weight, threshold worth, confrontation ability

INTRODUCTION

Contemporary decision making models use probability theory to explain unpredictability of future events [10]. To consider the uncertainty though the models rely on possibility theory [1][5] [17] [19]. The possibility theory deals with fuzzy variables.

Fuzzy decision making problems have been studied by Zadeh [20], Bellman [2], Kacprzyk, [4], Lai [7] [8], Novak [9], Zimmeran[21] [22], Kosko [6], Bojadziev [3], Prascevic and Petrovic-Lazarevic [11] [12] [14][15][16]. The essence of fuzzy decision making theory is fuzzy logic: In many real world problems there is more to do with fuzziness than randomness for the major source of imprecision [21]. The real world problems are a matter of degree[6].

Human Resource Management (HRM) is a process of managing people through recruitment and selection, performance appraisal, reward systems, training and development [18]. The recruitment and selection is a decision making process based on utility principle.

A decision-maker will choose an alternative preference that provides an extreme value of expected utility [12]. The choice is based on subjective value judgement.

This paper is an attempt to create HRM fuzzy decision model in order to minimise non-objective consideration of recruitment and selection of new employee. The model is formulated in part two. Part three contains an example and numerical computation.

THE MODEL

Structure of the Model

The process of recruitment and selection can be presented with three hierarchical levels of decision making process (Figure 1).

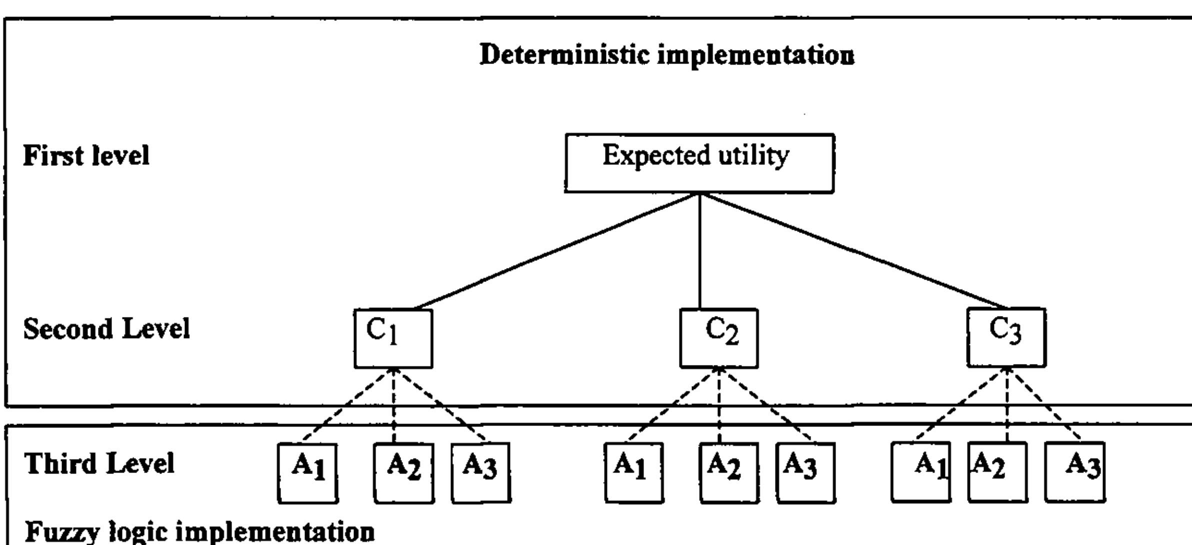

Figure 1: HRM decision process

Level one and level two have deterministic implementation by capturing decision alternatives, information and preferences. Decision alternatives are dependent on factors in decision situation worthy of probabilistic treatment. The probabilistic evaluation includes maximisation of expected utility.

In HRM decision process the expected utility corresponds to contribution to the organisational overall goal. Utility is understood as a characteristic of HRM decision process to satisfy a need of reaching the organisational overall goal. Its realisation depends on lower level goals selected through the process of individual subjective value judgement. Each lower level goal is further decomposed to decision criteria again selected through the process of individual subjective value judgement. Each decision criterion is determined by decision alternatives.

