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A Novel Performance Evaluation Approach for the College Teachers Based on Individual Contribution

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Abstract

The performance evaluation to college teachers has very important theoretical significance and practical value. Therefore, a novel performance evaluation approach is proposed to the college teachers based on individual contribution. Experimental results suggest that this approach is feasible and efficacious.

Keywords: *Performance Evaluation, College Teacher, Individual Contribution*

1. Introduction

At present, there are two main kinds of teacher evaluation system, they are reward and punishment evaluation system and the developing evaluation system [1].

Reward and Punishment Evaluation System. It is aimed at strengthening the performance management of teachers, giving corresponding reward or punishment according to their performance [2]. This kind of evaluation system can mobilize teachers' enthusiasm and creativity only by external rewards, and it can punish incompetent teachers to make them improve deficiencies constantly and make progress. Teachers can develop constantly through awarding part of excellent teachers and punish part of incompetent teachers, and then promoting the increase of educational level [3]. There are some following disadvantages of reward and punishment teacher evaluation system: teachers concern much about the evaluation results, which is easy to cause that teachers are not willing to exchange their own advanced information with other teachers with the purpose of competing for rewards or promotion; this kind of system is a superincumbent teacher evaluation system, which brings teachers with great psychological stress, affecting the relationship between teachers and leaders, between teachers and teachers, between teachers and administrators; this kind of system overly concerns with short-term results, which makes the evaluation indicators overly quantization and unification, neglecting the individual differences of teachers and the exchange between estimators and the evaluated, so that teachers cannot preserve their own interests during the evaluation process [4-5].

Developing Evaluation System. It is aimed at promoting teachers' development, promoting teachers' professional development and promoting schooling quality by teacher evaluation in a relaxing and democratic atmosphere, thereby realizing a win-win situation among the college and teachers [6-8]. The evaluation system of developing teachers believes that intrinsic motivation is much more motivate than external motivation because teachers have got high-level education. It believes that self-motivation should be the primary because external pressure can only make them reach the minimum requirement while intrinsic motivation can make them develop great enthusiasm and mobilize their initiative [9]. If giving them necessary working conditions, they can make their works excellent. The evaluation system of developing teachers provides teachers with necessary working conditions in a relaxing and democratic atmosphere, cultivating their professional ethics, mobilizing their working enthusiasm, stimulating their working enthusiasm, and then to realize the management and development objectives while in meeting teachers' self-value needs; the evaluation system of developing teachers lays emphasis on the subjectivity and difference of teachers [10]. The subjectivity mainly reflects in the evaluation process that it pays great attention to the dominant role of teachers, trusting and respecting them, attaching importance to the equal dialogue, exchange and communication between estimators and the evaluated. The difference mainly reflects in adopting different evaluation criterion to implement discrepancy evaluation according to teachers' different backgrounds, personalities, teaching styles and the current stage of their career [11]. Teachers participate in the evaluation process actively, estimators gather information from multiple channels and then evaluate teachers, feedback evaluation results in time and apply the evaluation results scientifically and reasonably.

2. Individual Contribution

In 1929, people held a tug-of-war test in Rangeland Germany. When a person participated in the tug-of-war, the power he or she contributed was 63 kg; while eight person participated in the tug-of-war, the power they contributed

was 63×8=504 kg in theory, however, the actual power was just 248 kg, which occupied 49% of the theoretical value; each person only contributed half of his or her whole power [12]. In 1979, Latanne etc. also did a similar test: when a person did his or her best to scream and clap, the voice he or she contributed was 100%, while six person screamed and clapped together, each person only contributed 40% of their voice in average. We are wondering how an administrator should motivate and stimulate employees to contribute more of their power after seeing the abovementioned two tests [13].

Why does it happen that the contribution of the same person will decrease in a team? It is called 'Social Loafing' in academe. In the actual life with increasingly fierce competition, the occurrence probability of 'Social Loafing' is higher in greater-scale and better-brand organization. The half-heartedness resulted by 'Social Loafing' can be summarized as 'Loss of coordination' and 'Reducing of sense of responsibility' from an administrative perspective. 'Reducing of sense of responsibility' is first because the personal contribution degree is not specific and then shuffling off responsibility onto others; the second is because the administrators do not implement organization objectives to each team member definitely. It cannot be prevented of the decreasing of individual initiative without specific measurement of personal contribution degree and impartial evaluation [14-15].

The paper will define personal contribution degree as: 'the increased degree of comprehensive competitiveness index in a team when adds someone' or 'the decreased degree of comprehensive competitiveness index in a team when reduces someone'. Obviously, the larger the range caused by adding (or reducing) someone to increase (or decrease) the team comprehensive competitiveness index, the more personal contribution the person made to the team, who should be one of the members to be taken seriously or protected; otherwise, the less personal contribution the person made to the team, who should be dispensable role in the team [16].

In the performance appraisal process of teachers in universities and colleges, the essay will measure the comprehensive competitiveness index of a team from five aspects: teaching (having lessons and counselling students), scientific research (application and implementation of scientific research projects), academic (basic research and composing academic paper), engineering development (design and development of engineering projects) and laboratory management (daily management of laboratory). In order to simplify the treatment of problems, the essay supposes that the works teachers have done in these five aspects all can be quantized according to specific standard; in a team, unilateral workload can be accumulated [17].

