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An empirical study on the optimization of university management evaluation system based on the hierarchical analysis method

Jiawei Chen[1,*]
[1] Discipline Inspection Commission and Office of Resident Supervisory Commissioner, Jiangsu Vocational Institute of Commerce, Nanjing, Jiangsu, 210000, China
Corresponding authors: (e-mail: 18833145229@163.com).

Abstract In order to be able to better assess the overall quality of the school's overall educational management in a comprehensive way, colleges and universities need to conduct a comprehensive evaluation of each class. In this paper, the comprehensive evaluation model of university management quality was constructed by combining the network hierarchy analysis method (ANP) and the material element topologizable theory, and the quality of university education management was dynamically evaluated by calculating the correlation function and correlation degree of the constructed evaluation index system. The sensitivity of the 16 index factors in the model was analyzed in detail by using SD software, and the results of the sensitivity analysis combined with the weight values made a comprehensive analysis of the importance of the indexes, which provided a certain basis for the evaluation of university management. And a university class A to be evaluated is selected as a sample, and its evaluation grade is excellent by using the model of this paper, which is consistent with the results of the class in the comprehensive evaluation of the previous semester. It shows that the method can not only reduce the subjective human factors, but also simple calculation and reliable results, which provides a strong support for colleges and universities to effectively improve teaching quality management.

Index Terms network hierarchy analysis, material element topologizable theory, university management, evaluation system

I. Introduction

With the continuous progress and development of society, the importance of higher education has become increasingly prominent. As an important platform for cultivating the future talents of the country, it is vital that the management system of higher education is constantly updated, and its management is carried out throughout the work of talent cultivation, scientific research, social service, cultural dissemination and scientific research and innovation [1], [2]. Although the work of higher education has been carried out for a long time, the management evaluation of colleges and universities has a big gap with the management evaluation of the world's leading-edge schools both in theoretical research and practice [3]. Nowadays, the management evaluation of colleges and universities is seriously homogenized, and more than half of the colleges and universities adopt the same set of evaluation system, and the so-called "school running characteristics" is heading towards ambiguous development, which results in the lack of characteristics of colleges and universities and their high-quality development is hindered [4]. In addition, the management evaluation system of colleges and universities has encountered many challenges in the process of practice. Talent cultivation, scientific research and innovation, social service and other work in the evaluation of education management shows that the degree of investment in scientific research and the rate of conversion of results of the two evaluation indicators do not match, always more than the former, the evaluation system of the weight of the indicators is unbalanced. And the evaluation system indicators and their weight distribution is often specified, in the dynamic environment of education, this type of evaluation system is difficult to adjust the dynamic needs of different backgrounds and educational needs. And the low efficiency of mutual circulation and utilization of data in various tasks does not provide advantages in comprehensive or all-round evaluation tasks [5]-[8]. How to improve the quality of higher education through the evaluation of university management and ensure that universities do not deviate from the preset goals is an important part of higher education management. Hierarchical analysis is a combination of qualitative and quantitative, systematic and hierarchical analysis method, which breaks down a complex decision-making problem into constituent factors and decomposes them according to their interrelationships into a hierarchical structure that includes levels of objectives, guidelines, and programs, and then applies the method of two-by-two comparisons to determine the relative importance of decision-making programs. Due to the practicality and effectiveness of hierarchical analysis in dealing with complex decision-making problems, in the field of education, it realizes several evaluation tasks, such as financial risk, facility construction, teaching performance, and teaching quality [9]-[12].

Combined with related research, this paper designs a college management evaluation system containing 2 primary indicators of ideological education and ability cultivation, 4 secondary indicators at the first level, and 16 tertiary indicators, and realizes the weight calculation and practical application of this evaluation system by combining the network hierarchy analysis method and the theory of material element topology. In order to verify the effectiveness of the proposed evaluation model, this paper analyzes the sensitivity of the evaluation index factors in the model and selects sample classes for model application.

II. Evaluation model of university management based on ANP-objective elemental topable theory

In this paper, we optimize the index system, index weights and calculation methods of previous evaluation models for the evaluation of university management, and establish ANP-objective elemental topological model applicable to the evaluation of university management.

II. A. Establishment of evaluation index system for university management

The effectiveness of management work in colleges and universities can be reflected by the effectiveness of counselor education work. Therefore, this paper is based on the effectiveness of counselor education work to build college management evaluation index system. The effectiveness of counselor education work can be evaluated through the effect of students' ideological education and ability cultivation. Ideological education includes the cultivation effect of students' ideological and political performance and moral quality. Ability cultivation mainly refers to the counselors help to improve the comprehensive ability and comprehensive quality of college students by creating external conditions and carrying out various forms of educational activities. According to the survey data on 620 counselors in 50 colleges and universities, the top four indicators for evaluating the effectiveness of counselors' work are students' ideological and political literacy, moral quality, comprehensive ability and comprehensive quality.

