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Development of Human Resource Assessment and Selection Model for Computer System Design

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Abstract

The paper offers the model of assessment and selection of human resources, which is based on a multi-criteria expert method – a TOPSIS method. The proposed model allows us for carrying out assessment and selection of human resources based on the results of expert estimates and testing. The use of this model will allow us for developing a computer-based system supporting the decision-making on assessment and selection of human resources.

Keywords: Human Resource; Model; TOPSIS; Multiple-Criteria Decision; Assessment; Selection.

1. Introduction

Human resource is the most critical resource that significantly determines the effectiveness of any organization that ensures the successful functioning of the organization. Humans are important resources for the organization, they determine the company's future strategy, but the implementation of strategy itself is carried out by humans. Humans participate in producing surplus value, and in company management, but they may also cause large losses to company by making mistakes. The main part of the mistakes made by human resource is due to their unskillfulness. In order to minimize mistakes made by human resources, it is necessary to select the most qualified staff, which is one of the most important tasks of human resource management. Today, the most important research field is the assessment and selection of human resources [1]. In this context, the paper presents the model of assessment and selection of human resources based on a method of multi-criteria decision analysis – a TOPSIS method.

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TOPSIS (The Technique for Order of Preference by Similarity to Ideal Solution) is a multi-criteria decision analysis method, which was originally developed by Hwang and Yoon in 1981with further developments by Yoon in 1987. TOPSIS is based on the concept that the chosen alternative should have the shortest geometric distance from the positive ideal solution and the longest geometric distance from the negative ideal solution [2].

2. Assessment and selection of human resources

Assessment and selection of human resource is a big-time and responsible commitment since mistakes made in the phase of human resource assessment and selection can bring heavy losses to the organization.

The need for assessment and selection of human resources comes once:

- the organization has determined the vacant job positions, for which the organiztion wants to select human resources, as well as the number of job places by posts;
- the organization has announced competition for vacant positions;
- the applicants have submitted their applications for the announced one or another vacant position;
- the organization has established the commission made up of expert appraisers;
- the organization has determined the assessment criteria and their importance.

In general, the selection process consists of the stages as follows:

1. review of the applicants' CV data;
2. interview;
3. testing;
4. making the selection decision.

Of course, the given assessment stages are general and they can be broken down into sub-stages (assessment criteria), depending on the specifics of job position.

The task of human resource assessment and selection can be formulated as follows: we have a set of job positions $P = \{p_1, p_2, p_3, \dots, p_n\}$ (for which we want to select human resources), and the number of vacancies $Z = \{z_1, z_2, z_3, \dots, z_n\}$ by posts. $A = \{A_1, A_2, A_3, \dots, A_n\}$ – is a set of the sets of the applicants by posts, where $A_i = \{a_{i1}, a_{i2}, a_{i3}, \dots, a_{im}\}$, – is a set of those applicants, who applied for the individual p_i vacant position. $E = \{e_1, e_2, e_3, \dots, e_v\}$ – is a set of the experts assessing the candidates to be selected by vacant posts according to the individual criteria; $C_i = \{c_{i1}, c_{i2}, c_{i2}, \dots, c_{ik}, c_{ik+1}, \dots, c_{ig}\}$, i=*1, n.* – are the assessment criteria for the individual p_i job position, where the $c_{i1}, c_{i2}, c_{i2}, \dots, c_{ik}$ assessment criteria are evaluated through the tests.

The assessment criteria for the individual p_i vacant position have the weights (which determine the value of the criterion in the final assessment) which are determined by a vector of the weights $W_i = \{w_{i1}, w_{i2}, w_{i2}, \dots, w_{ig}\}$, where w_{ij}, *j=1,g* is a weight of the assessment criterion c_{ij} for the individual p_i vacant position. The weights

of the assessment criteria of each P_i job position should satisfy the following condition:

$$\sum_{j=1}^{g} w_{ij} = 1 \qquad (1)$$

The above indicates clearly that selection of human resources is a multi-criteria task, that's why to solve it we use the method of analyzing the multi-criteria decision – a TOPSIS method.

Our goal is to ensure multilateral assessment and ranking of human resources, based on the assessment criteria, expert assessments and testing, which will allow us for finding the optimal solution to the problem of selecting adequate human resources.

3. A method of assessment and selection of human resources based on a TOPSIS method

The proposed method of assessment and selection of human resources provides the definition of a $i = 1,\dots,n$ decision matrix for each job position P_i, whose alternative will be a set of those applicants $A_i = \{a_1, a_2, a_3, \dots, a_m\}$, who applied for the P_i vacant position. And the criteria are represented by the P_i job position assessment criteria $C_i = \{c_{i1}, c_{i2}, c_{i2}, \dots, c_{ik}, c_{ik+1}, \dots, c_{ig}\}$. On the derived matrix, by using a TOPSIS method, let us determine the final assessments of the $A_i = \{a_1, a_2, a_3, \dots, a_m\}$ applicants applied for the P_i job position, and carry out ranking of the applicants in accordance with the obtained assessments. Let us select the z_i number of the applicants for the P_i job position with maximum assessment points.