3. Performance Evaluation Approach

The paper applies TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method to synthesize the workloads in teaching, scientific research, academic, engineering development and laboratory management, and then get the comprehensive competitiveness index of multiple teams with different individuals. TOPSIS method is ordering according to the limited evaluation objects and the approaching degree of ideal solution, and making the evaluation of relative superior or inferior among existing objects. Ideal solution has positive ideal solution and negative ideal solution, the best evaluation object should be closest to the positive ideal solution and be farthest to the negative ideal solution. The basic principles of TOPSIS method: ordering by testing the distance of evaluation object to the positive ideal solution and the negative ideal solution, if the evaluation object is the closest to the positive ideal solution and the farthest to the negative ideal solution, then he or she is the best; if not, he or she is the worst.

Let $M=\{1,2,\ldots,m\}$ and $N=\{1,2,\ldots,n\}$, suppose that the decision scheme set is $U=\{u_i\}$, the attribute set $V=\{v_j\}$, the index weight set $W=\{w_j\}$, the decision matrix $A=(a_{ij})_{m\times n}$ ($i\in M$, $j\in N$), where a_{ij} is the value obtained from the measure by scheme u_i according to index v_j, w_j is the index weight to be determined and $\sum_{j=1}^{n} w_j = 1$, then the quadruple $\langle U, V, W, A\rangle$ constitutes the mathematical model.

The physical dimensions of various indexes in the attribute set may be different, thus the decision matrix should be normalized by following some rules before making a decision. There are several attribute types, including the benefit-type, cost-type, fixed-type and interval-type, of which the most commonly used types are the benefit-type and the cost-type. Suppose that I_1 and I_2 are respectively the subscript sets of the benefit-type and cost-type attributes, and the normalized decision matrix can be written as $B=(b_{ij})_{m\times n}$, then the normalized formulas for the benefit-type and cost-type indexes are respectively

$$b_{ij} = \begin{cases} \dfrac{a_{ij} - a_{i\min}}{a_{i\max} - a_{i\min}}, & j \in I_1 \\ \dfrac{a_{i\max} - a_{ij}}{a_{i\max} - a_{i\min}}, & j \in I_2 \end{cases} \quad (1)$$

In which, $a_{i\max} = \max_{i\in M}\{a_{ij}\}$ and $a_{i\min} = \min_{i\in M}\{a_{ij}\}$.

(1) Determination of index weights by entropy method. The entropy H_j for the j^{th} index v_j calculated by the normalized decision matrix $B=(b_{ij})_{m\times n}$ is

$$H_j = -k\sum_{i=1}^{m}(\overline{b_{ij}}\ln\overline{b_{ij}}),\ \ j \in N \tag{2}$$

In here, $k=(\ln\ m)^{-1}$, $\overline{b_{ij}} = \dfrac{b_{ij}}{\sum_{i=1}^{m} b_{ij}}$,and suppose that when $\overline{b_{ij}} = 0$, $\overline{b_{ij}}\ln\overline{b_{ij}} = 0$. The entropy weight of the j^{th} index v_j calculated by H_j is

$$w_j = \frac{1-H_j}{n-\sum_{j=1}^{n} H_j},\ \ j \in N \tag{3}$$

After the index weight is determined, the weighted normalized decision matrix can be written as $C=(c_{ij})_{m\times n}$, its computational formula is

$$c_{ij} = w_j \times b_{ij},\ i \in M;\ \ j \in N \tag{4}$$

(2) Nearness Degree Computing. In this section, suppose $\Phi^+ = (c_j^+)$ and $\Phi^- = (c_j^-)$ ($j \in N$) are respectively the positive and negative ideal points, in which

$$c_j^+ = \max_{i\in M} c_{ij} \tag{5}$$

$$c_j^- = \min_{i\in M} c_{ij} \tag{6}$$

Written as $\Psi^+ = (d_i^+)$, $\Psi^- = (d_i^-)$ ($i \in M$), where

$$d_i^+ = \sqrt{\sum_{j=1}^{n}(c_{ij}-c_j^+)^2} \tag{7}$$

$$d_i^- = \sqrt{\sum_{j=1}^{n}(c_{ij}-c_j^-)^2} \tag{8}$$

d_i^+ and d_i^- are respectively the nearness degrees of scheme u_i to the positive ideal point Φ^+ and the negative ideal point Φ^- . Their physical meaning is that: the smaller d_i^+ and d_i^- , the larger the degrees of similarity between scheme u_i and the positive and negative ideal points respectively.

(3) Calculation for comprehensive index values. Suppose that the vector of the comprehensive ranking index value for scheme u_i is $Z=(z_i)(i \in M)$, in which

$$z_i = \frac{d_i^-}{d_i^- + d_i^+} \tag{9}$$

The schemes are sorted according to the comprehensive index values, and the larger the comprehensive index values, the better the schemes.

