Problem Chosen	2021 MCM/ICM Summary Sheet	Team Control Number
F		2118968

The Pulse and Temperature of Higher Education

A country has **a healthy and sustainable higher education system**, which means it has the core power to cultivate talents, promote the development of science and technology, and promote cultural construction, and more importantly, a strong driving force for sustainable social development. Therefore, based on the reality of the higher education situation, our goal is to develop a scientific and reasonable model to assess the health of the country. Then we apply it to some countries and propose corresponding policies, and then make an analysis of the policy effectiveness. We divide the job into 3 phases.

Firstly, we analyzed the Issue Paper and related materials. The higher education system is mainly divided into four areas: The input of higher education, The participation of higher education, The output of higher education and The environment of higher education. These four ***first-level indicators*** are further divided into nine ***second-level indicators*** and nineteen ***third-level indicators***. Also we collect a lot of relevant data to support our subsequent model construction.

Secondly, in the data preprocessing stage we use ***Principal Component Analysis(PCA)*** and ***The Range Melthod*** to obtain the weights of different indicators and the standardized decision matrix. We obtain the higher education evaluation index of each country through the ***TOPSIS*** method, and discuss the results. We select China whose evaluation results still have room for improvement, and use the weight ratio to optimize and simplify the four indicator levels. Then we select the most important six indicators, which includes Proportion of education expenditure in GDP, Enrollment rate of higher education and so on. Then we also analyzed the basic elements of the sustainable system and set a reasonable vision for China, which is a healthy and sustainable higher education system.

Thirdly, according to the evaluation results of the model and the specific national conditions of China, we propose some higher education policies from different perspectives such as individuals and countries to support the migration from the current state to our proposed state. And we make a ***ten-year schedule*** and the requirements that should be met at each stage. The effectiveness of the policy is also evaluated.

Fourthly, we have also considered discussing the real-world impacts from a micro and macro perspective during the implementation of the policy. Then, according to the data of QS, we took Hong Kong as an example to analyze the changes in the level of higher education after the implementation of some relevant policies, and found that the health status of higher education has indeed improved to some extent, but the change is not obvious, so we acknowledge ***the reality*** that change is hard.

Lastly, we test ***the stability and the sensitivity*** of our model. We conclude the strengths and the weaknesses of our model. In conclusion, our models stand out due to its interdisciplinary approaches, innovation, cohesiveness and high practical value.

Contents

I. Introduction

1.1 Background

Higher education is professional and vocational education conducted on the basis of completing secondary education, also it is the main social activities for training senior professionals. Higher education is one of the important components of the education system. Usually it includes various educational institutions with high-level learning and training, teaching, research and social services as their main tasks and activities. Higher education is of great significance to a country's talent pool and technological innovation. Also the quality and standard of higher education is an important manifestation of a country's comprehensive national strength and future development potential.Therefore, to make a scientific and effective evaluation of the level and quality of higher education in a country requires us to build a set of scientific and reasonable evaluation index system on the basis of accurately understanding and grasping the connotation of high-quality development in the field of higher education. So we need to carry out a comprehensive analysis of the data, establish a corresponding mathematical model, and make judgments and predictions on the higher education level and health status of each country.

