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Intelligent Construction and Practice of Quality Assurance System in Higher Education in Digital Era

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Abstract Taking the construction of higher education quality assurance as the research objective, this paper designs the framework of higher education quality assurance platform containing seven modules: quality planning, teaching process, quality monitoring, efficient data, quality evaluation, basic data and system management. Based on the hierarchical analysis method, the assignment steps and methods of evaluation system indicators are detailed. K-means mean algorithm is adopted as a distribution analysis tool for the indicator scoring data. Under the theoretical framework of the above method, a higher education evaluation system containing 19 indicators is proposed based on the five teaching quality criteria, namely, the guiding ideology of running a school, the management of the teaching process, the teaching conditions, the learning support service system, and the educational and teaching effects. The validity of the index system is verified by calculating the fuzzy evaluation matrix and extracting the common factor. Applying the higher education quality evaluation index system to assess the teaching quality of University X, it gets a perfect score close to 5.00 on the guiding ideology of running a school, and performs poorly on the teaching conditions with only 2.97. The study points out that the platform of higher education quality assurance should be constructed from the outside to the inside by means of digital technology, by means of rationally adjusting the disciplinary settings, and by means of supervising the teaching process.

Index Terms higher education quality assurance, hierarchical analysis, K-means algorithm, education quality evaluation

I. Introduction

Accompanied by the arrival of internationalization of higher education, higher education in various countries in order to compete for a larger student market, its education quality issues have become an important aspect of the general concern of colleges and universities [1]. Colleges and universities are the front line of talent cultivation, and at the same time, it is also the key place to implement the fundamental task of cultivating moral integrity and promoting the comprehensive growth and success of students [2], [3]. They should take the initiative to strengthen the top-down quality assurance consciousness, regard the construction of a perfect quality assurance system as a fundamental and strategic task on the agenda, consciously strengthen self-assessment, self-management, self-monitoring, and create a good quality assurance ecology [4]-[6].

Quality is a classic topic of higher education research, and educational quality assurance also runs through the development of higher education from the elitist stage to the massification stage and then to the popularization stage [7], [8]. The quality assurance system of higher education mainly contains two parts: internal assurance and external assurance, and the internal assurance system is responsible for the quality assurance within the higher education institutions, and the main organizations are generally colleges and universities [9]-[11]. The external assurance system leads, organizes, implements, and coordinates the higher education quality appraisal activities and supervises the internal quality assurance activities of higher education institutions, and the main organizations are generally the government and society [12]-[14]. As the current stage of China's major universities and colleges have integrated digitalization into the strategic development of the school, based on the construction of the smart campus, formulated the development plan for the digitalization of school education, and comprehensively promoted the construction of school digitalization [15], [16]. Therefore, adhering to the multi-measures to build an intelligent quality assurance system and solving the more prominent educational quality monitoring problems at present is the top priority for the high-quality development of higher education [17], [18].

Based on the digital technology platform, this paper analyzes the functional requirements of the higher education quality assurance system and the corresponding module settings, and determines the system framework consisting of seven modules: quality planning, teaching process, quality monitoring, efficient data, quality evaluation, basic data, and system management. Then the hierarchical analysis method was applied to calculate the weights of the higher education quality evaluation indicators, and the K-Means mean algorithm was used to analyze the evaluation results of the indicators. With the support of the above theories and technologies, the index system of higher education quality evaluation is constructed by synthesizing past researches and the actual situation of colleges and universities. After completing the test of the validity of the index system, P students are taken as the research object to analyze the effect of higher education quality assurance in X University. Based on the content and results of the analysis, the path of the construction of higher education quality assurance system is proposed.

II. Outline design for quality building in higher education

II. A. General Design Ideas

Higher education quality assurance platform aims to provide schools with a network platform for the collection, review and supervision of data in our schools, instead of collecting documents in the form of work, so that the collection of data, the filling of the national system is more reasonable, convenient and simple, and the use of computer technology to provide users with some of the more convenient and practical functions.

Based on the concept of software engineering to analyze the system, determine the needs, more targeted features, the determination of the module function is the basis of higher education quality assurance platform. The system module mainly adopts the front-end and back-end separation mode, using NodeJS and Java language to realize the B/S structure of the Web application and MongoDB with MySQL database implementation. It realizes modularization and hierarchical development mode to meet the maintenance of the system and future expansion of functions. The system analyzes the functional requirements of the system based on detailed information and designs various sub-modules, including quality planning module, teaching process module, quality monitoring module, university data module, quality evaluation module, basic data module, and system management module.