The developed method of assessment and selection of human resource consists of the following Stages:

Stage 1. Determine the decision matrix D_i, *i=1, n* for P_i - working position as follows:

$$D_i = \begin{pmatrix} x_{11}^i & x_{12}^i & \cdots & x_{1k}^i & x_{1k+1}^i & \cdots & x_{1g}^i \\ x_{21}^i & x_{21}^i & \cdots & x_{2k}^i & x_{2k+1}^i & \cdots & x_{2g}^i \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ x_{m1}^i & x_{m2}^i & \cdots & x_{mk}^i & x_{mk+1}^i & \cdots & x_{mg}^i \end{pmatrix} \qquad (2)$$

Where

$$x_{rl}^i = \begin{cases} \left(\frac{\sum_{j=1}^{v} q_{rj}^{il}}{v}\right) & if \;\; 1 \le l \le k \\ t_r^{il} & if \;\; k+1 \le l \le g \end{cases} \qquad (3)$$

i=1,..,n,

r=1..., m,

l=1,…k, k+1,…g.

x_{rl}^{i} - is the assessment (numeric value) of l criterion of the i working position of the applicant r, which is equal to the average arithmetic of the scores defined by the experts in the l criterion of the i working position of the r applicant, if the criterion is evaluated by the experts, Otherwise, it is equal to the score received by the r applicant in the l criterion assessment test.

Stage 2. Calculate the normalized decision matrix:

$$n_{rl}^{i} = \frac{x_{rl}^{i}}{\sqrt{\sum_{r=1}^{m}(x_{rv}^{i})^{2}}}, \quad (4)$$

Stage 3. Calculate the weighted normalized decision matrix:

$$v_{rl}^{i} = w_{ll} * n_{rl}^{i}. \quad (5)$$

Stage 4. Determine the positive ideal and negative ideal solutions:

Positive ideal solution

$$S^{i+} = \{v_1^{i+}, v_2^{i+}, \dots, v_g^{i+}\}, \quad (6)$$

Where

$$v_l^{i+} = \max\left(v_{rl}^{i}\right)$$

Negative ideal solution

$$S^{i-} = \{v_1^{i-}, v_2^{i-}, \dots, v_g^{i-}\}, \quad (7)$$

where

$$v_l^{i-} = \min\left(v_{rl}^{i}\right).$$

Stage 5: Calculate the separation measures from the positive ideal solution and the negative ideal solution:

The separation from the ideal alternative is:

$$d_r^{i+} = \sqrt{\sum_{j=1}^{n}\left(v_{rl}^{i} - v_j^{i+}\right)^2}; \quad (8)$$

the separation from the negative ideal alternative is:

$$d_r^{i-} = \sqrt{\sum_{j=1}^{n}\left(v_{rl}^{i} - v_j^{i-}\right)^2}. \quad (9)$$

Stage 6: Calculate the relative closeness to the positive ideal solution:

$$R_r^i = \frac{d_r^{i-}}{d_r^{i-} + d_r^{i+}}, \quad (10)$$

Where

$$0 \leq R_r^i \leq 1 \quad (11)$$

Stage 7: Ranking of applicants in terms of the values R_r^i and Select top z_i max values. Which will guarantee you to select the most qualified applicants for a particular job position.

4. Numerical example

Consider a human resources assessment and selection example, that clearly illustrates the work of the proposed methodology. For example, of the assessment and selection task we have the following:

$P = \{p_1, p_2, p_3\}$ - A set of job position, $Z = \{z_1 = 3, z_2 = 2, z_3 = 1\}$ - number of vacancies by job position,

$A = \{A_1, A_2, A_3\}$ - A set of sets of applications: where $A_1 = \{a_{11}, a_{12}, a_{13}, a_{14}\}, A_2 = \{a_{21}, a_{22}, a_{23}, a_{24}\},$

$A_3 = \{a_{31}, a_{32}, a_{33}\}.$

Assessment criteria and the weight of the assessment criteria for the individual job position are given in Table 1:

Table 1: Assessment criteria and the weight of the assessment criteria

p_1		p_2		p_3	
C_1	W_1	C_2	W_2	C_3	W_3
c_{11}	$w_{11} = 0.2$	c_{21}	$w_{21} = 0.2$	c_{31}	$w_{31} = 0.3$
c_{12}	$w_{12} = 0.1$	c_{22}	$w_{22} = 0.2$	c_{32}	$w_{32} = 0.1$
c_{13}	$w_{13} = 0.2$	c_{23}	$w_{23} = 0.1$	c_{33}	$w_{33} = 0.2$
c_{14}	$w_{14} = 0.2$	c_{24}	$w_{24} = 0.3$	c_{34}	$w_{34} = 0.2$
c_{15}	$w_{15} = 0.3$	c_{25}	$w_{25} = 0.2$	c_{35}	$w_{35} = 0.2$