To avoid a possible domination of subjective factor that follows the utility determinant of non-objective selection of recruiters for the job vacancy, utility function or a function of preferences presents the utility. Preferences govern decisions. The decision-maker implements a more preferred alternative to less preferred one.

In order to make decision the individual endeavours to predict how high is the utility if a chosen alternative is undertaken. The assessment of such utility is usually presented by the expected utility of u with respect to P, written as $E(u, P)$, and defined by the equations

$$E(u, P) = \sum_{x \in X} u(x)P(x) \tag{1}$$

where P is a simple probability measure on alternative X and u is a real-valued function on X.

A decision-maker will chose the preference that provides an extreme value of expected utility. It means that the individual behaviour is rational. It assigns to the preference with an extreme value of utility function. The individual behaviour is corrected by corresponding probabilities in consequence of future events followed by uncertainty and risk.

Hence the level one of HRM decision process determines the expected utility of contributing to the overall organisational goal realisation through the process of recruiting and selecting the appropriate candidate. Level two defines purposes of a job vacancy. Each *purpose* is decomposed to decision criteria. Decision criteria, or *attitudes,* represent level three of HRM decision process. Decision alternatives define each decision criterion. Corresponding membership functions define each decision alternative.

Level one and level two of HRM decision process focus probabilistic approach. That includes subjective evaluation while making short listed decisions. The basis of decision's criterion that cannot be purely prescriptive or purely descriptive is defined. The sense of value of decision-maker is presented in the form of multicriterion decision making. Deciding whether to short-list or not is based on factors of certain nature, but represents subjective task. Hence, the situation to choose a right candidate is dependent on knowledge of the value of matching of recruiter to the job vacancy. Worth assessment requires the subjective judgement. The measure of worth relies on preferences [1]. The worth-assessment procedure comprises:

- List of factors that influence upon purposes of the highest importance. The purposes are worth-independent

- Establishment of overall performance purposes and subdivision of each purpose into its lower constitute criteria

- Measurement of the degree of criteria satisfaction.

Level three includes probabilistic-possibilistic treatment based on maximisation of expected utility. It comprises fuzzy logic implementation. *The attributes* are fuzzy linguistic variables. Each linguistic variable relates to membership functions $\mu_{ij}(x)$. Once the membership functions are assigned to each alternative the set of multicriteria weights is obtained. The alternatives are ranked. The alternative with the highest weight is designated as preferred.

The Model

Let us consider the case in which the expected utility is defined such as

$$E(u, P) = \sum_{x \in X} u(x)P(x) \tag{2}$$

where P is a simple probability measure on decision criterion or purpose X and u is a real-valued function on X.

Purpose X is explained in details by " attributes". Each attribute S is equal to sum of S_i and corresponding worth weight w_i. Hence, total worth S is

$$S = w_1 S_1 + w_2 S_2 + \ldots\ldots w_n S_n \tag{3}$$

where

$$w_1 + w_2 + \ldots w_n = 1 \tag{4}$$

$$0 \leq S_i \leq 100,\ I = 1, 2, \ldots n$$

Value S_i represents the influence of corresponding factor i into final short list decision. It is a linguistic variable expressed by the pairs of values $\mathcal{S}_i$

$$\mathcal{S}_i = \{ S^1{}_i/\mu^1{}_i\ ,\ S^2{}_i/\mu^2{}_i\ , \ldots\ S^k{}_i/\mu^k{}_i \} \tag{5}$$

in the following way

$$S_i = \frac{S^1{}_i/\mu^1{}_i\ ,\ S^2{}_i/\mu^2{}_i\ , \ldots\ S^k{}_i/\mu^k{}_i}{\mu^1{}_i + \mu^2{}_i + \ldots\ldots + \mu^k{}_i} \tag{6}$$

Worth weight w_i determines the degree of significance of corresponding factor compared to other factors. Each factor has a threshold worth that expresses the degree of desirability of the strength of the decision. It is different from the minimum permitted value S.