In view of the effect of the educational function, the evaluation index system of university management is established as shown in Table 1. First-level indicator set: M={A, B}, second-level indicator set: A={A1, A2}, B={B1, B2}. Tertiary indicator set: A1={A11, A12, A13, A14}, A2={A21, A22, A23, A24}, B1={B11, B12, B13, B14}, B2={B21, B22, B23, B24}.

Table 1: Evaluation index system for university management

First-level indicator	Secondary Indicators	Symbol	Third-level indicators
Ideological education (A)	Ideological and political performance (A1)	A11	The manifestation of one's "three outlooks"
		A12	Social responsibility
		A13	Loyalty to the Party
		A14	The degree of recognition of communist ideals
	Moral quality (A2)	A21	Punish evil and promote good, and distinguish right from wrong
		A22	Behavioral habit performance
		A23	The integrity in dealing with people and matters
		A24	Dedication spirit
Ability cultivation (B)	Comprehensive ability (B1)	B11	Interpersonal communication and coordination skills
		B12	Planning and organizing ability
		B13	The ability of written and verbal expression
		B14	Teamwork ability
	Comprehensive quality (B2)	B21	Physical fitness
		B22	Psychological quality
		B23	Professional quality
		B24	Humanistic and artistic cultivation

In terms of the qualitative rubric set, this paper divides the rubric set into four grades P={excellent, good, qualified, unqualified} according to the evaluation principle of the qualitativeization of educational indicators, and each of the four grades specifies different evaluation conditions. “Excellent” requires students to have outstanding performance in thought and ability, and to have certain influence in the society. “Good” requires students to have certain achievements in thought and ability, and to play a certain role as a model and exemplary role model in the school. “Pass” means that students are basically able to fulfill the requirements set out in the indicators and actively participate in various activities within the school. “Unqualified” means that the student is in violation of the indicators in terms of thought and behavior, and is separated from the activity group.

II. B.ANP model

II. B. 1) ANP Basic Model

The basic model of Analytic Network Hierarchy (ANP) is a complex multi-criteria decision-making method developed on the basis of Analytic Hierarchy Process (AHP), which is used to solve the decision-making problems with multiple interdependent and mutual influencing factors, and the features of the computational method of ANP model include hierarchical structure, network relationship, weight calculation, pairwise comparison matrix and layer-by-layer calculation, etc. These features make the ANP model an an effective multi-criteria decision analysis method for college management work effectiveness evaluation problems [13], [14].

II. B. 2) ANP calculation steps

Step1: Construct network structure diagram

Firstly, establish the relationship diagram of first-level indicators and the comprehensive impact matrix adjusted by the threshold survey value, and then combine it with the actual situation of university management to construct and prepare the ANP network diagram, which emphasizes the mutual influence relationship between indicators, and through the establishment of the network diagram, it can be very clear to find out the connection between each indicator and distinguish the impact as positive or negative. The construction of the ANP network diagram requires comprehensive consideration of the definition of the problem, the hierarchical structure, the relationship between the elements, the determination of the weights, validation and adjustment, etc., in order to ensure that an accurate and reliable evaluation model is finally obtained.

Step2: Questionnaire design and processing

According to the characteristics of the network hierarchical analysis method and the connection between each evaluation index to develop the corresponding questionnaire, according to the requirements of the network structure, you experts need to compare the importance of the indicators at all levels, the expert staff surveyed need to use the way of the scale method to compare the importance of the two indicators between the judgment. When the scale a_{ij} of element i to j is 1, 3, 5, 7 and 9, it means that the former is equally important, slightly important, important, very important and extremely important than the latter, respectively, and the importance when the scale is 2, 4, 6 and 8 is between the two odd scales before and after, and when the scale is the inverse of 1~9, i.e., $1/a_{ij}$, then the elements will be compared in reverse. In order to facilitate the judgment of experts, the questionnaire design adopts the same judgment scale representation method as Super Decision software.

Step3: Construct judgment matrix

The first-level indicators are defined as the network level indicator set $C_1, C_2, \cdots, C_i (i=1,2,\ldots,n)$, each indicator set contains $C_{i1}, C_{i2}, \cdots, C_{in} (i=1,2,\ldots,n)$, and the indicator pairs C_{ij} of C_i in the indicator set are compared with each other to construct the judgment matrix.

The results of the questionnaire are converted into matrix form, which is used to describe the relative importance between indicators, as shown in equation (1):

$$C=[C_{ij}]_{n\times n}=\begin{bmatrix} 1 & C_{12} & \ldots & C_{1n} \\ C_{21} & 1 & \ldots & C_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ C_{n1} & C_{n2} & \ldots & 1 \end{bmatrix} \tag{1}$$

where $C_{ij}=1/C_{ji}(i=1,2,...,n)$, i,j is the indicator number of each level.

