Study on College Teachers’ Performance Appraisal Based on VE

Abstract—As the main resource for the development of universities, job performance of college teachers directly affect the development level of universities teaching and research, but their influencing factors of college teacher performance are numerous, certain, uncertain and fuzzy. Therefore, it is particularly important to establish a scientific and reasonable comprehensive evaluation model of college teacher performance for the development of universities in the new situation. In this paper, Value Engineering (VE) is introduced, on which basis new evaluation index systems of college teacher performance are worked out, and then AHP-multistage fuzzy comprehensive appraisal method is adopted to analyze them, in order to get the comprehensive and objective evaluation conclusion and provide a basis for actual performance management.

Keywords- College teacher performance; Value Engineering (VE); AHP, Multistage Fuzzy Comprehensive Evaluation

I. INTRODUCTION

Along with the deepening of China's higher education reform, the rank of college teachers has continuously expanded, as the main resources of colleges and universities. In this process, the level and potential of university faculty has become the key of personnel training, scientific research and social services in university. Therefore, it is particularly important to establish a scientific, comprehensive and practical evaluation index system of college teacher performance, and then build up optimal evaluation model, in order to construct high-quality faculty which adapt to the new form of the development of universities. And the college teacher performance is subject to complex, certain, uncertain and ambiguous factors because the job of college teacher relates to many aspects. So, in this paper, Value Engineering (VE) is applied, on which basis new evaluation index systems of college teacher performance are worked out, and then AHP-multistage fuzzy comprehensive appraisal method is adopted to analyze them, in order to get reasonable results as an actual evaluation reference for college teacher performance, which is of great significance to university development.

II. APPLICATION OF PRINCIPLE OF VALUE ENGINEERING IN COLLEGE TEACHER PERFORMANCE EVALUATION

Value engineering (VE), also called value analysis, was put forward by the American engineer known as L. D. Miles in 1940s. It has been widely used in various fields now. Chinese national standard (GB8223-87) “the basic term of value engineering and general working routine”, issued in 1987, defined: under the cooperation of every relevant fields, the function and cost of the object are analyzed systematically and innovated continuously to improve the thinking way and administrative skill. As a method of technical economic analysis, value engineering can be formulated as:

\[
\text{Value} = \frac{\text{Fuction}}{\text{Cost}}
\]

In the equation, value means the ratio between the total function and the total cost of an object; College teachers are different to common product or object, so function (ability) that the college obtains means ability quality that college teachers have; Cost means necessary ability quality that college teachers seek a certain job (his salary as a fixed value), which standard value is set 100; So, the core issue of VE application in college teaching performance evaluation is the function analysis of university teachers.

College teacher performance is specific strategic objectives of the university's development, are behaviors which a teacher demonstrated and results which a teacher achieved in the process of achieving the education, teaching and scientific research objectives. So there are numerous uncertain and certain factors on influencing of college teacher performance, not only quantitative factors, but also qualitative ones.

Therefore, it is usually difficult to appraise college teacher performance roundly and objectively by VE singly, which makes the application of VE limited. So, AHP- multistage fuzzy comprehensive appraisal theory based on VE has been put forward and applied in college teacher performance appraisal to optimize the function factors of VE.

III. INDEX SYSTEM ESTABLISHMENT ON COLLEGE PERFORMANCE

The core issue of VE application in college teaching performance evaluation is the function analysis of college teachers, so index system establishment on college teacher performance is mainly index system establishment of functional factors. Because the work of college teachers is complicated and variable, many factors in the process of teaching and education are more difficult to identify, and the cycle of education is long, etc. The author got the many
influencing factors of location through search, investigation and expert's interview, and established the functional factors' evaluation index system by AHP. (Shown in Fig. 1)

**IV. MULTISTAGE FUZZY COMPREHENSIVE APPRAISAL OF COLLEGE TEACHER PERFORMANCE**

**A. Establishment of Factor Sets Involved**

Definition: level 1 factor set is $U = \{U_1, U_2, \ldots, U_n\}$, and its corresponding weight vector is $A = (a_1, a_2, \ldots, a_n)$. Among them, $k = 1, 2, \ldots, N$, and $N$ is the number of sub-index of $U$; and \[ \sum_{k=1}^{N} a_k = 1 \]

Level 2 factor set is $U_i = \{u_{i1}, u_{i2}, \ldots, u_{in}\}$, and its corresponding weight vector is $A_i = (a_{i1}, a_{i2}, \ldots, a_{in})$. Among them, $l = 1, 2, \ldots, M$, and $M$ is the number of sub-index of $U_i$; and \[ \sum_{l=1}^{M} a_{il} = 1 \]

**B. Establishment of the Comment Sets**

Considered that the operation and precision of the practical problems, five-level comment set is adopted, which is $V = \{v_1, v_2, v_3, v_4, v_5\}$, and its corresponding comment grades are as follows: $v_1$ is “worse”; $v_2$ is “bad”; $v_3$ is “neutral”; $v_4$ is “good”; $v_5$ is “better”.

