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Health Insurance of Higher Education

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Abstract: A system of higher education has value both as an industry itself and as a source of trained and educated citizens for the nation's economy. In this paper, we develop a model to measure and assess the health of a system of higher education at a national level and to propose a suite of policies to migrate a nation from its current state to our proposed healthy and sustainable state. We first analyze various indicators that affect the health level of higher education, and build a CIPP evaluation system. Then, we establish the TOPSIS comprehensive evaluation model optimized by entropy weight method, determine the weight of each index, and quantify the health status of higher education in many countries. Our conclusion is that the average health index of higher education in European countries is higher. This model lays a foundation for our subsequent evaluation.

1. Introduction

Higher education is an important part of the education system. The rapid growth of the society's demand for senior specialized talents lead to the rapid development of higher education. However, building a country with a higher education power is a long and complicated process. Each country's higher education system has its own strengths and weaknesses. Therefore, how to evaluate the quality of higher education has become a key factor guiding the development of higher education in various countries.

2. Evaluation model

2.1 Model introduction

In order to quantify the health status of higher education systems in different countries, we first established a TOPSIS comprehensive evaluation model based on the CIPP evaluation system, which scored ten indicators of higher education in ten countries including the United States, Britain, and Germany. However, the TOPSIS model cannot confirm the importance of each indicator. Therefore, we adopted a dynamic comprehensive evaluation model combining entropy weight method and TOPSIS, and obtained the entropy weight of each indicator. Basedon this model, we scored and

ranked the health status of higher education systems in different countries.

2.2 CIPP evaluation system

At present, the basis for the design of the evaluation index system is mainly based on two aspects [1], one is to start from conceptual analysis [2], deductively decompose the attributes of the object to generate various indicators. The other is to determine the evaluation index system according to the evaluation purpose [3].

The purpose of evaluation has a guiding role in the selection of evaluation indicators. Different evaluation purposes will lead to differences in the evaluation index system. Based on the educational CIPP model (Context-Input-Process-Product) proposed by Stufflebeam, L.D. [4], we start with the structure of the evaluation purpose, analyze the various factors included in the evaluation purpose, and list them all, and then repeat Based on the analysis and selection, the index that best reflects the target system was refined, and finally the following higher education index evaluation system based on the CIPP framework was formed.

