On Using VIKOR for Ranking Personnel Problem

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Abstract: Personnel selection problem implies more than one dimension to be optimized. Many conflicting criteria should be considered when comparing alternatives to choose among or rank them. In This article, a Multi-Criteria Decision Making (MCDM) problem is presented and a real-life international company personnel selection problem of a new manner is illustrated. The technique used in solution named *Vlse Kriterijumska Optimizacija I Kompromisno Resenje* in Serbian (VIKOR) is applied for ranking the alternatives.

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1. Introduction

Personnel selection problem is a well known Multi Criteria Decision Making (MCDM) problem which involves many conflicting attributes. Personnel training process is very crucial in developing organizations. It implies more than one dimension to be optimized. Many conflicting criteria should be considered when comparing alternatives to choose among or rank them. The merit of MCDM techniques is that they consider both qualitative parameters as well as the quantitative ones, MCDM includes many solution techniques such as Simple Additive Weighting (SAW), Weighting Product(WP) [3], and Analytic Hierarchy Process (AHP) [7]. The personnel selection problem, from the multi-criteria perspective, has attracted the interest of many scholars as in [5,6].

In this paper a new personnel training selection problem existed in a multi-national company is presented. The technique named *Vlse Kriterijumska Optimizacija I Kompromisno Resenje* in Serbian (VIKOR), a branch of MCDM methods, is applied to rank the candidates for an international course of one year duration provided by the company to its employees. The rest of the paper is structured as following; in section 2 the VIKOR method is illustrated, section 3 is made for case study, finally section 4 is for conclusion.

2. VIKOR

A MCDM problem can be concisely expressed in a matrix format, in which columns indicate criteria (attributes) considered in a given problem; and in which rows list the competing alternatives. Specifically, a MCDM problem with m alternatives (A_1, A_2, ..., A_m) that are evaluated by n criteria (C_1, C_2, ..., C_n) can be viewed as a geometric system with m points in n-dimensional space. An element x_{ij} of the matrix indicates the performance rating of the i^{th} alternative A_i, with respect to the j^{th} criterion C_j, as shown in Eq. (1):

$$D = \begin{array}{c} \\ A_1 \\ A_2 \\ A_3 \\ \vdots \\ A_m \end{array} \begin{array}{c} \begin{array}{ccccc} C_1 & C_2 & C_3 & \cdots & C_n \end{array} \\ \begin{bmatrix} x_{11} & x_{12} & x_{13} & \cdots & x_{1n} \\ x_{21} & x_{22} & x_{23} & \cdots & x_{2n} \\ x_{31} & x_{32} & x_{33} & \cdots & x_{3n} \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ x_{m1} & x_{m2} & x_{m3} & \cdots & x_{mn} \end{bmatrix} \end{array} \qquad (1)$$

The VIKOR method was introduced as an applicable technique to implement within MCDM [4]. It focuses on ranking and selecting from a set of alternatives in the presence of conflicting criteria. The compromise solution, whose foundation was established by Yu [10] and Zeleny [11] is a feasible solution, which is the closest to the ideal, and here "compromise" means an agreement established by mutual concessions.

The VIKOR method determines the compromise ranking list and the compromise solution by introducing the multi-criteria ranking index based on the particular measure of "closeness" to the "ideal" solution. The multi-criteria measure for compromise ranking is developed from the *Lp-metric* used as an aggregating function in a compromise programming method. The levels of regret in VIKOR can be defined as:

$$L_{p,i} = \{\sum_{j=1}^{n} [w_j (x_j^* - x_{ij}) / (x_j^* - x_j^-)]^p\}^{1/p},\ 1 \le p \le \infty, \qquad (2)$$

where i = 1,2,…,m. $L_{1,i}$ is defined as the maximum group utility, and $L_{\infty,i}$ is defined as the minimum individual regret of the opponent.

The procedure of VIKOR for ranking alternatives can be described as the following steps [2]:

Step 1: Determine that best x_j^* and the worst x_j^- values of all criterion functions, where $j = 1, 2,\dots, n$. If the *jth* criterion represents a benefit then $x_j^* = \max_i f_{ij}$, $f_j^- = \min_i f_{ij}$.

Step 2: Compute the S_i (the maximum group utility) and R_i (the minimum individual regret of the opponent) values, $i = 1, 2,\dots, m$ by the relations:

$$S_i = L_{1,i} = \sum_{j=1}^{n} w_j (x_j^* - x_{ij}) / (x_j^* - x_j^-), \qquad (3)$$

$$R_i = L_{\infty,i} = \max_j \left[\sum_{j=1}^{n} w_j (x_j^* - x_{ij}) / (x_j^* - x_j^-)\right], \qquad (4)$$

where w_i is the weight of the j^{th} criterion which expresses the relative importance of criteria.

