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Models for the Health and Sustainability of Higher Education System

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Abstract: In order to measure and evaluate the health status of higher education system in a country, this article proposes a more comprehensive evaluation index system of higher education which model the health and sustainability of higher education. Firstly, this article uses the combination of Analytic Hierarchy Process (AHP) and factor analysis to determine the weight of evaluation indexes and then use the improved comprehensive weighted method to evaluate the health of higher education. This article also proposes a health index of higher education to reflect the health development status of higher education in this country.

1. Introduction

Education is the cornerstone of national and social progress, and the fundamental way to improve the quality of the people and promote their all-round development. The level of education can not only reflect the comprehensive strength of a country, but also improve the strength of a country. In today's world, talents have become the core of national competitiveness and education has become the foundation of national competitiveness. In the process of the profound transformation of human society, education is playing an increasingly important role in the leading position [1].

A comprehensive and complete higher education evaluation system must consider various factors from various angles and levels, including cost, access, equity, funds, degree value, education quality, research level and so on. At the same time, in order to ensure the implementation of the evaluation system and obtain reliable results, the following principles should be followed in the establishment of the evaluation system: scientific, instructive, dynamic and operable [2].

2. Model analysis by AHP

This article refers to previous articles on higher education evaluation and the basic principles of constructing the evaluation index system, designing the framework of the higher education health evaluation index system, students, investment, and production through the Analytic Hierarchy Process analysis method. The health evaluation index system of higher education is divided into four

levels:

(1) Target layer (A): The first-level indicator is the target layer (A), which takes the state of higher education as the target and is used to measure the overall situation of higher education in a country.

(2) Subsystem level (B): The second-level indicator is the subsystem level (B), which constitutes the sustainable development country, including basic indicators of education-related personnel, basic situation index of students, input index, output indicators.

(3) Criterion layer (C): The three-level index is the Criterion layer (C), which provides the representation of basic situation, health and sustainability for the subsystems it belongs to.

(4) Indicator level (D): The Four-level index is the indicator level (D), which is the specific factor for evaluating and assessing the situation of each subsystem. The ratio of teachers to students, the professional title of teachers, and the ranking of colleges and universities are selected to reflect the situation of higher education in terms of the personnel related to education.

3. Model building of HEHI

3.1 Determination of the weights

After using Analytic Hierarchy Process the article determines the weight of evaluation indexes and then uses the improved comprehensive weighted method to evaluate the health of higher education. Then, the article puts forward a health index of higher education, which reflects the health development status of higher education in this country [3].

Through construct judgment matrix, the article determinates the weights of the first and second indexes. The form of judgment matrix is shown in Equation1. In the formula, b_{ij} means: relative to a unit in the upper layer, the importance coefficient of element b_i and b_j in this level; N is the value of the number of elements associated with the specific units in the upper layer, which is generally determined by 1-9 scale method, as shown in Table 1.

$$B = \begin{pmatrix} b_{11} & \cdots & b_{1n} \\ \vdots & \ddots & \vdots \\ b_{n1} & \cdots & b_{nn} \end{pmatrix} \tag{1}$$

Table 1: 1-9 Scale method

Scale	Meaning
1	Indicates that two factors are equally important
3	One factor is slightly more important than the other
5	It means that one factor is obviously more important than the other
7	It means that one factor is more important than the other
9	One factor is more important than the other
2,4,6,8	The median value of the two adjacent judgments
The Bottom	B_{ij} is obtained by comparing B_i, and B_j is equal to $1/b_{ij}$

Calculates the product of each row element of the judgment matrix *B*.

$$M_i = \prod_{j=1}^{n} b_{ij} \quad (\ j\ =\ 1,2,\ldots,n\ ) \tag{2}$$

Compute the NTH root of M_i.

$$\bar{w}_i = \sqrt[n]{M_i} \quad (\ i\ =\ 1,2,\ldots,n\ ) \tag{3}$$

Normalize the vector $\bar{w}$.

$$W = \frac{\bar{w}_i}{\sum_{i=1}^{n} \bar{w}_i} \quad (\ i\ =\ 1,2,\ldots,n\ ) \tag{4}$$

The weight of three indexes is determined by factor analysis method. Firstly, retrieve and process data. In this paper, the final 16 indicators were scored according to the index system, and the statistical software SPSS24 was used for data processing. Secondly, Kaiser Meyer Olkin (KMO) Test and Bartlett's Test of Sphericity were used to verify the suitability of factor analysis in this study.