II. B. System Module Design

The higher education quality assurance platform includes quality planning module, teaching process module, quality monitoring module, efficient data module, quality evaluation module, basic data module, and system management module.

(1) Quality Planning Function

It mainly includes eight sub-functions: "setting and template management of teaching evaluation", "setting and template management of examination paper evaluation", "setting and template management of completion evaluation", "setting and template management of suggestion feedback", "setting and template management of department evaluation", "setting of university data collection", "setting and document management of quality assurance standards", "setting and data pulling of basic data collection".

(2) Teaching process function

This module mainly includes four sub-functions: "Input and Query of Course Teaching", "Input and Statistics of Course Design", "Entry and Statistics of Graduation Design", and "Entry and Statistics of Examination Paper Information".

(3) Quality monitoring function

This module mainly includes five sub-functions: "Teaching Evaluation", "Examination Paper Evaluation", "Completion Evaluation", "Suggestion Management" and "Teaching File Collection".

(4) Quality evaluation function

This module mainly includes five sub-functions: "self-evaluation of department evaluation", "self-evaluation review of department evaluation", "internal audit of department evaluation", "final evaluation of department evaluation", and "statistics of results of department evaluation".

(5) University data function

This module mainly includes six sub-functions: "Data Filling", "Data Review", "Data Archiving", "Data Query", "Data Analysis", and "Filling Personnel View".

(6) Basic data function

This module mainly includes six sub-functions: "organization filling", "discipline and specialty filling", "teacher data filling", "student file filling", "course data filling" and "training plan filling".

(7) System management function

This module mainly includes seven sub-functions: "Personnel Management", "Statistical Time Management", "Role Management", "Permission Management", "Menu Management", "Organization Management", and "Workflow Settings".

III. Methods of evaluating the quality of higher education

III. A. Hierarchical Analysis

When applying the hierarchical analysis method, the complex problem to be solved is first regarded as a large system, and the factors of the system are analyzed to delineate the hierarchical order of the interconnection between the factors. Then conduct a survey or ask experts to make a more objective judgment on each level of the factors, and accordingly give the relative importance of the quantitative expression. Then establish a mathematical model to solve the problem, calculate the relative importance of all the factors at each level of the weight, and sorting: Finally, according to the sorting results of the planning decision-making, selecting the solution to the problem.

The use of hierarchical analysis in the evaluation or decision-making process can be roughly divided into four steps: the establishment of the recursive structural model. Construct judgment matrix. Hierarchical single ranking and consistency test. Hierarchical total ordering and consistency test. The specific realization of the process is as follows.

III. A. 1) Modeling of recursive structures

When using hierarchical analysis to solve evaluation or decision-making problems, the first thing to do is to organize and hierarchize the problem, and establish a hierarchical structural model of the evaluation system in Fig. 1. In this model, the complex problem is regarded as a combination of multiple elements, which form a number of hierarchical levels according to their attributes and relationships, and the elements of the previous level serve as guidelines for the elements at the next level to play a dominant role in the next level. These levels can be divided into three categories:

(1) The highest level (goal level): there is only one element in this level, which is generally the predetermined goal of analyzing the problem or the desired result, and it is the highest criterion of the evaluation system.

(2) The intermediate layer (criterion layer) includes all the intermediate aspects involved in order to achieve the goal, it can include the criteria, sub-criteria, etc. to be considered, and consists of a number of levels.

(3) The bottom level (solution level), which includes various solution measures, decision-making options, etc. that are available to achieve the goal.

