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Checking the Pulse and Temperature of Higher Education

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Abstract: In order to better evaluate the development of the higher education system, this article analyzes and establishes a model. First of all, according to the collected data and the current higher education system of various countries, a perfect evaluation index system of higher education development health level is established, which is divided into five levels. Then the AHP-NBM-fuzzy comprehensive evaluation (ANFCE) model is established, which consists of three parts. In order to verify the accuracy of the model, this article uses seven countries for evaluation.

1. Introduction

Higher education is a professional education and vocational education based on the completion of secondary education. Taking the road of high quality development is the inevitable requirement of higher education modernization [1]. Therefore, we should scientifically determine the evaluation index system of higher education development quality, evaluate the quality level of higher education development, test the national higher education development level.

2. Index system of health status in Higher Education

This article divides the Health status of higher education system into the following five class:

(1) Higher education foundation: Per Capita GDP (X1), GDP (X2), Population growth rate (X3), Population density (X4), Population aging rate (X5), Tertiary school enrollment rate (X6), Number of college students per thousand (X7), Proportion of graduate students in school (X8), Proportion of doctoral students in school (X9).

(2) Higher education investment: Proportion of public higher education expenditure in GDP (X11), Proportion of non-public higher education expenditure in GDP (X12), the proportion of per capita education expenditure in per capita GDP (X13), Research and development funds of colleges and Universities in GDP (X14).

(3) Higher education process: Proportion of foreign students (X15), Student to Teacher Ratio (X16), Proportion of new PhD graduates in population aged 25-34 (X17), the increase rate of the number of master's and doctor's degrees (X18), the scale of university website (X19)

(4) Higher education development performance: Number of winners of international awards (X20), International University Rankings (X21), International academic rankings (X22), Employer evaluation of graduates' quality (X23), Proportion of research papers published in international

cooperation (X24), Number of papers on Nature (X25), Number of SCI and SSCI papers per teacher (X26), Number of EI papers per teacher (X27), Number of highly cited papers (X28), Increase rate of the number of special patents (X29), The improvement rate of the percentage of professional degrees granted in various disciplines (X30)

(5) Social development foundation: Life expectancy (X31), Mortality rate (X32), Health expenditure per capita (X33), Depth of the food deficit (X34), Improved water source with access (X35), Household expenditure per capita(X36), Tertiary industry rate(X37)

3. AHP-NBM-Fuzzy Comprehensive Evaluation Model

Because of the complexity of the index system, the weight and classification of each index is particularly important when establishing the evaluation model. The fuzzy comprehensive evaluation model (ANFCE) consists of analytic hierarchy process, natural breakpoint method and fuzzy comprehensive evaluation. They complement each other and improve the reliability and validity of evaluation.

3.1 determining the weight of evaluation index

A clear classification index system is established to analyze the N indexes in the established index system. The index set is represented as the first class index set $V=\{V_1,V_2,\cdots,V_N\}$ and sub-index set $V_i=\{V_{i1},V_{i2},\cdots,V_{ik}\}$.The 1-9 proportions scale method is used to qualitatively describe the relative importance of each level's evaluation index. The first level index concentrates each index relative to the total evaluation goal. The comparison matrix between the two is as follows.

$$A=\begin{bmatrix} 1 & V_{12} & \cdots & V_{1N} \\ V_{21} & 1 & \cdots & V_{2N} \\ \cdots & \cdots & \cdots & \cdots \\ V_{N1} & V_{N2} & \cdots & 1 \end{bmatrix}=(V_{ij})_{N\times N} \qquad (V_{ij}=\frac{1}{V_{ji}}) \tag{1}$$

In terms of the indexes of the sub index concentration, the comparison matrix between the two is follows.

$$B_i=\begin{Bmatrix} v_{i1} \\ v_{i2} \\ \cdots \\ v_{ik} \end{Bmatrix}\begin{bmatrix} 1 & f_{12}^i & \cdots & f_{1k}^i \\ f_{21}^i & 1 & \cdots & f_{2k}^i \\ \cdots & \cdots & f_{12}^i & \cdots & \cdots \\ f_{k1}^i & f_{k2}^i & \cdots & 1 \end{bmatrix}=f_{k\times k}^i \quad (i=1,2,\cdots N)\ (f_{lj}^i=\frac{1}{f_{jl}^i}) \tag{2}$$

3.2 Natural breakpoint method

The natural breakpoint method is a statistical method based on the statistical distribution law of numerical statistics. It considers that the data itself has breakpoints, which can be classified by the characteristics of data. ArcGIS software can be used to classify data. Applying it to the evaluation of fuzzy comprehensive evaluation.