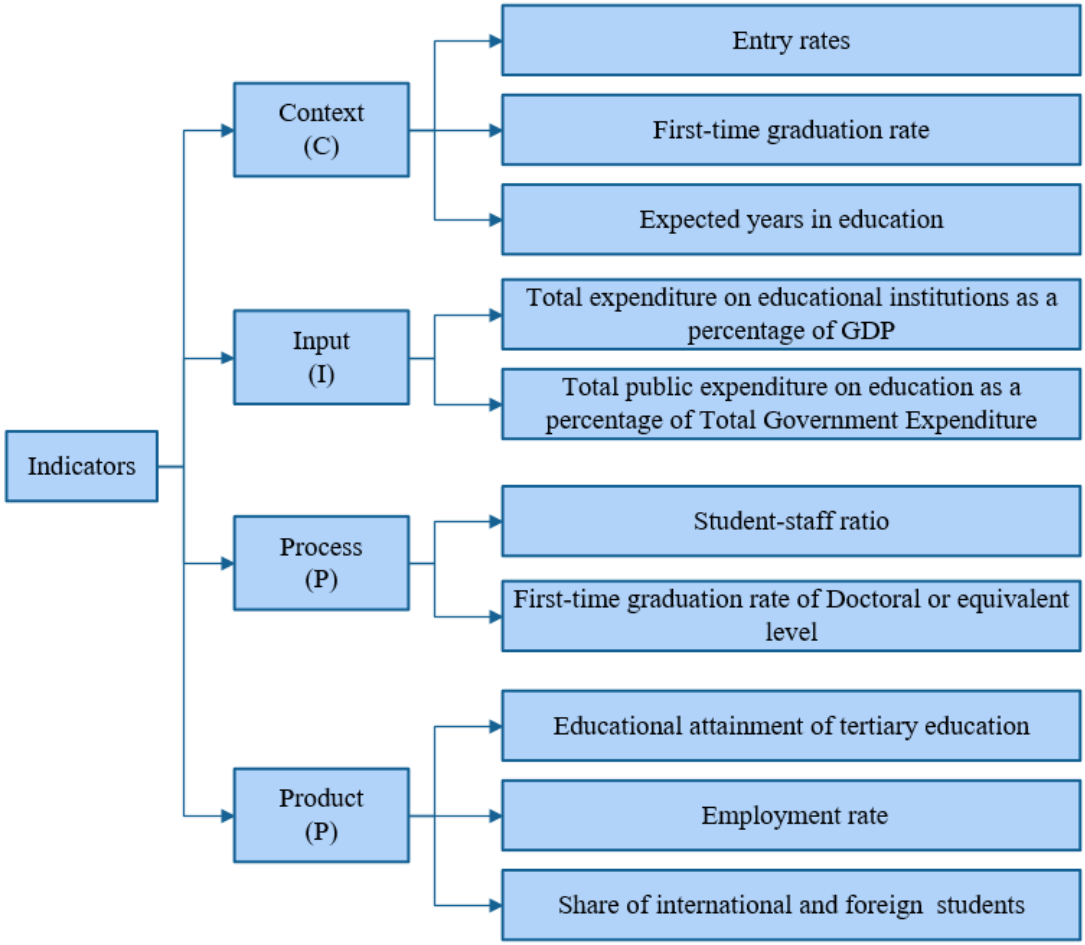

Figure 1. CIPP evaluation system

2.3 Data preprocessing

In order to establish a model based on the above-mentioned CIPP evaluation system, we first collected the latest data on the above-mentioned indicators in 10 countries including theUnited States and the United Kingdom from the OECD official website [5].

among them,x_1Represents the enrollment rate,x_2Indicates the first graduation rate,x_3Indicates the average years of education per capita,x_4Indicates the ratio of expenditures of higher education institutions to GDP,x_5Indicates the ratio of total higher public education expenditure to total government expenditure,x_6Indicates the ratio of students to teachers,x_7Indicates the graduation rate of doctoral students under 35,x_8Indicates the proportion of people aged 25-64 receiving higher education,x_9Represents the employment rate of the population aged 25-64,x_{10}Indicates the proportion of international students.

Table 1 National Higher Education Indicators Data

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}
United States	44	50	6.6	0.8	3.7	13.82	1	48.3	56.1	5.2
United Kingdom	54	41	5.4	0.7	3.4	15.38	1	47.2	65.4	18.3
Germany	45	32	8.1	1.0	2.8	11.97	2	29.9	61.9	10.0
Norway	57	43	7.0	1.7	4.2	9.35	1	44.1	61.5	4.3
New Zealand	48	36	5.5	0.8	3.7	18.07	0	39.1	71.7	19.7
Luxembourg	15	8	8.5	0.4	1.1	4.36	0	51.6	61.6	47.7
Finland	43	37	8.2	1.1	3.1	15.33	1	45.9	54.9	8.4
Hungary	32	23	6.3	0.7	1.7	11.54	1	26.0	57.0	11.4
Mexico	45	15	5.6	0.8	3.5	18.13	0	18.3	65.6	0.2
Sweden	41	25	8.0	1.2	3.6	10.14	1	44.0	67.0	7.2

Because the meaning of each indicator is different, we first forward the data, that is, all the above data becomes a positive indicator. In particular, the ratio of students to teachers$x_6$in this intermediate variable, take the optimal valuex_{best}Do the following normalization processing:

$$\overline{x_i} = 1 - \frac{|x_i - x_{best}|}{max(|X - x_{best}|)}$$

Then, because the measurement units of various indicators are not uniform, we standardize the results of the normalization:

$$Zij = \frac{xij - min(xj)}{max(xj) - min(xj)}$$

The value range of the standardized matrix is between (0,1). Standardized results are as follow

Table 2 Standardization Results

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}
United States	0.69	1.00	0.39	0.31	0.84	1.00	0.50	0.90	0.07	0.11
United Kingdom	0.93	0.79	0	0.23	0.74	0.87	0.50	0.87	0.63	0.38
Germany	0.71	0.57	0.87	0.46	0.55	0.80	1.00	0.35	0.42	0.21
Norway	1.00	0.83	0.52	1.00	1.00	0.53	0.50	0.77	0.39	0.09
New Zealand	0.79	0.67	0.03	0.31	0.84	0.59	0	0.62	1.00	0.40
Luxembourg	0	0	1.00	0	0	0	0	1.00	0.40	1.00
Finland	0.67	0.69	0.90	0.54	0.65	0.88	0.50	0.83	0	0.17
Hungary	0.40	0.36	0.29	0.23	0.19	0.76	0.50	0.23	0.13	0.24
Mexico	0.71	0.17	0.06	0.31	0.77	0.58	0	0	0.64	0
Sweden	0.62	0.40	0.84	0.62	0.81	0.61	0.50	0.77	0.72	0.15

2.4 TOPSIS evaluates higher education

We use the above processing data to establish a TOPSIS model.

First, we select and combine from the processed data into a set of optimal and worst solutions. Then, we calculated the positive distance and the negative distance of each set of index data relative to the optimal and worst plan sets.

$$Di^{+} = \sqrt{\sum_{j=1}^{10}(Zj^{+} - Zij)}^{2}$$

$$Di^{-} = \sqrt{\sum_{j=1}^{10}(Zj^{-} - Zij)}^{2}$$

According to the positive distance and the negative distance, we can calculate the comprehensive evaluation index:

$$Vi = \frac{Di^{-}}{Di^{+} + Di^{-}}$$

However, TOPSIS comprehensive evaluation model cannot measure the importance of various indicators. In order to solve this problem, we can use expert scoring or entropy weight method to determine the weight of various indicators. Compared with expert scoring, entropy weight method is completely based on data and is more objective. Therefore, we will adopt the TOPSIS comprehensive evaluation model optimized by entropy weight method.

