ISSN 2522-6398 Vol. 4, Issue 4: 89-92, DOI: 10.25236/FER.2021.040418

Research on Higher Education Evaluation System Based on AHP-NBM Comprehensive Evaluation Model

Qirong Liang, Yuxuan Pang, Xin Xiong, Da Pan*

School of Information and Communication Engineering, Communication University of China, Beijing 10000, China
**Corresponding author*

Abstract: *This paper discusses the path to achieve high-quality development of higher education, which is conducive to improving the overall quality of higher education and the level of sustainable development. According to the collected data and the current higher education system of various countries, a perfect evaluation index system of higher education development health level is established, which is divided into five levels: higher education foundation, higher education investment; higher education process, higher education development performance and social development foundation, including 37 sub-indicators. Then the AHP-NBM comprehensive evaluation (ANCE) model is established, which consists of two parts. The first part is analytic hierarchy process, which determines the index weight scientifically and solves it with Matlab software. The second part: using the natural breakpoint method to determine the* higher *education health level score level, and using ArcGIS software to solve the problem. The breakpoints are 3.2, 5.5 and 8.*

Keywords: *analytic hierarchy* process*, natural breakpoint method*

1. Introduction

Higher education is a professional education and vocational education based on the completion of secondary education. It is the main social activity to cultivate senior professionals and professionals. Higher education is one of the important parts in the education system. It usually includes all kinds of educational institutions whose main tasks and activities are high-level learning and training, teaching, research and social services. The second half of the 20th century is an unusual stage of expansion and qualitative change in the history of higher education. With the rapid growth of social demand for senior professionals and the urgent need of individuals for access to higher education, higher education has developed at an unprecedented speed, from elite education to popular education. The higher education system is an important factor in a country's efforts to make its citizens receive the necessary further education beyond primary and secondary education. Therefore, the higher education system has value as an industry itself and as a source of trained and educated citizens in a country's economy.

Taking the road of high quality development is the inevitable requirement of higher education modernization. Therefore, we should scientifically determine the evaluation index system of higher education development quality, evaluate the quality level of higher education development, test the national higher education development level, clarify the development direction of China's higher education, and promote connotative development.

2. AHP-NBM Comprehensive Evaluation Model

Because of the complexity of the index system, the weight and classification of each index is particularly important when establishing the evaluation model. The fuzzy comprehensive evaluation model (ANCE) consists of two parts. The first part is analytic hierarchy process. The second part: natural breakpoint method to determine the level of environmental pressure. [1]

Next, we will introduce how to use the ANCE model to evaluate the health level of higher education.

ISSN 2522-6398 Vol. 4, Issue 4: 89-92, DOI: 10.25236/FER.2021.040418

2.1 Analytic hierarchy process (AHP) - scientifically determining the weight of evaluation index

The analytic hierarchy process of mathematical thinking of complex system, human subjective judgment based qualitative quantitative analysis, the differences between the various factors determine the numerical value, help people to maintain the consistency of the thinking process is suitable for fuzzy comprehensive evaluation of complex system, is currently one of the most widely used to determine weight method. The use of analytic hierarchy process (AHP) to determine the weight of the index can be carried out according to the following steps.

Step 1: **Establishing hierarchical structure of vulnerability assessment system**

A clear classification index system is established to analyze the N indexes in the established index system. The index set is represented as the first class index set$V = \{V_1, V_2, \cdots, V_N\}$and sub-index set$V_i = \{V_{i1}, V_{i2}, \cdots, V_{ik}\}$, $V_i$represents the first level index, N is the number of indexes, and the set of these indexes is a simple sort by numbered.

Step 2: **Determine the comparison matrix between the two**

The 1-9 proportions scale method is used to qualitatively describe the relative importance of each level's evaluation index, and quantify it with accurate numbers, and then determine the discriminant matrix.

Table 1: The meaning table of discriminant matrix and scale

Scale	Meaning
1	It is of the same importance that the two elements are compared.
3	One element is slightly more important than the other.
5	One element is more important than the other.
7	One element is intensely more important than the other.
9	One element is extremely more important than the other.

2, 4, 6, 8 are the median of the adjacent judgments, and if the index a and B are compared to a_{ij}, then the index B and a are compared to $1/a_{ij}$. The first level index concentrates each index relative to the total evaluation goal. The comparison matrix between the two is as follows.

$$A = \begin{bmatrix} 1 & V_{12} & \cdots & V_{1N} \\ V_{21} & 1 & \cdots & V_{2N} \\ \cdots & \cdots & \cdots & \cdots \\ V_{N1} & V_{N2} & \cdots & 1 \end{bmatrix} = (V_{ij})_{N\times N} \quad (V_{ij} = \frac{1}{V_{ji}})$$

Among them, for the total evaluation target, the value of the relative importance of elements is characterized by the diagonal elements of 1, that is, the importance of each index relative to itself is 1. In terms of the indexes of the sub index concentration, the comparison matrix between the two is follows.

$$B_i = \begin{matrix} v_{i1} \\ v_{i2} \\ \cdots \\ v_{ik} \end{matrix} \begin{bmatrix} 1 & f_{12}^i & \cdots & f_{1k}^i \\ f_{21}^i & 1 & \cdots & f_{2k}^i \\ \cdots & f_{12}^i & \cdots & \cdots \\ f_{k1}^i & f_{k2}^i & \cdots & 1 \end{bmatrix} = f_{k\times k}^i \ (i = 1,2,\cdots N)(f_{lj}^i = \frac{1}{f_{jl}^i})$$

Step 3: The application and product method are used to solve the discriminant matrix, and the relative weight of the index one by one is obtained under a single criterion.

