Health Assessment of Higher Education System Based on TOPSIS Model

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Abstract:This article mainly discusses the health status and sustainability of the higher education system in various countries, and uses China as an example to assess the health of the higher education system and make relevant recommendations. This article mainly utilizes the optimal sequence diagram method, the TOPSIS model and the grey relational analysis method to construct the relevant evaluation model, and completes the suggestion policy for the specific country.

Keywords: higher education system; TOPSIS model; grey relational analysis method; grey prediction model

I. Introduction

First,it has an obligation to develop a set of models to evaluate the health status of the national higher education system, select appropriate and fair indicators. Secondly, this article evaluates the health of each country's higher education system based on the optimal sequence diagram and the TOPSIS model; finally, this article is based on the gray prediction model based on the health index obtained by the TOPSIS model Carry out sustainability analysis of higher education system on selected representative countries.

At the end of this article, we objectively evaluate the advantages and disadvantages of the model, and further evaluate and promote the model. In the current pandemic, we hope that this article can provide countries with applicable improvement ideas and suggestions.

II. Restatement of Problems

A. Background Knowledge

The development of higher education has always been the focus of international and academic circles, especially in this era of rapid information transmission and advanced science and technology. Higher education level is an important index to measure a country's comprehensive strength and national quality. Internationally, every country has its own unique higher education system, which has its own advantages and disadvantages. However, in today's society, the global economic integration and the rapid development of science and technology also mean that there are higher requirements for talents and technology, so the advantages and disadvantages of higher education system are more important [1-2]. Under the current environment of new-type coronary pneumonia epidemic, higher education systems in different countries present different situations, so it is necessary for us to think about the health of higher education system.

Therefore, we will use TOPSIS mathematical model and index weight method of precedence diagram to evaluate the health status and state sustainability of higher education in various countries, select China, a country with higher education system characteristics, evaluate its higher education system health, and put forward suggestions on its related policies.

B. Hypothesis of the Model

1. In this paper, the data from 2000 to 2018 are selected to study the level of higher education system.
2. This paper does not consider the economic and political reasons that can directly or indirectly affect the level of higher education system.
3. This paper does not consider the changes of the government's fiscal policy in the higher education system at that time.
4. It is assumed that the cited documents or conclusions are true and correct.
5. It is assumed that there are no special circumstances of uncontrollable factors such as natural disasters.

III. The Establishment and Solution of the Model

A. Determination of Weights by the Method of Precedence Diagram

When calculating the weights by the ordinal graph method, it is first necessary to construct the ordinal graph weight table (automatically constructed by SPSS),the construction method of priority graph weight table is:

First, calculate the average value of each analysis item, and then use the average value to compare it in pairs;Second, when the average value is relatively large, it is 1 point, when it is relatively small, it is 0 point, and when the average value is completely equal, it is 0.5 point;

Third, the larger the average value means the higher the importance (please make sure it is such data) and the higher the weight;

After completing the priority graph weight calculation table, then calculate TTL value and finally get weight value;

Firstly, combining with the priority graph weight calculation table, sum each row of data to obtain TTL value;Secondly, the TTL value is normalized, and finally the weight value is obtained.

B. The Establishment of TOPSIS Model

In TOPSIS, "ideal solution" and "negative ideal solution" are two basic concepts of TOPSIS. The so-called scheme ranking rule is to compare each alternative with the ideal

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solution and the negative ideal solution,If one of the alternatives is closest to the ideal solution and far away from the negative ideal solution, it is the best one among the alternatives.

We regard the higher education system mentioned as a multi-objective optimization problem. In this question, we select M evaluation objectives $D_1, D_2, \cdots, D_m$,In other words, there are n indicators for each goal of the country$X_1, X_2, \cdots X_n$[13].

The first step is matrix initialization

$$D = \begin{bmatrix} x_{11} & \cdots & x_{jn} \\ \vdots & x_{ij} & \vdots \\ x_{m1} & \cdots & x_{mn} \end{bmatrix} = \begin{bmatrix} D_1(x1) \\ \vdots \\ D_m(xn) \end{bmatrix} = [X_1(x1), \quad \cdots \quad X_n(xm)] \tag{1}$$

The second step is to calculate the normalization matrix

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \tag{2}$$

The third step is to construct the weight normalization matrix

By calculating the weight normalization value V_ij, the weight normalization matrix about the weight normalization value V_ij is established,

$$v_{ij} = w_j r_{ij} \tag{3}$$

The fourth step is to determine the ideal solution and the anti-ideal solution

The ideal solution A * and the anti-ideal solution A − can be determined according to the weight normalized value V_ij:

$$A^* = (max_i v_{ij} | j \in J_1), (min_i v_{ij} | j \in J_2), |i=1,2,\cdots m \tag{4}$$

$$A^* = (min_i v_{ij} | j \in J_1), (max_i v_{ij} | j \in J_2), |i=1,2,\cdots m \tag{5}$$

The fifth step is to calculate the distance scale

The distance from the target to the ideal solution A * is S *, the distance to the anti-ideal solution A is S^-:

$$S^* = \sqrt{\sum_{j=1}^{n} (V_{ij} - v_j^*)^2} \qquad S^- = \sqrt{\sum_{j=1}^{n} (V_{ij} - v_j^-)^2} \tag{6}$$

The sixth step is to calculate the closeness C * of the ideal solution.

$$C_i^* = \frac{S_i^-}{(S_i^* + S_i^-)} \tag{7}$$

The seventh step is to sort according to the closeness C * of the ideal solution.

