ISSN 2663-8169 Vol. 3, Issue 3: 38-41, DOI: 10.25236/IJNDE.2021.030309

Higher Education System Evaluation System Based on Mathematical Modeling

Fei Zhou[1], Renmeng Jin[2], Jing Hu[3]

[1]School of Economics, Anhui University of Finance and Economics, Bengbu, Anhui, 233000, China
[2]College of Accounting, Anhui University of Finance and Economics, Bengbu, Anhui, 233000, China
[3]School of Economics and Finance, Anhui University of Finance and Economics, Bengbu, Anhui, 233000, China

Abstract: *The higher education system plays a vital role in the development of a country. Each country's higher education system has its strengths and weaknesses, and it faces various external risks (such as the global pandemic), so countries need to rethink their higher education systems and make adjustment accordingly. Therefore, it is important to study the health status and sustainability of the national higher education system. We have developed a model for assessing health status in higher education at the national level. We respectively consider the higher education environment, higher education input and higher education output, and then a three-level evaluation system with 16 specific indicators was established. Then, in order to make a comparative analysis, we chose the United States, China and India, which are all representative countries of developed and developing countries. The health status of national higher education system was evaluated by using principal component analysis method and fuzzy comprehensive evaluation method, and the ranking result was the United States> China> India. So we identify India as the country with more room for improvement, and conduct follow-up analysis.*

Keywords: *higher education, evaluation system, mathematical modeling, quantitative*

1. Introduction

Higher education consists of post-secondary education, third-level, or tertiary education and is the last optional stage of formal study, usually after completion of the secondary level of education. The higher education system is an organizational structure composed of higher education institutions (colleges, universities, etc.) and the personnel and infrastructure needed to educate students above secondary level.

Higher education is one of the important interrelated components of the education system. In the second half of the 20th century, due to the rapid growth of social demand for senior professional talents and the urgent need of individuals for higher education opportunities, higher education has developed at an unprecedented speed. In addition, the sustainable development of higher education is to ensure the sustainable development and utilization of educational resources, coordinated development of economy and society, the establishment of green education ecological environment, training of sustainable development of talents, and finally, to achieve the coordinated development of human and nature and society as the goal of higher education development.

Looking around the world, whether it's the United States, which has a relatively good higher education system, or India, which has a relatively weak one, the reality is that each country's higher education system has its strengths and weaknesses. Especially now the international environment is during the current pandemic, all countries need to rethink their higher education system and adjust accordingly. However, the effectiveness and efficiency of changing realities at the national level are often difficult to judge. Therefore, it is necessary to study the health status and sustainability of the national higher education system.

2. Index Selection

Higher education is the embodiment of the highest end of a country's education, as well as the strongest pillar of a country's researchers and scientific and technological undertakings. The strength of a country is often related to the cultivation of national talents. The healthy and sustainable development

ISSN 2663-8169 Vol. 3, Issue 3: 38-41, DOI: 10.25236/IJNDE.2021.030309

of higher education system requires many conditions and guarantees first. The paper reference Wang Zhengqing[2] and others published the "area" all the way along the national higher education competitiveness level measure and research on correlation between factors and Yang Yi kun[3] and others of the research on the development of higher education in yunnan province level fuzzy comprehensive evaluation and so on literature material, the environment of higher education, higher education input and output as a measure of higher education system of higher education level of health indicators, and then there are 7 subsystems, the higher education popularity, social and economic development is the secondary indexes of higher education environment, teachers' input, funds investment is the secondary indexes of higher education investment, Talent training, scientific and technological innovation and social service are the second-level indicators of higher education output, and a three-level evaluation index system consisting of 16 specific data indicators has been established.

3. Country Selection and its Empirical Study

3.1 Selection of States

Higher education is a key factor to measure a country's comprehensive strength, one of the development level of different countries have different structure of the higher education system, in this paper, based on the country's level of economic development and population, the differences between the cultural factors, such as to determine the selection of the country, refer to the related literature, we finally choose the United States, China and India to analysis.