First, the elements in the matrix are normalized by column normalization. Then the matrices that are processed are added in line respectively. Then the row vectors are normalized to get the weight vectors of each comparison element under a single criterion. Finally, the unique maximum eigenvalue is calculated according to the following formula.

$$\lambda \sum_{i=1}^{n} \frac{(A\omega)_i}{n\omega_i}_{max}$$

(The other discriminant matrix is equal to the same.)

Step 4: Hierarchy - a matrix that calculates the combination weight of the same level index $(H_1, H_2, \cdots, H_m)$

ISSN 2522-6398 Vol. 4, Issue 4: 89-92, DOI: 10.25236/FER.2021.040418

Step 5: Consistency test

First, the consistency index$C.I$ is calculated，$C.I = \lambda_{max}$.N is the order of the discriminant matrix [6]. Finding the average random consistency index$R.I$.Computing conformance ratio$C.R = C.I/R.I$. When$C.R < 0.1$, it is generally accepted that the consistency of discriminant matrix is acceptable. The smaller the value of $C.R$ is, the smaller the value of discriminant matrix deviates from the actual situation, the closer it is to the reality. Therefore, from the above we can see that the weight using the analytic hierarchy process to solve the various evaluation index, a qualitative evaluation is given only to the relative importance of each evaluation personnel elements 22 description, and then through the AHP method can accurately calculate the weight of each evaluation element, which are based on strict scientific theory as a basis, greatly enhance the scientific and effective evaluation process.

2.2 Natural breakpoint method (NBM) ——evaluation grade classification

The natural breakpoint method is a statistical method based on the statistical distribution law of numerical statistics. It considers that the data itself has breakpoints, which can be classified by the characteristics of data. The principle of the algorithm is a small clustering, and the end of the cluster is the maximum variance between groups and the minimum variance within the group. [2]

There are some natural turning points and characteristic points in any statistical sequence [3]. These points can be used to divide the research objects into groups of similar nature. Therefore, the split point itself is a good boundary of classification. Statistics can be measured by variance. By calculating the variance of each class, the sum of the variance is calculated and the quality of the classification is compared with the variance and the size of the variance. Therefore, it is necessary to calculate the variance of various classifications, and the minimum value is the optimal classification result.

ArcGIS software can be used to classify data. Applying it to the evaluation of fuzzy comprehensive evaluation.

3. Model application: Health assessment of Higher Education

Based on the relevant data collected, seven different types of countries were selected. The model is applied to these countries to get the health score of higher education system. According to the analysis of the results, choose a country with room for improvement in the higher education system.

First of all, we choose the countries to study in this paper. Higher education systems vary from country to country, and to make our models more universally applicable, we need to cover as many different types of countries as possible around the world. After comprehensively considering factors such as geographical location and development level, we selected 7 highly representative countries from North America, Europe, Asia, and Oceania, covering different education systems and different national development levels. The countries discussed in this article are China, United States, United Kingdom, Germany, France, Japan, and Australia.

Then, we chose the time frame for this article to study. The study was launched in 2021, so 2020 should be the focus. However, as we all know, the outbreak of COVID-19 has had a huge impact on human society, and our higher education system has not been spared. In order to exclude other influencing factors as much as possible and make our results more reliable, we finally chose 2019 as the research scope.

The scores of higher education health level of seven countries can be obtained, which are arranged in the Table 2 below.

Table 2: Scores of higher education health level of seven countries

country	score	Grade Level	rank
China	2.0456	Fragile	7
United States	7.1485	Stable	1
United Kingdom	6.3142	Stable	2
Germany	2.9362	Fragile	6
France	5.2679	Common	3
Japan	3.3587	Common	5
Australia	4.5314	Common	4

ISSN 2522-6398 Vol. 4, Issue 4: 89-92, DOI: 10.25236/FER.2021.040418

4. Conclusion

Through the analysis of the above results, the lowest ranking China is selected as the country for improvement.

Through the analysis of each index, we find that China's higher education performs well in scientific research and graduates' quality, but needs to be improved in national quality and financial investment. Looking at the achievements of the United States, it is obvious that the United States has far surpassed China in terms of infrastructure and investment.

Is higher education just a problem in the field of education? Obviously not. Developing countries are at a disadvantage both economically and socially, which brings problems to their higher education system. To improve the level of higher education in developing countries represented by China, we need to consider it from a comprehensive political and economic perspective. Higher education is an important factor in the development of a country. As the country with the highest health level of higher education among the seven countries, the research on American higher education system is of universal significance and can provide reference for other countries in the world.

References

[1] Xu Jian, Wang Xuhui. Efficiency evaluation of regional higher education in China: An Empirical Analysis Based on DEA model [J]. Research on higher engineering education, 2009(04):81-85.
[2] Yu Yang. How far is China from a powerful country in higher education, 2009?
[3] Huang Bei. Research on the construction of a powerful country in higher education based on the comparison of international competitiveness [D]. Zhejiang Normal University, 2011.