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University Education Evaluation System Based on Weighted TOPSIS Model

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Abstract: *The higher education system is an important factor in the promotion of the national econ- omy, so it is of great significance to evaluate the higher education system of a country or region. Next, our team will build a model to evaluate the health of higher education systems in some countries. We first determined 9 education-related indicators including international awards, and selected 11 countries including the United States and the United Kingdom for eval- uation. The entropy weight TOPSIS model was used to complete the preliminary evaluation, but the ranking results are far from reality. Therefore, we introduced a new index variation coefficient to improve our model. Finally, the TOPSIS method is used to evaluate the indicators again, and the results are close to reality and satisfactory.*

Keywords: *higher education system, balanced weighted TOPSIS, evaluation model*

1. Introduction

The level of higher education system is an important symbol of a country's comprehensivenational strength and development potential, and therefore has value both as an industry itself and as a source of trained and educated citizens for the nation's economy. As we look around the world, we see a variety of national approaches to higher education.In the wake of adjustmentsrequired during the current pandemic, we need to develop a model to measure and assess the health of a system of higher education at a national level, to identify a healthy and sustainablestate for a given nations higher education system.

2. Model Establishment and Solution

2.1 Establishment of evaluation indexes and reference countries

2.1.1 Selection of evaluation indexes

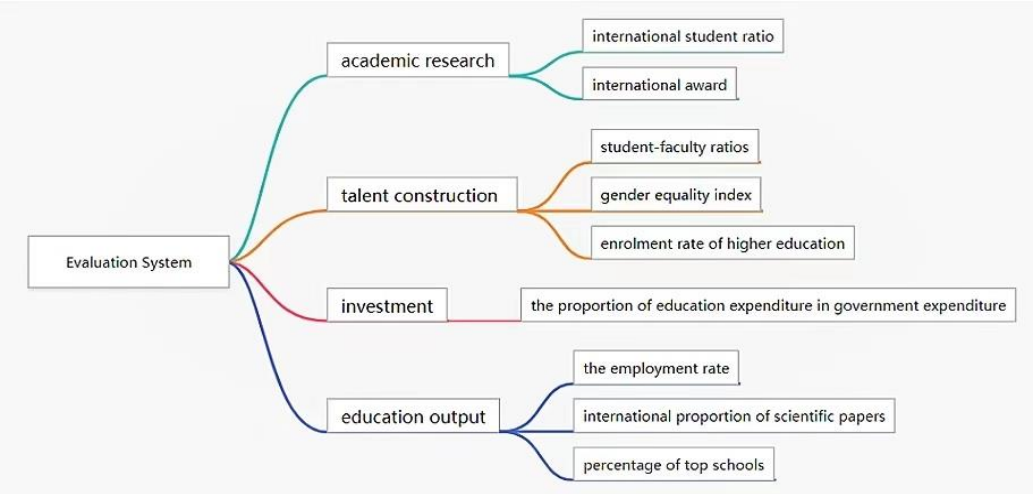

Figure 1: Evaluation index system

The selection of evaluation index is a process of repeated practice and abstract logical thinking. A scientific evaluation system uses as few indicators as possible to reflect as comprehensive information as possible. Therefore, we combined with the existing literature, according to the integrity principle and

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scientific comparability principle, constructed the evaluation index system, as shown in Figure 1. There are a total of 9 evaluationindexes.

2.1.2 Reference country selection

This paper selects the country application model based on the developed countries. Eleven countries are selected, including six developed countries (the United States, the United Kingdom, France, Germany, South Korea, and Japan) and five developing countries (Russia, China, India, Brazil, Turkey).