In the process of processing the results, it is necessary to use the arithmetic average method to integrate the preferences of the experts, in order to achieve the comprehensive consideration of the experts on the same indicator of the main perception of the data to control the data in a relatively balanced range, so as to reduce the scope of the data deviation.

Step4: Consistency testing

From the operation of the matrix can be known, if there exists a set of numbers $\lambda_1, \lambda_2, \lambda_3, ..., \lambda_n$ and a set of vectors ω to meet the formula (2), then we can say that this set of numbers $\lambda_1, \lambda_2, \lambda_3, ..., \lambda_n$ for the corresponding eigenvalues of the matrix, the vector ω for the eigenvectors of the matrix:

$$C\omega = \lambda\omega \tag{2}$$

In order to ensure the uniformity and consistency of the calculation results, and to ensure that the questionnaire respondents' judgments have a consistent result, the consistency of the judgment matrix needs to be verified after the eigenvalues have been calculated, and the CI and CR values are calculated by using equations (3) to (4):

$$CI = (\lambda_{\max} - n)/(n-1) \tag{3}$$

$$CR = CI / RI \tag{4}$$

where: CI represents the consistency index, CR value represents the consistency ratio, n represents the order of each judgment matrix. RI is the average random consistency indicator, the size of which is a fixed value, depending on the judgment matrix order, and the specific value of RI is shown in Table 2. $\lambda_{\max}$ is the maximum eigenvalue calculated by formula (2).

Table 2: Average random consistency index

Order	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.52	0.89	1.12	1.26	1.36	1.41	1.46	1.49

As can be seen from the formula and the definition of each indicator, the consistency indicator CI determines the consistency ratio CR. $CR > 0.1$, which indicates that the questionnaire respondents' judgments are inconsistent, the judgment matrix consistency does not meet the requirements and is unacceptable. $CR \leq 0.1$, indicates that the questionnaire respondents' judgment is basically consistent, the judgment matrix consistency is good, meets the requirements, and is acceptable.

Step5: Construct unweighted supermatrix

In accordance with the construction method of judgment matrix above, build the judgment know matrix of mutual comparison for C_{ij} in the C_i indicator set, and calculate its normalized eigenvectors $(\omega_{i1}^{(g)}, \omega_{i2}^{(g)}, \omega_{i3}^{(g)}, ..., \omega_{in}^{(g)})$, and integrate each of the resulting eigenvectors into a comprehensive matrix, which becomes the unweighted supermatrix W_s.

Step6: Construct the weighted supermatrix

Taking C_{ij} of the set of C_i indicators one by one as a criterion, compare the other indicator sets with this indicator set with each other, build judgment matrix B_j, and calculate normalized eigenvectors $\eta_j = (b_1, b_2, b_3, ..., b_n)$, and integrate all calculated normalized vectors to form a weighted matrix:

$$B_s = [\eta_1, \eta_2, \eta_3, ...\eta_n] = \begin{bmatrix} b_{11} & b_{12} & ... & b_{1n} \\ b_{21} & b_{22} & ... & b_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ b_{n1} & b_{n2} & ... & b_{nn} \end{bmatrix} \tag{5}$$

Then, the weighted supermatrix W_{ss} can be computed by multiplying the full matrix B_s with the unweighted matrix W_s, and it can be found that its vertical sums are all 1, which is also called the column random matrix:

$$W_{ss} = W_s B_s \tag{6}$$

Step7: Solve the limit supermatrix

The indicators in the constructed network structure diagram are all interrelated and interact with each other. There are both direct and indirect influences between indicators. For example, the calculation of the weighted supermatrix W_{ss} in the indicator ω_{ij} reflects the first step of the degree of dominance of the i indicators on the j indicators, W_{ss}^2 in the indicator $\sum_{i=1}^{n} W_{ik} W_{kj}$ reflects the second step of the degree of dominance of the i indicators on the j indicators, and so on W_n^t, we can learn that when t is close to positive infinity, that is:

$$W_{ss}^{\infty} = \lim W_{ss}^{t} \tag{7}$$

Then the j th column of W_{ss}^{∞} is the limit sequence vector of each indicator within the network layer for j indicators.

Through the above seven steps, the weight sizes of all indicators of the established network structure graph can be found, i.e., the global weight size of each indicator.