As a developed country, the United States leads the world in economic development and is one of the first countries to popularize higher education. The quality of its higher education has always been at the forefront of the world, with a complete degree system, and the number of foreign students has always been far ahead of other countries.

China is a developing country, in recent decades, the economy, science and technology constantly improve the comprehensive strength, has arranged the world's second economic level, the higher education has been entering the popularization stage, but with higher education power, small proportion of graduate education in China, can't meet the needs of economic and social development of high-level personnel, and constantly committed to the education of foreign students in China, received a big breakthrough, to become the world's third country foreign students.

India is a developing country with relatively backward economic strength, but its level of science and technology ranks first in the world. At present, India has formed a relatively perfect structure of higher education, and the gross enrollment rate of higher education has also made a major breakthrough, and it is striving to achieve the goal of 30% gross enrollment rate of higher education by 2030.

3.2 Standardization Treatment

Select the data of the above 16 indicators from the above three countries.

Since different evaluation indexes often have different dimensions and dimensionless units, the 16 selected indexes are all dimensionless and the data are greatly different. In order to eliminate the uncommensability, the original data should be processed without dimensionality. In this paper, range normalization method was adopted to transform data:

$$Z_{ij} = \frac{X_{ij} - \min\{Z_{ij}\}}{\max\{Z_{ij}\} - \min\{Z_{ij}\}} \qquad (i=1,2,...,m;j=1,2,...,n)$$

Where, represents the data after dimensionless processing; Is the original data, representing the j index value of the i level index.

3.3 Empirical Study on National Higher Education System

According to the established national health status evaluation index system of higher education, the relevant data are collected and sorted out, and then the principal component analysis method is used to evaluate, analyze and discriminate the health status of higher education by using SPSS software.

① KMO and Bartlett’s Test

ISSN 2663-8169 Vol. 3, Issue 3: 38-41, DOI: 10.25236/IJNDE.2021.030309

Before carrying out the principal component analysis, the data was first tested to see whether it was suitable for principal component analysis. In this study, KMO statistics and Bartlett sphericity test were used to test partial correlation between variables. According to the output results, the value of KM0 is 0.658, which can be used for principal component factor analysis.In addition, Bartlett's sphericity test results show that the approximate chi-square value is 20.800, the degree of freedom is 6, and the significance probability of the test is 0.002, which is less than the significance level of 0.05. Therefore, the null hypothesis of Bartlett's sphericity test is rejected, and it is considered suitable for principal component analysis.

Table 1: KMO and Bartlett's Test.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.658
Bartlett's Test of Sphericity	Approx.Chi-Square	20.800
	df	6
	Sig.	0.002

② The load matrix after orthogonal rotation of the factor

Higher Education Environment:

Table 2: Y_1 The Load Matrix after Orthogonal Rotation of the Factor.

Refers to the standard	X_{11}	X_{12}	X_{21}	X_{22}	Factor contribution rate / %
Common factor 1	0.954	0.811	-0.281	-0.983	65.380
Common factor 2	-0.244	0.574	0.956	-0.036	98.014

Investment in Higher Education:

Table 3: Y_2 The Load Matrix after Orthogonal Rotation of the Factor.

Refers to the standard	X_{31}	X_{41}	X_{42}	X_{43}	Factor contribution rate / %
Common factor	0.930	-0.885	0.423	0.987	70.019

Higher Education Output:

Table 4: Y_3 The Load Matrix after Orthogonal Rotation of the Factor.