1.2 Restatement of the Tasks

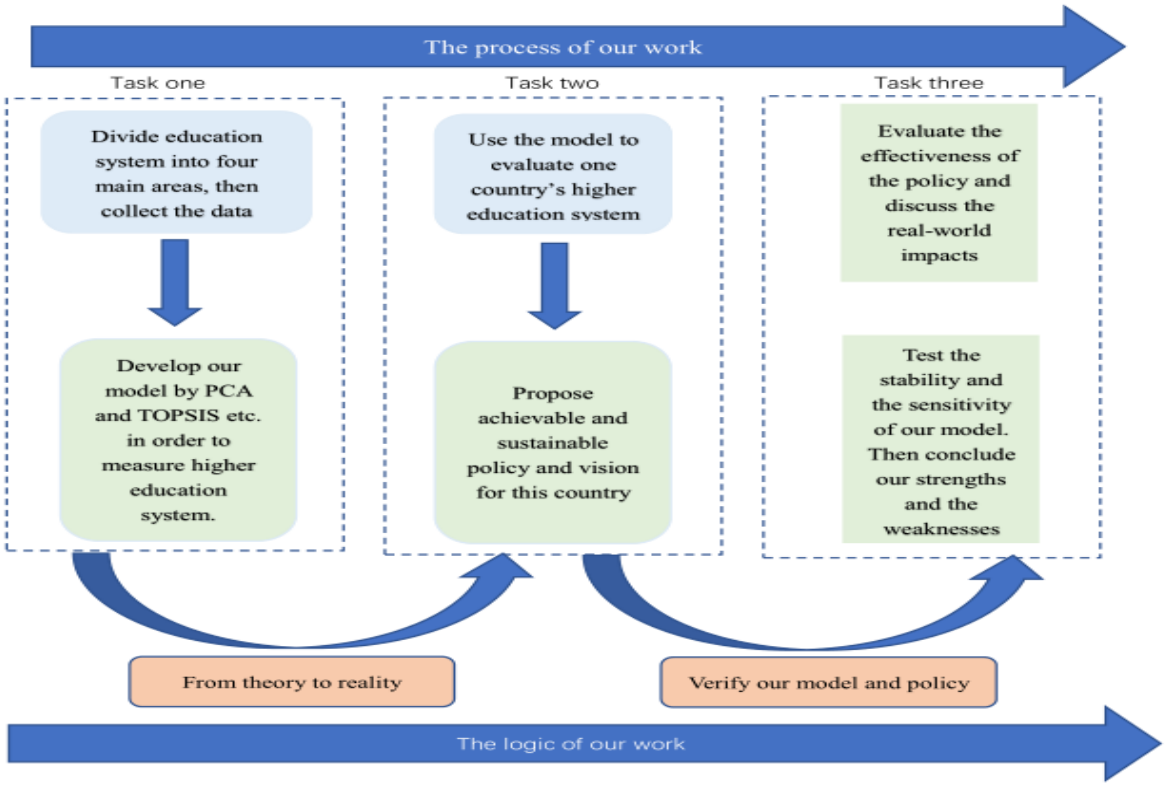

Figure 1. Overview of our work

- **Task 1**
  Based on relevant data, develop and verify a model that can assess the health status of a country's higher education system, apply the model to some countries, and then select a country with room for improvement in the higher education system and analyze it.
- **Task 2**
  According to the actual situation of the selected country, put forward a vision that the country may achieve in the future, in which the country's higher education system has a good sustainable development and health, then do analysis and comparison with the country's current higher education system.
- **Task 3**
  According to the analyzed status of the higher education system and the proposed vision, formulate corresponding policies and implementation timeline to realize the migration from the current state to the proposed state.
- **Task 4**
  Evaluate the effectiveness of the specified policies, and discuss the actual impact of implementing the plan during the transition and final stages (for example, the impact on students, teachers, schools, communities, and the country).

II. Preparation of the Models

2.1 Basic assumption

The following assumptions are all applied for all models in this paper:

1. We won't ask every country to build a completely consistent higher education system.
2. We won't ask every country to completely abandon the traditional higher education system.
3. The relevant policies are only promulgated by the government of the country.
4. All policies formulated are in compliance with the laws of the country to which they are applied.
5. The data we get from some websites and databases is accurate and error-free

2.2 Glossary

• **Degree of informatization:** It is represented by the national informatization level index, which is an important indicator reflecting the comprehensive strength of the country in the information age. And the national informatization level index. It is obtained through a comprehensive calculation of 20 indicators including 6 aspects including resource development and utilization,

information network construction, information technology applications, information products and services, informationized human resources and informationized development environment.

• **Consumer price level :** Consumer price level is a macroeconomic indicator that reflects the changes in the price levels of consumer goods and services generally purchased by households, which measures the relative number of changes in the price level of a set of representative consumer goods and services over time in a specific period of time. It is used to reflect the changes in the price level of consumer goods and services purchased by households. Also it is a commodity within a month and the coefficient of change in retail prices of services.

