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The novel performance evaluation approach to martial arts teachers based on TOPSIS method

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ABSTRACT

The promotion of teachers' professional technical position, the increase in the salary and treatment and evaluation of various awards involve evaluation of teachers' work performance. For this reason, the novel performance evaluation approach to martial arts teachers is proposed based on TOPSIS method. The experimental results suggest that the proposed approach is feasible and correct.

Key words: Performance Evaluation; Martial Arts Teachers; TOPSIS Method

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INTRODUCTION

In colleges, promotion of teachers' professional technical position, the increase in the salary and treatment and evaluation of various awards involve evaluation of teachers' work performance. For a long term, evaluation of teachers' work performance has rested on qualitative analysis. Hierarchy is often adopted to describe teachers' work performance. The shortcoming of such method is that the evaluation result is single and cannot comprehensively reflect the evaluation information. Besides, the objectivity is poor, and teachers have different views. Teachers' work performance is decided by correlated multi-aspect factors, so it cannot be evaluated unilaterally. It is required to carry out comprehensive evaluation of related factors influencing teachers' work performance. Thus, this paper tries to apply TOPSIS method to establish evaluation model for teachers' work performance so as to improve traditional evaluation method.

PERFORMANCE EVALUATION INDEX SYSTEM

For the work performance of a teacher, different human factor analysis perspectives will lead to different evaluations. Analytic hierarchy process should be adopted to decompose several analytical factors influencing teachers' work performance into fix factors: ideology and politics; teaching quality, achievements in scientific research; works; foreign language level; workload. These six factors are expressed as $u_1, u_2, u_3, u_4, u_5, u_6$. The evaluation factor set is:

$$U = \{u_1, u_2, u_3, u_4, u_5, u_6\} \quad (1)$$

For every evaluation factor, set up four comment grades. V represents the set of comment grades

$$V=\{u_1/\text{excellent}, u_2/\text{good}, u_3/\text{ moderate}, u_4/\text{poor}\} \quad (2)$$

Assume $\underset{\sim}{R}$ is $U \to V$ fuzzy relation. $R_{ij}\left(i=1,2,\cdots,6;\ j=1,2,\cdots,4\right)$ means the possibility of the j^{th} comment made for the teacher with the analysis from the i^{th} factor (expressed with %). If i is fixed, $\left(r_{i1}, r_{i2}, r_{i3}, r_{i4}\right)$ is a fuzzy set on V. It means single-factor evaluation of the teacher with the analysis from the i^{th} factor. The multi-factor evaluation matrix is:

$$\underset{\sim}{R} = \left[r_{ij} \right]_{6\times4} \left(i = 1, 2, \cdots, 6;\ j = 1, 2, \cdots, 4 \right) \quad \textbf{(3)}$$

Besides, each factor in U is $u_i \left(i = 1, 2, \cdots, 6 \right)$. The influence degree of each factor on the evolution result is different. According to the importance, different weight should be given. The weight must meet normalization requirement. The solving method of the weight is as follows:

Firstly, experts compare the elevation factors in pairs and write the comparison results into the matrix. In the matrix, the factor d_{ij} means the importance of the factor i on the factor j (expressed with non-zero positive number). The weight of each factor can be calculated with the following formula:

$$\alpha_i = \frac{1}{n} \sum_{j=1}^{n} \left(\frac{d_{ij}}{\sum_{i=1}^{n} d_{ij}} \right) \quad \textbf{(4)}$$

Where, n means the number of factors; i means the line; j means the row.

$$d_{ij} = \frac{1}{d_{ji}}$$

$$d_{ij} = d_{ji} = 1$$

When$i$=j. The corresponding weight of each factor will consist of a fuzzy vector on the factor set, expressed as

$$\underset{\sim}{A} = \left(\alpha_1, \alpha_2, \cdots, \alpha_6 \right) \quad \textbf{(5)}$$

Where, $\alpha_i \geq 0$ and $\sum_{i=1}^{6} \alpha_i = 1 \left(i = 1, 2, \cdots, 6 \right)$.

Regard $\underset{\sim}{R}$ as a fuzzy converter from U to V. Corresponding comprehensive evaluation result will be gained when a group of weight $\underset{\sim}{C}$ is inputted. The comprehensive evaluation model can be gained through applying compound operation of the fuzzy matrix.

$$\underset{\sim}{A} \cdot \underset{\sim}{R} = \underset{\sim}{B} \quad \textbf{(6)}$$