II. C.Optimization of the computational procedure of the material element topology theory

The specific arithmetic process of the object element topable theory is as follows [15]:

(1) Evaluation index normalization processing

Before carrying out the evaluation of physical elements, we need to determine the measured data of each indicator and the evaluation level division. Because there are many evaluation indicators of university management, and the unit of measurement of different indicators, the range of values, and the range of values of different evaluation levels are also different. Therefore, it is necessary to normalize the measured data of each evaluation index and the range of evaluation levels. The processing is shown in equations (8) to (9):

$$v_{sg} = \frac{v_s - (v_s)_{\min}}{(v_s)_{\max} - (v_s)_{\min}} \tag{8}$$

$$v_{sg} = \frac{(v_s)_{\max} - v_s}{(v_s)_{\max} - (v_s)_{\min}} \tag{9}$$

For the evaluation indicators whose quantitative value is bigger and better we choose formula (8) for processing, and for the indicators whose quantitative value is smaller and better we choose formula (9) for processing.

(2) Determination of evaluation elements

The object element to be evaluated is generally composed of three parts: things, features and quantitative value, which are represented by capital letters N, C and V respectively. In life, most things have more than one feature, and each feature has its corresponding quantitative value, so we can use formula (10) to express the evaluation object element:

$$R = \begin{bmatrix} N & c_1 & v_{j1} \\ & c_2 & v_{j/2} \\ & \vdots & \vdots \\ & c_n & v_{jn} \end{bmatrix} \tag{10}$$

When applying Eq. (10) to the evaluation of university management, R refers to the object element of university management evaluation, N refers to the university management work evaluated, c_i refers to the i th indicator in the evaluation system of this university management, and v_{ji} refers to the quantitative value of the i th indicator.

(3) Determine the classical domain object element

According to the relevant specifications of the range of values for the grade of each evaluation indicator to establish the classical domain object element as shown in Equation (11):

$$R_k = \begin{bmatrix} N_{ki} & c_1 & v_{ki1} \\ & c_2 & v_{ki2} \\ & \vdots & \vdots \\ & c_n & v_{kin} \end{bmatrix} = \begin{bmatrix} N_{ki} & c_1 & (a_{ki1}, b_{ki1}) \\ & c_2 & (a_{ki2}, b_{ki2}) \\ & \vdots & \vdots \\ & c_n & (a_{kin}, b_{kin}) \end{bmatrix} \tag{11}$$

where N_{ki} is the reliability of the evaluation grade of i in the evaluation of university management, c_j is the j th evaluation indicator in the evaluation system, v_{kij} is the range of values of the j th indicator evaluation grade of i, and a_{kij} is the minimum value of b_{kij} is the maximum value.

(4) Determine the section domain object element

According to the value range of each evaluation index to determine the section domain object element is shown in Equation (12):

$$R_\rho = \begin{bmatrix} N_\rho & c_1 & v_{\rho 1} \\ & c_2 & v_{\rho 2} \\ & \vdots & \vdots \\ & c_n & v_{\rho n} \end{bmatrix} = \begin{bmatrix} N_\rho & c_1 & (a_{\rho 1}, b_{\rho 1}) \\ & c_2 & (a_{\rho 2}, b_{\rho 2}) \\ & \vdots & \vdots \\ & c_n & (a_{\rho n}, b_{\rho n}) \end{bmatrix} \tag{12}$$

where v_{pn} is the range of values of the n th evaluation indicator measure.

(5) Determination of the object element to be evaluated

According to the actual quantitative value of each evaluation index to establish the object element to be evaluated as shown in Equation (13):

$$R_d = \begin{bmatrix} N_d & c_1 & x_{d1} \\ & c_2 & x_{d2} \\ & \vdots & \vdots \\ & c_n & x_{dn} \end{bmatrix} \tag{13}$$

where R_d refers to the object element to be evaluated, N_d refers to the management work of the university to be evaluated, c_i refers to the evaluation indicators in the evaluation system, and x_{di} refers to the quantitative value of the i th evaluation indicator.

(6) Calculate the correlation function of each evaluation indicator

Before calculating the correlation function of each evaluation indicator, we first need to determine the size of the distance, that is, to calculate the distance of the quantitative value of each evaluation indicator from the range of the value of each evaluation level, and the counting formula of the distance of the classical domain and the section domain is shown in the formulas (14)~(15):

$$\rho(x_{dj}, v_{kij}) = \left| x_{dj} - \frac{1}{2}(a_{kij} + b_{kij}) \right| - \frac{1}{2}(b_{kij} - a_{kij}) \tag{14}$$

$$\rho(x_{dj}, v_\rho) = \left| x_{dj} - \frac{1}{2}(a_{\rho i} + b_{\rho i}) \right| - \frac{1}{2}(b_{\rho i} - a_{\rho i}) \tag{15}$$

The correlation function of the evaluation indicators is calculated as shown in equation (16):

$$k_{zb}(x_{dj}) = \begin{cases} \dfrac{\rho(x_{dj}, v_{kij})}{\rho(x_{dj}, v_{\rho i}) - \rho(x_{dj}, v_{kij})} & x_{dj} \notin v_{kij} \\ \dfrac{-\rho(x_{dj}, v_{kij})}{|v_{kij}|} & x_{dj} \in v_{kij} \end{cases} \tag{16}$$

