EMPLOYEES`RECRUITMENT: SELECTING THE BEST CANDIDATES BY THE UTILIZATION OF AHP AND WSA METHOD

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Abstract

Company's human resources functions focus mostly on the people's side of management. Human resource planning helps the personnel managers to anticipate and meet changing needs related to recruitment, deployment, and utilization of employees. The recruitment process of human resource management involves procedures and policies used by companies to select and hire employees. The objective of recruitment practices is to determine a suitable pool of applicants quickly, cost-efficiently and legally. Selection process involves the assessment and selection among job candidates. The main concern of the recruitment process, for both HR managers and applicants, is the process's transparency. This paper presents a model of candidates' recruitment with the application of multiple attribute decision making (MADM) methods; in particular Analytic Hierarchy Process (AHP) for weight estimation and finding the optimal solution, and WSA for the determination and ranking of the candidates. Based on the results the HR manager will be able to decide which candidates are the most suitable and should therefore be put through the next phase of the hiring process where selected applicants are pair-wise compared using AHP method to reveal the best candidate. This model is tested in a medium-sized company in cooperation with the HR department.

Key words: Employees' recruitment, personnel management, AHP, WSA

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Introduction

Currently, it is very difficult for companies to fulfill primary objective, thus the profit and other partial targets, since the market environment where the company works is constantly changing. One of the possibilities how to reach this objective is to have a competitive advantage. Competitive advantage does not have to be only in the capital or technical equipment, good management or availability of materials; it can be represented also by the company's employees, who are one of the sources of entrepreneurial success and they represent increase in the competitiveness. Human resource is the most important factor for any company functioning and selection of suitable, quality and perspective employees. The task of human resources management is to ensure that human resources are fulfilled in both qualitative and quantitative parts; meaning employees' physical presence and their qualification as well as required performance, creativity, motivation and also their identification with company goals (Kleibl, 2001).

Main aim of this paper is, based on created work position – determined requirement, to find by utilizing statistical and quantitative methods the most suitable applicant for the position. The analysis is executed using weighted sum approach WSA and analytic hierarchy process AHP.

1 Multicriteria evaluation of variants method

The multicriteria evaluation of variants method is a discipline which is dealing with the research of decision problems, in which final number of variants is evaluated based on several criteria. In the multicriteria evaluation of variants models is given final group *m* variants, which are evaluated based on *n* criteria. Such decision situation can be described with criteria matrix, which follows (Fiala, Jablonský, Maňas, 1994).

$$\begin{array}{c c} & \begin{array}{cccc} A_1 & A_2 & \dots & A_n \end{array} \\ \begin{array}{c} K_1 \\ K_2 \\ \vdots \\ K_m \end{array} & \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ a_{m1} & a_{m2} & \dots & a_{mn} \end{bmatrix}, \end{array} \tag{1}$$

where individual rows correspond to evaluated variants (A_1, A_2, …, A_m) and individual columns to evaluated criteria (K_1, K_2, …, K_n) and for elements of this matrix applies that a_{ij} represents evaluation of i-th variant based on j-th criteria. The task is to find optimal variant or draw up ranking of variants based on their quality.

Criteria can be either maximization or minimization type. Based on maximization criteria variants with higher criteria values are better evaluated, on the contrary based on minimization criteria variants with lower criteria values are evaluated better. Selection of criteria for variant's evaluation, own creation of variants and its evaluation represent the decision problem's solution phase and should be executed in a close connection. Basic guideline for the determination of criteria evaluating individual variants are primarily the objectives, which the decision maker wants to achieve from the problem's solution (Fiala, Jablonský, Maňas, 1994) with the respect to sufficient information about criteria in decision process. Multicriteria decision problems can be divided based on type of information that represent criteria preferences or variants: they do not require information about criteria importance, require aspiration level of criteria, and require ordinal or cardinal information about criteria. The nature of decision problem "candidate selection" requires the utilization of methods with cardinal information about criteria, which will be further described in detail.

1.1 Overall criteria method with cardinal information about criteria

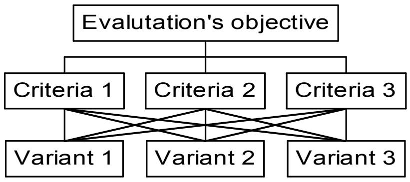
Individual methods, which require cardinal information about criteria, can be divided into three basic groups: methods based on maximization utility function (weighted sum approach WSA or AHP method), methods based on minimization distance (TOPSIS method) and evaluation based on preference relation method.