The first three of the evaluation criteria are evaluated by the Expert Group and the remaining two criteria through pricing testing. Experts assessment and test results are presented in the table 2 according to the applicant:

Table 2: Experts assessments and test results

p_1

	a_{11}				
	Expert			Test	
	c_{11}	c_{12}	c_{13}	c_{14}	c_{15}
e_1	8	8	7	8	9
e_2	7	8	6		
e_3	7	7	7		
	a_{12}				
	Expert			Test	
	c_{11}	c_{12}	c_{13}	c_{14}	c_{15}
e_1	8	9	5	6	9
e_2	8	7	5		
e_3	7	8	6		
	a_{13}				
	Expert			Test	
	c_{11}	c_{12}	c_{13}	c_{14}	c_{15}
e_1	6	8	7	7	8
e_2	6	8	5		
e_3	7	7	6		
	a_{14}				
	Expert			Test	
	c_{11}	c_{12}	c_{13}	c_{14}	c_{15}
e_1	8	6	7	7	6
e_2	9	5	7		
e_3	9	6	6		

p_2

	a_{21}				
	Expert			Test	
	c_{21}	c_{22}	c_{23}	c_{24}	c_{25}
e_1	8	7	7	9	8
e_2	8	7	6		
e_3	7	6	6		
	a_{22}				
	Expert			Test	
	c_{21}	c_{22}	c_{23}	c_{24}	c_{25}
e_1	8	7	7	10	10
e_2	8	7	7		
e_3	7	6	6		
	a_{33}				
	Expert			Test	
	c_{21}	c_{22}	c_{23}	c_{24}	c_{25}
e_1	8	8	7	7	9
e_2	9	7	6		
e_3	7	6	7		
	a_{24}				
	Expert			Test	
	c_{21}	c_{22}	c_{23}	c_{24}	c_{25}
e_1	8	8	7	8	9
e_2	8	7	7		
e_3	7	7	6		

p_3

	a_{31}				
	Expert			Test	
	c_{31}	c_{32}	c_{13}	c_{34}	c_{35}
e_1	9	8	7	9	9
e_2	9	7	5		
e_3	8	6	6		
	a_{32}				
	Expert			Test	
	c_{31}	c_{32}	c_{33}	c_{34}	c_{35}
e_1	9	8	7	8	8
e_2	9	7	7		
e_3	7	6	6		
	a_{33}				
	Expert			Test	
	c_{31}	c_{32}	c_{33}	c_{34}	c_{35}
e_1	8	8	7	7	9
e_2	7	8	6		
e_3	7	6	6		

Determine the matrix of the decision for job position p_1 table 3:

Table 2: Decision matrix of p_1 job position

	c_{11}	c_{12}	c_{13}	c_{14}	c_{15}
a_{11}	7,30	7,70	6,70	8,00	9,00
a_{12}	7,70	8,00	5,30	6,00	9,00
a_{13}	6,30	7,70	6,00	7,00	8,00
a_{14}	8,70	5,70	6,70	7,00	6,00

Table 3: Result of assessment for p_1 job position

	R_i	Rank
a_{11}	0,787324	1
a_{12}	0,698641	3
a_{13}	0,56257	4
a_{14}	0,725483	2

According to the results of the assessment, the following applicants will be selected for p_1 job position: a_{11}, a_{14}, and a_{12}(Because $z_1 = 3$).

Determine the matrix of the decision for job position p_2 table 5:

Table 4: Decision matrix of p_2 job position

	c_{21}	c_{22}	c_{23}	c_{24}	c_{25}
a_{21}	7,70	6,70	6,30	8,00	9,00
a_{22}	7,70	6,70	6,70	10,00	10,00
a_{23}	8,00	7,00	6,70	7,00	9,00
a_{24}	7,70	7,30	6,70	8,00	9,00

Table 5: Result of assessment for p_2 job position

	R_i	Rank
a_{21}	0,306505	4
a_{22}	0,891057	1
a_{23}	0,769388	3
a_{24}	0,812095	2

According to the results of the assessment, the following applicants will be selected for p_2 job position: a_{22}, and a_{24}(Because $z_2 = 2$).

Determine the matrix of the decision for job position p_3 table 7:

Table 6: Decision matrix of p_3 job position

	c_{31}	c_{32}	c_{33}	c_{34}	c_{35}
a_{31}	8,70	7,00	6,00	9,00	9,00
a_{32}	8,30	7,00	6,70	8,00	8,00
a_{33}	7,30	7,70	6,30	7,00	9,00

Table 7: Result of assessment for p_3 job position

	R_i	Rank
a_{31}	0,757885	1
a_{32}	0,628373	2
a_{33}	0,532273	3

According to the results of the assessment, the following applicants will be selected for p_2 job position: a_{31}(Because $z_3 = 1$).

4. Conclusion

The paper offers methodology for human resource assessment and selection, which allow us for ensuring the optimal assessment and selection of human resources. The use of the model developed will allow us for developing a computer-based system of assessment and selection of human resources.

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