(7) Calculate the correlation function of comprehensive evaluation of university management

On the basis of the correlation function calculated for each evaluation index on each evaluation level, the correlation function for comprehensive evaluation of university management can be calculated by combining the weights of each index. The calculation formula is shown in formula (17):

$$M_{zj} = \sum_{j=1}^{n} \omega_j k_{zb}(x_{dj}) \tag{17}$$

The formula for calculating the management evaluation rating of higher education institutions is shown in formula (18):

$$M_{di} = \max M_{zj} \tag{18}$$

From formula (18), the evaluation grade of university management is i .

III. Evaluation of university management based on ANP-objective elemental topable modeling

This chapter analyzes the sensitivity of the ANP-objective metrics topable college management evaluation model on the basis of the weights of college management evaluation indexes, and makes practical applications of the model.

III. A. Results of the calculation of the weights of the indicators of the evaluation system

In this paper, the judgment matrices of university management index elements made by experts are inputted into SD software, and after checking the consistency ratio, the ANP model constructed by SD software can output the limit supermatrix, and each row in the matrix is the corresponding internal weight of the element. Finally, combining the external weights and internal weights of all elements, the final weights of all evaluation indicators of university management can be outputted through SD, and the weights of each evaluation indicator element group of university management for the corresponding criterion layer can be derived, and the results of the obtained indicator weights are shown in Table 3.

Table 3: Weights of evaluation indicators for university management

First-level indicator	Weight	Secondary Indicators	Weight	Third-level indicators	Weight
A	0.500	A1	0.561	A11	0.251
				A12	0.247
				A13	0.174
				A14	0.328
		A2	0.439	A21	0.245
				A22	0.253
				A23	0.293
				A24	0.209
B	0.500	B1	0.607	B11	0.294
				B12	0.197
				B13	0.264
				B14	0.245
		B2	0.393	B21	0.197
				B22	0.278
				B23	0.405
				B24	0.120

III. B. Model sensitivity analysis

In this paper, we will use the sensitivity analysis function of SD software to analyze the 16 influencing factors in the 4 criteria affecting university management as independent variables, and analyze the corresponding changes in the evaluation scheme when the weights of these 16 indicators change, so as to further analyze the influencing factors affecting the effectiveness of university management.

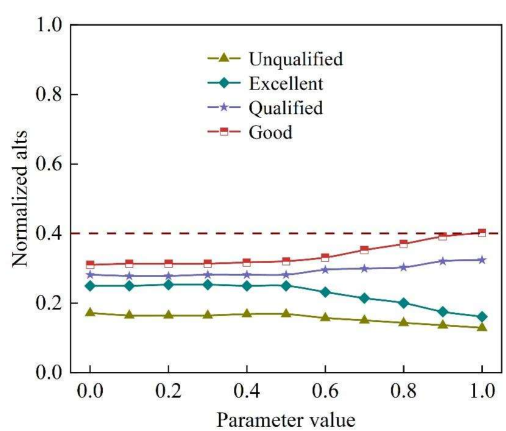

Figure 1: The sensitivity illustration with A11 as the independent variable

(1) Select the "three views" performance A11 as an independent experimental variable, so that its weight from 0 to 1, the step size of 0.1, by the SD software output its sensitivity analysis results shown in Figure 1. The analysis shows that when the weight of the "three views" performance A11 gradually increases, the evaluation results will be nonlinear changes, when the weight of A11 is greater than 0.5, the weight of good and qualified two rating levels

will be nonlinearly increasing, the weight of unqualified and excellent levels will be nonlinearly decreasing, but the weight of the four rating levels in the importance of the ranking However, the order of importance of the weights of the four grades remains unchanged, and the response to the good grade is still the first one, with the maximum weight of 0.40. Therefore, the change of the weights of A11 of the "three views" performance does not have a high sensitivity to the evaluation results.

(2) Choose social responsibility A12 as an independent experimental variable, the sensitivity analysis results are shown in Figure 2, when the weight of social responsibility A12 gradually increases, its evaluation results will be non-linear changes, when the weight of A12 is greater than 0.5, the proportion of qualified and unqualified comment grade is linearly increasing, while the proportion of good and excellent grade will be linearly decreasing. When the weight of A12 reaches 0.6, the evaluation result changes from good to qualified, and the weight of qualified grade is maximum 0.40. When the weight of A12 is 0-0.85, the evaluation result of unqualified and excellent is least likely to occur, and when it is greater than 0.85, the evaluation result of good and excellent is least likely to occur. Therefore, the sensitivity of the change in the A12 weights of social responsibility to the evaluation results is high.