(4) General steps of general TOPSIS. Based on the above analysis, the solving steps of TOPSIS ranking model are listed as follows.

Step 1: Suppose that there is a MADM problem, and its decision matrix is $A=(a_{ij})_{m\times n}$, then the normalized decision matrix $B=(b_{ij})_{m\times n}$ is obtained by (1);

Step 2: The index weights w_j are calculated by (2) and (3), and the weighted normalized decision matrix $C=(c_{ij})_{m\times n}$;

Step 3: The positive ideal point $\Phi^+ = (c_j^+)$ and the negative one $\Phi^- = (c_j^-)$ are solved by (5) and (6), and the nearness degrees of scheme u_i to c^+ and c^- by (7) and (8);

Step 4: The comprehensive ranking index value z_i of scheme u_i is solved by (9), and determine the relative merits of the schemes using the values of z_i.

4. Experimental Results

The paper supposes that there are 10 teachers in the team, their workloads in teaching, scientific research, academic, engineering development and laboratory management are as Table 1. From Table 1, we can see that the first teacher is outstanding in all aspects; the second to fifth teachers are in the medium in all aspects; the sixth to tenth teachers are outstanding in a single aspect of teaching, scientific research, academic, engineering development and laboratory management, and a slightly short in other aspects. Then, we will use a method based on individual contribution degree to evaluate the performance of each teacher.

Table 1: The Workload of Each Teacher in the Team

No.	Teaching (class hours)	Scientific research (thousand yuan)	Academic (scores)	Engineering development (hours)	Laboratory management (hours)
1	100	40	30	150	150
2	50	25	15	100	110
3	55	21	16	110	105
4	50	30	15	120	100
5	60	20	15	110	110
6	800	10	10	50	50
7	30	320	10	50	50
8	30	10	240	50	50
9	30	10	10	1600	50
10	30	10	10	50	1600

Table 2 enumerates that the total team workloads in teaching, scientific research, academic, engineering development and laboratory management after missing any a teacher. Table 2 also provides the positive ideal solution and the negative ideal solution under ten situations.

In order to simplify the treatment of problems, we synthesize the workloads of teaching, scientific research, academic, engineering development and laboratory management and set all their weight coefficient as 0.2. Table 3 provides the comprehensive competitiveness index of each team under different situations. We can calculate the individual contribution degree of single teacher by comparing the comprehensive competitiveness index of a team with missing a teacher and the comprehensive competitiveness index of a team without missing a teacher (see Table 3).

Table 2: The Total Team Workloads under Different Situations

No.	Group status	Teaching (class hours)	Scientific Research (thousand yuan)	Academic (scores)	Engineering Development (hours)	Laboratory Management (hours)
1	The first teacher is missing	1135	456	341	2240	2225
2	The second teacher is missing	1185	471	356	2290	2265
3	The third teacher is missing	1180	475	355	2280	2270
4	The fourth teacher is missing	1185	466	356	2270	2275
5	The fifth teacher is missing	1175	476	356	2280	2265
6	The sixth teacher is missing	435	486	361	2340	2325
7	The seventh teacher is missing	1205	176	361	2340	2325
8	The eighth teacher is missing	1205	486	131	2340	2325
9	The ninth teacher is missing	1205	486	361	790	2325
10	The tenth teacher is missing	1205	486	361	2340	775
11	No one missing	1235	496	371	2390	2375
12	Positive ideal solution	1235	496	371	2390	2375
13	Negative ideal solution	435	176	131	790	775

Table 3: Experimental Results of Simulation Example

No.	Group status	Comprehensive Competitiveness Index of Team	Individual Contribution of Single Teacher
1	The first teacher is missing	0.8872	0.1128
2	The second teacher is missing	0.9329	0.0671
3	The third teacher is missing	0.9329	0.0671
4	The fourth teacher is missing	0.9279	0.0721
5	The fifth teacher is missing	0.9323	0.0677
6	The sixth teacher is missing	0.6623	0.3377
7	The seventh teacher is missing	0.6630	0.3370
8	The eighth teacher is missing	0.6629	0.3371
9	The ninth teacher is missing	0.6526	0.3474
10	The tenth teacher is missing	0.6508	0.3492
11	No one missing	1	—

It can be seen from the results of Table 3: (1) the first teacher is outstanding in all aspects and his or her individual contribution degree to the team is higher; (2) the second to fifth teachers are in the medium in all aspects, their individual contribution degrees to the team are lower; the sixth to tenth teachers are extremely outstanding in a single aspect of teaching, scientific research, academic, engineering development and laboratory management although they are a slightly short in other aspects, they have higher individual contribution degrees to the team.

5. Conclusions

In conclusion, if a teacher in universities and colleges can be outstanding in many aspects like teaching, scientific research, academic, engineering development and laboratory management, then his or her individual contribution degree to a team is higher, which is an ideal development pattern; at the same time, if he or she is extremely outstanding in a single aspect of teaching, scientific research, academic, engineering development and laboratory management, he or she can also make great contribution to the team, and this part of person are deserved to be provided with good development opportunities and wide development platform.

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