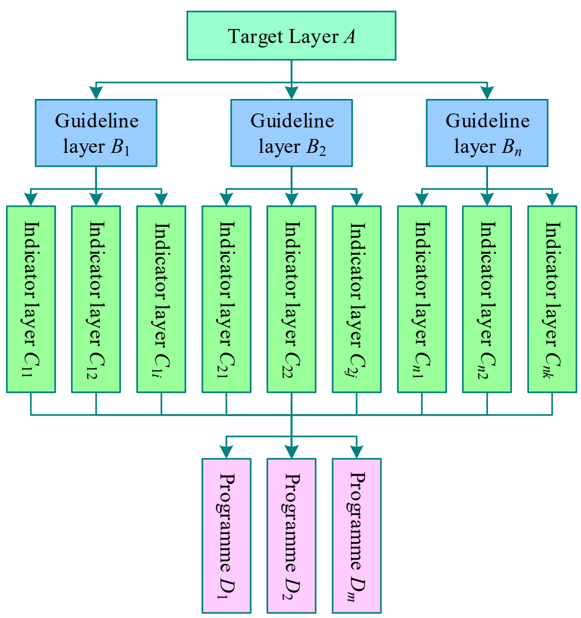

Figure 1: Hierarchical structure model of evaluation system

The number of levels in a recursive structural model is related to the complexity of the problem itself and the level of exhaustiveness in analyzing the problem; in general, the number of levels is not limited. Each level of the elements dominated by the elements generally do not exceed 9 elements, this is because too many elements dominated by the next two to two comparisons to construct the judgment matrix brings difficulties. A good hierarchical structure is extremely important for solving problems. If you are uncertain about the hierarchical division and determining the dominant relationships between the elements of the hierarchy, you should reanalyze the problem and try to clarify the interrelationships between the elements to ensure that a reasonable hierarchical structure is established. The recursive structure model is the simplest and most practical form of hierarchy in AHP. When a complex problem is difficult to represent with a recursive structure model, a more complex form of extension can be used, such as recursive structure of internal dependencies, feedback hierarchy, etc.

III. A. 2) Constructing judgment matrices

After modeling the recursive structure, the affiliations between the hierarchical elements of the system are determined. The next step is to determine the weights of the elements at each level. For most socio-economic problems, especially the more complex ones, the weights of the elements are not easy to obtain directly, and then it is necessary to derive their weights by appropriate methods. Hierarchical analysis uses the method that the decision maker compares the elements of the same level two by two about the importance of a criterion in the previous level, and gives a judgment matrix to derive the weights.

Assume this mathematical model: Suppose some object A has n elements: $B_1, B_2, \ldots, B_i, \ldots, B_n$, and the status (role, weight, importance) of the i th element B_i with respect to the object A is denoted as b_i. $\frac{b_i}{b_j}$ then denotes the multiplicity of the importance of B_i over B_j with respect to A, denoted as b_{ij}, i.e., $b_{ij} = \frac{b_i}{b_j}$. This yields the judgment matrix A.

Properties of judgment matrix: A is a positive inverse matrix, i.e., each element b_{ij} of matrix A satisfies: $0 < b_{ij} \le 9$, $b_{ii} = 1$, $b_{ji} = \frac{1}{b_{ij}}$.

Experimental psychology has shown that the maximum number of things that people can correctly identify when they are comparing some attribute of a set of things at the same time and have to keep their judgments essentially the same is 5-9. Therefore, the values of b_{ij} are chosen to be integers between 1-9 and their reciprocals, and the scale of the judgment matrix A is defined.

III. A. 3) Single ordering of hierarchies and consistency tests

The eigenvector W of the judgment matrix A corresponding to the maximum eigenvalue $\lambda_{\max}$ is normalized to the ranking weights of the corresponding factors at the same level with respect to the relative importance of a criterion at the previous level, and this process is known as hierarchical single ranking. The square root method is used to calculate the relative weight or importance vector W^0, the calculation step is divided into two steps:

(1) The elements of judgment matrix A are multiplied by rows and then squared n times to get the column vector W, whose components W_i are shown in equation (1):

$$W_i = \left(\prod_{j=1}^{n} b_{ij} \right)^{\frac{1}{n}} \tag{1}$$

(2) The resulting column vector W is normalized to the weight coefficient vector W^0, whose components W_i^0 are shown in equation (2):

$$W_i^0 = \frac{W_i}{\sum_{i=1}^{n} W_i} \tag{2}$$

The steps of consistency test for judgment matrix are as follows:

(1) From Perron's theorem for positive matrices, the largest eigenroot $\lambda_{\max}$ of the judgment matrix A exists and is unique, $AW = \lambda_{\max} W$, as in equation (3):

$$\lambda_{\max} \approx \frac{1}{n} \sum_{i=1}^{n} \frac{(AW)_i}{W_i} = \frac{1}{n} \sum_{i=1}^{n} \frac{\sum_{j=1}^{n} b_{ij} W_j}{W_i} \tag{3}$$

(2) The formula for the consistency indicator C.I. is shown in equation (4):

$$C.I.=\frac{\lambda_{\max}-n}{n-1} \tag{4}$$

(3) Find the corresponding average random consistency indicator R.I., the positive inverse matrix of order 1-14 is calculated 1000 times to obtain the average random consistency indicator.

