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Research on the Health Status of Higher Education System Based on Computer Simulation Decision

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Abstract

In order to better assess the quality of higher education in a certain country, we adopted two methods to compare modeling. According to the Times World University Rankings, four key dimensions that can fully describe the health of higher education have been refined. With FAHP as the main model, five schools in the UK are the analysis objects, and the coefficient of variation is obtained to rank the schools. At the same time, supplemented by the decision tree model to verify the accuracy of the model, a higher education health assessment model based on the FAHP and the decision tree model was constructed. And this model can evaluate the health status of any country's higher education system.

Keywords

Computer Simulation Decision; FAHP; Decision tree; Coefficient of variation; Comparative modeling.

1. INTRODUCTION

The higher education system is an important element in a country's efforts to further educate its citizens beyond the required primary and secondary education and is therefore both an industry in itself and a source of trained and educated citizens of the economy. When we look around the world, from Germany to the United States, from Japan to Australia, we see the higher education methods of various countries that not only educate their own students, but also attract large numbers of international students each year. Each of these countries has its strengths and weaknesses in its higher education systems, and after the recalibration required by the current pandemic, countries have the opportunity to think about what works and what is better. Change, however, is often difficult. The institutional reforms needed to advance any system require the long-term implementation of policies in order to build a healthier and more sustainable system.

In this regard, we have developed a model to measure and assess the health status of higher education systems at the national level to determine a healthy and sustainable status.

Obviously, we need to pick out several indicators that can evaluate the higher education system of these countries in detail, and these indicators can clearly reflect the level of higher education of a country. The fuzzy analytic hierarchy process (FAHP) is used as the main evaluation model, and the decision tree model is used to verify the effectiveness of the FAHP model. The two methods are compared to ensure the robustness of the model.

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2. METHODS

2.1. FAHP Model

We have extracted four key indicators, namely teaching, research, citation and international perspective, and each key indicator is composed of many specific indicators. The indicator architecture we built is shown in the figure below:

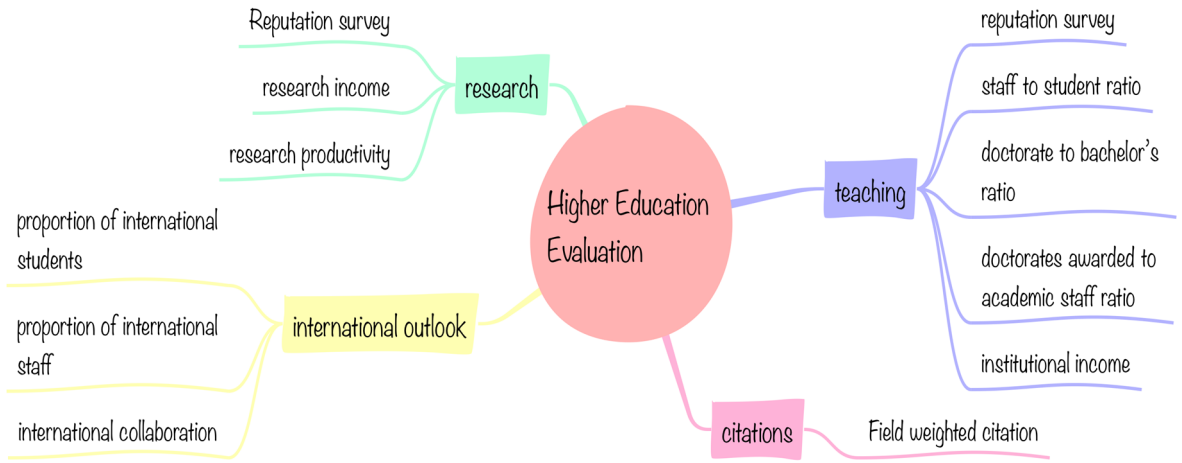

Figure 1. Higher Education Index System Structure

By checking the Times Higher Education Global 2021 University Rankings [1], we collected relevant data on teaching, research, citations and international perspectives in the UK, and visualized the data. The results are shown in the following figure:

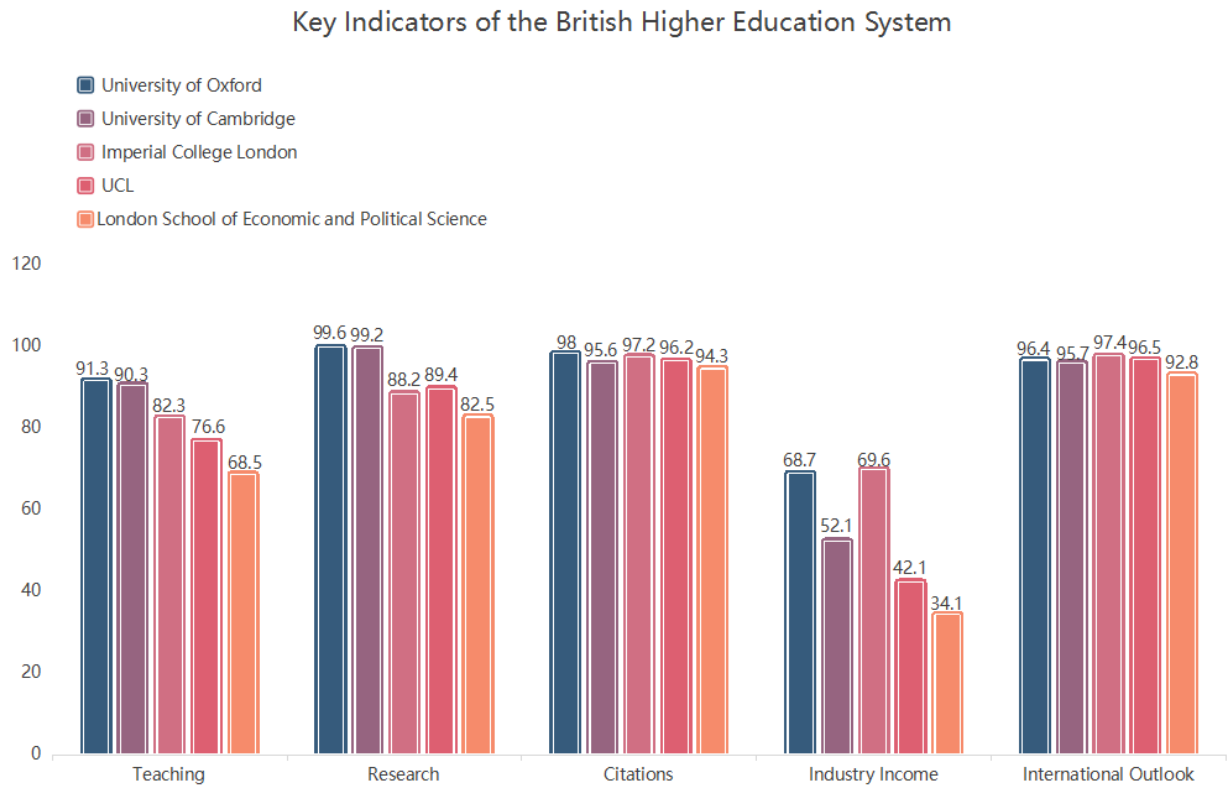

Figure 2. Architecture diagram taking the United Kingdom as an example

We use FAHP to build the first part of the model, which is described in detail as follows:

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Step 1: Construct fuzzy matrix C and decompose it into three matrices.

Step 2: Calculate the fuzzy linear homogeneous equation system through the three matrices obtained in the previous step.

$$\overline{C}_l w_l + \overline{C}_m w_m + \overline{C}_u w_u - \overline{\lambda}_l w_l - \overline{\lambda}_m w_m - \overline{\lambda}_u w_u = 0$$

$$\overline{C}_l = 2C_l + C_m,\ \overline{C}_m = C_l + 4C_m + C_u,\ \overline{C}_u = C_m + 2C_u$$

Step 3: Calculate eigenvalues according to the matrix. The calculation process of eigenvalues is as follows:

$$\overline{\lambda}_l = 2\lambda_l + \lambda_m,\ \overline{\lambda}_m = \lambda_l + 4\lambda_m + \lambda_u,\ \overline{\lambda}_u = \lambda_m + 2\lambda_u$$