Total threshold worth is

$$S^* = w^*{}_1 S^*{}_1 + w^*{}_2 S^*{}_2 + \ldots\ldots w^*{}_n S^*{}_n \tag{7}$$

Difference

$$D = S - S^* \tag{8}$$

is used for determination of decision power coefficient d to stress the justification of decision to short list, where

$$d = k \quad \text{for} \qquad 10(k-1) \angle D \leq 10k,\ k = 1, 2, ..10$$

$$d = 0 \quad \text{for} \qquad D \angle 0 \tag{9}$$

Coefficient d justifies a decision to short list.

Threshold worth $S^*{}_i$ is assigned for each attribute.

After determination of a short list the second phase of HRM model should be defined. This is a process of selecting the final candidate for the job vacancy.

For the given purpose *I a* resulting membership function $\mu(t)$ can be derived. This function is dependent on a possibility of providing selected candidate in time *t*.

Following Zadeh's probabilistic-possibilistic approach [20] we can formulate function $F^*(t)$ for the purpose *i*

$$F^*(t) = \frac{1}{P_n}\int_0^t f^*(t)\, dt \tag{10}$$

$$f^*(t) = f(t)\,\mu(t), \quad P_n = \int_0^t f^*(t)\, dt \tag{11}$$

$$f(t) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left[-(t-t_e)^{2/2}\sigma^2\right] \tag{12}$$

t_e and σ are *expected time* and *standard deviation* to effectively join the company.

Now, the purpose i for the attribute A_i for the time t is assumed to be a fuzzy event with probability of occurrence $F^*(t)$. P_n is normalising factor.

Expected time t^*_e of providing *i* purpose as a fuzzy event is

$$t^*_e = \int_0^t f^*(t)\, dt \tag{13}$$

This time is possible and probable expected time of providing purpose *i*.

The recruiter or employer can access his/her own expectations of the attribute A_i, like confrontation ability $\phi(t)$, for the short-listed candidate based on the available information.

For the probabilistic approach an expected confrontation ability ϕ for the candidate *i* is

$$\phi^*_e = \int_0^\infty f(t)\,\phi(t)\, dt \tag{14}$$

In a similar way an expected confrontation ability ϕ for the probabilistic-possibilistic approach may be derived by formula

$$\phi^*_e = \int_0^\infty f^*(t)\, \phi(t)\, dt \qquad (15)$$

In addition to these characteristic values, the following coefficients should be calculated

- expected time coefficient

$$k_t = t^*_e / t_e \qquad (16)$$

- expected confrontation abilities coefficient

$$k_c = \phi^*_e / \phi_e \qquad (17)$$

The candidate will be selected with a min ϕ^*_e and values of k_t, k_c and normalising factor P_n which are close to 1.

If these values, especially P_n are different from 1 then there is a difference between the candidates' possibility and probability to start a new job. Therefore the candidate who has a minimal value of the confrontation abilities ϕ_e

$$\phi_n = \min \phi^*_e\, k_t\, k_c / P_n \qquad (18)$$

will be selected.

EXAMPLE

The explained procedure is illustrated by the case study example.

The job vacancy is: **Senior economic and financial analyst** for the corporate unit of an ABC Telephone Company.

The overall objective of the company is a share growth of 10%.

Lower level objectives, or *purposes*, determined through the job vacancy perspective are:

1. Lead the implementation of EVA drivers
2. Provide financial analysis to use for development, maintenance and communication of the business plan
3. Team work
4. Create business model to support business plan

Decision criteria, or *attitudes*, for each *purpose* are listed bellow

1. Lead the implementation of EVA drivers
    1.1. Value based management background
    1.2. Key drivers
    1.3. Facilitation
    1.4. Training
    1.5. Coaching skills
    1.6. Reliable
2. Provide financial analysis to use for development, maintenance and communication of the business plan
    2.1. Financial background
    2.2. Business planning background
3. Team work
    3.1. Team player
    3.2. Ability to work in different business units
4. Create business model to support business plan
    4.1. Economic-Mathematical background
    4.2. Strategic thinking
    4.3. Computer Excel Skills

The values of relative weight are given in Table 1.