Step 3: Compute the value Q_i, $i = 1,2,\dots,m$, by the relation

$$Q_i = v(S_i - S^*)/(S^- - S^*) + (1-v)(R_i - R^*)/(R^- - R^*), \qquad (5)$$

where $S^* = \min_i S_i$, $S^- = \max_i S_i$, $R^* = \min_i R_i$, $R^- = \max_i R_i$, and v is introduced weight of the strategy of S_i and R_i.

Step 4: Rank the alternatives, sorting by the *S, R,* and *Q* values in decreasing order. The results are three ranking lists.

Step 5: Propose as a compromise solution the alternative (A') which is ranked the best by the minimum Q if the following two conditions are satisfied:

C1. "Acceptable advantage":
$Q(A'') - Q(A') \geq DQ$, where A'' is the alternative with second position in the ranking list by Q, $DQ = 1/(m - 1)$ and m is the number of alternatives.

C2. "Acceptable stability in decision making":
Alternative A' must also be the best ranked by S or/and R. This compromise solution is stable within a decision making process, which could be: "voting by majority rule" (when $v > 0.5$ is needed), or "by consensus" ($v \approx 0.5$), or "with vote" ($v < 0.5$). Here, v is the weight of the decision making strategy "the majority of criteria" (or "the maximum group utility"). $v = 0.5$ is used in this paper. If one of the conditions is not satisfied, then a set of compromise solutions is proposed [2].

Recently, VIKOR has been widely applied for dealing with MCDM problems of various fields, such as environmental policy [8], data envelopment analysis [9], and personnel training selection [1].

3. Case Study

A multi-national company that works in Tele-Communications is willing to select one employee from its personnel to join a two-year course provided by one of its suppliers in Europe. The course is budgeted by 100,000 Euros for one person; the supplier company will pay the fees, and the whole charges of the selected employee suggested by the multi-national company in order to train and teach the rest of the company during the orientation phase after the supplier company installs and provides its software packages. The company restricted the selection to middle management in the technical support department found in the whole company branches and offices. After many procedures and tests done, four candidates are eligible to have the opportunity of the course, the multinational company Human Resources department specifies five criteria to compare the four candidates and put them through many tests for them in order to select only one. The process of ranking the four candidates in order to select optimally one is a typical MCDM problem.

The Human Resources department set two exams to the six candidates; first the fluency in the foreign language test, and second is computer skills test including basic programming concepts. Both tests are combined to be one grade out of 100 points. The human resources department set the first criterion C_1 to be the age of the candidate, the younger is preferable. C_2 is set to be the experience years in the field; C_3 is the number of years passed by the candidate inside the company. C_4 is the average point attained by the candidate on the performance assessment annual report during the last 5 years; and finally C_5 is the grade obtained by each candidate in the two exams set by Human Resources department. Table 1 shows the five criteria, their weights, and their computation units. The Human Resources department presented the data included in the decision matrix found in Table 2 showing the four candidates, and their performance ratings with respect to all criteria. All candidates are indexed by the term (CAND) for simplicity.

Table 1. Criteria and their computation units

Criterion Index	Criterion Description	Computation Units	Weights
C_1	Age	No. of Years	0.30
C_2	Work Experience	No. of Years	0.15
C_3	Company Experience	No. of Years	0.20
C_4	Annual Assessment Report	Average of 5 years	0.10
C_5	Human Resources Tests	Grade (1-100)	0.25

Table 2. Decision matrix

	C_1	**C_2**	**C_3**	**C_4**	**C_5**
CAND1	48	23	10	70	78
CAND2	42	15	12	80	70
CAND3	36	16	16	62	95
CAND4	45	10	20	77	68

By applying the procedure of VIKOR, we can calculate the *S*, *R* and *Q* values as shown in Table 3 to derive the preference ranking of the candidates. Management should choose the third candidate because he has the minimum *S*, *R*, and *Q* values; also, the two conditions mentioned earlier in section 2 are satisfied.

Table 3. Ranking lists and scores

	S	*R*	*Q*	Rank
CAND1	0.5556	0.3000	1	4
CAND2	0.4023	0.1600	0.39007	2
CAND3	0.2608	0.1000	0	**1**
CAND4	0.3917	0.2250	0.534521	3

4. Conclusion

A VIKOR method is presented to solve a real-life personnel training problem existed in multinational company. A MCDM problem of a new manner is introduced. The VIKOR method is employed to rank the candidates. It might be combined to other techniques in further research. The MCDM problem should be reformulated and solved if any parameter or alternative is added or deleted because of its sensitivity to any changes.

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