C. Establishment of Grey Prediction Model

In this paper, based on the grey prediction model, the data of various countries in the past 18 years are predicted and analyzed, and the sustainability of the data is analyzed according to the fitting results shown in the twelve periods of prediction. In the grey prediction model, GM(1,1) model can predict the data with few data, incomplete series and low reliability, which does not consider the distribution law or change trend, and is suitable for short-term and medium-term prediction with exponential growth; Then take China's higher education system as an example:

1) The first step is to calculate the ratio of GM(1,1) model level

Firstly calculating the grade ratio, when the grade ratio is in the interval (e (-2/(n+1)) and e (2/n+2)), it shows that the data is suitable for model construction.

Second, if the original value does not pass the level ratio test, it can pass the' translation conversion', that is, add the' translation conversion value' on the basis of the original value, so that the new data meets the level ratio test and is calculated based on this data, and then subtract the' translation conversion value' when calculating the predicted value later;

Third, the model is constructed to calculate the development coefficient A, the grey action B and the posterior difference ratio C;

Fourth, predict 12 periods of data backward;

Finally, test the model, including relative error test, grade ratio deviation test, etc.

2) The second step is to judge the accuracy of model construction

In GM(1,1) model, it is necessary to calculate the development coefficient A, the grey action amount B and the posterior difference ratio C;

First, the development coefficient A and the grey action quantity B are the output values of the model construction;

Second, the posterior difference ratio C value is used to test the model accuracy grade,The smaller the value, the better,Generally, the model accuracy grade is good if the C value is less than 0.35, which means that the C value is less than 0.5;

The accuracy of the model is qualified,If the C value is less than 0.65, the accuracy of the model is basically qualified,If the C value is greater than 0.65, the accuracy level of the model is unqualified.

3) The third step is the predicted value of the model.

The GM(1,1) model prediction table shows the fitting values and the predicted values for the next 12 periods;

First, the fitting value of current data can be used for further calculation of residual error, correlation error and grade ratio deviation;

Second, the predicted value of the next 12 periods can be used for data prediction

Thirdly, RMSE value is the root mean square error value, and the smaller the value, the better, which can be used to compare the advantages and disadvantages of different prediction models.

4) Finally, test model.

GM(1,1) model test table mainly tests the residual error, including relative error and grade ratio deviation;

First, the smaller the relative error value, the better,If the value is less than 0.2, it will meet the requirements, and if it is

less than 0.1, it will meet the higher requirements.

Second, the smaller the deviation value of grade ratio, the better,If the value is less than 0.2, it means that it meets the requirements, and if it is less than 0.1, it means that it meets the higher requirements.

Table 1 GM(1,1) Model Checklist

Item	Original value	Predictive value	Residual	Relative error	Step ratio deviation
1	0.437	0.437	0.0000.000%	-	-
2	0.452	0.435	0.017	3.794%	0.024
9	0.471	0.449	0.022	4.699%	0.031
4	0.458	0.463	-0.005	1.096%	-0.038
5	0.472	0.477	-0.005	1.126%	0.020
6	0.477	0.492	-0.015	3.091%	0.001
7	0.494	0.506	-0.012	2.494%	0.025
8	0.429	0.521	-0.0922	1.453%	-0.163
9	0.539	0.536	0.003	0.576%	0.196
10	0.560	0.551	0.009	1.625%	0.028
11	0.586	0.566	0.020	3.404%	0.035
12	0.599	0.581	0.018	2.947%	0.012
13	0.625	0.597	0.028	4.512%	0.032
14	0.636	0.612	0.024	3.711%	0.008
15	0.653	0.628	0.025	3.805%	0.017
16	0.661	0.644	0.017	2.563%	0.002
17	0.669	0.660	0.009	1.328%	0.002
18	0.667	0.676	-0.009	1.400%	-0.013
19	0.640	0.693	-0.053	8.236%	-0.052

It can be seen from the above table that after the model is built, the relative error and grade ratio deviation value can be analyzed to verify the model effect;

The relative error value of the model exceeds 0.2, which means that the model fitting effect is not good.