2.5 TOPSIS optimized by entropy method to evaluate higher education

Entropy method is a method to determine the weight of index data according to the degree of difference of index data between different schemes. According to the characteristics of entropy, we use the entropy value to judge the degree of dispersion of indicators that affect the level of higher education, and to reflect the impact of each indicator on the results of the comprehensive evaluation.

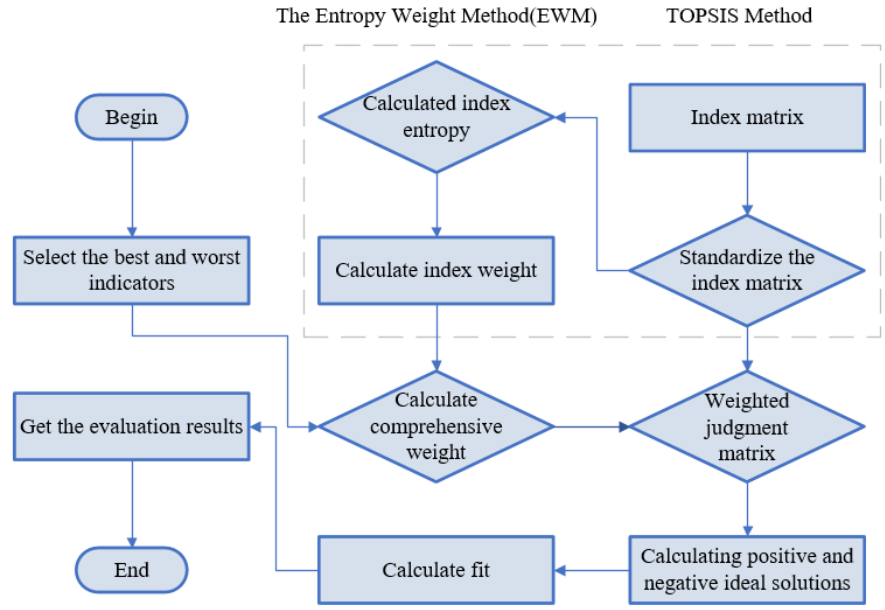

Figure 2. Flow chart of TOPSIS model optimized by entropy method

We use the entropy method to optimize the TOPSIS model. The steps are as follows:

First, after we standardize the data of each indicator j under the index i the proportion of items in this indicator is:

$$Pij = \frac{zij}{\sum_{i=1}^{10} zij}, i = 1,2,\cdots,10, j = 1,2,\cdots,10$$

Then, we calculate the first$j$the entropy value of an indicator. The greater the information entropy, the less information can be obtained.

$$ej = -\frac{1}{ln(n)}\sum_{i=1}^{10} Pijln(Pij)$$

By entropyej,we obtain the information utility value:

$$dj = 1 - ej$$

Finally, we can obtain the entropy weight of each indicator:

$$wj = \frac{dj}{\sum_{j=1}^{10} dj}$$

The calculation results of the entropy weight of each indicator are as follows:

Table 3 Entropy weight of each index

	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}
w_j	0.0532	0.0796	0.1467	0.0921	0.0661	0.0516	0.1603	0.0710	0.1152	0.1643

According to the above result of w_j, we modify the positive and negative distance formulas in TOPSIS model:

$$Di^{+} = \sqrt{\sum_{j=1}^{10} wj(Zj^{+} - Zij)^{2}}$$

$$Di^{-} = \sqrt{\sum_{j=1}^{10} wj(Zj^{-} - Zij)^{2}}$$

Finally, we substitute the corrected positive and negative distances into the comprehensive evaluation index calculation formula to calculate the health index of higher education in each country.

2.6 Scoring of higher education systems in various countries

Based on the TOPSIS comprehensive evaluation model optimized by the above entropy method, the health index scores and ranking results of countries are as follows:

Table 4 Score of Higher Education Systems in Different Countries

Country	Score	Rank
Germany	0.5751	1
Sweden	0.5592	2
Norway	0.5550	3
Finland	0.5204	4
United Kingdom	0.5072	5
United States	0.4846	6
Luxembourg	0.4616	7
New Zealand	0.4599	8
Hungary	0.3334	9
Mexico	0.3181	10

The results show that Germany, Norway, Finland and Sweden have higher health index of higher education, which means higher quality of higher education, while Hungary and Mexico have a poorer quality of education. Comparing the ranking of higher education health index generated by the model with the official ranking provided by OECD, they are roughly the same. This further verifies the rationality of the model.

3. Conclusion

The CIPP evaluation system is used to support us to select indicators, and the data are more convincing. optimizing TOPSIS evaluation method by entropy weight method only starts with data, ignoring the actual background of the problem, which may be contrary to common sense when determining the weight.

We use entropy weight method based on CIPP evaluation system to optimize the evaluation model of TOPSIS method, and use entropy weight method to determine the missing objective weight in TOPSIS method. The combination of the two makes the evaluation of higher education system more stable and reliable. We applied the model to Colombia, Greece and Italy, and chose Colombia with the worst health condition as our country for improvement.

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