• **Quacquarelli Symonds (QS):** Quacquarelli Symonds is a British company specialising in the analysis of higher education institutions around the world. The company was founded in 1990 by Nunzio Quacquarelli.

• **Number of higher education institutions**[1]**:** This refers to the number of higher education institutions including universities, colleges, higher vocational and technical colleges, technical colleges, and related research institutes;

• **Number of papers published：** In this paper, it refers to the number of high-quality papers included in the JCR REPORTS search source journals published by the Institute of Scientific Information (ISI) in District 1, District 2, and District 3.

• **Number of full-time teachers：** In this paper, it refers to the number of teachers with teacher qualifications who specialize in teaching work and have both a higher education teacher qualification certificate and undertakes teaching work during the statistical period.

III. Models

3.1 The model of higher education system health

In order to make a comprehensive and accurate evaluation of a country's higher education health system, it is necessary to consider various indicators that can reflect the health status of the higher education system. Therefore, in response to this problem, we refer to the education index system of OCED (Organization for Economic Cooperation and Development), UNESCO, etc. Then we comprehensively consider the health level of the higher education system from the perspective of the general education development level, and build an index system of the health status of the higher education based on this.

By consulting a large number of relevant literature[2], we believe that it is necessary to select reasonably and accurately representative and informative indicators, which reveals the country's

demographic and economic conditions when constructing such a higher education evaluation system. Above all, we obtain some data from Word Bank Open Data[13], UN Databases and some local government databases for model creation . The indicator system has 4 first-level indicators, 9 second-level indicators, and 19 third-level indicators. The specific indicators are described in the table below.

First level index	Second level index	Third level index	
The input of higher education	Education funding	1. Proportion of education expenditure in GDP	C_1
	Human resources investment	2. Number of full-time teachers	C_2
		3. Degree of informatization	C_3
The participation of higher education	Opportunity of participation	4. Number of higher education institutions	C_4
		5. Enrollment rate of higher education	C_5
		6. Number of students in colleges and universities	C_6
		7. Proportion of women in colleges and universities	C_7
	Ability of participation	8. Per capita annual income of residents (USD)	C_8
The output of higher education	Scientific research results	9. Number of patent applications	C_9
		10. Number of papers published	C_{10}
		11. Number of international conferences held	C_{11}
	Academic Achievements	12. Number of international students	C_{12}
		13. Proportion of graduate students	C_{13}
The environment of higher education	Policy Environment	14.Proportion of private universities	C_{14}
	Economic environment	15. National GDP (USD)[14]	C_{15}
		16. Consumer price level	C_{16}
	Population environment	17. Percentage of higher education[13]	C_{17}
		18. unemployment rate	C_{18}
		19. employment rate	C_{19}

Table 1. Comprehensive evaluation index system odicator of higher education health

Then, we used PCA, Topsis method and other methods to process and calculate the data in batches. We get the closeness of the higher education health status of different countries to the positive ideal point, and finally use the results to evaluate the health status of different countries.

3.1.1 Model Preparation

(1) Data Processing [11]

We divide the data into efficiency indicators, cost indicators, and interval indicators. Then use the range method to standardize the data according to different classes by Python. The standardized data is shown in the appendix.

After obtaining the standardized data, we use principal component analysis to reduce the dimensionality of the data. Then the weight of each indicator w_i is

$$w_i = \frac{k_i}{\sum_i k_i}$$

from which Comprehensive score model coefficient ki is

$$k_i = \frac{\sum_i pcvp_i * 100 * \mathrm{l}_i}{\sum_i \mathrm{pcvp}_i}$$

and the linear combination coefficient l_i is

$$l_i = \frac{\text{Normalized number}}{\text{the square root of the characteristic root of the principal component}}$$

ps: The symbol $pcvp_i$ is Principal component variance percentage.

Specific weight data has been provided in the appendix

(2) The Foundation of Model

When constructing the educational development level index[3]， It is necessary to select representative and informative indicators reasonably and accurately, also it should add the current population, economic development, and social development of the country, to illustrate the current development status of national education in this context. Through research on OECD, UNESCO, World Bank and the U.S. Education Development Index System，Combining the specific status quo of the country's higher education development level，We have selected indicators that can reflect the country’s population and economic and social development level，Constructed a national and regional higher education development level evaluation standards and models.