3.2 Calculation of the HEHI

Then, calculation of the national higher education health composite index (HEHI). The longitudinal evaluation analysis refers to the evaluation and analysis of the health status of higher education in specific countries in different years [4]. For a specific country, in a given time range (assumed to be m years), each indicator D_i (assumed to have n indicators) in the index system has m specific values, then the corresponding standardized formula is:

When D_i is the positive indicator (positive indicator refers to the indicator that the greater the value in the development of national water resources, the better):

$$v_{ij} = \frac{d_{ij} - \min(d_{ij})}{\max(d_{ij}) - \min(d_{ij})} \quad (i\ =\ 1,2,\ldots,n;\ j\ =\ 1,2,\ldots,m) \tag{5}$$

When D_i is the inverse indicator (inverse indicator refers to the indicator that the lower the value is in the development of the country's water resources, the better):

$$v_{ij} = \frac{\min(d_{ij}) - d_{ij}}{\max(d_{ij}) - \min(d_{ij})} \quad (i\ =\ 1,2,\ldots,n;\ j\ =\ 1,2,\ldots,m) \tag{6}$$

V_{ij} – The standardized value of the *i*th indicators in the year *j* of a specific country.

d_{ij} – The *i*th index value in year *j* for a specific country.

$Max(d_{ij})$ – The maximum value of the *i*th index of a specific country in a given time range.

$Min(d_{ij})$ – The minimum value of the *i*th index of a specific country in a given time range.

Then, calculate the values of the four-level indicator.

$$Q_{ij} = v_{ij} \quad (i\ =\ 1,2,...,n;\ j\ =\ 1,2,...,m) \tag{7}$$

Calculate the national higher education health composite index (HEHi).

$$HEHi_j\ =\ \sum_{i=1}^{s} W_i Q_{ij}\ \ (i\ =\ 1,2,...,n;\ j\ =\ 1,2,...,m) \tag{8}$$

Due to the development of a national education must be to build in the context of social stability, when a country faced extreme natural disasters and communicable diseases, war, and so on and so forth, the country's HEHi cannot correct expression of the overall situation of education of the country, so we introduce a major accident factor λ. The effect of λ on the health of higher education is shown below:

$$HEHI = e^{-\lambda} HEHi \quad (9)$$

The value of major accident coefficient λ will be determined by the severity of major accident in a country, and its corresponding relationship is shown in the Table 2.

Table 2: The value of λ

The value of λ	Impact of major accidents
0	Not affected by major accidents
0-0.5	Less affected by major accidents
0.5-1	Generally affected by major accidents
＞1	Seriously affected by major accidents

4. Testing model

In this case, we use our model to calculate HEHI values for 96 countries. The Figure 1 shows the result, with missing data for countries shown in white.

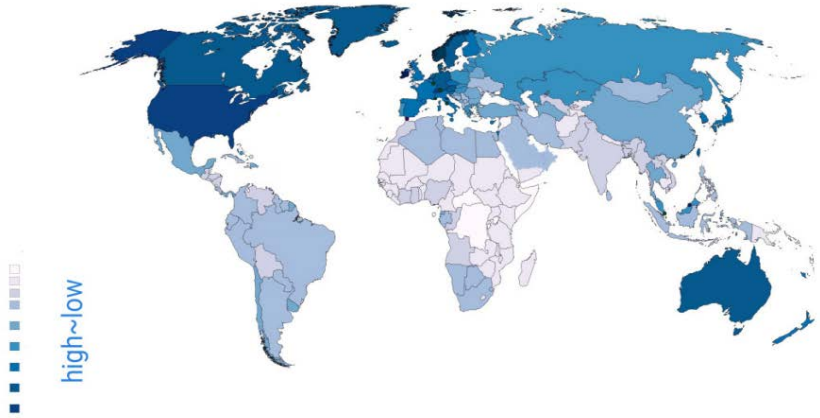

Figure 1: National view of HEHI

5. Conclusion

In this paper, the improved comprehensive weighted method is adopted to evaluate, and the AHP analytic hierarchy process analysis method are combined to solve the weight problem of comprehensive analysis and evaluation, which can be more effective in comprehensive evaluation of the health of higher education. The model also has some shortcomings. Indicators are selected on the basis of considering the availability of existing data, so there are inevitably incomplete defects. Some of the problems associated with higher education cannot be accurately described by a single indicator.

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