

Evaluation algorithm of Health status of higher Education system based on Analytic hierarchy process

Zhouyue Shen¹, Linyan Huang², Weixiao Bian³

¹College of Economics and Management, Nanjing University of Aeronautics and Astronautics, Nanjing, Jiangsu 211106, China

²College of Aerospace Engineering, Nanjing University of Aeronautics and Astronautics, Nanjing, Jiangsu 210016, China

³College of Automation Engineering, Nanjing University of Aeronautics and Astronautics, Nanjing, Jiangsu 211106, China

Abstract: As an educational system to train high-quality citizens, higher education system plays an important role in the overall layout of the country. In order to assess the health of a country's higher education system, a variety of factors must be fully taken into account. In order to quantitatively analyze and evaluate the health status of higher education in a country, we must choose an appropriate model to solve this problem. In this paper, the analytic hierarchy process comprehensively reflects the influence of various factors on the index. In this paper, in order to build a model that can evaluate the health status of the higher education system in any country, taking into account the huge differences between countries in the world, we select the common characteristics of all countries from massive data. At the same time, in order to eliminate the numerical differences of various indicators caused by the differences in the size of different countries, and try to reflect the quality of education rather than the scale, it is necessary to preprocess the relevant data.

Keywords: Higher Education, Analytic Hierarchy Process (AHP), data mining

1. Introduction

Under the background of globalization, science and technology change with each passing day, and the competition of comprehensive national strength becomes more and more fierce. The level of higher education reflects the ability of a country or region's higher education to adapt to the needs of economic and social development, as well as the basic ability to participate in international competition under the background of higher education internationalization. With the deep development of global knowledge-based economy, all countries in the world are emphasizing the improvement of their own higher education level in the process of building an innovative country. Based on the representative data of the United States, Germany, China, India and Vietnam, this paper conducts an empirical study on the higher education level of the five countries by using the analytic hierarchy process (AHP), and establishes a set of higher education system health testing model that can be applied to different situations in different countries in the world, in order to provide decision-making reference for the development strategy of higher education in various countries. In this paper, we use the analytic hierarchy process to evaluate the health status of higher education systems in different countries.

2. Health Status Evaluation Model of Higher Education

The higher education system is a complex and large system, and there are many factors that need to be considered when assessing its health status. The Analytic Hierarchy Process (AHP) is used for modeling and analysis in order to make a comprehensive and accurate health evaluation model for higher education system.

In evaluation problems, the Analytic Hierarchy Process (AHP) classifies the factors contained in the comprehensive evaluation indicators according to the nature and requirements of the problems, and generally arranges them in target layer, criterion layer and sub-criterion layer to form a hierarchical structure. The factors in the same level are pairwise compared to determine the weight of the factors

relative to the target of the upper level. As the hierarchical analysis goes down to the bottom level, a ranking of all factors according to the importance relative to the general target is given. This is a qualitative and quantitative, systematic and hierarchical analysis method [1].

2.1 Indicator Selection

Considering that the higher education systems of different countries greatly differ due to the difference of the size of the country, the education structure and other factors, we select some common characteristics of the higher education system in each country by comparing the higher education system of many countries, in order to develop a model that can evaluate the health status of higher education system in any country. We establish a comprehensive evaluation model of the health status of higher education system by using analytic hierarchy process (AHP) from six aspects: Scale, Investment, Faculty, Internationalization, Research Level and Pluralism [2].

In order to eliminate the impact caused by differences in the size of countries, the following indicators are selected as the observed variables in table 1.

Table 1: Indicator Selection

Latent variables	Observed Variables
Scale	Gross Enrollment Rate(X1)
	The Proportion of College Students in the Population(X2)
Investment of Funds	The Proportion of Education Expenditure in GDP(X3)
	Education Expenditure Per Student(X4)
Faculty	Faculty-student Ratio(X5)
	Proportion of Teachers with Doctor's Degree(X6)
Internationalization	The Proportion of International Students in College Students(X7)
	Amount of Cooperation Projects with Foreign Countries (X8)
Research Level	Per Capita Amount of Core Journal Papers(X9)
	Average Amount of International Patent Applications(X10)
	Amount of Research Institutions(X11)
Pluralism	Proportion of Non-Financial Appropriations in Education Appropriations(X12)
	Amount of School-enterprise Cooperation Projects(X13)