3.1.2 Model Establishment

Topsis method is a basic method for comprehensive evaluation and comparison of multiple schemes in multi-attribute decision-making theory, the basic idea is: the optimal solution should have the smallest distance from the positive ideal solution and a large distance between the negative ideal solution. Based on this idea, we can sort multiple evaluated objects with measurable attributes. However, using the Topsis method needs to determine the attributes of the evaluated object and the weight information of each attribute. Principal Component Analysis(PCA)[4]is a useful tool to solve this kind of problem. Use the PCA method to convert the 19 indicators into several comprehensive index (principal components), which contain most of the information of the original 19 indicators. At the same time, the variance contribution rate of each comprehensive index is also obtained. The attributes and attribute weights of each evaluated object can be determined according to the principal components and their respective variance contribution rates. Principal component analysis is a method of dealing with dimensionality reduction in multivariate statistical analysis. It re-linearly combines the original variables into a number of unrelated comprehensive indicators to replace the original variables, and extracts the original variable information as much as possible to explain the original covariance structure.

(1) Construct an evaluation matrix. The indicators in this index system include benefit-type indicators, cost-type indicators, and interval-type indicators. A evaluation matrix can be obtained. Suppose there are n (n=4) evaluated objects and p (p=19) evaluation indicators, then the evaluation matrix is:

$$X = \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1p} \\ x_{21} & x_{22} & \dots & x_{2p} \\ \dots & \dots & \dots & \dots \\ x_{n1} & x_{n2} & \dots & x_{np} \end{bmatrix}$$

(2) Starting from the evaluation matrix, for normalization, the Miniaturization, intermediate, and interval type data are based on different formulas

Miniaturization index：

$$x_i = max\{X\} - xi$$

Intermediate index：

$$M = max\{|x_i - x_{best}|\}, \bar{x_i} = 1 - \frac{|x_i - x_{best}|}{M}$$

Interval index：

$$M = \max\{a - \min\{x_i\}, \max\{x_i - b\}$$

$$\widetilde{x_i} = \begin{cases} 1 - \dfrac{a - x_i}{M}, x_i < a \\ 1 \qquad\quad , a \le x_i \le b \\ 1 - \dfrac{x_i - b}{M}, x_i > b \end{cases}$$

After that we get indicators having a positive impact consist of matrix A

(3) Then we use the range method for different types of data for matrix A：

Indicators with positive impact:

$$x_i = \frac{x_i - min}{max - min}$$

Miniaturization index:

$$x_i = \frac{\max - x_i}{max - min}$$

interval indicators:

for intervals like [lb,ub],for which its anticipated ideal value intervals is [a,b]

$$x_i = \begin{cases} x_i = \dfrac{x_i - lb}{a - lb}, lb \le x_i < a \\ x_i = 1, \qquad lb \le x < 0 \\ x_i = \dfrac{ub - x_i}{ub - b}, b \le x_i \le ub \\ x_i = 0, x_i < lb \ or \ x > ub \end{cases}$$

for standardization， which is to reach a goal to omit the influence of dimensions. After calculation we get Standardized decision matrix A_0.

(4) For A_0， Use the principal component analysis method of the factor analysis method to obtain the corresponding weight w_i

(5) construct the weighted Standardized decision matrix.Each column of A_0, x_{ij} is multiplied by the weight w_i corresponding to the attribute of the column. Therefore, the element t_{ij} in the weighted standardized decision matrix is equal to :

$$t_{ij} = w_i \cdot x_{ij}.$$

Then we determine the worst alternative A_w and the best alternative A_b:

$$A_w = \{< \max(t_{ij}|i = 1,2,\dots,m)\,|j \in J_- >, < min < t_{ij}|i = 1,2,\dots,m)|j \in J_+ >\} = \{t_{wj}|j = 1,2,\dots,n\}$$

$$A_b = \{< \min(t_{ij}|i = 1,2,\dots,m)\,|j \in J_- >, < max < t_{ij}|i = 1,2,\dots,m)|j \in J_+ >\} = \{t_{bj}|j = 1,2,\dots,n\}$$