Where, $b_j = \bigvee_{i=1}^{n} \left(\alpha_i \wedge r_{ij} \right)$. $\wedge$ is fuzzy multiplication (take the minimum); is fuzzy addition (take the maximum). Gain $\underset{\sim}{B}^*$ through normalization of Formula (6); in view of Formula (2), the final evaluation result for a teacher is

$$W = \underset{\sim}{P}^* \cdot V^T \quad \textbf{(7)}$$

PERFORMANCE EVALUATION APPROACH

Evaluation factor set is the set of evaluation indexes of high-tech research projects. Since evaluation indexes of high-tech research projects are divided into several levels, evaluation factors have many levels.

$$U = \{U_1, U_2, \cdots, U_i, \cdots, U_n\}, \qquad i = 1, 2, \cdots, n$$
$$U_i = \{U_{i1}, U_{i2}, \cdots, U_{ij}, \cdots, U_{in_i}\}, \quad j = 1, 2, \cdots, n_i$$

Where, n is the number of factors in U; n_1 is the number of factors in U_1.

The weight of each index is set up with the form of judgment matrix in AHP. Assume a_{ij} is the importance of the index i for the factor j (scale), expressed with the scale of 1-9 rows in Table 1. Besides, $a_{ij} > 0$, $a_{ij}=1/ a_{ij}$, $a_{ij} =1$. The judgment matrix is:

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix}$$

For *A*, square root method is generally adopted to solve weight vectorw_i.

$$w_i = \frac{\sqrt[n]{\prod_{j=1}^{n} a_{ij}}}{\sum_{i=1}^{n} \sqrt[n]{\prod_{j=1}^{n} a_{ij}}}$$

Table 1. 1-9 scales and the meanings

Importance level	a_{ij}
Two factors are equally important	1
One is slightly more important than the other	3
One is obviously more important than the other	5
One is strongly more important than the other	7
One is extremely more important than the other	9
One is slightly less important than the other	1/3
One is obviously less important than the other	1/5
One is strongly less important than the other	1/7
One is extremely less important than the other	1/9
Mid-value of 2 factors	2, 4, 6, 8, 1/2, 1/4, 1/6, 1/8

The weight set of 1st-level indexes *w* and the weight set of 2nd -level indexes w_i can be gained respectively.

$$w = [w_1, w_2, \cdots, w_i, \cdots, w_n]^T$$

$$w_i = [w_{i1}, w_{i2}, \cdots, w_{ij}, \cdots, w_{in_i}]^T$$

$$j = 1, 2, \cdots, n_i, \quad \sum_{i=1}^{n} n_i = m$$

The relative weight of 2-level indexes can be gained according to the above Formula.

$$w^* = [w_1^*, w_2^*, \cdots, w_j^*, \cdots, w_m^*]^T$$

Where $w_j^* = w_i \times w_{ij}$ .Since experts have certain subjectivity during scoring, complete judgment consistence cannot be reached during the comparison in pairs. In other words, there is evaluation error. In order to avoid large errors, consistency check is required for the judgment matrix, i.e. calculate random consistency ratio (CR) of the judgment matrix. Only when CR$<$0.1, consistency of the judgment matrix is acceptable.

During evaluation of high-tech research projects, in view of fuzziness and subjectivity of each index, semantic judgment is adopted. To be more specific, there are 5-level standards: low, relatively low, general, relatively high and high. The 5 semantic variables are expressed with interval fuzzy number, as shown in Table 2.

Table 2 Evaluation set

Judgment standard	Interval fuzzy number
Low	(0, 0.2)
Relatively low	(0.2, 0.4)
General	(0.4, 0.6)
Relatively high	(0.6, 0.8)
High	(0.8, 1.0)

Initial interval fuzzy matrix of 2nd-level indexes constructed according to the comment set is

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1m} \\ x_{21} & x_{22} & \cdots & x_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ x_{k1} & x_{k2} & \cdots & x_{km} \end{bmatrix}$$

Where, x_{ij} is the semantic value of the i^{th} scheme and the j^{th} evaluation index, and $x_{ij} = (x_{ij}^l, x_{ij}^u)$.

Standardize *X*:

$$\boldsymbol{R} = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ r_{k1} & r_{k2} & \cdots & r_{km} \end{bmatrix}$$

Where

$$r_{ij} = x_{ij} / A_i$$
$$A_i = \max(\max(x_{i1}^l, x_{i1}^u), \max(x_{i2}^l, x_{i2}^u), \cdots, \max(x_{in}^l, x_{in}^u))$$

Standardization fizzy matrix of weight interval constructed according to the weight of the evaluation index and initial fuzzy matrix is:

$$\boldsymbol{V} = [v_{ij}]_{k\times m}$$
$$i = 1, 2, \cdots, k;\ j = 1, 2, \cdots, m$$

Where $v_{ij} = x_{ij} \times w_j$.