2.2 Establishment of Analytic Hierarchy Process Model

When it comes to the evaluation of human factors, these factors are usually not easily measured quantitatively. When there are many factors, the results given are often incomplete and inaccurate through making judgments based on people’s own experience and knowledge. The Analytic Hierarchy Process (AHP) proposed by Professor Saaty does not compare all factors together, but compare them pairwise. In addition, the relative scale is used to reduce the difficulty of comparing the factors with different properties to improve the accuracy.

Calculated by a python program, all paired comparison matrices have passed the consistency test, and the weights of mid-layer indexes and lower-layer indexes are obtained as follows: (shown in the figure1 and figure2)

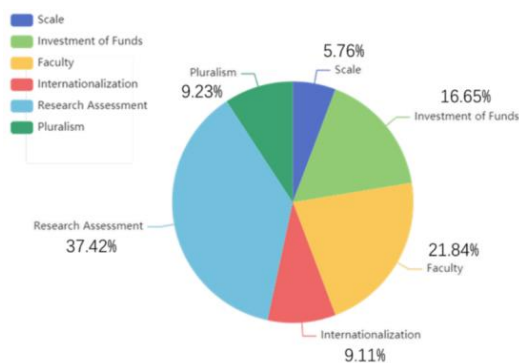


Figure 1: The weight of intermediate layer index

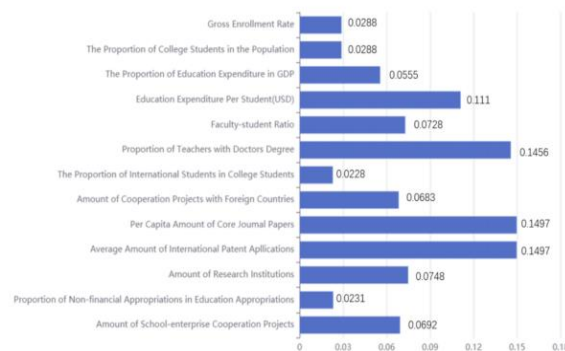


Figure 2 The weight of bottom layer index

3. The Application of Health Status Evaluation Model

3.1 Data Statistics

In order to test the actual effectiveness of the model, the higher education data of several countries are selected to solve the model. Taking the gap of the development level of higher education between developed and developing countries into account, we select several representative countries: America, Germany, China, India, Vietnam. All the data come from the websites of education departments and statistical departments of various countries [3][4][5][6][7][8][9][10][11][12]. The data is for 2019.

3.2 Analysis of the model

The above normalized data were substituted into the analytic hierarchy process model to obtain the scores at three levels of observation variables, latent variables and comprehensive evaluation indicators for the five countries. We sort out all the data and draw five radar charts for each country. The charts were drawn as shown in figure 3-8:

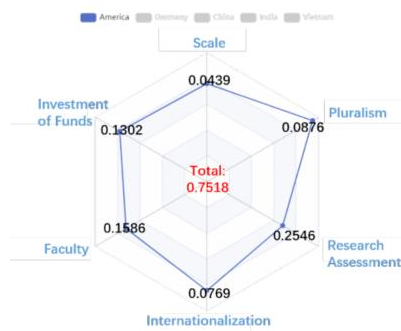


Figure 3: America

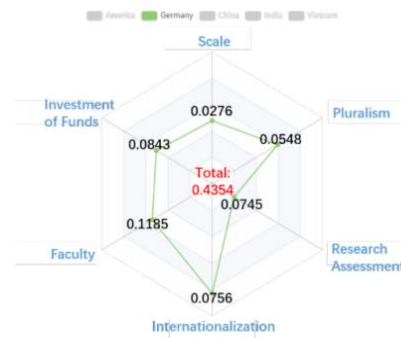


Figure 4: Germany

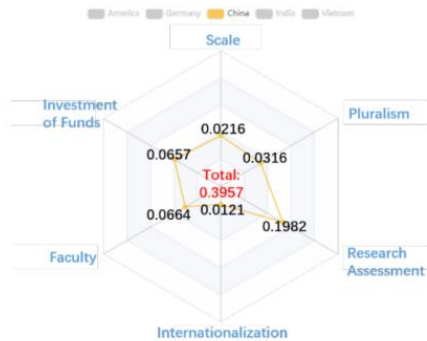


Figure 5: China

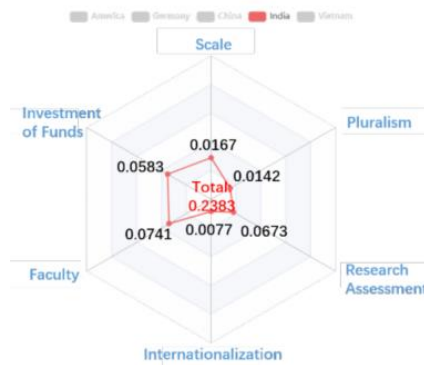


Figure 6: India

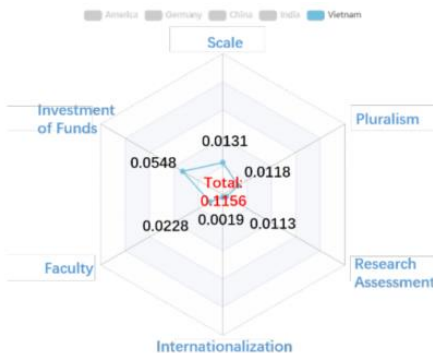


Figure 7: Vietnam

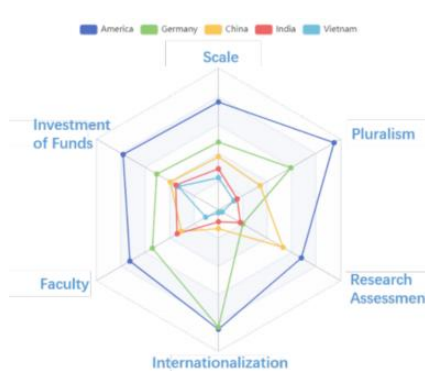


Figure 8: Comparison of five countries

According to the above radar charts, it can be found that each country's higher education system has

its own characteristics, and at the same time, the development level is also quite different.

In general, the overall score of health of higher education system from high to bottom is: America, Germany, China, India, Vietnam. It can be clearly found that this is approximately positively correlated with the economic development level and comprehensive national power of the selected country, and the result is also consistent with people's popular perception of higher education in countries of the world. As developing countries, China, India and Vietnam still have a big gap with developed countries such as America and Germany.

4. Conclusion

It is found that all the indicators of higher education in the United States are among the best in the world, which indicates that the higher education system of the United States is developing healthily and comprehensively. Germany has obvious advantages in internationalization, and the other indicators are also at a high level. As the fastest developing country in recent decades, China has made rapid progress in economy and science and technology. Its scientific research level is far ahead of other countries and close to that of the United States.

References

- [1] Feng Lin, Xiulan Zhang. *Mathematical modeling and experiments*. Beijing: Chemical Industry Press, 2016. 12.
- [2] Nanxing Zhang, Shu Wang, Jihong Sun. *Research on Evaluation and Regional Difference of Comprehensive Development Level of Higher Education in China [J]*. *Education research*, 2014, 35(05): 28-36.
- [3] http://www.moe.gov.cn/s78/A03/moe_560/jytjsj_2019/
- [4] <https://data.stats.gov.cn/easyquery.htm?cn=C01>
- [5] <https://cn.knoema.com/atlas>
- [6] <https://www-genesis.destatis.de/genesis/online>
- [7] <http://www.ed.gov>
- [8] <https://studienwahl.de/studieninfos/studieren-im-ausland/internationale-studiengaenge>
- [9] <https://de.statista.com/statistik/daten/studie/259927/umfrage/einnahmen-der-hochschulenin-deutschland-nach-hochschularten/>
- [10] <https://www.research-in-germany.org/de/forschungslandschaft/forschungseinrichtungen.html>
- [11] <https://www.moet.gov.gn>
- [12] <https://www.education.gov.in/hi>