$$J_+ = \{j = 1,2,\dots n|j\}$$

associated with the criteria having a positive impact

$$J_- = \{j = 1,2,\dots n|j\}$$

associated with the criteria having a negative impact

Calculate the L^2-distance between the target alternative i and the worst condition A_w

$$d_{iw} = \sqrt{\sum_{j=1}^{n}(t_{ij} - t_{wj})^2}, i = 1,2,\dots,m$$

And the distance between the alternative i and the best condition A_b

$$d_{ib} = \sqrt{\sum_{j=1}^{n}(t_{ij} - t_{bj})^2}, i = 1,2,\dots,m$$

Where d_{iw} and d_{ib} are L^2-norm distances from the target alternative i to the worst and best conditions, respectively

(6) Calculate the similarity to the worst condition:

$$d_{iw} = \frac{d_{iw}}{d_{iw} + d_{ib}}, 0 \le s_{iw} \le 1, i = 1,2,\dots,m.$$

$$s_{iw} = 1$$

if and only if the alternative solution has the best condition;

$$s_{iw} = 0$$

if and only if the alternative solution has the worst condition.

(7) Rank the alternatives according to $s_{iw}(i = 1,2,\dots,m)$.

3.1.3 Results

After calculation, we obtained the numerical value of the index that can comprehensively evaluate the health status of the national higher education system. （As is listed in the Table 2）

Countries	Results
China	**0.550156**
The US	**0.651048**
Japan	**0.434538**
India	**0.386175**

Table 2. The results of the model

3.1.4 Analysis of the Result

Then we also collected the evaluation results of the higher education system of various countries by the British higher education rating agency QS. The evaluation system is based on the advantages of the system (the situation that the universities in the region enter the top 700 in the world), the possibility of enrollment in high-quality schools (the students in the region) The opportunity to enter the top 500 global universities in the region), top universities (the overall performance of the top universities in the region in the world), and financial investment (the government's financial investment in higher education institutions) are comprehensively evaluated. Then we compared the output of our model with it and drew the following figure. (In order to better compare the two, we expanded the index obtained by our model a hundred times)

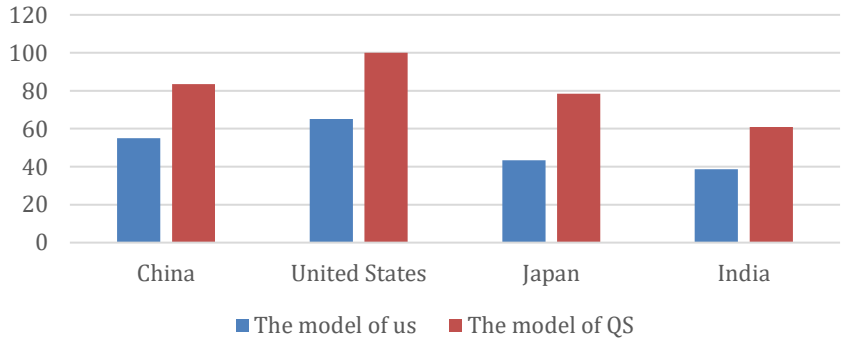

Figure 2. The comparison of two results

It can be seen from the above figure that although the evaluation index used by our model is different from the other one, the two evaluation results are basically the same, and the overall trend is also very similar. This also shows that our model is comprehensive and scientific in evaluating the health status of the higher education system.

3.2 The proposed vision of China's higher education system

In the discussion above，We analyzed and established a model to evaluate the health of the higher education system from multiple perspectives, and then selected China where the higher education system still has room for improvement to analysis. However, the specific idealized and more successful education system has not been clearly pointed out, which also leads to our model may be considered to be unable to play a substantial role. Therefore, in the following we will continue to take China as an example to propose an achievable and good higher education system. We use this as a vision to analyze and explore the specific differences and distances between China and the vision, so as to lay a foundation for policy formulation

3.2.1 Basic theory

(1)Sustainable higher education[5]

