College Counselors' Performance Measure System and Fuzzy Measure Analysis Model

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Abstract—**We evaluate the performance of college counselors so as to find ways to promote competence of college counselors as well as teaching quality and core competence of the colleges. The issue of performance measure analysis is discussed and a performance measure system is devised. The indicators are selected based on the multi-perspective and multi-level principle, thus enhancing the reasonability, validity and operability of the measure system. A modified fuzzy measure analysis model is established, and a qualitative approach is combined with a quantitative approach for the fuzzy analysis of various indicators. The membership model is built for fuzzy measure of the performance of college counselors, and the best counselors are found out based on fuzzy membership. Finally, the propose model is verified through a specific case.**

Index Terms—**Colleges and universities, counselor, performance, measure system and model, fuzzy theory, gray system theory**

I. INTRODUCTION

Counselors are important part of the teaching team in colleges and universities. Besides teaching, they also bear the responsibility of student administration. The performance of college counselors directly affects the competence and scientific development of colleges and universities [1-3]. The topic of performance evaluation of college counselors is highlighted after the issuance of Regulations on Constructing the Team of College Counselors and Opinions on Enhancing the Construction of the Team of College Counselors [4-5]. Some constructive progress has been achieved in performance evaluation of college counselors[6-9], but several limitations are summed up: (1) The selection of performance evaluation indicators lacks scientificity, normativity and objectivity; (2) The quantitative model for performance measure analysis of college counselors is not fully formalized, leading to large deviation of the performance evaluation results; (3) The fuzzy indicators are usually measured by specific values, so fuzzy analysis is not realized in real sense. The reliability of the performance measure analysis of college counselors remains to be improved. In this study, we aim to investigate the college counselors' performance measure system through survey and statistics and establish a modified performance measure system. A fuzzy measure model for performance evaluation is proposed by using the gray system theory [10-12] and fuzzy theory [13-15]. This model provides a new pathway for performance evaluation of college counselors.

II. MODIFIED COLLEGE COUNSELORS' PERFORMANCE MEASURE SYSTEM

A scientific performance measure system is the precondition for college counselors' performance evaluation. The performance measure should be implemented jointly by experts, college leaders, teachers and students. Moreover, the selection of measure indicators should be based on the multi-level and multi-perspective principle. Here we construct a modified performance measure system by clustering analysis after soliciting opinions, statistical analysis, questionnaire survey and referring to the performance evaluation system and standards of colleges and universities. This measure system consists of indicators in five aspects, namely, caucus construction, employment guidance, daily affairs handling, professional qualification and occupational quality. The indicators selected for each aspect are shown in Table 1.

III. FUZZY MEASURE MODEL FOR PERFORMANCE EVALUATION OF COLLEGE COUNSELORS

A. Scheme set and indicator set for performance measure analysis

Suppose m college counselors are evaluated and the set P of performance measure analysis schemes is formed:

$$P = \left(P_1, P_2, \mathrm{L}, P_m \right) \tag{1}$$

The above measure indicators constitute the primary indicator set C and the secondary indicator set C_i, i.e.

$$C = \left(C_1, C_2, C_3, C_4, C_5 \right) \tag{2}$$

$$C_i = \left(c_{i1}, c_{i2}, \mathrm{L}, c_{im_i} \right), 1 \le i \le 5 \tag{3}$$

Where m_i is the number of secondary indicators in set C_i.

Thus for m counselors, the performance measure analysis A_{mxn} is obtained for the performance evaluation scheme set based on the above indicators:

$$A_{mxn} = \begin{bmatrix} a_{11} & a_{12} & \mathrm{K} & a_{1n} \\ a_{21} & a_{22} & \mathrm{L} & a_{2n} \\ \mathrm{M} & \mathrm{M} & \mathrm{L} & \mathrm{M} \\ a_{m1} & a_{m2} & \mathrm{L} & a_{mn} \end{bmatrix}$$

(4)

Where a_{ij} is the value of measure indicator j for counselor i.