(4) Calculate the consistency ratio C.R.. It is generally believed that when $C.R.\leq 0.1$, the judgment matrix basically meets the full consistency test. When $C.R.>0.1$, the given judgment matrix does not comply with the full consistency test, and needs to be adjusted and corrected, with equation (5):

$$C.R.=\frac{C.I.}{R.I.} \tag{5}$$

III. A. 4) General ordering of the hierarchy and consistency test

Let the previous level (B level) contain $B_1,B_2,\ldots,B_i,\ldots,B_n\left(i=1,2,3,\ldots,n\right)$ a total of n elements whose total hierarchical ordering weights are $b_1,b_2,\ldots,b_i,\ldots,b_n$. Let also the next level (C level) of the B level contain $C_1,C_2,\ldots,C_j,\ldots,C_m\left(j=1,2,3,\ldots,m\right)$ a total of m elements, and the hierarchical single-ordering weights of these m elements with respect to the element (criterion) B_i in the B level are $c_{j1},c_{j2},\ldots,c_{jm}$ (when B_i is not relevant to C_j, $c_{ij}=0$). Now find the weights of each element in the C level with respect to the total goal, i.e., find the calculation process of the hierarchical total ordering weights $c_1,c_2,\ldots,c_j,\ldots,c_m$ for each element in the C level.

In general, a consistency test is also required for the hierarchical total ordering, and the test process is still performed layer by layer from top to bottom as in the case of calculating the hierarchical total weight ordering. Because although all levels have passed the consistency test of the hierarchical single sort, indicating that each judgment matrix has a more satisfactory consistency, but when considered together, the non-consistency of each level may still accumulate, thus causing the final analysis results in a more serious non-consistency.

Let the two-by-two comparison judgment matrices of the factors related to B_i in the C level pass the consistency test in single sorting, and the single sorting consistency index is found to be $\left(C.I.\right)_i\left(i=1,2,3,\ldots,n\right)$, and the corresponding average random consistency index is $\left(R.I.\right)_i,\left(i=1,2,3,\ldots,n\right)$, then the total ranked random consistency ratio at the C level is equation (6):

$$C.R.=\frac{C.I.}{R.I.}=\frac{\sum_{i=1}^{n}(C.I.)_i b_i}{\sum_{i=1}^{n}(R.I.)_i b_i} \tag{6}$$

Similarly, when $C.R.\leq 0.1$, the results of hierarchical total ranking are considered to have a more satisfactory consistency.

In summary, the specific steps for determining the weights of the indicator system using hierarchical analysis are shown in Figure 2.

III. B. Clustering Algorithm

Clustering algorithm is a kind of unsupervised machine learning algorithm, the essence of which is to group the data sets that are not known beforehand, so that the data in the same group are as similar as possible and the data in different groups are as different as possible, and its purpose is to reveal the real situation of data distribution.

Current clustering algorithms are broadly categorized into five main types: segmentation methods, hierarchical methods, density-based methods, grid-based methods, and model-based methods. K-means algorithm is a typical representative of segmentation clustering algorithms, which is essentially based on the average value of the objects in the cluster. In order to be able to achieve the global optimum, division-based clustering requires the exhaustion of all possible divisions.

The K-means algorithm is a typical representative of partitional clustering algorithms. In essence, the algorithm is based on the average value of the objects in the cluster. In order to be able to achieve global optimization, division-based clustering requires exhausting all possible divisions. The process of the algorithm is as follows:

Input to the algorithm: the number k of objects and clusters in the database.

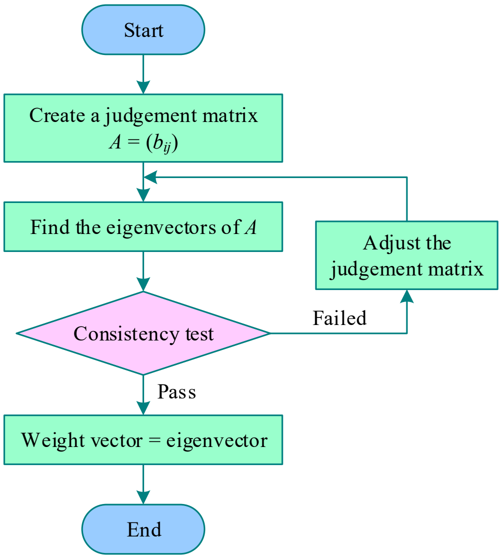

Figure 2: Specific steps of AHP to calculate the index weight

Output of the algorithm: the k clusters that minimize the squared error criterion.

