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Higher Education Health Evaluation Based on Analytic Hierarchy Process

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Abstract: *Looking around the world, the higher education system has both the value of industry itself and the value of providing well-trained citizens for the national economy. Therefore, the health status of a country's higher education system is of particular importance. We have seen higher education methods in various countries, which have both strengths and weaknesses. Each country needs to think about what is feasible and better in the education system. Therefore, this paper establishes a model that can evaluate the health of the country's higher education system. Combined with some relevant data on education in recent years, we choose to use the amount of intellectual property rights, the proportion of public education in GDP, the number of universities, and higher education penetration rate and the number of international students as five indicators to assess the health of the education system. Then use the Analytic Hierarchy Process (AHP) to obtain the weight of the five indicators through Matlab, namely [0.3542 0.3542 0.1632 0.0800 0.0484], and then obtain the national higher education system score through a series of calculations. In addition, we have also conducted a consistency test to ensure the accuracy of the data.*

Keywords: *National Higher Education System Health Assessment, AHP*

1. Introduction

Having a healthy and sustainable higher education system in a country means more and higher education costs, opportunities, fairness, education quality, and research levels. The higher education system is an important factor in a country's efforts to further educate its citizens rather than the required primary and secondary education. Therefore, it is both an industry itself and a source of trained and educated citizens in the country's economy. Each country's higher education system has its own strengths and weaknesses. Through long-term implementation of policies, a healthier and more sustainable higher education system can be obtained.

Therefore, assessing the health of the current higher education system is particularly important for the development of a country.

2. Models of Higher Education System Evaluation

2.1 Model of Scoring

In order to obtain the health status of the higher education system in each country, we have determined the use of intellectual property rights, the proportion of public education in GDP, the number of universities, the penetration rate of higher education, and the number of international students as five indicators to assess the health status of the education system. After searching for a large amount of data and synthesizing the opinions of experts in related fields and referring to the World University Bachelor Ranking [1], we relatively objectively determined the importance of the five indicators, and the approximate proportions are shown in Figure 1.

Intellectual property and public education account for the same proportion of GDP, followed by the number of colleges and universities, followed by the popularization rate of higher education, the lowest proportion of foreign students.

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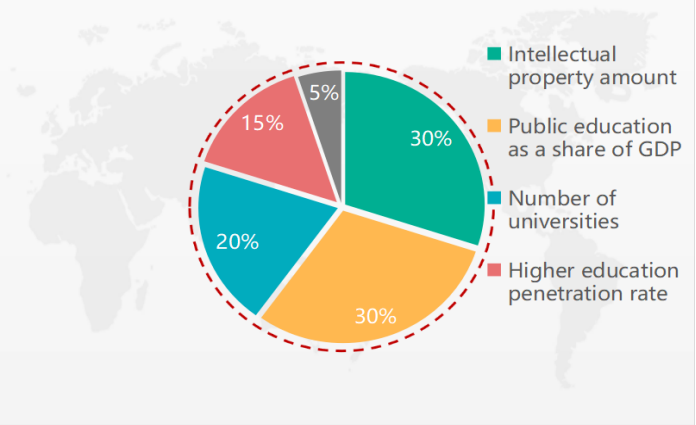

Figure 1: Percentage of indicators

2.2 Analytic hierarchy process to calculate index weight

The algorithm is designed as follows.

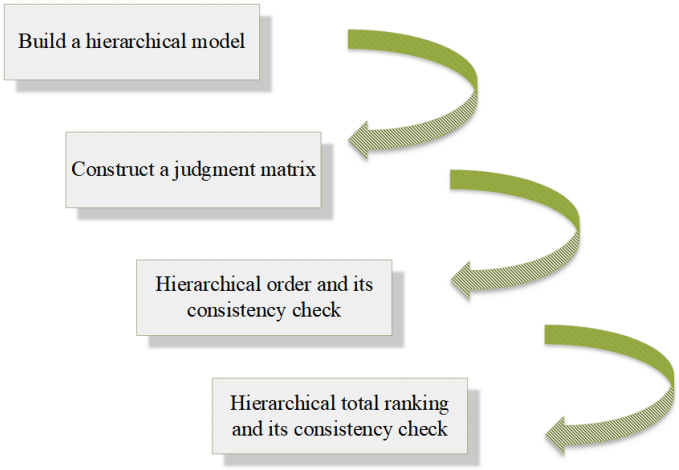

Figure 2: Model algorithm design

Through the above preparations such as consulting information, we first construct a judgment matrix A for the five indicators.

$$A=\begin{pmatrix} 1 & a_{12} & a_{13} & a_{14} & a_{15} \\ a_{21} & 1 & a_{23} & a_{24} & a_{25} \\ a_{31} & a_{32} & 1 & a_{34} & a_{35} \\ a_{41} & a_{42} & a_{43} & 1 & a_{45} \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 \end{pmatrix}$$

In the matrix, a_{ij} represents the importance of index i compared with index j, and this matrix is a reciprocal matrix.