**C. Calculating Weight Vector of Factor Sets**

In fuzzy comprehensive evaluation, weight of the index has much influence on the evaluation of college teacher performance, and determining the weight vectors accurately, objectively will affect the work performance of college teacher directly. So it is very important. The method of AHP is introduced.

The analytical hierarchy process is a multigoal decision-making method with combining qualitative analysis and quantitative analysis. The main calculation process is as follows:

Step1. Ask all members of expert panel to write down the relative importance degree between every two factors in each factor set, and then get fuzzy judgement matrixes.

Step2. Calculate the weight vector of each judgement matrix with eigenvector method, and carry consistency check on these matrices to choose acceptance or rejection for them;

Step3. Use geometrical weighted arithmetic to compute weight vectors of judgement matrix group in terms of multiperson and single rule;

Step4. Work out the final weight vectors of all factor sets.

The basic principle of AHP is to calculate the eigenvector of a judgement matrix to determine the indexes' contribution degree or the weights toward upper indexes. With utilizing the powerful matrix function of the software Matlab6.x to program, the calculation of a judgement matrix’s maximal eigenvalue and corresponding eigenvector are greatly simplified. Finally, the weight vector $W$ is drawn after computation.

**D. Determining Fuzzy Judgment Matrixes of Factor Sets**

1) Determining Single Factor Judgment of a Quantitative Index:

According to the above comment set above, determine five rational ranges of each quantitative index value through consulting experts of college teacher appraisal repeatedly, which is corresponding to the five grades of the comment set. The division basis refers to actual situation of college teacher. As for a positive correlation index, suppose that five ranges of the value of $u_{ik}$, which is corresponding to five grades of the comment set, is respectively as follows: $\alpha_1 < \alpha_2 < \alpha_3 < \alpha_4 < \alpha_5$, and then trigonometric membership function is worked out:

\[
\begin{align*}
    r_1(u_{ik}) &= \begin{cases} 
    1, & u_{ik} \leq \alpha_1 \\
    \frac{(u_{ik} - \alpha_1)}{(\alpha_2 - \alpha_1)}, & \alpha_1 \leq u_{ik} \leq \alpha_2 \\
    0, & \text{others}
    \end{cases}, \\
    r_2(u_{ik}) &= \begin{cases} 
    1, & u_{ik} \geq \alpha_5 \\
    \frac{(u_{ik} - \alpha_5)}{(\alpha_4 - \alpha_5)}, & \alpha_4 \leq u_{ik} \leq \alpha_5 \\
    0, & \text{others}
    \end{cases}, \\
    \cdots & \\
    r_5(u_{ik}) &= \begin{cases} 
    1, & u_{ik} \leq \alpha_1 \\
    \frac{(u_{ik} - \alpha_1)}{(\alpha_2 - \alpha_1)}, & \alpha_1 \leq u_{ik} \leq \alpha_2 \\
    0, & \text{others}
    \end{cases}.
\end{align*}
\]  

Hereinto, with different quantificational indexes, the value of $\alpha_i(i=1,\ldots,5)$ is also different. Curve graph of trigonometric membership function is displayed in Fig. 4.

2) Determining Single Factor Judgment of a Qualitative Index

Firstly, determine the comment criteria according with actual situation of college teacher himself. Then, calculate single factor judgment of qualitative indexes by fuzzy statistical; that is to say, let all members of the expert panel classify $U_{kj}$ into the factor set $U_i$. Then gather the result and count the frequency $v_{mk}$ that $u_{ik}$ belongs to the grade $v_m(m=1,2,3,4,5)$ in $r$, and then $r_{mk}(u_{ik})$ can be calculated:

\[ r_{mk}(u_{ik}) = \frac{W^{mk}}{N} \]  

In the equation, $r_{mk}(u_{ik})$ means the membership degree or the membership function. Thus, single factor judgment of the qualitative index $u_{ik}$ is:

![Fig. 2 Curve graph of trigonometric membership function](image-url)
3) Calculating Fuzzy Judgment Matrix of Level 2 Index $U_k$

After calculating single factor judgment of each index in the factor set $U_k$, set $I \times 5$ matrix, which is fuzzy judgment matrix of $U_k$:

$$
R_k = \begin{bmatrix}
r_{k11} & r_{k12} & r_{k13} & r_{k14} & r_{k15} \\
r_{k21} & r_{k22} & r_{k23} & r_{k24} & r_{k25} \\
\vdots & \vdots & \vdots & \vdots & \vdots \\
r_{kI1} & r_{kI2} & r_{kI3} & r_{kI4} & r_{kI5}
\end{bmatrix}
$$

(4)

And, $r_{ki}(i=1,2,\ldots,I; j=1,2,3,4,5; k=1,2,\ldots,N)$ is single factor judgment of the index $u_{ki}$.