(1) From the entire n sample, arbitrarily select k objects as the center of the initial cluster $m_i\left(i=1,2,\ldots,k\right)$.

(2) Using equation (7), calculate the distance $d(p,m_i)$ from each object P in the dataset to the center of the k clusters.

$$d(i,j)=\sqrt{(x_{i1}-x_{j1})^2+(x_{i2}-x_{j2})^2+\ldots+(x_{in}-x_{jn})^2} \tag{7}$$

where $i=\left(x_{i1},x_{i2},\ldots,x_{in}\right)$ and $j=\left(x_{j1},x_{j2},\ldots,x_{jn}\right)$ are two n-dimensional data objects.

(3) Find the smallest $d\left(p,m_i\right)$ of each object P and group P into the same cluster as m_i.

(4) After traversing all objects, use (8) to recalculate the value of m_i as the new cluster center.

$$m_k=\sum_{i=1}^{N}\frac{x_i}{N} \tag{8}$$

where m_k represents the cluster center of the k th cluster and N represents the number of data objects in the k th cluster.

(5) Reassign the objects in the entire data set to the most similar cluster.

(6) Repeat steps (2)-(5) until the squared error criterion is minimized.

The squared error criterion attempts to make the clustering results as independent and compact as possible, i.e., the objects within the clusters are as similar as possible. It is defined as in equation (9):

$$E=\sum_{i=1}^{k}\sum_{P\in C_i}\left|P-m_i\right|^2 \tag{9}$$

IV. Construction and practice of quality assessment in higher education

With the support of the methodology proposed above, this chapter designs a set of higher education quality evaluation index system that meets the actual situation of Chinese universities from five perspectives, and empowers the indexes by using the hierarchical analysis method. Then the proposed higher education quality evaluation index system is validated by constructing a fuzzy evaluation matrix and extracting common factors. The index system is applied to University X, and the higher education quality assurance system is discussed with the results of the analysis.

IV. A. Indicator system for evaluating the quality of higher education

IV. A. 1) Construction of the indicator system

This paper synthesizes the past research, combines the reality, with the goal of establishing a comprehensive indicator system for the quality level of higher education, comprehensively analyzes the current situation of the development of higher education and the existing problems, combined with the identified quality problems, and establishes a comprehensive evaluation indicator system as shown in Table 1.The indicator system takes the quality of higher education as the goal, and takes five aspects as criterion layers, namely, (B1) the guiding ideology of running a school, (B2) the management of teaching and learning process, (B3) teaching and learning conditions , (B4) Learning Support Service System, and (B5) Educational and Teaching Effect as the guideline layer. (C1) Orientation and Safeguards, (C2) Cultivation Objectives, (C3) Construction and Management of Teaching Sites, (C4) Enrollment Management, (C5) Specialization Setting, (C6) Examination Management, (C7) Academic Affairs and Academic Degree Management, (C8) Practical Teaching Management, (C9) Process Monitoring and Records Management, (C10) Teaching Team Building, (C11) Teaching Facility Construction, (C12) Teaching resources construction, (C13) financial guarantee, (C14) support services for the learning process, (C15) teaching management services, (C16) consulting services, (C17) education quality, (C18) student evaluation, and (C19) employer evaluation 19 indicators as the indicator layer, and based on this, we constructed the quality evaluation index system of China's modern higher education as shown in Table 1.

Table 1: Multi-level quality evaluation index system

Criterion layer	Index level
(B1) Guiding ideology for running the school	(C1) Educational positioning and safeguard measures
	(C2) Training objective
(B2) teaching process management	(C3) Construction and management of teaching sites
	(C4) Enrollment management
	(C5) Major setup
	(C6) Examination management
	(C7) Academic affairs and student status and degree management
	(C8) Practical Teaching Management
	(C9) Process monitoring and file management
(B3) teaching condition	(C10) Team construction
	(C11) Construction of teaching facilities
	(C12) Teaching resource construction
	(C13) Fund guarantee
(B4) learning support system	(C14) Support services for the learning process
	(C15) Teaching management service
	(C16) Consultation service
(B5) Educational and teaching effect	(C17) Quality of education
	(C18) Student assessment
	(C19) Employer Evaluation

IV. A. 2) Determination of indicator weights

This subsection combines the hierarchical analysis method to determine the weights of the indicators of the higher education quality evaluation system as shown in Table 2.