So far there is actually no definition that everyone agrees on. In terms of the development level of a country, developed countries and developing countries have different specific national conditions and different theoretical concepts, so their understanding of the definition of sustainable higher education is also different. The main task of the development of higher education in developed countries is to find a way to control the balanced development of talent training and rationally use educational resources to generate a virtuous circle.,while the main problem in developing countries is the serious shortage of higher education resources and the shortage of education.On this basis, we combined different perspectives to sum up the basic connotation of the sustainable development of higher education—sustainability and coordinated development based on fairness criteria or the unity of rational logic, time dimension and space dimension. It is emphasized that the cultivation of higher education talents should be based on the sustainability of educational resources, social justice and the people's active participation in their own development decisions, and the higher education model should be combined with the specific environment for improvement.

(2) Classification of higher education

From different perspectives or different levels, the higher education system has many division levels. Our model divides it from the perspectives of higher education supply, participation, investment, and environment. But this does not fully show the pros and cons of all aspects of the higher education system. Therefore, it is of great significance to update the concept and establish the overall development view of the higher education system.

3.2.2 A healthy and sustainable higher education system

For the model we have established, such a system does not require all the 19 third-level indicators to meet the standards, but needs to ignore the indicators with weak impact, and try to select the most influential indicators from the four first-level indicators for improvement. Therefore, we considered the weight of each indicator obtained by the principal component analysis method, and the specific meaning of these indicators to select the priority indicators for improvement.

- The principle of Principal Component Analysis method to determine the weight is based on the contribution of the variance of the common factor of each indicator to the ov erall variation. Therefore, in order to more intuitively show the impact of each indicator on t he health status of the higher education system, we have performed the weighting visualizati on process which is shown as the following pie chart.

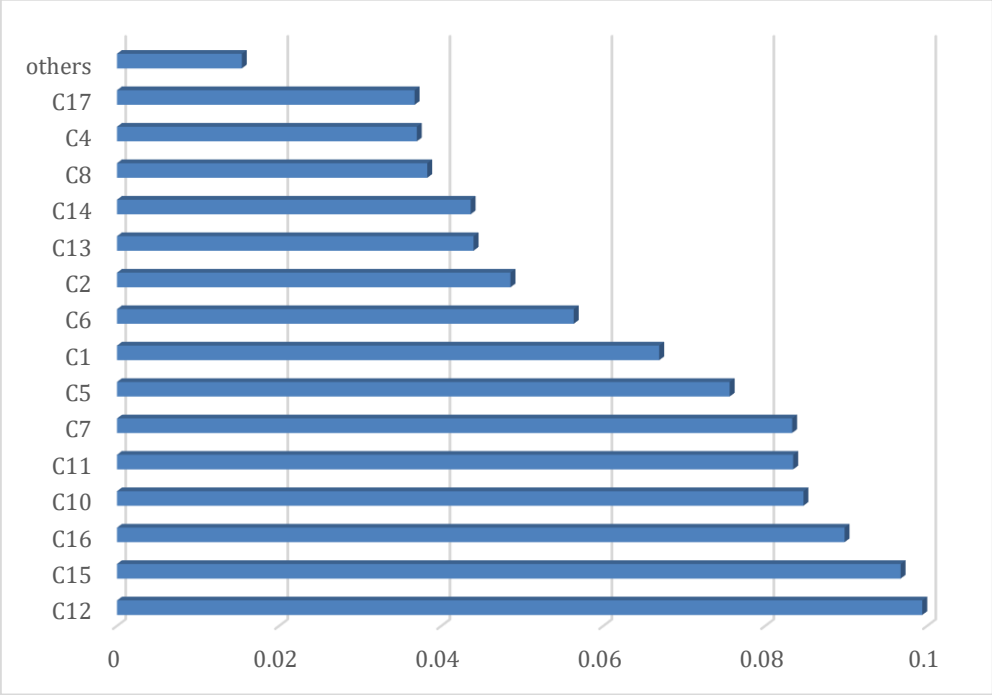

Figure 3. Percentage of each indicator weight

- From the above figure, we can draw that the sum of the weights of the four indicators C_3, C_9, C_{18}, and C_{19} on the system health status is not even as significant as that of the C_{17} indicator, so we decided to ignore its impact for the time being.
- From the result analysis of the first question, we know that if some data only consider the value of its value without considering the size of its own base, it will have a great impact on the judgment of the result. So we ignored these factors in the improved

indicators.Proportion of private universities C_{14} is also related to the country's cultural background and social system, so we still do not consider its role after improvement. Since proportion of education expenditure in GDP C_1 and proportion of women in colleges and universities C_7 are no need to improve, we decided to prioritize the improvement of 6 indicators such as C_5, C_7,and C_8.