The nature of the problem is to find the most suitable applicant by utilizing method based on utility maximization. Hsiao et. al. (2011) used analytic hierarchy process to analyze selection criteria for recruitment of five different roles in the area of information system. Whereas, Chen et. al. (2011) applied AHP to assess human factor in the air plane accidents. Zolfani et. al. (2012) perceived selection of new employees or group of employees as a fundamental problem in the human resources area. He used AHP method to identify that the criteria are important when selecting a new team member and then he used TOPSIS method to evaluate the alternatives. Zhang et. al. (2009) used AHP method on factors which influence company's personnel competencies. Chou et. al. (2009) aimed his opinion on quality of call center services and emphasized it as a key factor for successful company operations based on quality management.

1.2 Decomposition AHP method

Multicriteria decision making includes distribution of decision problem to partial components (criteria) and consequent solution's connection of all sub-components (sub-criteria) into total solution. Elementary feature of AHP method is the projection of complete decision problem as a certain hierarchical structure, see Fig. 1, which is based on the assumption that identified elements of the system can be grouped together into disjunctive groups in which the elements of one group influence elements of other group and at the same time are also influenced by the elements of one other group (Ramík, Perzina, 2008).

Fig. 1: Decision hierarchy in AHP



Source: Černý, Glückaufová, 1987.

Many various methods exist for weight determination; the simplest ones are linear methods, in which are subjectively determined non-normalized weights of individual criteria in a priory agreed ranking scale. These methods include e.g. ranking method, classification method etc. Second group includes so called non-linear methods, e.g. pairwise comparison, where Fuller triangle method or more complex Saaty method belongs. In this paper the aforementioned Saaty's method is used. Criteria weights are enumerated reflection of their significance or more precisely importance of observed company's objectives, which are transformed into these individual criteria. The more the decision maker considers the criteria as more significant, the higher is criteria weight. Weight calculation is the key to solve the problem of complex evaluation of variants, basic foundation for weight construction of considered criteria $f_i \in C$ is pairwise comparison matrix S with elements s_{ij}. Preference is expressed in the interval $s_{ij} \in (1;9]$, basic values are following 1 = equally important, 3 = moderately important, 5 = significantly important, 7 = very significantly important, 9 = absolutely more important. Even numbers represent intermediate stages and are used for more precise preference differentiation. The level of non-preference (inverse preference) belongs to interval $s_{ij} \in [1/9;1)$. For diagonal elements is considered the $s_{ij} = 1$ and for inverse $s_{ij} = \dfrac{1}{s_{ij}}$.

The criteria weights can be determined very easily by so called approximation methods, which are practically well solvable by determination of normalized weights w_i by the utilization of geometrical mean of lines.

$$v_i = \frac{R_i}{\sum_{i=1}^{m} R_i} = \frac{\left[\prod_{j=1}^{m} s_{ij}\right]^{1/m}}{\left[\sum_{i=1}^{m}\prod_{j=1}^{m} s_{ij}\right]^{1/m}}, i = 1, 2, ..., m. \qquad (2)$$

Own relevant evaluation is that Saaty's matrix is consistent, meaning the elements fulfill the condition of transitivity. It is important to mention that many methods do not take this aspect into consideration. The consistency can be evaluated based on consistency ratio

CR (Consistency Ratio), where consistent is value $CR =\leq 0,1$. Concurrently $CR = \frac{CI}{RI}$, where $C.I. = (\lambda_{\max} - k)/(k-1)$, where k is number of criteria and λ_{max} is the largest eigenvalue. Matrix's eigen value can be determined in various ways, one of the possibilities is: $\lambda_{\max} = \frac{1}{N}\sum_{i}^{N}(S \cdot w)_i / w_i$, where w is vector and $(S \cdot w)_i$ is vector's i-th element. RI represents random consistency index.

Tab. 1: Selected values of RI index

k	1	2	3	4	5	6	7	8	9	10
R	0	0	0,58	0,9	1,12	1,24	1,32	1,41	1,45	1,49

Source: Fiala, Jablonský, Maňas (1994)

In the final phase it is very important to determine values of individual sub-criteria. By Saaty's pairwise comparison individual sub-criteria are compared within one superior criteria and with the respect to determined decision objective. This is how local weights of sub-criteria with respect to decision subject are determined. Calculation of global weights follow, these include initial (partial) weights, whose sum equals one (Zmeškal, 2012).