Step 4: Calculate the feature vector by the following formula:

$$\overline{w}_l = \frac{w_l\ \lambda_l}{s_l\ \lambda_m},\ \overline{w}_m = \frac{w_m}{s_m},\ \overline{w}_u = \frac{w_u\ \lambda_u}{s_u\ \lambda_m}$$

$$s_l = \sum_{i=1}^{n} w_{i,l},\quad s_m = \sum_{i=1}^{n} w_{i,m},\quad s_u = \sum_{i=1}^{n} w_{i,u}$$

Step 5: Use the following formula to calculate the consistency coefficient and consistency ratio. We need to understand that the size of the matrix depends on random consistency.

$$CI = \frac{\lambda_{\max} - n}{n-1},\ CR = \frac{CI}{RI}$$

Step 6: Set the priority fuzzy matrix according to the known conditions, which contains the normalized feature vector.

Step 7: Set the global priority vector, which can be obtained by the following formula:

$$\overline{w}_l{}^T = \left[\overline{w}_{1,l}\quad \overline{w}_{2,l}\ \ldots \overline{w}_{n,l}\right]^T$$

$$\overline{w}_m{}^T = \left[\overline{w}_{1,m}\quad \overline{w}_{2,m}\ \ldots \overline{w}_{n,m}\right]^T$$

$$\overline{w}_u{}^T = \left[\overline{w}_{1,u}\quad \overline{w}_{2,u}\ \ldots \overline{w}_{n,u}\right]^T$$

$$g_l = \overline{P}_l \overline{w}_l = \left[g_{1,l}\ g_{2,l} \cdots g_{m,l}\right]^T$$

$$g_m = \overline{P}_m \overline{w}_m = \left[g_{1,m}\ g_{2,m} \cdots g_{m,m}\right]^T$$

$$g_u = \overline{P}_u \overline{w}_u = \left[g_{1,u}\ g_{2,u} \cdots g_{m,u}\right]^T$$

Step 8: Calculate the expected value based on the above calculation.

$$g_{i,e} = \frac{g_{i,l} + 2g_{i,m} + g_u}{4}$$

$$\sigma_i = \left(\frac{1}{80}\left(3{g_{i,l}}^2 + 4{g_{i,m}}^2 + 3{g_{i,u}}^2 - 4g_{i,l}g_{i,m} - 2g_{i,l}g_{i,u} - 4g_{i,m}g_{i,u}\right)\right)^{1/2}$$

2.2. Decision Tree Model

2.2.1 Model preparation

In order to verify the validity of the FAHP model, we use the decision tree model to conduct comparative modeling and verify the rationality of the model.

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Firstly, the data needed for the decision tree are collected. We used British students as the analysis subjects. Through referring to relevant materials, we have collected the assessment tests done by students receiving higher education in the UK. The difficulty of the questions in the assessment tests is shown in the figure below.