TABLE I.
COLLEGE COUNSELORS' PERFORMANCE MEASURE SYSTEM

Primary indicator	Secondary indicator	Description
Caucus construction C_1	Party and league member administration capacity c_{11}	This indicator deals with the counselor's ability in implementing caucus construction and cultivating applicants for party membership. Improving the quality of caucus construction is the basic responsibility of counselors in ideological and political aspect
	Cultivation of applicants for party membership c_{12}	
	Ideological and political education c_{13}	
	Ability in organization party branch activities c_{14}	
	Social services and practice c_{15}	
Employment guidance capacity C_2	Career planning for students c_{21}	This indicator reflects counselor's ability and attitude in providing guidance for students' employment. A major responsibility of the counselor is to provide effective assistance in student employment and career planning.
	Validity of employment information published c_{22}	
	Ability in organization employment recruitment conference c_{23}	
	Employment rate c_{24}	
	Cultivation of students' employment ability c_{25}	
	Cultivation of students' professional ethics c_{26}	
Daily affairs handling capacity C_3	Construction of student organizations c_{31}	This indicator reflects counselor's ability in supervising students' daily life and learning activities. To effectively deal with emergency, ensure students' safety, organize diversified scientific activities and enhance the construction of academic atmosphere and examination discipline are the basic responsibilities of the counselors.
	Construction of academic atmosphere and examination discipline c_{32}	
	Administration of students' learning and life c_{33}	
	Safeguard of students' ability and psychological guidance c_{34}	
	Response to emergency events c_{35}	
	Ability in organizing extracurricular activities c_{36}	
	Student administration c_{37}	
	Reward and punishment mechanism c_{38}	
Professional qualification C_4	Educational and teaching methodology c_{41}	This indicator is concerned with the professional qualification of the counselors. Professional qualification of the counselors is the premise for the cultivation of qualified graduates.
	Educational and teaching innovation c_{42}	
	Scientificity of education and teaching c_{43}	
	Qualification ratio of student cultivation c_{44}	
	Standard-reaching rate of scientific research programs c_{45}	
	Standard-reaching rate of academic papers c_{46}	
	Proportion of problem students c_{47}	
	Specialized knowledge c_{48}	
Occupational quality C_5	Sense of responsibility c_{51}	This indicator measures other occupational qualifies that a counselor is supposed to possess. Higher occupational quality of the counselors can help them fulfill their responsibilities more effectively.

B. Normalization of different types of measure indicators

Different measure indicators may have different dimensionality. The fuzzy indicators are usually expressed by intervals. Therefore, the measure indicators are first normalized.

The fuzzy indicators are scored using hundred-mark system. The fuzzy indicators and their meanings are shown in Table II.

TABLE II.
NORMALIZATION OF FUZZY INDICATORS

Indicator		Meaning	
Positive indicator	Negative indicator	Positive indicator	Negative indicator
100	0	Best	Worst
90	10	Very good	Very poor
70	30	Good	Poor
50	50	Moderate	Moderate
30	70	Poor	Good
10	90	Very poor	Very good
0	100	Worst	Best
20,40,60,80		Intermediate between two adjacent states	Intermediate between two states

Let the initial value of measure indicator j for counselor i is $r_{ij} = \left[r_{ij}^{lef}, r_{ij}^{rig} \right]$, then the value after normalization is $v_{ij} = \left[v_{ij}^{lef}, v_{ij}^{rig} \right]$.

The formula for the normalization of cost-related measure indicator j is

$$v_{ij}^{lef} = \frac{\max_{1 \le i \le m}\left(v_{ij}^{rig}\right) - r_{ij}^{rig}}{\max_{1 \le i \le m}\left(v_{ij}^{rig}\right) - \min_{1 \le i \le m}\left(r_{ij}^{lef}\right)} \quad (5)$$

$$v_{ij}^{rig} = \frac{\max_{1 \le i \le m}\left(v_{ij}^{rig}\right) - r_{ij}^{lef}}{\max_{1 \le i \le m}\left(v_{ij}^{rig}\right) - \min_{1 \le i \le m}\left(r_{ij}^{lef}\right)} \quad (6)$$

The formula for the normalization of benefit-related measure indicator j is

$$v_{ij}^{lef} = \frac{r_{ij}^{lef} - \min_{1 \le i \le m}\left(r_{ij}^{lef}\right)}{\max_{1 \le i \le m}\left(v_{ij}^{rig}\right) - \min_{1 \le i \le m}\left(r_{ij}^{lef}\right)} \quad (7)$$

$$v_{ij}^{rig} = \frac{r_{ij}^{rig} - \min_{1 \le i \le m}\left(r_{ij}^{lef}\right)}{\max_{1 \le i \le m}\left(v_{ij}^{rig}\right) - \min_{1 \le i \le m}\left(r_{ij}^{lef}\right)} \quad (8)$$