The indicator of justification of bid making D by equation (8) is

$$D = 68.78 - 50.30 = 18.47$$

and by equation (9)

$$d=2$$

Therefore there is a significant justification of decision to short list. The candidates with the

- Financial background *attitude,* and
- *criterion:* Provide financial analysis to use for development, maintenance and communication of the business plan

should have priority in the process of selecting final candidate for the job vacancy.

Two candidates have been short-listed.

According to created computer programme [11], input data are: number of short listed candidates, expected time t_e, standard deviation σ, values of membership function $\mu(t)$ and confrontation abilities $\phi(t)$ for every short listed candidate. A time interval is selected [$t_e - \sigma_T$, $t_e + \sigma_T$] and divided into 18 subintervals for numerical calculations of all characteristic values.

Expected time for the Candidate One to effectively join ABC Company is t_e = 200 days, standard deviation to effectively join ABC Company σ = 60 days, normalising factor P_n =0.6751, t^*_e = 222.2 days, k_t =1.111, k_c= 1.007, expected confrontation ability ϕ_e= 554.98, possibly expected confrontation $C\phi^*_e$= 558.72, valid confrontation ability ϕ_n=925.73 (See Table 2a).

Expected time for the Candidate Two to effectively join ABC Company is t_e = 210 days, standard deviation to effectively join ABC Company σ = 57 days normalising factor P_n =0.5207, t^*_e = 210.0 days, k_t =1.129, k_c= 1.005 , expected confrontation ability ϕ_e= 557.23, possibly expected confrontation ability ϕ^*_e= 560.23, valid confrontation ability ϕ_n=1221.44 (See Table 2b).

According to the results the expected possible confrontation abilities are similar for the both candidates. The Candidate Two has P_n which is less favourable, bigger difference between the possibility and probability of providing the purpose i for the attribute A_i for the time t, and much bigger value ϕ_n then Candidate One. Hence the recruiter has to select the Candidate One.

Senior economic and financial analyst

	Purpose	Pairwise component	Relative weight	Normalised weight		Attributes	Pairwise component	Relative weight	Normalised weight	Overall normal weight				
I			wi (1)	w1(1)	j			wij	wij	wk	Sk	S*k	S*kw	S*kw*
1	**Lead the implementation of EVA drivers**	1.00	1.000	0.2319	1	Value based management background	1.00	1.000	0.179	0.0415	80	70	3.32	2.90
					2	Key drivers	1.1 1.0	1.100	0.197	0.0456	90	50	4.10	2.28
					3	Facilitation	1.0 0.8	0.880	0.157	0.0365	42	50	1.53	1.82
					4	Training	0.8 1.0	0.740	0.132	0.0307	41	45	1.26	1.38
					5	Coaching skills	1.0 1.4	0.986	0.176	0.0409	55	40	2.25	1.64
					6	Reliable	0.90	0.887	0.159	0.0368	53	40	1.95	1.47
						Sum		5.593	1.000	0.2319	361	295		
2	**Provide financial analysis for development, maintenance anc communication of the business plan**	1.00	1.200	0.2783	1	Financial background	1.0	1.00	0.6667	0.1855	100	30	18.55	5.57
		1.00			2	Business Planning background	0.5	0.50	0.3333	0.0928	62	50	5.75	4.64
						Sum		1.50	1.0000	0.2783	162	80		
3	**Team work**	0.80	0.960	0.2226	1	Team player	1.0	1.00	0.4545	0.1012	54	60	5.46	6.07
		1.00			2	Ability to work in different business units	1.2	1.20	0.5455	0.1214	65	45	7.89	5.46
						Sum		2.20	1.0000	0.2226	119	105		
4	**Develop business model to support business plan**	1.20	1.152	0.2672	1	Economic-mathematical background	1.0	0.2226	0.126	0.0337	90	75	3.04	2.53
					2	Strategic thinking	0.7 1.0	0.7000	0.397	0.1061	40	65	4.24	6.90
					3	Computer excel skills	1.2	0.8400	0.477	0.1273	74	60	9.42	7.64
	Sum		4.312	**1.0000**		**Sum**		1.7626	1.000	0.2672	204	200	68.78	50.30

Symbols Bold numbers Calculated D equals **18.47** d equals

Candidate One Expected time is 200 days

Standard deviation is 60 days

Table 2a.