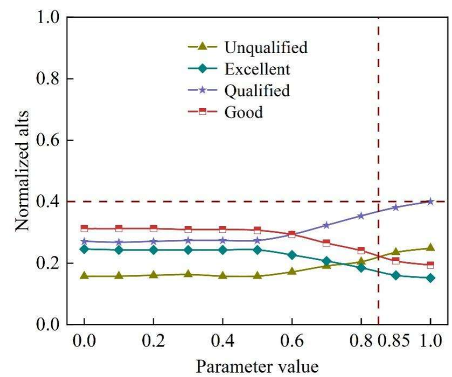

Figure 2: The sensitivity illustration with A12 as the independent variable

(3) Select the loyalty to the party A13 as an independent experimental variable, sensitivity analysis results are shown in Figure 3, when the weight of A13 gradually increases, its evaluation results will be non-linear changes, when the weight of A13 is greater than 0.5, the weight of good and qualified evaluation grade will be non-linear increase, the weight of unqualified and excellent evaluation grade will be non-linear decrease, but the weight importance of the four evaluation grades ordering remains unchanged, still responding first to the good grade, with a maximum weight of 0.40, and always least likely to be unqualified and good grades. Therefore, the sensitivity of the change in the weights of A13 for the identification with the communist ideals to the evaluation results is not high.

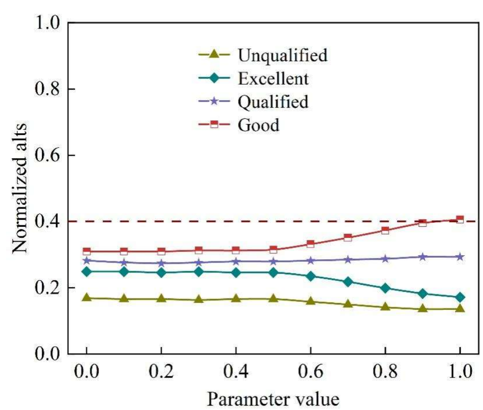

Figure 3: The sensitivity illustration with A13 as the independent variable

(4) Selecting the degree of identification with communist ideals A14 as an independent experimental variable, the results of sensitivity analysis are shown in Fig. 4, when the weight of A14 gradually increases, its evaluation results will be non-linear changes, when the weight of A14 is greater than 0.5, the weight of good and excellent evaluation grades will increase linearly, and the weight of qualified and unqualified evaluation grades will decrease linearly. However, the main evaluation result remains unchanged, a good grade, and the maximum weight is 0.39. When

the weight of A14 is 0-0.83, the evaluation results of unqualified and excellent are least likely to occur, and when it is greater than 0.83, the evaluation results of unqualified and excellent are least likely to occur. Therefore, the sensitivity of the change in the A14 weights of loyalty to the party to the decision-making program is high.

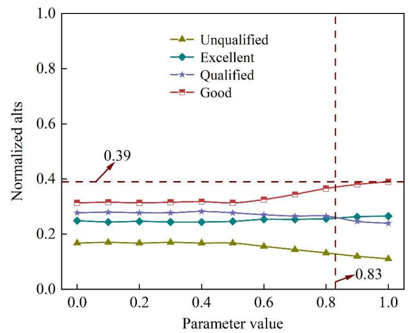

Figure 4: The sensitivity illustration with A14 as the independent variable

Similarly, A21~A24 in guideline A2, B11~B14 in B1, and B21~B24 in B2 are selected as independent experimental variables respectively, so that their weights are from 0 to 1 with a step of 0.1, and the results of their sensitivity analyses are outputted by SD software. Comprehensive sensitivity analysis of the 16 factors and the size of the weight value, it can be concluded that the two factors of treating people with integrity A23 and professionalism B23 have the highest sensitivity, and the change of their weights will cause substantial changes in the evaluation results of university management, and the weight value is large, so it should be most important to cause attention to the university managers. Secondly, the sensitivity of identification with communist ideals A14, interpersonal communication and coordination ability B11, written and verbal expression ability B13, and psychological quality B22 is higher, and the proportion of weights is larger, so the importance is higher.

III. C. Application of management evaluation system in higher education institutions

III. C. 1) Object element modeling

According to the importance of each indicator in the evaluation system, after widely soliciting the opinions of all parties, it is determined that each evaluation indicator is divided into four grades: excellent, good, qualified and unqualified, and the weights of each indicator at each level are obtained, and the classical domains of each level of object elements and section domains are shown in Table 4.