The formula for the normalization of appropriateness-related measure indicator j is

$$v_{ij}^{lef} = \min\left\{ 1 - \frac{\left| r_{ij}^{lef} - r_j^o \right|}{\max\left\{ \left| \max\left(v_{ij}^{rig}\right) - r_j^o \right|, \left| \min\left(r_{ij}^{lef}\right) - r_j^o \right| \right\}}, 1 - \frac{\left| v_{ij}^{rig} - r_j^o \right|}{\max\left\{ \left| \max\left(v_{ij}^{rig}\right) - r_j^o \right|, \left| \min\left(r_{ij}^{lef}\right) - r_j^o \right| \right\}} \right\} \quad (9)$$

$$v_{ij}^{rig} = \max\left\{ 1 - \frac{\left| r_{ij}^{lef} - r_j^o \right|}{\max\left\{ \left| \max_{1 \le i \le m}\left(v_{ij}^{rig}\right) - r_j^o \right|, \left| \min\left(r_{ij}^{lef}\right) - r_j^o \right| \right\}}, 1 - \frac{\left| v_{ij}^{rig} - r_j^o \right|}{\max\left\{ \left| \max_{1 \le i \le m}\left(v_{ij}^{rig}\right) - r_j^o \right|, \left| \min\left(r_{ij}^{lef}\right) - r_j^o \right| \right\}} \right\} \quad (10)$$

C. Fuzzy analysis model for the measure indicators

All measure indicators have uniform dimensionality after normalization. Let the normalized value of measure indicator j for counselor i be $v_{ij} = \left[v_{ij}^{lef}, v_{ij}^{rig} \right]$, then the fuzzy ideal value v_{oj} for indicator j is calculated as

$$v_{oj} = \left[v_{oj}^{lef}, v_{oj}^{rig} \right] = \left[\max_{1 \le i \le m}\left(v_{ij}^{lef}\right), \max_{1 \le i \le m}\left(v_{ij}^{rig}\right) \right] \quad (11)$$

The fuzzy ideal sequence V_o of measure indicators is formed as follows for the measure analysis scheme set:

$$V_o = \left\{ v_{o1}, v_{o2}, L, v_{oj}, L, v_{on} \right\} \quad (12)$$

The fuzzy distance K_{ij} between the measure indicator j and the fuzzy ideal value v_{oj} for counselor i is calculated as follows:

$$K_{ij} = \sqrt[T]{\frac{\left| v_{oj}^{lef} - v_{ij}^{lef} \right|^T + \left| v_{oj}^{rig} - v_{ij}^{rig} \right|^T}{2}} \quad (13)$$

Generally, $T = 2$. Fuzzy distance K_{ij} is the Euclidean distance, and the above formula becomes

$$K_{ij} = \sqrt{\frac{\left| v_{oj}^{lef} - v_{ij}^{lef} \right|^2 + \left| v_{oj}^{rig} - v_{ij}^{rig} \right|^2}{2}} \quad (14)$$

With fuzzy distance K_{ij} obtained, the maximum fuzzy distance DIS_{max} and the fuzzy distance DIS_{min} of performance measure indicator are calculated for the measure analysis scheme set with respect to the measure indicator set:

$$DIS_{max} = \max_{1 \le i \le m} \max_{1 \le j \le n}\left(K_{ij}\right) \quad (15)$$

$$DIS_{min} = \min_{1 \le i \le m} \min_{1 \le j \le n}\left(K_{ij}\right) \quad (16)$$

Thus the gray relevance coefficient δ_{ij} between measure indicator j and fuzzy ideal value v_{oj} for counselor i is expressed as

$$\delta_{ij} = \frac{DIS_{min} + \beta * DIS_{max}}{\left| K_{ij} \right| + \beta * DIS_{max}} \quad (17)$$

Where ρ is the distinguishing coefficient in gray relevance analysis, $\rho \in [0,1]$ and $\rho = 0.5$.