	Time t	Memebership function	f(t)	f*(t)	F(t)	F*(t)	Confrontation ability
1	20	0.00	0.0001	0.0000	0.0130	0.0000	600
2	40	0.00	0.0002	0.0000	0.0039	0.0000	595
3	60	0.00	0.0004	0.0000	0.0102	0.0000	580
4	80	0.10	0.0009	0.0001	0.0236	0.0013	570
5	100	0.20	0.0017	0.0005	0.0492	0.0076	560
6	120	0.30	0.0027	0.0012	0.0931	0.0246	555
7	140	0.40	0.0040	0.0024	0.1607	0.0607	550
8	160	0.50	0.0530	0.0039	0.2543	0.1240	545
9	180	0.60	0.0063	0.0036	0.3704	0.2193	540
10	200	0.70	0.0066	0.0069	0.4988	0.3442	550
11	220	0.80	0.0063	0.0075	0.6292	0.4876	555
12	240	0.90	0.0053	0.0071	0.7454	0.6331	560
13	260	1.00	0.0040	0.0060	0.8389	0.7638	565
14	280	1.00	0.0027	0.0040	0.9066	0.8641	575
15	300	1.00	0.0017	0.0025	0.9505	0.9291	585
16	320	1.00	0.0009	0.0013	0.9761	0.9670	595
17	340	1.00	0.0004	0.0004	0.9894	0.9868	600
18	360	1.00	0.0002	0.0002	0.9557	0.9961	610
19	380	1.00	0.0001	0.0001	0.9984	1.0000	620

Candidate Two Expected time is 210

Standard deviation is 57

Table 2b.

	Time t	Memebership function	f(t)	f*(t)	F(t)	F*(t)	Confrontation ability
1	39	0.00	0.0001	0.0000	0.0013	0.0000	620
2	58	0.00	0.0002	0.0000	0.0039	0.0000	610
3	77	0.00	0.0005	0.0000	0.0102	0.0000	605
4	96	0.00	0.0009	0.0000	0.0236	0.0000	600
5	115	0.10	0.0017	0.0003	0.0492	0.0032	595
6	134	0.20	0.0029	0.0011	0.0931	0.0169	580
7	153	0.30	0.0042	0.0024	0.1607	0.0506	560
8	172	0.35	0.0560	0.0038	0.2543	0.1096	550
9	191	0.40	0.0066	0.0051	0.3704	0.1937	540
10	210	0.50	0.0070	0.0067	0.4988	0.3059	535
11	229	0.60	0.0066	0.0076	0.6292	0.4422	545
12	248	0.70	0.0056	0.0075	0.7454	0.5863	555
13	267	0.80	0.0042	0.0065	0.8389	0.7198	570
14	286	0.90	0.0029	0.0050	0.9066	0.8290	580
15	305	1.00	0.0017	0.0034	0.9505	0.9081	590
16	324	1.00	0.0009	0.0018	0.9761	0.9572	605
17	343	1.00	0.0005	0.0009	0.9894	0.9829	620
18	362	1.00	0.0002	0.0004	0.9557	0.9499	640
19	381	1.00	0.0001	0.0001	0.9984	1.0000	650

CONCLUSION

In order to avoid subjective value judgement in the recruitment and selection processes it is proposed to implement HRM fuzzy logic model. The model comprises three levels of hierarchy of which second level and third level are developed. Both levels relay on fuzzy linguistic variables contributing to minimisation of subjective evaluation of candidates for the offered job vacancy. The Model could be further developed including other factors than those that strictly influence HRM decision process.

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