Fuzzy positive ideal solution (V^+) refers to the set of the maximum evaluation values selected in each standard item. Fuzzy negative ideal solution (V^-) is opposite, i.e.:

$$V^+ = \{v_j^{+l}, v_j^{+u}\} = \{(\max_i v_{ij} \mid j \in I'), (\min_i v_{ij} \mid j \in I'')\}$$
$$V^- = \{v_j^{-l}, v_j^{-u}\} = \{(\min_i v_{ij} \mid j \in I'), (\max_i v_{ij} \mid j \in I'')\}$$

Where, i=1, 2,…, k; j=1, 2,…, m; *I'* is efficiency index; *I''* is cost index.

The distance between each alternative scheme and fuzzy positive & negative ideal solutions is:

$$S_i^+ = \sum_{j=1}^{m} d(v_{ij}, v_j^+) = \sqrt{\sum_{j=1}^{m}[(v_{ij}^l - v_j^{+l})^2 + (v_{ij}^u - v_j^{+u})^2]}$$
$$S_i^- = \sum_{j=1}^{m} d(v_{ij}, v_j^-) = \sqrt{\sum_{j=1}^{m}[(v_{ij}^l - v_j^{-l})^2 + (v_{ij}^u - v_j^{-u})^2]}$$

The proximity of each scheme and the ideal solutions is:

$$C_i = S_i^- / (S_i^+ + S_i^-)$$

According to above Formula, if C_i is larger, Scheme A_i further approaches ideal value. Each scheme can be sorted according to C_i.

CASE ANALYSIS

A college will evaluate 3 high-tech research projects. The college invites 9 experts to evaluate high-tech research projects with the evaluation indexes and the evaluation model. The weight of 1st-level indexes is confirmed with AHP. The judgment matrix is:

$$A = \begin{bmatrix} 1 & \frac{1}{2.2} & 1.8 & 2.6 \\ 2.2 & 1 & \frac{1}{1.5} & \frac{1}{1.2} \\ \frac{1}{1.8} & 1.5 & 1 & \frac{1}{3} \\ \frac{1}{2.6} & 1.2 & 3 & 1 \end{bmatrix}$$

The weight of the evaluation indexes calculated according to the above Formula is:

$$w_1 = 0.297, \quad w_2 = 0.258$$
$$w_3 = 0.178, \quad w_4 = 0.267$$

The judgment matrixes of relative importance of 2nd-level indexes are:

$$A_1 = \begin{bmatrix} 1 & 2.5 & 1/1.4 \\ 1/2.5 & 1 & 2.2 \\ 1.4 & 1/2.2 & 1 \end{bmatrix}$$

$$A_2 = \begin{bmatrix} 1 & 1.8 & 1/2.2 \\ 1/1.8 & 1 & 1.2 \\ 2.2 & 1/1.2 & 1 \end{bmatrix}$$

$$A_3 = \begin{bmatrix} 1 & 2.1 & \frac{1}{2.3} & \frac{1}{1.6} \\ \frac{1}{2.1} & 1 & 1.8 & 2 \\ 2.3 & \frac{1}{1.8} & 1 & \frac{1}{1.5} \\ 1.6 & \frac{1}{2.0} & 1.5 & 1 \end{bmatrix}$$

$$A_4 = \begin{bmatrix} 1 & 1.5 & 1/1.3 \\ 1/1.5 & 1 & 1.6 \\ 1.3 & 1/1.6 & 1 \end{bmatrix}$$

The weight of 2nd-level indexes calculated according to the above formula is:

$$w_1 = (0.400, 0.316, 0.284)$$
$$w_2 = (0.308, 0.288, 0.404)$$
$$w_3 = (0.214, 0.295, 0.281, 0.210)$$
$$w_4 = (0.349, 0.340, 0.311)$$

Through synthesizing the above weight at each level, the relative weight of 2nd-level indexes is:

$$w^* = (0.119, 0.094, 0.084, 0.080, 0.074, 0.104, 0.038, 0.053, 0.050, 0.037, 0.093, 0.091, 0.083)$$

Evaluate 2nd-level indexes of the 3 high-tech research projects in accordance with the comment set. Interval fuzzy evaluation matrix is:

$$X=\begin{bmatrix} [0.4, 0.5] & [0.2, 0.4] & [0.6, 0.8] \\ [0.6, 0.8] & [0.4, 0.6] & [0.2, 0.4] \\ [0.2, 0.4] & [0.6, 0.8] & [0.4, 0.6] \\ [0.6, 0.8] & [0.8, 1.0] & [0.2, 0.4] \\ [0.4, 0.6] & [0.2, 0.4] & [0.6, 0.8] \\ [0, 0.2] & [0.2, 0.4] & [0.2, 0.4] \\ [0.4, 0.6] & [0.6, 0.8] & [0.4, 0.6] \\ [0.4, 0.6] & [0.4, 0.6] & [0.6, 0.8] \\ [0, 0.2] & [0.8, 1.0] & [0, 0.2] \\ [0.6, 0.8] & [0.4, 0.6] & [0.4, 0.6] \\ [0.2, 0.4] & [0, 0.2] & [0.6, 0.8] \\ [0.2, 0.4] & [0.4, 0.6] & [0.6, 0.8] \\ [0.6, 0.8] & [0.6, 0.8] & [0.2, 0.4] \end{bmatrix}^{T}$$