Different measure indicators may have different weights. If the weight of measure indicator j is w_j, the weighted gray relevance ψ_i between the measure indica-

tor and the fuzzy ideal sequence V_o of the indicators is expressed as

$$\psi_i = \sum_{j=1}^{n}\left(w_j * \delta_{ij}\right) \tag{18}$$

According to the principle of selecting the best in decision-making analysis, there is

$$\psi_{max} = \max\left(\psi_1, \psi_2, L, \psi_m\right) = \psi_t \tag{19}$$

Thus counselor t has the best performance.

Similarly, let the threshold of the performance measure be ψ_0. If

$$\psi_t \geq \psi_0 \tag{20}$$

Then counselor t is qualified.

Further, the performance of counselor can be classified into different grades based on gray relevance ψ_t using threshold ψ_0. For example, if the gray relevance ψ_t falls into the interval corresponding to grade s, then this counselor is considered belonging to the grade s.

IV. CASE STUDY AND MODEL VERIFICATION

The yearly performance evaluation data of counselors in charge of undergraduate class in a provincial-level key college are used to verify the proposed measure system. Combining the opinions of the leaders of the school and the experts, the raw data of performance measure analysis are obtained by scoring and statistical analysis (Table III).

Using the normalization formulae and the fuzzy distance formula proposed in this article, the fuzzy distance of different indicators for each counselor is calculated, as shown in Table IV.

The gray relevance coefficients are calculated for each measure indicator using the gray relevance model, with the results given in Table V.

Thus the sequence of gray relevance for each counselor is obtained as $\psi = \left(0.6523, 0.9234, 0.6788, 0.6394\right)$. It can be seen that counselor B has the best performance. If the threshold is set as 0.60, then all counselors are qualified in this year. This is consistent with the actual performance evaluation result by the school.

V. CONCLUSION

This article proposes a college counselors' performance measure system, based on which the fuzzy measure model is established. After normalization of the measure indicators, the fuzzy distance model and the gray relevance model are constructed for counselors' performance evaluation. The performance of college counselors working at a specific university is then evaluated based on comprehensive gray relevance. The result shows that the model is reliable in performance evaluation of college counselors.

TABLE III.
RAW DATA OF PERFORMANCE MEASURE ANALYSIS

Primary indicator	Weight	Secondary indicator	Weight	Counselor			
				A	B	C	D
C_1	0.15	c_{11}	0.25	80-90	90-100	90-100	80-90
		c_{12}	0.10	90-100	90-100	70-80	70-80
		c_{13}	0.25	90-100	80-85	90-100	80-85
		c_{14}	0.20	75-80	90-100	75-80	80-85
		c_{15}	0.20	50-60	90-100	70-80	50-60
C_2	0.10	c_{21}	0.15	40-50	90-100	50-60	50-60
		c_{22}	0.10	90-100	90-100	90-100	90-100
		c_{23}	0.15	80-90	80-90	90-100	70-80
		c_{24}	0.25	80-90	90-100	50-60	50-60
		c_{25}	0.20	50-60	90-100	80-90	50-60
		c_{26}	0.20	80-90	80-90	90-100	90-100
C_3	0.25	c_{31}	0.15	90-100	70-80	90-100	70-80
		c_{32}	0.20	80-90	90-100	50-60	90-100
		c_{33}	0.15	80-90	90-100	90-100	70-80
		c_{34}	0.10	80-90	80-90	90-100	50-60
		c_{35}	0.10	70-80	90-100	70-80	90-100
		c_{36}	0.10	90-100	70-80	90-10	50-60
		c_{37}	0.15	50-60	90-100	50-60	80-90
		c_{38}	0.05	80-90	90-100	50-60	90-100
C_4	0.30	c_{41}	0.10	80-90	90-100	90-100	80-90
		c_{42}	0.10	80-90	90-100	80-90	80-90
		c_{43}	0.10	80-90	90-100	80-90	80-90
		c_{44}	0.15	0.85	1.00	0.80	0.85
		c_{45}	0.10	0.60	1.00	0.40	0.60
		c_{46}	0.10	0.60	1.00	0.40	0.60
		c_{47}	0.15	0.05	0	0.05	0
		c_{48}	0.20	80-90	90-100	80-90	80-90
C_5	0.20	c_{51}	0.15	80-90	90-100	70-80	90-100
		c_{52}	0.15	80-90	90-100	80-90	90-100
		c_{53}	0.15	70-80	90-100	50-60	90-100
		c_{54}	0.15	80-90	70-80	90-100	90-100
		c_{55}	0.25	90-100	90-100	80-90	70-80
		c_{56}	0.15	80-90	90-100	70-80	80-90