IV. B. Effectiveness of the indicator system

IV. B. 1) Fuzzy evaluation matrix

In order to determine the fuzzy evaluation matrix of each evaluation index in higher education, this paper takes X University of Finance and Economics as the experimental object. The “Questionnaire on Teaching Quality Indicators of X University of Finance and Economics” was designed to determine the degree of affiliation of each indicator, and the results of the comprehensive evaluation of teaching quality indicators of X University of Finance and Economics are shown in Table 3.

Table 2: Index weight value

Criterion level indicators	Weight	Evaluation index	Weight
B1	0.0392	C1	0.4255
		C2	0.5745
B2	0.5642	C3	0.1912
		C4	0.1004
		C5	0.0972
		C6	0.1003
		C7	0.1772
		C8	0.1616
		C9	0.1721
B3	0.1831	C10	0.3121
		C11	0.2113
		C12	0.3068
		C13	0.1698
B4	0.1263	C14	0.3878
		C15	0.4124
		C16	0.1998
B5	0.0872	C17	0.2355
		C18	0.3674
		C19	0.3971

Table 3: The evaluation results of the teaching quality of University X

Index	The Highest	Higher	High	Low	Lower
C1	0.06	0	0.06	0.32	0.07
C2	0.39	0.03	0.35	0.29	0.11
C3	0.41	0.03	0.45	0	0.18
C4	0.43	0.15	0.24	0.02	0.12
C5	0.35	0.3	0.23	0.31	0.47
C6	0	0.02	0.09	0.15	0.36
C7	0.44	0.37	0.19	0.04	0.19
C8	0.02	0.09	0.47	0.4	0.31
C9	0.07	0.47	0.06	0.31	0.18
C10	0.42	0.4	0.46	0.11	0.47
C11	0.26	0.16	0.44	0	0.07
C12	0.41	0.2	0.42	0.34	0.04
C13	0.43	0.4	0.16	0.48	0.12
C14	0.28	0.25	0.27	0.32	0.01
C15	0.02	0.14	0.12	0.43	0.04
C16	0.49	0.32	0.07	0.13	0.27
C17	0.31	0.28	0.49	0.36	0.35
C18	0.15	0.14	0.46	0.15	0.42
C19	0.16	0.09	0.3	0.12	0.32

The fuzzy comprehensive evaluation matrix $R1$、$R2$、$R3$、$R4$、$R5$ for each level of indicators is obtained as Eqs. (10)-(14):

$$R1=\begin{bmatrix} 0.06 & 0 & 0.06 & 0.32 & 0.07 \\ 0.39 & 0.03 & 0.35 & 0.29 & 0.11 \end{bmatrix} \tag{10}$$

$$R2=\begin{bmatrix}0.41 & 0.03 & 0.45 & 0.00 & 0.18\\ 0.43 & 0.15 & 0.24 & 0.02 & 0.12\\ 0.35 & 0.30 & 0.23 & 0.31 & 0.47\\ 0.00 & 0.02 & 0.09 & 0.15 & 0.36\\ 0.44 & 0.37 & 0.19 & 0.04 & 0.19\\ 0.02 & 0.09 & 0.47 & 0.40 & 0.31\\ 0.07 & 0.47 & 0.06 & 0.31 & 0.18\end{bmatrix} \quad (11)$$

$$R3=\begin{bmatrix}0.42 & 0.40 & 0.46 & 0.11 & 0.47\\ 0.26 & 0.16 & 0.44 & 0.00 & 0.07\\ 0.41 & 0.20 & 0.42 & 0.34 & 0.04\\ 0.43 & 0.40 & 0.16 & 0.48 & 0.12\end{bmatrix} \quad (12)$$

$$R4=\begin{bmatrix}0.28 & 0.25 & 0.27 & 0.32 & 0.01\\ 0.02 & 0.14 & 0.12 & 0.43 & 0.04\\ 0.49 & 0.32 & 0.07 & 0.13 & 0.27\end{bmatrix} \quad (13)$$

$$R5=\begin{bmatrix}0.31 & 0.28 & 0.49 & 0.36 & 0.35\\ 0.15 & 0.14 & 0.46 & 0.15 & 0.42\\ 0.16 & 0.09 & 0.30 & 0.12 & 0.32\end{bmatrix} \quad (14)$$

IV. B. 2) Extracting the common factor

In order to make the data retain more original information, eliminate the covariance of the original variables, and achieve the effect of effective dimensionality reduction, the correlation coefficients are calculated using SPSS for the valid data on the basis of the above analysis is shown in Figure 3.