Refers to the standard	X_{51}	X_{52}	X_{71}	X_{72}	Factor contribution rate / %
Common factor	0.924	-0.802	-1.000	0.996	87.175

③ Finally, the variance of each index was calculated according to the score value of the three first-level factor indicators, and the contribution rate of each variance was used as the weight to calculate the score of the higher education health status indicator of each country. The comprehensive scoring formula is as follows:

$$G_j = \sum F_i * W_i \qquad W_i = \delta_i / \sum \delta_i \qquad \delta_i = \sqrt{\frac{\sum (F_{ij} - E(F_{ij})^2)}{n}}$$

In the formula, G_j is the score of higher education health status of the JTH country; F_i is the score of Class I indicators; δ_i is the standard deviation of the ith index; $F_{ij}$is the comprehensive score of the j country in the I index; $E(F_i)$ is the mean of the composite scores in category I indicators; W is the weight of index of class i.

Finally, the comprehensive score of the health status of higher education in the three countries was obtained, as shown in Table 5.

Table 5: National Comprehensive Ranking of Health in Higher Education

Country	Y_1	Y_2	Y_3	Synthesis	Ranking
America	5.24	3.27	4.38	4.69	1
China	4.09	3.05	3.22	3.65	2
India	2.89	2.24	2.22	2.41	3

It can be seen that the health status of higher education in the United States is in the developed stage, while China is in the popularization stage, while India has the lowest score and is in the popularization stage. Therefore, we choose India as the object of subsequent study and make a reasonable and sustainable vision for it.

ISSN 2663-8169 Vol. 3, Issue 3: 38-41, DOI: 10.25236/IJNDE.2021.030309

4. Conclusion

In order to help better understand and effectively solve the problem, according to the requirements of the topic, refer to relevant literature and works, first determine the selection of relevant indicators, establish the higher education environment, higher education input and higher education output as the first-level indicators, and adopt 7 A three-level indicator system for specific analysis of two second-level indicators and 16 three-level indicators. Secondly, we look for specific data on the three-level indicators of three representative countries, and then we use principal component analysis to analyze the national higher education system The health status is evaluated and analyzed, and finally the country with the lowest overall system score is selected and a feasible improvement measure is proposed for it.

References

[1] L. H. Zhao. "Higher education sustainable development strategy research", Educational Research in Liaoning Province, no.1, pp.124-125, 2007.

[2] Z. Q. Wang, Y. Wang, X. Y. Sun. Research on the Measure of Higher Education Competitiveness Level and Related Factors of Countries along "One Belt and One Road". Journal of Southwest University (Social Science Edition), no.1, pp. 112-123+227, 2021.

[3] Y. K. Yang, X. F. Lu. Study on fuzzy comprehensive evaluation of higher education development level in Yunnan Province. Journal of Kunming Metallurgical College, no. 6, pp. 12-20, 2020.

[4] H. Zhao, L. J. Guan. Research on Sustainable Development of Higher Education in China Based on IFE and EFE Matrix. Modern Educational Management, no. 9, pp. 87-92, 2016.

[5] T. D. Wang, J. X. Cao, Y. H. Zhao, L. Han, and elc. Shaanxi province land ecosystem health evaluation based on PSR model. Journal of applied ecology: pp. 1-12, 2021. https://doi.org/10.13287/j.1001-9332.202105.013.

[6] Y. C. Zhang. Problems, Countermeasures and Enlightenment of American Higher Education Governance. Educational Review, no. 11, pp. 157-161, 2020.

[7] F. C. Mao, B. Fang. Current Situation and Characteristics of Cross-border Flow of Higher Education Students -- Based on the Analysis of Relevant Statistical Data of Eight Major Countries in the World. Journal of Xizang Minzu University (Philosophy and Social Sciences Edition), no. 6, pp. 189-198+212, 2020.

[8] Y. Z. Lv, C. H. Xu. Internationalization of higher education in India. World Education Information, no. 9, pp. 70-73, 2020.

[9] J. Ma. Challenges faced by higher education in India and countermeasures—Based on the analysis of India's "Twelfth Five-Year Plan for Higher Education". Higher Education Exploration, no. 3, pp. 65-70+76, 2014.