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A Higher Education Health Evaluation Model

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Abstract: In response to the current trend of world higher education development, a healthy higher education system has had a profound impact on all dimensions of a country. This article established a higher education health evaluation model in response to the subject's requirements. This article screened 10 indicators such as the number of Nobel Prizes won, the number of national SCI papers, and the proportion of college students in the country's total population as secondary indicators. Then, the principal component analysis method was utilized to reduce the dimensionality of the data. Finally, the index is extracted into three first-level indicators, namely Access, Education achievement, and Quality of education to evaluate higher education system.

1. Introduction

In order to indicate the significance of researching this problem, the following background is worth mentioning. The development of higher education (post-secondary education, third-level, or tertiary education), an optional final stage of formal learning that occurs after completion of the required (many times secondary) level of education. Not only is it useful for the development of the education industry itself, it can also effectively promote international cultural exchanges, increase the strength of national cultural construction, improve scientific research capabilities, and provide the country with high-level human resources. Scholars represented by Martin Trow have conducted research on education in the popularization stage of higher education, and believe that higher education in the popularization stage will shape a new relationship between the country, education and society, and relevant characteristics will also be generated within higher education. Therefore, higher education is critical to society.

2. Indicator Selection Model Based on PCA

2.1 Preliminary Indicator Screening

According to the reference, we have selected ten indicators:

·Gender Ratio: The ratio of boys to girls among higher education students, reflecting the degree of gender equality

·College Enrollment: The ratio of the number of people over 18 years old in higher education to the population of that age group

·Number of Nobel Prizes

·Employments Rate: The ratio of college graduates who get jobs to those who are unemployed. This reflects that talent training is in line with market needs □

·SCI: The number of articles published in the "Science Citation Index" □

·QS: Quacquarelli Symonds ranking of universities around the world

·Cost: The financial investment in higher education, reflecting the state's construction of education

·College Students/Population: Divide college students by the country's total population

·Number of Universities

·Average Tuition: The average annual tuition required for higher education

We classify it into three first-level indicators:

·Access: Opportunities for school-age students/pursue higher education

·Quality of education: The level of education and the degree of effectiveness.

·Education Achievement: Education-related achievements reached so far

2.2 Model

Take the data of the national higher education system in a certain year as a sample. However, in the process of processing data, when data with different characteristics are grouped together, the small data in absolute value is "eaten" by big data due to the expression of the characteristics. Therefore, PCA has to be used to reduce the dimensionality of features.

$$X_{norm} = \frac{X - X_{\min}}{X_{\max} - X_{\min}}$$

KMO（Kaiser - Meyer - Olkin）inspection:

The statistics of this test are used to compare the simple correlation and partial correlation coefficients between variables. The value is between 0-1. And the closer it is to 1, indicating that the sum of squares of the simple correlation coefficients between all variables is much larger than the sum of squares of partial correlation coefficients, and the more suitable for principal component analysis.

KMO calculation formula:

$$KMO = \frac{\sum\sum_{i\neq j} r^2_{ij}}{\sum\sum_{i\neq j} r^2_{ij} + \sum\sum_{i\neq j} r^2_{ij\cdot 1,2\cdots k}}$$

For the problem environment, the calculated value is 0.8771. In summary, the correlation coefficient test coefficients are all greater than 0.3, and the test value is 0.8771, which is suitable for principal component analysis.

$$\tilde{a}_{ij} = \frac{a_{ij} - \mu_j}{s_j}, i = 1, 2, \cdots, 30, j = 1, 2, \cdots, 10$$

$Where: \mu_j = \frac{1}{30}\sum_{i=1}^{30} a_{ij}; s_j = \sqrt{\frac{1}{30-1}\sum_{i=1}^{30}(a_{ij} - \mu_j)^2}, j = 1, 2, \cdots, 10$ that μ_j, s_j are the sample mean and sample standard deviation of the jth index. which is:

$$\tilde{x}_j = \frac{x_j - \mu_j}{s_j},\ j = 1, 2, \cdots, 10; r_{ij} = \frac{\sum_{k=1}^{30} \tilde{a}_{ki} \cdot \tilde{a}_{kj}}{30 - 1} i,\ j = 1, 2, \cdots, 10$$

Selected $p(p \le 10)$, principal components to calculate total evaluation value.