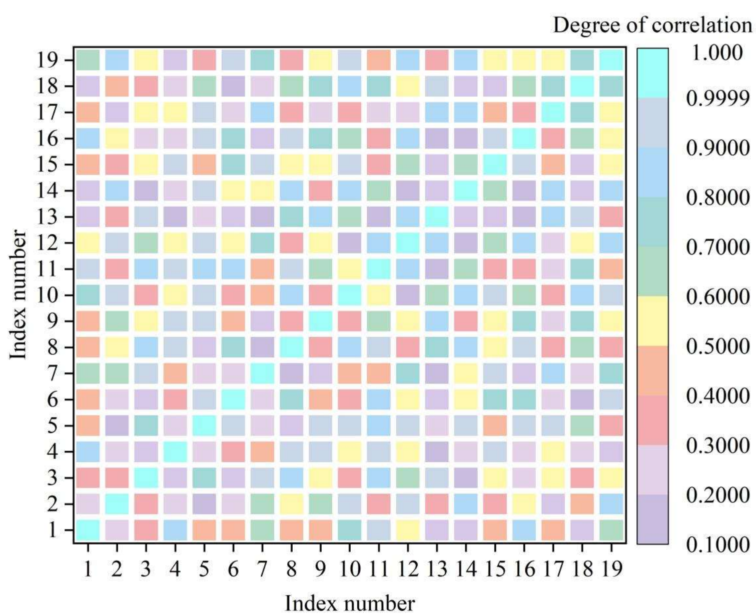

Figure 3: Correlation coefficient

Among them, the correlation coefficients among 19 factors were ≧0, which had strong correlation and could be extracted as the common factor, and the results of (Y1) eigenvalue, (Y2) variance contribution rate and (Y3) cumulative variance contribution rate of each factor were calculated and shown in Table 4.

Table 4: The factor explains the total variance value of the original variable

Number	Initial solution			Initial factor solution			Final factor solution		
	Y1	Y2	Y3	Y1	Y2	Y3	Y1	Y2	Y3
1	8.881	51.137	51.137	8.881	51.137	51.137	6.972	33.438	33.438
2	8.143	10.311	61.448	8.143	10.311	61.448	4.801	18.131	51.569
3	7.065	6.979	68.427	7.065	6.979	68.427	4.751	13.54	65.109
4	7.03	5.495	73.922	7.03	5.495	73.922	4.417	7.725	72.834
5	6.583	4.173	78.095	6.583	4.173	78.095	4.184	4.057	76.891
6	1.247	4.043	82.138	1.247	4.043	82.138	1.163	2.37	79.261
7	1.737	3.092	85.23	1.737	3.092	85.23	0.983	0.195	79.456
8	1.711	2.951	88.181						
9	1.027	1.704	89.885						
10	0.923	1.682	91.567						
11	0.881	1.541	93.108						
12	0.872	1.414	94.522						
13	0.732	1.355	95.877						
14	0.59	1.072	96.949						
15	0.355	0.945	97.894						
16	0.317	0.911	98.805						
17	0.274	0.520	99.325						
18	0.22	0.484	99.809						
19	0.108	0.191	100.00						

As can be seen from Table 4: In the analysis results of the initial factor solution, the characteristic root of the first factor is 8.881, the total variance of the original 19 variables is 51.137%, and its variance contribution rate is 33.438% after factor rotation. The cumulative variance contribution rate of the first 7 factors is 79.456%, in order to retain as much original information as possible, 7 factors are extracted according to the idea of principal component factors, in order to eliminate variable covariance as much as possible, to maximize the amount of original information, and to obtain a more ideal analysis result.

IV. C. Application analysis

A freshman student (student P) in University X was selected as the research object, and the academic performance of his freshman semester was counted, and the index system of higher education quality evaluation designed in this paper was used to score the quality of University X education. In order to facilitate the actual scoring, the index evaluation score interval is set to [0,5], and the results of the cluster analysis of the scoring results on the criterion layer are shown in Figure 4.