Weight standardization interval fuzzy evaluation matrix constructed according to index weight and interval fuzzy standardization evaluation matrix is:

$$V=\begin{bmatrix} [0.059, 0.089] & [0.024, 0.048] & [0.089, 0.119] \\ [0.071, 0.094] & [0.038, 0.056] & [0.024, 0.047] \\ [0.021, 0.042] & [0.050, 0.067] & [0.042, 0.063] \\ [0.060, 0.080] & [0.064, 0.080] & [0.020, 0.040] \\ [0.037, 0.056] & [0.015, 0.030] & [0.056, 0.074] \\ [0, 0.026] & [0.021, 0.042] & [0.026, 0.052] \\ [0.019, 0.028] & [0.023, 0.030] & [0.019, 0.028] \\ [0.026, 0.040] & [0.021, 0.032] & [0.040, 0.053] \\ [0, 0.012] & [0.040, 0.050] & [0, 0.012] \\ [0.028, 0.037] & [0.015, 0.022] & [0.018, 0.028] \\ [0.023, 0.046] & [0, 0.019] & [0.070, 0.093] \\ [0.023, 0.046] & [0.036, 0.055] & [0.068, 0.091] \\ [0.062, 0.083] & [0.050, 0.066] & [0.021, 0.042] \end{bmatrix}^{T}$$

According to Formula (9) and (10), positive and negative ideal solutions of 13 2nd-level evaluation indexes in the 3 high-tech research projects are shown in Table 3. Calculate the distance between each scheme and positive & negative ideal solutions according to Table 2 and the above formulas: S_1^+=0.129, S_1^-=0.130; S_2^+ =0.173, S_2^-=0.104; S_3^+ =0.121, S_3^- =0.175. According to the formula, the relative proximity of each scheme and ideal solution is: C_1=0.503; C_2=0.374; C_3=0.591. It can be seen from the above results that the third high-tech research project is the best, followed by the first one. According to the evaluation result, the third high-tech research project is the preferred support object.

Table 3. Positive and negative ideal solutions of 2nd-level evaluation indexes

Index	A^+	A^-
C_{11}	[0.089, 0.119]	[0.024, 0.048]
C_{12}	[0.070, 0.094]	[0.024, 0.047]
C_{13}	[0.050, 0.067]	[0.021, 0.042]
C_{21}	[0.064, 0.080]	[0.020, 0.040]
C_{22}	[0.056, 0.074]	[0.015, 0.030]
C_{23}	[0.026, 0.052]	[0, 0.026]
C_{31}	[0.023, 0.030]	[0.019, 0.028]
C_{32}	[0.040, 0.053]	[0.021, 0.032]
C_{33}	[0.040, 0.050]	[0, 0.012]
C_{34}	[0.028, 0.037]	[0.015, 0.022]
C_{41}	[0.070, 0.093]	[0, 0.019]
C_{42}	[0.068, 0.091]	[0.023, 0.046]
C_{43}	[0.062, 0.083]	[0.021, 0.042]

CONCLUSION

In this paper, the novel performance evaluation approach to martial arts teachers is proposed based on TOPSIS method. The experimental results suggest that the proposed approach is feasible and correct.

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REFERENCES

[1] OY Adisa, *Construction Management and Ec*., **2010**, 28(5), 509-526
[2] JS Shane, *J. MANAGE. ENG*., **2009**, 25(4), 221-229
[3] Lin C; Hu J; Kong XZ, *Chinese Journa*., **2012**, 35(1), 1-15
[4] Hu CP; Deng SL, *J. INTELL*., **2006**, 24(3), 321-325
[5] L Dudek, *ACM Trans. Comput. Hum. Interact*., **2006**, 18(1), 1-30
[6] Li XQ, J. *INTELL*., **2010**, 28(5), 763-767
[7] Pang QH, *Computer Engineering*, **2007**, 33(18), 59-61
[8] Zhou RG, *Computer Engineering and Applications*, **2007**, 43(31), 102-105
[9] Hu CP; Deng SL, *J. INTELL*., **2006**, 24(3), 321-325
[10] L Dudek, *ACM Trans. Comput. Hum. Interact*., **2006**, 18(1), 1-30
[11] Pang QH, *Computer Engineering*, **2007**, 33(18), 59-61
[12] Zhou RG, *Computer Engineering and Applications*, **2007**, 43(31), 102-105