1.3 Weighted sum method WSA

It is a method, which is based on the linear utility function construction at the scale 0 to 1. The worst variant based on given criteria will have utility 0; the best variant will have utility 1 and other variants will have utility between both extreme values. Weighted sum method derives from the principle of utility maximization; however the method presumes only linear utility function. Firstly, the normalized criteria matrix will be created R = (r_{ij}), whose elements are derived from criteria matrix Y = (y_{ij}), based on,

$$r_{ij} = \frac{Y_{ij} - D_j}{H_j - D_j}, \tag{3}$$

where r_{ij} is variant's utility X_i when evaluated based on criteria Y_j, r_{ij} represents corresponding values from initial criteria matrix, D_j is the lowest criteria value Y_j, H_j is the highest criteria value Y_j. This matrix represents matrix of utility values from i-th variant based on j-th criteria. Based on (1) criteria values are linearly transformed, that $r_{ij} \in \langle 0,1 \rangle$, D_j corresponds to minimal criteria value of column j and H_j corresponds to maximum criteria value in column j. Relation (3) is used in case that criteria in given column j

considered as maximization. In case of minimization criteria normalization of such column in matrix can be executed by using:

$$r_{ij} = \frac{H_j - Y_{ij}}{H_j - D_j}. \tag{4}$$

If it is necessary that all criteria in the matrix must be maximization then before executing standardization (normalization) of matrix it is necessary to re-count elements in such column as follows:

$$Y_{ij-\max} = H_{j-\min} - Y_{ij-\min}; i = 1, 2, ..., p, \tag{5}$$

Meaning, deduct from current highest element (maximum) $H_{j-\min}$ in given column progressively all other elements and by this the column with minimization criteria will be transformed to maximization. This transformation is in formula (4) already included and most computer software take this possibility into account. When using additive multicriterial utility function the variant utility a_i is then equal to,

$$u(a_i) = \sum_{j=1}^{k} v_j \cdot r_{ij}. \tag{6}$$

Variant, which reaches the maximum utility value is selected as the best, alternatively it is possible to rank the variants based on descending utility values (Fiala, Jablonský, Maňas, 1994).

3 Applicant's selection

Example on which the multiple criteria decision method will be applied simulates situation in which company X is currently looking for most suitable applicant for work position „*Specialist in the area of quality management*“. Company X in not certain how many working position will be fulfilled, it depends on how many and what quality applicants will apply and based on this they will evaluate their benefit for the company. Vacant work position will be offered for applicant from external resources as well as for applicants from internal resources (i.e. company's current employees). EDUCATION (maximization criteria). Available is range of applicants with high school or university education, the scale has two values (binary variables) 0 – high school education, 1 – university education. FIELD OF STUDY (minimization criteria). Available is range of applicants with various type of schools. The scale has three values 0 – similar field, 1 – economic field, 2 – technical field. PRACTICE (maximization criteria). Needed is „Specialist in the area of quality management“, so practice is important. The scale has been set as follows: 0-0, 1 – (1-3 years), 2 – (3-5 years), 3 – (5 – more years). ENGLISH LANGUAGE TEST (maximization criteria). Applicants will take English language test (multiple choice test, listening exercise and essay question). Scale 1-50 point; applicant must accomplish at least the minimum level of 25 points in order to stay in the selection process. PC LITERACY (maximization criteria). PC literacy is very important for this job, therefore the applicant must demonstrate good knowledge of programs, work with them and overall work on computer. The scale was set at range 1-10, where1 represents very bad work on the PC and 10 represents excellent work on PC. KNOWLEDGE TEST (maximization criteria). Applicants will undergo knowledge test and they will be tested on general knowledge, logical thinking etc. The scale is 1-50 points; applicants who achieved less than minimum level, which is 25 points were for non-complying with requirements automatically excluded from the selection process. ANALYTICAL SKILLS (maximization criteria). The applicant must prove that he/she understands given problematic and he/she is able to apply his/her knowledge in practice. Scale 1-10, where 1 represents very bad analytical skills and 10 represents excellent analytical skills. PRESENTATION SKILLS (maximization criteria). Presentation skills are very important for this particular position because one of employee responsibilities is the preparation and consequent presentation of project's reports. The ability to attract listeners' attention is also taken into consideration. Scale 1-10, where 1 represents very bad presentation skills and 5 represents excellent presentation skills. PSYCHOLOGICAL ASSESSMENT (maximization criteria). The interview is overseen by a psychologist who evaluates applicant's psychological state, reactions in stressful situations. The psychologist also observes if the applicant is able to deal with work stress, time demand etc. Scale 1-5, where 1 specifies very bad reactions, the applicant is disconcert and has unaccepted, inappropriate reactions, whereas 5 represents very good reactions, where the applicant keeps cool head and reacts accordingly to given situation.