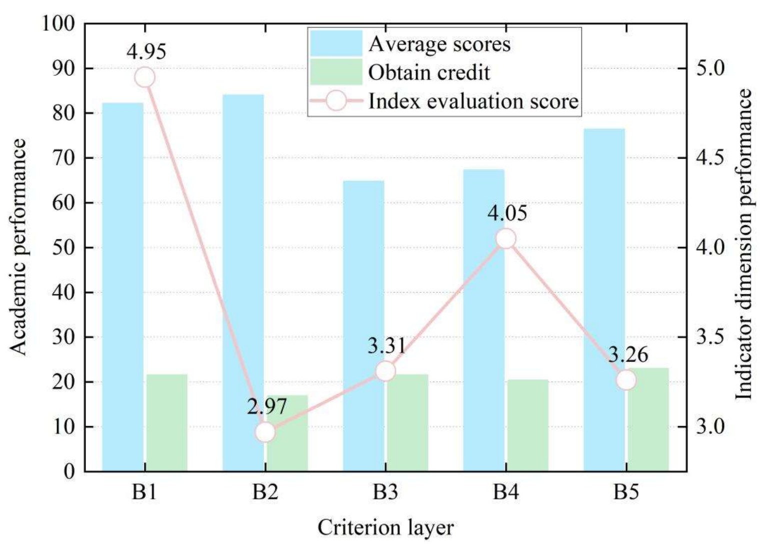

Figure 4: The clustering result of student P's freshman semester grades

Observing student P's academic performance on the five indicators, all of them reached 60 points and above, and the earned GPA was also stable at around 20. Based on the academic performance of student P, it is found that the overall quality of education in University X is good, with two indicators, (B1) the guiding ideology of running a school and (B4) the learning support service system, obtaining scores of more than 4.00 and above, and two indicators, (B3) the conditions of teaching and learning and (B5) the effectiveness of teaching and learning, obtaining scores of more than 3.00 and above. Among them, (B1) Guiding ideology of school running reaches 4.95, which tends to be close to a perfect score. (B2) Teaching process management is slightly lower at 2.97, indicating that University X still needs to improve the management of the teaching process to guarantee the stability and improvement of its education quality.

IV. D. Quality assurance system for higher education

The result of the quality assurance of higher education is ultimately the assurance of the quality of talent cultivation. Therefore, synthesizing the results of the above analysis, this section focuses on talent cultivation and education quality, and puts forward the following three suggestions for the construction of higher education quality assurance system:

(1) Establish the concept of talent cultivation and form a diversified and multi-faceted cultivation process. To build a high-quality type of education, it is necessary to establish a scientific concept of talent cultivation quality. Among them, it should cultivate the concept of diversified talent quality and specifications and update the concept of sustainable development of talent cultivation quality. Define the training objectives, focus on the mutual integration and coordination between the construction of various specialized disciplines, improve the quality of higher education teaching, and match the realistic needs of social and economic development.

(2) Set up a scientific and reasonable training program. It is not only necessary to establish a scientific process for the development of talent training programs, but also to build a professional system that meets the needs of both domestic and international markets. Self-development, regulation of existing disciplines and specialties, broaden the connotation of disciplines and specialties, and promote the enrichment of teaching content and the rise of educational quality.

(3) In the construction of education quality assurance system, the internal quality assurance system of talent training should be improved, and a reasonable and effective higher education quality evaluation index system should be designed. At the same time, we should improve and strengthen the digital monitoring system and platform for teaching quality, optimize the process of education quality evaluation, and strengthen the macro-planning of quality assurance.

V. Conclusion

This paper proposes a set of higher education quality evaluation index system, uses hierarchical analysis as the method of index assignment, and analyzes the index scoring data using K-Means algorithm to complete the assessment of higher education quality. The correlation coefficients of the 19 factors of the designed higher education quality evaluation index system are $\geqq 0$, with strong correlation. With reference to the assessment results of higher education quality and based on the modular framework of the designed higher education quality assurance platform, it is suggested that the current higher education quality assurance should take talent cultivation as the ultimate goal, focus on the setting of disciplines and specialties, and the enrichment and supervision of teaching content, so as to realize the intelligent construction of higher education quality assurance system.

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