Table 4: The matter-element model of the university management evaluation system

Evaluation index			Weight			Classical domain				Pitch domain
First-level	Second -level	Third-level	First-level	Second -level	Third-level	Unqualified	Qualified	Good	Excellent	
A	A1	A11	0.500	0.561	0.251	[0,60]	[60,80]	[80,90]	[90,100]	[0,100]
		A12			0.247	[0,60]	[60,80]	[80,90]	[90,100]	[0,100]
		A13			0.174	[0,60]	[60,80]	[80,90]	[90,100]	[0,100]
		A14			0.328	[0,60]	[60,80]	[80,90]	[90,100]	[0,100]
	A2	A21		0.439	0.245	[0,60]	[60,80]	[80,90]	[90,100]	[0,100]
		A22			0.253	[0,60]	[60,80]	[80,90]	[90,100]	[0,100]
		A23			0.293	[0,60]	[60,80]	[80,90]	[90,100]	[0,100]
		A24			0.209	[0,2]	[2,4]	[4,7]	[7,10]	[0,10]
B	B1	B11	0.500	0.607	0.294	[0,60]	[60,80]	[80,90]	[90,100]	[0,100]
		B12			0.197	[0,60]	[60,80]	[80,90]	[90,100]	[0,100]
		B13			0.264	[0,60]	[60,80]	[80,90]	[90,100]	[0,100]
		B14			0.245	[0,60]	[60,80]	[80,90]	[90,100]	[0,100]
	B2	B21		0.393	0.197	[0,20]	[20,30]	[30,40]	[40,50]	[0,50]
		B22			0.278	[0,20]	[20,30]	[30,40]	[40,50]	[0,50]
		B23			0.405	[0,60]	[60,80]	[80,90]	[90,100]	[0,100]
		B24			0.120	[0,60]	[60,80]	[80,90]	[90,100]	[0,100]

III. C. 2) Determination of elements to be evaluated

A class was arbitrarily selected from the classes of the university to be evaluated as class A to be evaluated, and the scores of the class for each indicator in the previous semester are shown in Table 5.

Table 5: The scores of various indicators of the class to be evaluated

Index	Score	Index	Score
A11	91	B11	86
A12	88	B12	79
A13	90	B13	82
A14	95	B14	91
A21	93	B21	42
A22	82	B22	40
A23	85	B23	92
A24	7	B24	75

III. C. 3) Determination of correlation function and analysis of evaluation results

The correlation function between the characteristic parameters of the class to be evaluated and the evaluation level can be obtained through the calculation of formula (16), and the specific calculation results are shown in Table 6.

Table 6: Calculation data of the third-level correlation function

Evaluation index		Classical domain			
Second -level	Third-level	Unqualified	Qualified	Good	Excellent
A1	A11	1.000	-0.506	-0.761	-0.864
	A12	-0.204	1.000	-0.326	-0.624
	A13	-0.453	-0.217	-0.279	-0.217
	A14	-0.386	-0.168	0.221	-0.248
A2	A21	-0.324	0.095	-0.087	-0.322
	A22	-0.402	-0.231	0.205	-0.158
	A23	-0.859	-0.760	-0.594	1.000
	A24	-0.261	0.347	-0.505	-0.687
B1	B11	-0.812	-0.693	-0.475	0.634
	B12	-0.682	-0.491	0.242	-0.193
	B13	-0.741	-0.605	-0.093	0.112
	B14	-0.864	-0.662	-0.485	0.624
B2	B21	-0.438	-0.201	0.268	-0.202
	B22	-0.419	-0.203	0.268	-0.324
	B23	-0.348	-0.112	0.129	-0.263
	B24	-0.737	-0.558	-0.124	0.165

Because the weights of the first-level indicators are all 0.5, this paper directly uses the second-level relative weights for the correlation calculation. The correlation degree of each evaluation state of the class to be evaluated is calculated by formula (17), and then the evaluation results of the class with evaluation are obtained according to formula (18) as shown in Table 7.

From the correlation results, it can be seen that the evaluation grades of the four second-level evaluation indicators A1, A2, B1 and B2 of the class to be evaluated A are qualified, excellent, outstanding and good, respectively. Since the weight of B1 comprehensive ability is the largest among the four secondary evaluation indexes, the correlation of comprehensive evaluation in Table 7, $K_{\text{excellent}} > K_{\text{good}} > K_{\text{qualified}} > K_{\text{unqualified}}$, the evaluation grade of the class is excellent. Checking the information of the class evaluation of the Academic Staff Office, the evaluation grade obtained by the class in the comprehensive evaluation of the previous semester is also excellent. It shows that the method can make a comprehensive evaluation of the quality of education management in colleges and universities in a fair, scientific and standardized way.

Table 7: The first-level correlation of the classes to be evaluated

Evaluation index	Unqualified	Qualified	Good	Excellent	Grade
A1	-0.005	0.027	-0.248	-0.490	Qualified
A2	-0.487	-0.185	-0.249	0.031	Excellent
B1	-0.780	-0.622	-0.235	0.331	Excellent
B2	-0.432	-0.208	0.165	-0.217	Good
Comprehensive	-0.860	-0.525	-0.326	-0.147	Excellent

IV. Conclusion

This paper proposes a comprehensive evaluation model of college management quality that combines the network hierarchy analysis method and the material element topable theory, and carries out sensitivity analysis and practical application of the model.