- In summary, by consulting official data such as the World Bank and UNESCO, we put forward the following goals for the six indicators as indicators for the ideal higher education system.

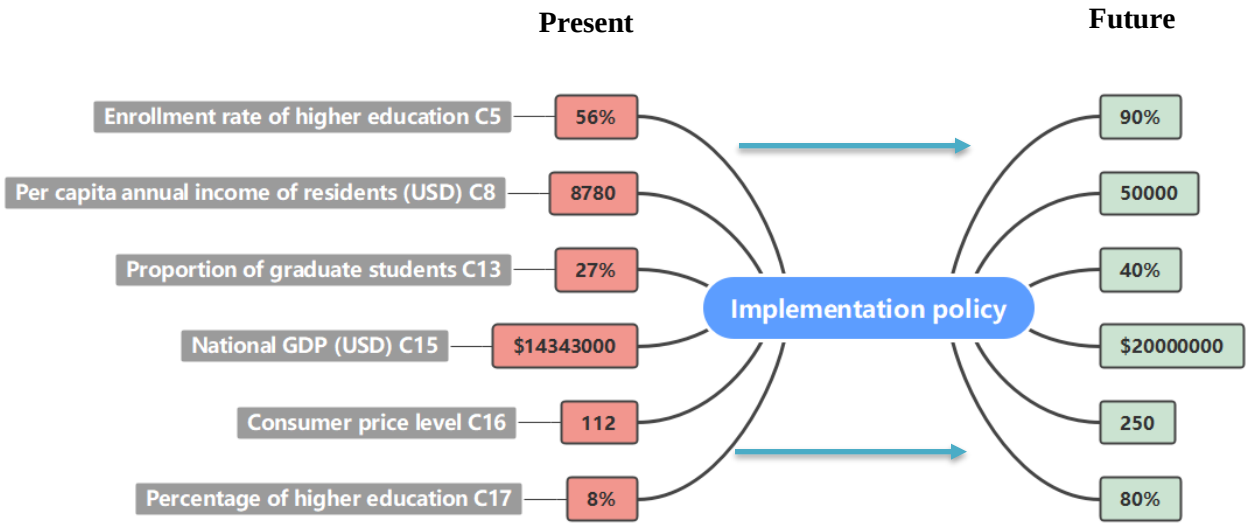

Figure 4. Estimated policy effect

3.2.3 Results

Using the indicators in the above vision, we calculated the health education indicators of the higher education system in the vision through the solution of the model, ranging from 0.550156 to 0.672891, even surpassing the current higher education system in the United States.

3.2.4 Analysis of the Result

- From the above operating results, we can see that the health status index of China's higher education in the vision has reached 0.672891. Compared with the developed countries, the United States, the system can be considered to be in a quite better health status.
- Since our model evaluation system is relatively comprehensive, it can be considered from

this level that China's higher education system that meets the above conditions can guarantee its higher education level and sustainability, which is similar to the current Chinese higher education system.However the current education system still holds a certain distance from the proposed one

3.3 Policy formulation and evaluation

3.3.1 Policy formulation

According to the model results and the analysis above, we have found six main factors that affect the country's higher education level: the proportion of higher education C_{17}, the average annual income of residents C_8, the proportion of graduate students C_{13}, the enrollment rate of higher education C_5, the consumer price level C_{16}, National GDP C_{15}， In response to these factors and China's specific national conditions, we have scheduled the "Higher Education Development Plan from 2020 to 2030" with reference to relevant documents, and adopted the following policies to improve China's higher education evaluation system

(1) The promotion policy of higher education from popularization to popularization[6].Determine the overall development scale, development goals and promotion strategies of higher education, and extend higher education to everyone as much as possible.