E. Multistage Fuzzy Comprehensive Evaluation

1) Fuzzy Comprehensive Evaluation of Level 2 Index

With fuzzy weighted averaging operator $M \ast \ominus$, carry matrix synthetic operation on fuzzy judgment matrix $R_k$ and its weight vector $A = (a_1, a_2, \ldots, a_I)$. So, the membership vector of $U_k \rightarrow V$ is computed:

$$
\tilde{B}_k = A \ast R_k = (a_{k1} a_{k2} \cdots a_{kI}) = \\
\begin{bmatrix}
a_{k1} & a_{k2} & a_{k3} & a_{k4} & a_{k5} \\
a_{k1} & a_{k2} & a_{k3} & a_{k4} & a_{k5} \\
\vdots & \vdots & \vdots & \vdots & \vdots \\
a_{kI} & a_{kI} & a_{kI} & a_{kI} & a_{kI}
\end{bmatrix}
$$

(5)

Here, fuzzy subset $B_k = (b_{k1}, b_{k2}, \ldots, b_{kI}), (k=1,2,\ldots,N)$ is also the result of fuzzy comprehensive evaluation of level 2 index $U_k$.

2) Fuzzy Comprehensive Evaluation of Level 1 Index

With all fuzzy subset $\tilde{B}_i (k=1,2,\ldots,N)$, fuzzy judgment matrix of the factor set $U = \{U_1, U_2, \ldots, U_I\}$ is got:

$$
R = \begin{bmatrix}
\tilde{B}_1 \\
\tilde{B}_2 \\
\vdots \\
\tilde{B}_I
\end{bmatrix} = \begin{bmatrix}
b_{11} & b_{12} & b_{13} & b_{14} & b_{15} \\
b_{21} & b_{22} & b_{23} & b_{24} & b_{25} \\
\vdots & \vdots & \vdots & \vdots & \vdots \\
b_{I1} & b_{I2} & b_{I3} & b_{I4} & b_{I5}
\end{bmatrix}
$$

In the same way, with the operator $M \ast \ominus$, carry matrix synthetic operation on fuzzy judgment matrix $R$ and its weight vector $A = (a_1, a_2, \ldots, a_I)$. So the membership vector of $U \rightarrow V$ is computed:

$$
\tilde{B} = A \ast R = (a_{11} a_{12} \cdots a_{1I}) = \\
\begin{bmatrix}
h_1 & h_2 & h_3 & h_4 & h_5 \\
h_1 & h_2 & h_3 & h_4 & h_5 \\
\vdots & \vdots & \vdots & \vdots & \vdots \\
h_I & h_I & h_I & h_I & h_I
\end{bmatrix}
$$

(6)

When $\sum b_i \neq 1$, carry on normalization; namely, set

$$
b_i' = b_i / \sum b_i
$$

and then compute: $\tilde{B}' = (b_1', b_2', \ldots, b_I')$

$\tilde{B}'$ is the fuzzy evaluation result of level 1 index $U$.

F. Evaluation result of college level 1 index $U$

Based on above fuzzy comprehensive evaluation of college teacher’s functional factors, the result can be got: $\tilde{B} = (b_1, b_2, b_3, b_4, b_5)$

In order to compare and get calculation more conveniently, the author changes results into the number value type. After consulting the experts, corresponding weight value $f_m (m=1,2,3,4,5)$ is set to each comment set each comment $v_m (m=1,2,3,4,5)$, which denotes the importance of this comment grade. So, the result becomes:

$$
F = B(f_1, f_2, f_3, f_4, f_5)^T
$$

(7)

Then, put $F$ and $C (=100)$ into formula (1), and so the work “value” (performance) of each college teacher is calculated.

In terms of “Value”, the job performance of each college teacher is work out according to the calculation principle above, then sort them from great to small. The V is more close to or equal to 1, indicating the higher teacher performance. Compare the situation of the function (ability) among college teachers respectively, analyze their differences, and find out the key factor of influencing function. Obviously, this analysis is highly useful to take corresponding measures to improve ability of college teacher, also provides the evaluation basis for college teachers performance management.

V. CONCLUSION

The purpose of VE is functional analysis, aiming at improving the object’s value. Logistic systems are similarly a analytical and appraisal problem of system value and the conversion of cost and function. VE is applied to evaluate the logistic centers in terms of value,—combine the cost and function reasonably, in order to increase the value farthest and the efficiency of resources utilization. It can not only standardize the logistics industry but also reach the aim of reducing the cost and increasing the value of logistic centre from the beginning.

However, logistic centre-appraising is influenced by a lot of factors, —some are indefinite and fuzzy, and their structures are also complicated. So it is difficult to obtain scientific and effective result through simple and common methods to appraise logistic centers. While the combination of AHP with multistage fuzzy comprehensive evaluation can sufficiently consider the numerous, uncertain, fuzzy and latent factors that influence the appraisal of logistic centre location in order to improve the decision-making work scientific and reliable, and make VE method of this paper have highly practicability. In addition, although its calculation process is more tedious, computer programming can make the work of logistic centre appraisal just and efficient.

REFERENCES