Calculate $\lambda_j = (j = 1, 2, \cdots, 10)$, the information contribution rate and cumulative contribution rate of the feature value:

$$\begin{cases} y_1 = u_{11}\tilde{x}_1 + u_{21}\tilde{x}_2 + \cdots + u_{101}\tilde{x}_{10} \\ y_2 = u_{12}\tilde{x}_1 + u_{22}\tilde{x}_2 + \cdots + u_{102}\tilde{x}_{10} \\ \vdots \\ y_{10} = u_{110}\tilde{x}_1 + u_{210}\tilde{x}_2 + \cdots + u_{1010}\tilde{x}_{10} \end{cases}$$

It is calculated that the y_1, $y_2, \cdots, y_p$ cumulative contribution rate is reached,and the cumulative contribution rate reaches more than 80%. These indicator variables can be selected as the main components instead of the original secondary indicators to achieve the effect of dimensionality reduction. These main components can be used for comprehensive analysis. Choose n (n<=12) principal components and calculate the comprehensive score:

$$z = \sum_{j=1}^{p} b_j y_j$$

$$F_i = \beta_{i1} X_1 + \beta_{i2} X_2 + \cdots + \beta_{in} X_n \quad ; \qquad F = \alpha_1 F_1 + \alpha_2 F_2 + \cdots + \alpha_m F_m$$

It can be seen from the above that through principal component analysis, the national higher education indicators are divided into three categories, and the weights of each indicator in each component are different.In order to replace the secondary indicators with the constructed first- level indicators, it needs to be based on the above relationship to establish expressions for calculating each level index. The specific expression is:

$$\begin{cases} \text{Access} = 0.558F_1 + 0.558F_2 \\ \text{Education achievement} = -0.172F_3 0.463F_2 + 0.773F_5 \\ \text{Quality of education} = 0.384F_6 + 0.066F_7 - 0.378F_8 - 0.112F_9 + 0.365F_{10} \end{cases}$$

3. Implementation and Results

After verifying the application of the principal component analysis method, we used the model to filter 10 indicators from the three aspects of Access, Education achievement, and Quality of education. After quantification and standardization, the principal component analysis method was performed to extract the first principal component as a first Level indicators, using three level indicators, namely Access, Education achievement and Quality of education.

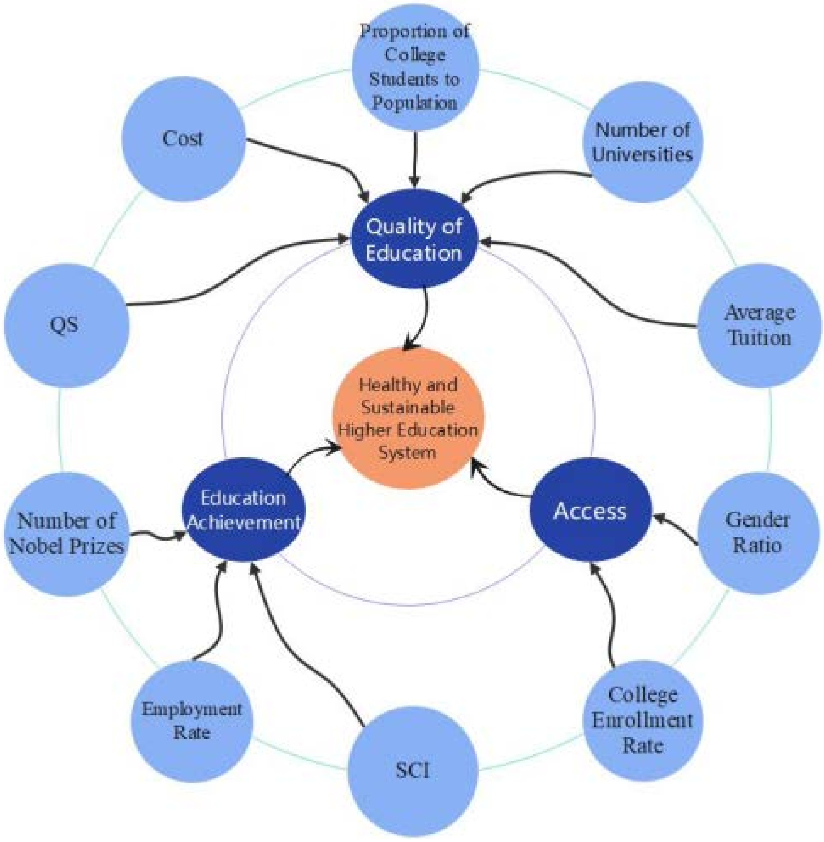

Figure 1: Evaluation index chart

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