2.2 Modeling method: weighted TOPSIS model

2.2.1 Background of TOPSIS model

TOPSIS method (Approximate Ideal Ranking Method) is a multi-objective decision making method in systems engineering. It can find the best and worst solutions in limited solutions. When a feasible solution is closest to the best solution and far away from the worst solution, thevector set of the solution is the optimal impact evaluation index.As a kind of comprehensive index evaluation method, TOPSIS method is different from such as fuzzy comprehensive evaluation method, analytic hierarchy process (ahp), its subjectivity is stronger, don't need the objective function, also do not need through the corresponding inspection, which limit requirements reduced greatly, make wider range of application, this method had advantages of simple calculation, the result is reasonable, the application of flexible etc, its use and comprehensive evaluation of higher education system, to achieve satisfactory results.

2.2.2 Modeling steps

Step1: The evaluation index system is used to establish anormalized matrix to standardize the data.The formula can be expressed as

$$Z_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{n} x_{ij}^2}}$$

Where i represents the number of selected countries,j represents the number of indexsystems constructed, and x_{ij} table show the score of the j TH evaluation index system inthe ith country.

Step2: Based on the Z matrix obtained above, the optimal vect $z_j^+ = max_{1\le i\le m}\left|z_j^i\right|$ and the worst vector $z_j^- = min_{1\le i\le m}\left|z_j^i\right|$ can be obtained.

Step3: Entropy weight method is used to determine the weight.

Step4: Calculate the Euclidean distance between the index of each country selected or constructed and the optimal vector $D^+ = \sqrt{\sum_{j=1}^{n}(z_{ij} - z_j^+)^2}$ and the distance from the worst vector $D^- = \sqrt{\sum_{j=1}^{n}(z_{ij} - z_j^-)^2}$

Step5: Finally get the relative close degree to the optimal value $W_i = \frac{D_i^-}{D^+ + D^-}$ and then the score and ascending order (the higher the score, the higher the ranking) are ranked.

Through the weighted TOPSIS method, we carry out the same trend and normalization processing on the original data, eliminating the influence of different indicators dimension.Theresults of sorting make full use of the original data information, and can quantitatively reflect the merits and demerits of different evaluation units, which is more intuitive and reliable.The relative proximity of the weighted average value obtained is between 0 and 1. The closer this value is to 1, the higher the degree of the evaluation unit to the optimal level is. On the contrary,the closer this value is to 0, the lower the degree of the evaluation unit to the optimal level is orthe closer to the worst level.

2.3 Results analysis

The result ranking obtained by the TOPSIS evaluation model has some irrationality.China, for example, came in third place, scoring higher than developed countries such as Germany and Japan.After observing the normalized data of the indicators, it can be found that China is much higher than these countries in theratio of high-quality paper publication with the highest weight, while other indexes are almostinferior to Germany and Japan. In other words,there is a phenomenon that a country relieson

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a few extremely high indexes to pull the ranking.This indicates that the TOSIS evaluation model has certain deficiencies and can not fully explain the health degree of a country's highereducation system, which needs to be further improved.

2.4 Model improvement

2.4 1 Equilibrium TOPSIS method

The TOPSIS method considers that there is linear complementarity among the indica- tors.When the value of some indexes is low, other indexes with higher values can be supple-mented in the evaluation results.In this way, the influence of the balance degree of the index on the evaluation result is ignored.In view of the problem that the balance degree of evaluation indexes is not considered in the current comprehensive evaluation method, which leads to someextreme values having a great impact on the evaluation results. Therefore, we introduced the

Coefficient of variation to measure the balance degree of evaluation indexes, and proposed the balanced weighted TOPSIS model to improve the evaluation results.

a) The specific operation method is as follows:

$$C_i = \sum_{j=1}^{n} (w_j \times x_{ij})^2$$

Where x_{ij} is the dimensionless value of the index, w_j is the weight of the j TH index of theindex, and C_i is the comprehensive evaluation value of the i th object.

b) Calculate the coefficient of variation of dimensionless value of the index. The calculationformula is as follows:

$$V_i = \frac{\sigma_i}{\vartheta_i} = \frac{\sqrt{\frac{1}{n}\sum_{j=1}^{n}(x_i - \vartheta_i)^2}}{\vartheta_i}$$