TABLE IV.
FUZZY DISTANCE FOR EACH COUNSELOR

Secondary indicator	Counselor			
	A	B	C	D
c_{11}	0.100	0	0	0.100
c_{12}	0	0	0.200	0.200
c_{13}	0	0.127	0	0.127
c_{14}	0.177	0	0.177	0.127
c_{15}	0.400	0	0.200	0.400
c_{21}	0.500	0	0.400	0.400
c_{22}	0.100	0	0	0
c_{23}	0.100	0.100	0.100	0
c_{24}	0.100	0	0.400	0.400
c_{25}	0.400	0	0.100	0.400
c_{26}	0.100	0.100	0	0
c_{31}	0	0.200	0	0.200
c_{32}	0.100	0	0.400	0.100
c_{33}	0.100	0	0	0.200
c_{34}	0.100	0.100	0	0.400
c_{35}	0.200	0	0.200	0
c_{36}	0	0.200	0.200	0.400
c_{37}	0.400	0	0.400	0.100
c_{38}	0.100	0	0.400	0
c_{41}	0.100	0	0	0.100
c_{42}	0.100	0	0.100	0.100
c_{43}	0.100	0	0.100	0.100
c_{44}	0.15	0	0.20	0.15
c_{45}	0.40	0	0.60	0.40
c_{46}	0.40	0	0.60	0.40
c_{47}	0.05	0	0.05	0
c_{48}	0.100	0	0.100	0.100
c_{51}	0.100	0	0.200	0
c_{52}	0.100	0	0.100	0
c_{53}	0.200	0	0.400	0
c_{54}	0.100	0.200	0	0
c_{55}	0	0	0.100	0.200
c_{56}	0.100	0	0.200	0.100

TABLE V.
GRAY RELEVANCE COEFFICIENTS FOR DIFFERENT COUNSELORS

Secondary indicator	Counselor			
	A	B	C	D
c_{11}	0.1668	0.250	0.250	0.1668
c_{12}	0.100	0.100	0.050	0.050
c_{13}	0.250	0.1543	0.250	0.1543
c_{14}	0.1062	0.200	0.1062	0.1234
c_{15}	0.0666	0.200	0.100	0.0666
c_{21}	0.0429	0.150	0.050	0.050
c_{22}	0.0667	0.100	0.100	0.100
c_{23}	0.100	0.100	0.1001	0.150
c_{24}	0.1668	0.250	0.0833	0.0833
c_{25}	0.0666	0.200	0.1234	0.0666
c_{26}	0.1234	0.1234	0.200	0.200
c_{31}	0.150	0.075	0.150	0.075
c_{32}	0.1234	0.200	0.0666	0.1234
c_{33}	0.1001	0.150	0.150	0.075
c_{34}	0.0667	0.0667	0.1000	0.0333
c_{35}	0.050	0.100	0.050	0.100
c_{36}	0.100	0.050	0.0500	0.0333
c_{37}	0.050	0.150	0.050	0.100
c_{38}	0.0334	0.050	0.1665	0.050
c_{41}	0.0667	0.100	0.100	0.0667
c_{42}	0.0667	0.100	0.0667	0.0667
c_{43}	0.0667	0.100	0.0667	0.0667
c_{44}	0.0857	0.150	0.075	0.0857
c_{45}	0.0333	0.100	0.0250	0.0333
c_{46}	0.0333	0.100	0.0250	0.0333
c_{47}	0.120	0.150	0.120	0.150
c_{48}	0.1234	0.200	0.1234	0.1234
c_{51}	0.1001	0.150	0.075	0.150
c_{52}	0.1001	0.150	0.1001	0.150
c_{53}	0.075	0.150	0.050	0.150
c_{54}	0.1001	0.075	0.150	0.150
c_{55}	0.250	0.250	0.1668	0.075
c_{56}	0.1001	0.150	0.075	0.1001

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