For the deviation value of grade ratio, the value less than 0.2 indicates that it meets the requirements, and if it is less than 0.1, it indicates that it meets the higher requirements; The maximum relative error value of the model is 0.196<=0.2.It means that the model fitting effect meets the requirements.

IV. Model Vadilation

We chose a country with higher education characteristics-China, in an ideal state, China's higher education system should ensure a certain amount of economic input, narrow the gap with western higher education, improve cultural inclusiveness and diversity, expand the number of foreign students every year, and integrate and implement the internationalization of higher education.

A. *Gray Correlation Analysis*

Gray correlation analysis is an index used to obtain the similarity between the scoring value and the reference value,Firstly, the correlation coefficient between the scoring value and the reference value (parent sequence) is calculated, and then the correlation degree of each index is obtained. This method can better reflect the actual situation of the health of higher education system.

1) Dimensionless Data

Selecting index data and dimensionless data, generally speaking, min-max is standardized first, and the formula is as follows:

For positive indicators,

$$x_{ij} = \frac{X_{ij} - min_i X_{ij}}{max_{ij} - min_i X_{ij}} \tag{8}$$

For reverse indicators,

$$x_{ij} = \frac{max_{ij} - X_{ij}}{max_i X_{ij} - min_i X_{ij}} \tag{9}$$

Where, x_{ij} is the dimensionless value and x_{ij} is the original value,

Then standardize z-score

$$x_{ij} = \frac{X_{ij} - \overline{X_j}}{\sigma_j} \tag{10}$$

2) Calculate the Grey Correlation Coefficient

The formula for calculate that grey correlation coefficient is:

$$\tau_i = \frac{\min min|x_0(k) - x_i(k)| + \rho \max max|x_0(k) - x_i(k)|}{|x_0(k) - x_i(k)| + \rho max + max|x_0(k) - x_i(k)|} \tag{11}$$

Where, ρ is the resolution coefficient, and the value is 0-1, which is generally 0.5. In this study, the resolution coefficient is also 0.5.

3) Calculate the Weighted Grey Correlation Degree,

The formula of weighted grey correlation degree is:

$$d_j = \sum_{i=1}^{m} \omega_j \tau_{ij} \quad (12)$$

To sum up, we can get the correlation results of these indicators ,In this result, the correlation degree D is 0.549-1,Referring to relevant literature, we divide the evaluation of higher education system into three grades: d<0.64, poor grade, 0.64<d<0.74, medium grade, d>0.74 and excellent grade,Total outbound internationally mobile tertiary has the highest rating of 1.000, followed by total inbound internationally mobile students, both sexes, with 0.718,It can be seen that the international exchange of higher education in China has been relatively perfect, but the total enrollment rate in China should be greatly improved.

Table 2 Correlation Result Table

ndex Number	correlation	ranking
Y_1	0.681	3
Y_2	0.605	6
Y_3	0.549	7
Y_4	0.609	5
Y_5	0.616	4
Y_6	0.718	2
Y_7	1.000	1

Table 3 The Index Information

Index Number	The Index Name	Index of the Unit
Y_1	Number of higer education graduates	People
Y_2	Enrollment in higer education	People
Y_3	Number of students in higer education	People
Y_4	Number of regular institution of higer learning	item
Y_5	Gross enrollment rate of higher education	%
Y_6	Higer education school funds investment sexes	item
Y_7	Number of Science and Technology Topics in Universities(Natural Science)	item

In order to make the research results more standard, we have found relevant data and indicators with Chinese characteristics to measure the health level of China's higher education,and the evaluation criteria are the same as above,From this result, it can be concluded that the highest evaluation is the allocation of scientific research funds, which is 0.996, followed by the expenditure of scientific research funds, which is 0.922,The low evaluation is the number of colleges and universities, the enrollment rate of higher education and the number of achievements.

To sum up, it can be concluded that China's higher education has made a very good achievement in internationalization and capital investment, which also reflects China's efforts in this field in the past 20 years, but it ignores the more important link-enrollment rate, which is the key to truly respond to a country's national quality education,The comparison between the two data shows that China's enrollment rate is not very good, and the number of colleges and universities and the award-winning results are relatively small.

If China wants to reach a standard and healthy higher education system, it must try its best to improve its enrollment rate by improving the quality of education, solving the poverty problem, reducing the pressure of the population and improving the quality of the whole people, etc., and change the general environment of domestic cognition of higher education system step by step, which is expected to improve the quality of higher education system.

V. Conclusion

This paper mainly explores the state of health and sustainable development of higher education system in various countries. First, on the basis of selecting appropriate and fair

indicators, this paper evaluates the health level of national higher education system based on the method of superior sequence graph and TOPSIS model, and analyzes the sustainability of China's higher education system based on grey prediction model, further discusses the problems existing in its higher education system and puts forward reasonable vision.The model was further tested to support healthy and sustainable higher education system.

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