In the formula, $\vartheta_i$is the mean value, σ_i is the standard deviation, and ϑ_i is the coefficient of variation. The coefficient of variation is zero, indicating that the dimensionless values of theindicators are consistent and the indicators are completely balanced. Obviously, the greaterthe coefficient of variation, the more unbalanced the indicators.

c) The comprehensive evaluation value considering the degree of equilibrium is calculated. Considering the different meanings represented by the evaluation value and the coefficient of variation, it is necessary to combine them after standardized treatment. Considering that thesmaller the coefficient of variation is, the better the index, and the larger the evaluation valueis, the better the index, this paper adopts the following formula to combine the evaluation value and the coefficient of variation:

$$T_i = (1 - \vartheta)\frac{C_i}{max(C_i)} + \vartheta(1 - \frac{V_i}{max(V_i)} + \frac{min(V_i)}{max(V_i)})$$

In the formula, V is the weight of the balance degree. If more attention is paid to the balancedegree, $V >$ 0.5 is desirable. When all the index values are 0, the coefficient of variation cannot be calculated and T_i=0 is directly chosen.

2.4.2 Analysis of improvement results

Based on the above improved model, the comprehensive evaluation value of each countryis solved, as shown in Figure 2. Comparing the ranking before the improvement, it can be found that the ranking has changed slightly. After the improvement of China from the third to the seventh ranking, the reason is to take into account the balance of each indicator on the basis of TOSIS evaluation results, to eliminate the false high ranking caused by insufficient andunbalanced development, so that the evaluation results are more accurate and more scientific, the overall ranking is more in line with the actual situation.It can also be seen from the coefficient of variation. As shown in the Table 1, the coefficient of variation of developed countries is larger than that of developing countries on the whole, indicating that the education level of developed countries is more balanced.

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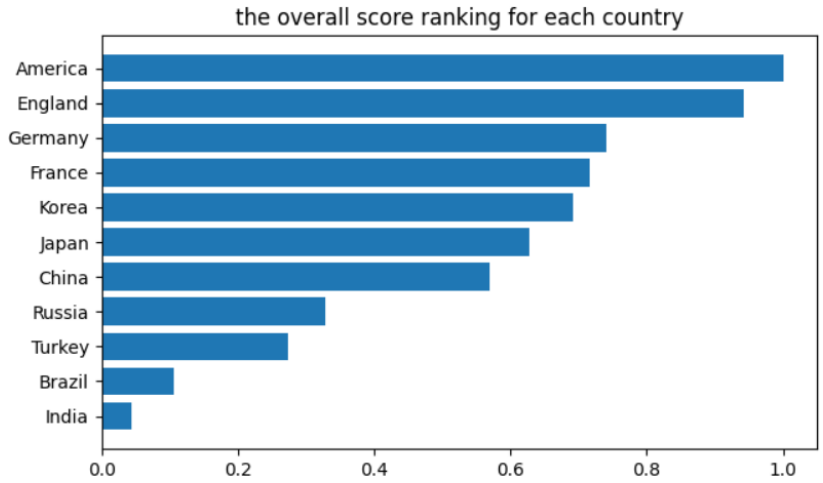

Figure 2: The results described

Table 1: Coefficient of variation

scale	implication
1	the same difficult
3	slightly difficult
5	obviously difficult
7	very difficult
9	sharp difficult
2,4,6,8	the mean of the two adjacent judgments above
reciprocal	If the first contrast between A and B is 1, then B and A will be 1/3.

3. Model Evaluation

3.1 Strengths

The models and data in this paper make a survey of the global higher education situationfrom both horizontal and vertical dimensions, and select countries at different levels foranalysis. The selection of data and models is representative.

When obtaining the comprehensive evaluation score, we introduced the coefficient of variation to measure the index equilibrium degree, and proposed the balanced weighted TOPSIS model to improve the evaluation results

3.2 Weaknesses

As the data websites of various countries are not updated in time, the lag of data query may affect the evaluation and prediction results.

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