Calculate the consistency index CI, n is the matrix order.

$$CI=\frac{\lambda_{\max}-n}{n-1}$$

Find the corresponding average random consistency index RI

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Table 1: Coincidence indicator

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0	0	0.52	0.89	1.12	1.26	1.26	1.41	1.46	1.49	1.52	1.54	1.56	1.58	1.59

Calculate the agreement ratio CR

$$CR = \frac{CI}{RI}$$

If CR<0.1, we determine that the consistency of the judgment matrix A is acceptable, and the matrix passes the consistency test.

If the consistency test is not passed, the judgment matrix needs to be readjusted.

After passing the consistency test, we choose the arithmetic average method to calculate the weight w_i.

$$w_i = \frac{1}{n}\sum_{j=1}^{n}\frac{a_{ij}}{\sum_{k=1}^{n}a_{kj}}(_{i=1,2,3,4,5})$$

After using the analytic hierarchy process [2], we get the weights of five indicators, and the results are show in Table 3.

Table 2: Indicator weights

Evaluation index	**Index Weight**
Intellectual property amount	0.3542
Public education as a share of GDP	0.3542
Number of universities	0.1632
Higher education penetration rate	0.0800
Number of international students	0.0484

2.3 Calculating country scores and assessing

First, according to the analytic hierarchy process, we list the paired comparison matrices for the five indicators between the predicted country and the average country, and calculate the corresponding weights, get the final weight matrix, and calculate the score C_i. And could through the processing of $Ci \times 100$ to get a more intuitive comparison.

For assessing the health status of a country's higher education system, we can obtain the health status by comparing the country's scores with the "average country", and can more intuitively detect the relative levels of the five indicators.

3. Application of the Model

Based on the application of the above education system evaluation model and we query related index data about the United States [3], Japan [4], China [5], and Germany [6]. These four countries were selected as the evaluation countries, and the results shown in Table 4 were obtained.

Table 3: Final Weight and Score

countries / Evaluation index	Index Weight	America	Japan	Chain	Germany
Intellectual property amount	0.3542	0.6664	0.2124	0.0304	0.0908
Public education as a share of GDP	0.3542	0.5762	0.1341	0.0509	0.2389
Number of universities	0.1632	0.6304	0.0668	0.2396	0.0632
Higher education penetration rate	0.0800	0.5292	0.3098	0.0408	0.1202
Number of international students	0.0484	0.6720	0.0677	0.1648	0.0955
Country score		0.617871	0.16169274	0.08744638	0.14133218

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In order to more intuitively see the differences in various indicators and scores of the four countries, we visualized the data and obtained the results shown in Figure 2 and Figure 3.

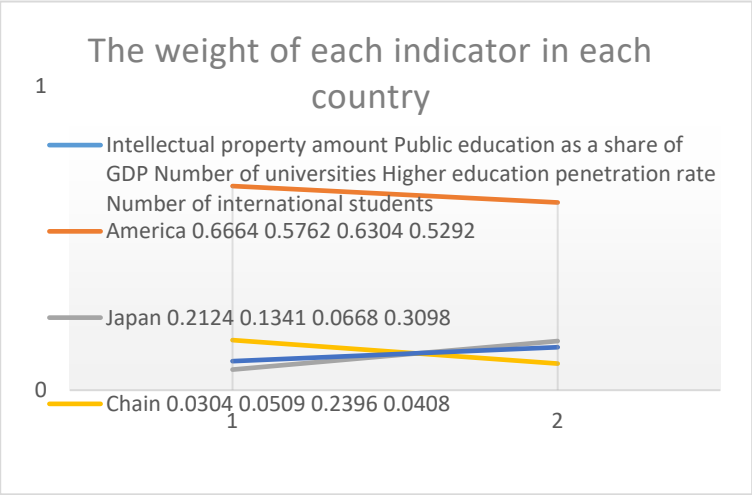

Figure 3: Indicator differences

In Figure Figure 3, we can see that although Japan ranks higher in the total score, there are still some indicators with lower scores. For this reason, we will propose some policies and visions for Japan.

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