Criteria were evaluated by ranking method, see Tab. 2. This method assumes that the user is able to quantitatively evaluate the importance of individual criteria, in this case the importance was assessed by five experts from company X. The more important is the criteria, the higher is the ranking. For the selection of most appropriate candidate, WSA method was used, the weights were determined by Saaty's method.

Tab. 2: Input criteria data

Var/criteria.	Education	Practice	Psych.	Knowl.	AJ	PC	Analyt.	Field	Present.
1	0	0	4	35	34	5	3	2	2
2	0	1	3	41	41	4	7	2	5
3	0	0	1	37	26	5	7	1	4
4	0	0	2	33	30	7	9	1	4
5	0	1	5	37	43	2	2	2	4
6	0	0	4	25	37	4	6	2	3
7	1	2	2	34	27	6	4	1	3
8	0	0	3	29	39	7	5	0	2
9	0	0	3	42	42	9	2	1	3
10	1	1	1	27	28	6	3	0	3
11	1	1	2	36	39	2	3	0	4
12	0	0	3	43	41	6	2	0	4
13	1	3	1	44	35	3	4	2	5
14	1	2	2	38	38	3	3	1	5
15	0	0	4	30	35	4	1	1	3
16	0	0	3	31	43	10	1	1	4
17	0	0	4	26	28	6	2	2	4
18	0	0	5	29	44	5	1	1	2
19	0	1	2	33	26	4	2	1	3
20	0	1	3	29	25	5	3	1	3

Source: Own elaboration

From the input data it is evident that individual criteria are maximization type, the task is to find that variant, which is evaluated as the best based on all decision criteria (i.e. optimal variant) or rank the variants from the best to the worst. In this part the weights are calculated based on input data and Saaty's method of pairwise comparison, see chap. 1.2. The value of criteria was determined by the functions in MS Excel. Global weighs state desired preferences of individual criteria.

Tab. 3: Values of criteria groups' and individual criteria's scale

Criteria group	Weights of criteria's groups	Criteria	Local weights	Global weights
Education and practice	0,0719	High school/University	0,2583	0,0186
		Field of study	0,1047	0,0075
		Practice	0,6370	0,0458
Knowledge and skills	0,6491	PC literacy	0,1133	0,0735
		Language knowledge	0,3791	0,2461
		Knowledge test	0,5076	0,3295
Personality requirements	0,2790	Psychological assessment	0,0972	0,0271
		Presentation skills	0,2021	0,0564
		Analytical skills	0,7007	0,1955

Source: Own elaboration

Tab. 4: Maximum (H_j) and minimum (D_j) values from initial data matrix Y_j.

H_j	1	3	5	44	44	10	9	2	5
D_j	0	0	1	25	25	2	1	0	2
$H_j - D_j$	1	3	4	19	19	8	8	2	3

Source: Own elaboration

As a compromise variant is chosen the variant which will have highest value of weighted sum. From the results it is evident that individual variants are very near each other. The task for multicriteria evaluation of variants is to find a variant, which is based on all decision criteria evaluated the best overall (i.e. optimal variant) and in this case variant 2 achieves the maximum utility value and is selected as the best alternative. In the following table can be seen all applicant's score and their ranking.

Tab. 5: Applicant's ranking based on WSA method

Ranking	$u(a_i)$	a_i
1.	0,742	2
2.	0,670	13
3.	0,640	9
4.	0,632	12
5.	0,568	14
6.	0,553	5
7.	0,499	11
8.	0,493	4
9.	0,466	16
10.	0,437	3
11.	0,408	8
12.	0,394	1
13.	0,374	18
14.	0,371	7
15.	0,343	6
16.	0,278	15
17.	0,239	19
18.	0,212	10
19.	0,197	20
20.	0,183	17

Source: Own elaboration

4 Conclusion

Multicriteria evaluation of variants method belongs among the mathematical modeling methods. This paper presented AHP (analytic hierarchy process) method, which is used for multicriteria decision making and takes into consideration preferences of individual evaluators. At present time, companies are in permanent fight with the competition. Sometimes it is difficult for them to keep up with trends and at the same time ensure effective fulfillment of work positions. The paper presented how some of the methods can be used in practice, in this paper specifically when selecting applicants. This method uses criteria and determined weights to establish the best variant based on utility function.

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