3.3 Fuzzy comprehensive evaluation

The fuzzy set A in the domain U is a set characterized by the membership function μ_A .

$\forall \mu_A : U \to [0,1]$, $u \in \mu_A(u)$, $\mu_A(u) \in [0,1]$. $\mu_A(u)$ is called the membership degree of the element u to the A, which indicates the degree of u belonging to the A. The fuzzy set can be quantified by the membership function.

Step1: The judgment set is set to $U = \{\text{excellent, good, qualified, unqualified}\}$ by natural breakpoint method. So $U = \{400, 300, 200, 100\}$.

Step2: The membership degree of this paper refers to the conformity degree between the health level of higher education and the evaluation set.

$$D_i = \begin{Bmatrix} v_{i1} \\ v_{i2} \\ \cdots \\ v_{ik} \end{Bmatrix} \begin{bmatrix} S_{11}^i & S_{12}^i & \cdots & S_{1n}^i \\ S_{21}^i & S_{22}^i & \cdots & S_{2n}^i \\ \cdots & \cdots & S_{11}^i & \cdots & \cdots \\ S_{k1}^i & S_{k2}^i & \cdots & S_{kn}^i \end{bmatrix} \qquad (i = 1, 2, \cdots m) \tag{3}$$

Step3: First order fuzzy comprehensive evaluation - fuzzy relation matrix is determined by fuzzy operator $R = (R_1, R_2, \cdots\cdots, R_n)^T$. Where

$$R_i = (w_1^i, w_2^i, \cdots\cdots, w_k^i) \begin{bmatrix} S_{11}^i & S_{12}^i & \cdots & S_{1n}^i \\ S_{21}^i & S_{22}^i & \cdots & S_{2n}^i \\ \cdots & S_{11}^i & \cdots & \cdots \\ S_{k1}^i & S_{k2}^i & \cdots & S_{kn}^i \end{bmatrix} = (r_{i1}, r_{i2}, \cdots\cdots, r_{in}) \tag{4}$$

Secondary fuzzy comprehensive evaluation - determine the final evaluation result of the evaluated object.

$$E = H \circ R = (H_1, H_2, \cdots, H_m) \times \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix} = (e_1, e_2, \cdots e_k, \cdots e_n) \tag{5}$$

4. Model application: Health assessment of Higher Education

Based on the relevant data collected, seven different types of countries were selected. Using airgic software, the health level of higher education is divided into three levels. The fragile level is [0,3.2), the common level is [3.2,5.5), the stable level is [5.5,8]. Taking China as an example, the score of China can be calculated by formulas.

$$E_1 = H \circ R_1 = (e_1, e_2, \cdots e_k, \cdots e_n) = [0.1223, 0.1220, 0.1758, 0.4156, 0.1643] \cdot \begin{pmatrix} 0.2 & 0.4 & 0.3 & 0.1 & 0 \\ 0.6 & 0.2 & 0.1 & 0.1 & 0 \\ 0.2 & 0.3 & 0.1 & 0.4 & 0 \\ 0.4 & 0.2 & 0.1 & 0.1 & 0.2 \\ 0.3 & 0.3 & 0.2 & 0.1 & 0.1 \end{pmatrix} \tag{6}$$

$= [0.3458, 0.3136, 0.1710, 0.1594, 0.0330]$

The score of health level of higher education in China is 2.0456, which is in a fragile level [2]. The score of US is 7.1485, the score of UK is 6.3142, the score of Germany is 2.9362, the score of France is 5.2679, the score of Japan is 3.3587, the score of Australia is 4.5314 [3].

5. Conclusion

According to the specific circumstances of the country, we can flexibly adjust the weight matrix, the determination of the natural breakpoint and the fuzzy relation matrix in order to achieve the purpose of applying this model to every country. However, due to the limited number of data samples, the accuracy of the model needs to be improved.

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