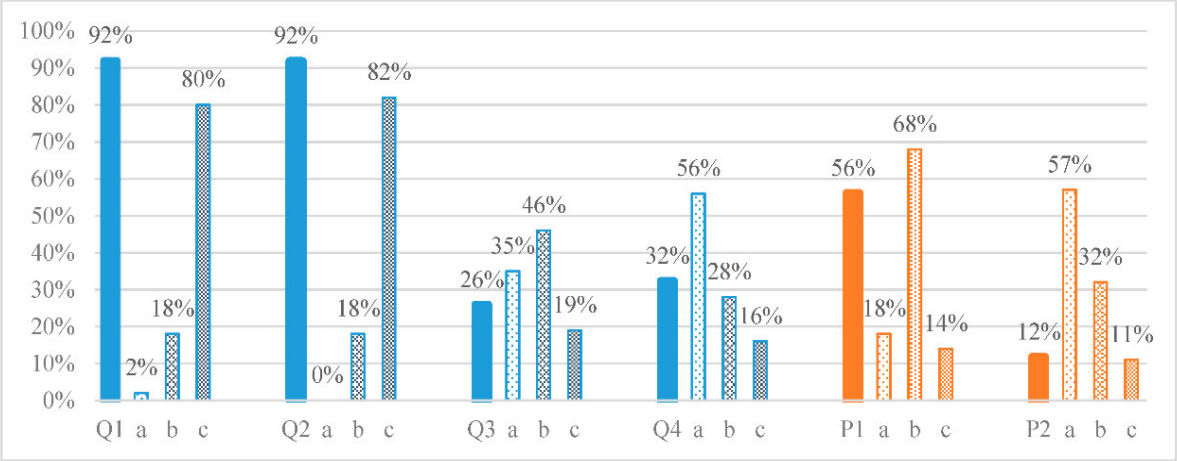

Figure 3. The result graph of the problem difficulty evaluation in the evaluation test. The results of the students' self-assessment in the difficulty of assessment (background filling) and question S1 (shaded column) are displayed

For the measured level of overall competence in the study sample, we found that:

- Low level of competence (0-27%)
- Intermediate level of competence (28-73%)
- High level of competence (74%-100%)

2.2.2 CART score regression model

We used the model to assess the impact of individual question scores, as well as other key factors, on the overall score of the assessment tests administered. The Cart method is not affected by the type of the variable and the use of distribution or normalized values.

Table 1. Regression summary statistics of the CART model

	S1, %			S2, %			S3, %			S4, %		
	a	b	c	a	b	c	a	b	c	a	b	c
Q1	2	18	**80**	13	29	**58**	13	25	**62**	0	31	**69**
Q2	0	18	**82**	33	10	**57**	27	18	**55**	3	33	**64**
Q3	35	**46**	19	73	8	19	14	12	**74**	**50**	33	17
Q4	**56**	28	16	**49**	19	32	14	13	**73**	**46**	34	20
P1	19	**68**	13	0	34	**66**	19	36	**45**	8	**67**	25
P2	**57**	32	11	**69**	10	21	24	6	**70**	**52**	33	15

The last column of the above table shows the relative influence of each variable in the model. The model has internal consistency and stability. To some extent, the statistics are relatively low. As realized by the model, we can easily directly assess the ability level through variable ability, which shows that the correct classification of cases has good consistency.

The decision tree model is used to evaluate the ability of students, and the results are shown in the figure below.

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Table 2. Student ability level scale

Observed	Predicted			
	Low Competency	Medium Competency	High Competency	Percent Correct
Low competency	8	1	0	88.9%
Medium competency	2	46	0	95.8%
High competency	0	2	3	60.0%
Overall Percentage	16.1%	79.0%	4.8%	91.9%

Cronbach's alpha statistics [3] were used to study the reliability of the survey, respectively, for a total of 24 variables for students. The results are as follows:

Table 3. Structure coefficient scale

Scale from S1, S2, S3, S4	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	Number of Items
Variables: Q1, Q2, Q3, Q4	0.767	0.746	16
Variables: Q1, Q2, Q3, Q4, P1, P2	0.818	0.819	24

The coefficients of both sets of structures are greater than 0.7, so they are reasonable.

3. SENSITIVITY TEST

The main model adopted in this paper is FAHP, and the decision tree model is used to test the sensitivity. Decisions are obtained through the model to assist the judgment of FAHP. If the decision ordering is the same as the result ordering obtained by FAHP, it is proved that the model established by us has a high sensitivity.

4. CONCLUSIONS AND EXTENSIONS

As for how to improve the quality of higher education from a macro perspective, based on the above research, we believe that countries should make improvements in four aspects: environmentally efficient operation, adequate guarantee for internal and external students, education and research on sustainability, and social participation in sustainable development society. In terms of the operation of environmental universities, all efficient measures should be taken in terms of sustainability, including but not limited to the use of environmental solar-powered infrastructure, the reduction of the ecological impact caused by invention and the correct management of e-waste. At the same time, the teaching curriculum system should be reformulated to require students to attend a certain number of courses related to sustainability, so as to highlight the importance of sustainable education.

To verify the degree of improvement of the higher education level, the higher education system evaluation model based on FAHP and decision tree can be used to re-evaluate the country's higher education system. The coefficient of variation is significantly reduced, indicating that the higher education system is healthy, Sustainability has been improved.

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