Comprehensive sensitivity analysis and the size of the weight value of the 16 factors in the proposed university management evaluation system can be concluded that the two factors with the highest sensitivity are the integrity in dealing with people and professionalism, and the change of their weights will cause a substantial change in the results of the university management evaluation and the weight value is large, which should be paid attention to by the university administrators. Secondly, the degree of identification with communist ideals, interpersonal communication and coordination ability, written and verbal expression ability, and psychological quality, with higher sensitivity and a larger proportion of weight, are of higher importance and should also be emphasized.

The evaluation grades of the four secondary evaluation indexes of Class A to be evaluated are qualified, excellent, excellent and good, and the calculation gets that therefore the comprehensive evaluation grade of the class is excellent, which is consistent with the comprehensive evaluation grade of the class in the previous semester, which shows that the method is able to carry out a comprehensive evaluation of the quality of education management in colleges and universities in a fair, scientific and standardized way.

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References

[1] Tomchuk, O., Tserklevych, V., Hurman, O., Petrenko, V., & Chymosh, K. (2020). The efficiency of higher education institutions: evaluation and management of managers. Studies of Applied Economics, 38(4).

[2] Mambetkaziyev, A., Baikenov, Z., & Konopyanova, G. (2022). CLUSTER ANALYSIS OF THE EFFECTIVENESS OF MANAGEMENT OF HIGHER EDUCATION INSTITUTIONS. Eastern-European Journal of Enterprise Technologies, 120(3).

[3] Leiber, T., Stensaker, B., & Harvey, L. C. (2020). Bridging theory and practice of impact evaluation of quality management in higher education institutions: a SWOT analysis. In Impact evaluation of quality management in higher education (pp. 117-132). Routledge.

[4] Beuren, I. M., & Teixeira, S. A. (2014). Evaluation of management control systems in a higher education institution with the performance management and control. JISTEM-Journal of Information Systems and Technology Management, 11, 169-192.

[5] Badrtdinov, N. N., & Gorobets, D. V. (2016). Evaluation of the Effectiveness of Management Development Institutions of Higher Education on the Basis of the Factor and Criterion Model. International journal of environmental and science education, 11(18), 12167-12182.

[6] Agasisti, T. (2017). Management of higher education institutions and the evaluation of their efficiency and performance. Tertiary Education and Management, 23(3), 187-190.

[7] Manatos, M. J., Sarrico, C. S., & Rosa, M. J. (2017). The integration of quality management in higher education institutions: a systematic literature review. Total Quality Management & Business Excellence, 28(1-2), 159-175.

[8] Braslavska, O., Penkova, O., Plets, I., Sus, T., Biloshkurska, N., & Biloshkurskyi, M. (2020). Management of the higher education institutions innovative potential: Formalization and evaluation. Revista Inclusiones, 624-645.

[9] Liu, S. (2023). Research on the application of hierarchical analysis method in the construction of financial risk evaluation system of colleges. Advances in Economics and Management Research, 6(1), 267-267.

[10] Zhengzhou, J., Yijian, Z., & Lei, S. (2021, March). The laboratory construction effectiveness evaluation of high-education institutions via the FAHP method and its application. In 2021 IEEE 2nd International Conference on Big Data, Artificial Intelligence and Internet of Things Engineering (ICBAIE) (pp. 632-636). IEEE.

[11] Thanassoulis, E., Dey, P. K., Petridis, K., Goniadis, I., & Georgiou, A. C. (2017). Evaluating higher education teaching performance using combined analytic hierarchy process and data envelopment analysis. Journal of the Operational Research Society, 68(4), 431-445.

[12] Chen, J., & Huang, H. (2018). Analytic Hierarchy Process of the Evaluation System of Physical Education Teaching Quality in Colleges and Universities. Educational Sciences: Theory & Practice, 18(6).

[13] Gökçe Tuğdemir Kök, Mehmet Serdar Celik & Elif Koc. (2025). Evaluating IMO 2030 strategies for environmental sustainability in maritime transportation using ANP method. Marine pollution bulletin,215,117847.
[14] Fang Liu, Lin Tao Dai, Fei Yang Cheng & Wei Guo Zhang. (2025). An axiom system of the analytic hierarchy process based on the completeness of preferences. International Journal of Approximate Reasoning,183,109449-109449.
[15] Hao Peng, Jin Zhang, Xinyu Wang & Chenyang Peng. (2025). A Novel Vulnerability Evaluation Model of a Public Service Building Based on Structural Equation Modeling and Matter-Element Extension. Buildings,15(6),948-948.