(2) Policies for improving university structure and layout

- Vigorously organize local colleges and universities, and strengthen the service function of local universities for local social development**.** To change the current situation that China's domestic universities are over-concentrated in large cities, with fewer universities in small and medium-sized cities, and the unreasonable geographic distribution of universities. Encourage local governments to establish local universities, with a focus on the establishment of higher-professional colleges and universities to improve the appropriateness of local universities to local social development and economic construction.
- In the process of running schools, local universities should make full use of various resources, actively broaden the channels for running schools, continuously improve the quality of running schools, and enhance the competitiveness of running schools to ensure that they will not be eliminated in the fiercely competitive market.[7]
- To further adjust the teaching policies of higher education, institutions should center on cultivating students with global awareness, international knowledge and cross-cultural communication capabilities. On the design of the curriculum, make it reflect the international

characteristics of the curricular more clearly, while continuing to adhere to and strengthen the nationality characteristic of the curriculum And localization it holds;

- Further adjust the management policy of college teachers, deepen the reform of the personnel system centered on the implementation of the employment system, adopt more effective incentive mechanisms, introduce incentive policies, increase salaries, appropriately relax the conditions for evaluating professional titles, attract overseas returnees, and continue to strengthen the construction of college teachers .
- In response to the problems in the development of private higher education, such as the unbalanced distribution of teaching resources in private colleges and universities, a series of policies and management rules for private higher education should be issued[8] to regulate the rights and obligations of various actors in private higher education together with Its management behavior**.**
- Actively promote the process of domestic and foreign cooperation in current running schools. Actively open up the international market for education, constantly explore effective management methods and means, adhere to law-based administration and standardized management, and strive to guide domestic-foreign cooperation in a healthy and orderly direction.
- Pay special attention to the quality of graduate students. Promulgate relevant policies such as raising the threshold for graduate students to implement the quality of graduate students to ensure that the general level of graduate students can reach a certain height.

(3) Improve and implement the employment rate of college students. Actively advocate "school-enterprise docking" or the government to increase investment in saturated industries, so that saturation becomes unsaturated, so as to have a normal cycle. At the same time, the maximum working years and age should be restricted as much as possible. Avoid clusters of elderly workers and create a normal industrial cycle chain.

(4) Adjust the ratio of higher education expenditure to GDP[9]. Require relevant departments to improve the use efficiency of higher education funds and improve the quality of higher education. The implementation timeline

3.3.2 The implementation timeline

Figure 5. The implementation timeline

3.3.3 Model-based policy effectiveness analysis and policy adjustment

We can analyze the indicators related to these policies, C_{17} the proportion of who have received higher education, C_{19} the proportion of employment, C_{14} the proportion of private colleges, $C_{13}$the proportion of graduate students, C_{12} the number of international students, C_2 the number of full-time teachers, C_4 the number of higher education institutions, C_5 and the number of higher education institutions enrollment rate, C_6 number of students in colleges and universities, C_9 number of patent applications, C_{10} number of papers published

(1) Effectiveness analysis According to the of the model：

The fundamental purpose of higher education policy performance evaluation effectiveness research is to evaluate the impact of education policies on the “people” who are educated[10].Therefore, the focus of our evaluation of effectiveness is on people.

When considering Effectiveness evaluation, time factor must be taken into account , that is, the effect produced during the implementation of the policy, time beyond given will not be considered. Therefore, the effect of the policy within the implementation time must also be considered. At the same time, in order to avoid one-sided results from a single evaluation, we should consider both efficiency and benefit.

Simply looking at the expected effect of the policy： The policy can increase the education penetration rate, improve the quality of private universities, increase the number and quality of university teachers, increase the internationalization rate of universities, increase the international attractiveness of universities, increase the number of international students, and improve the employment rate of saturated industries, also the quality of the graduate students has improved significantly.

Corresponding to the time factor and the consideration of the policy implementation timeline (compared to the estimation of the completion speed of similar projects in China before):

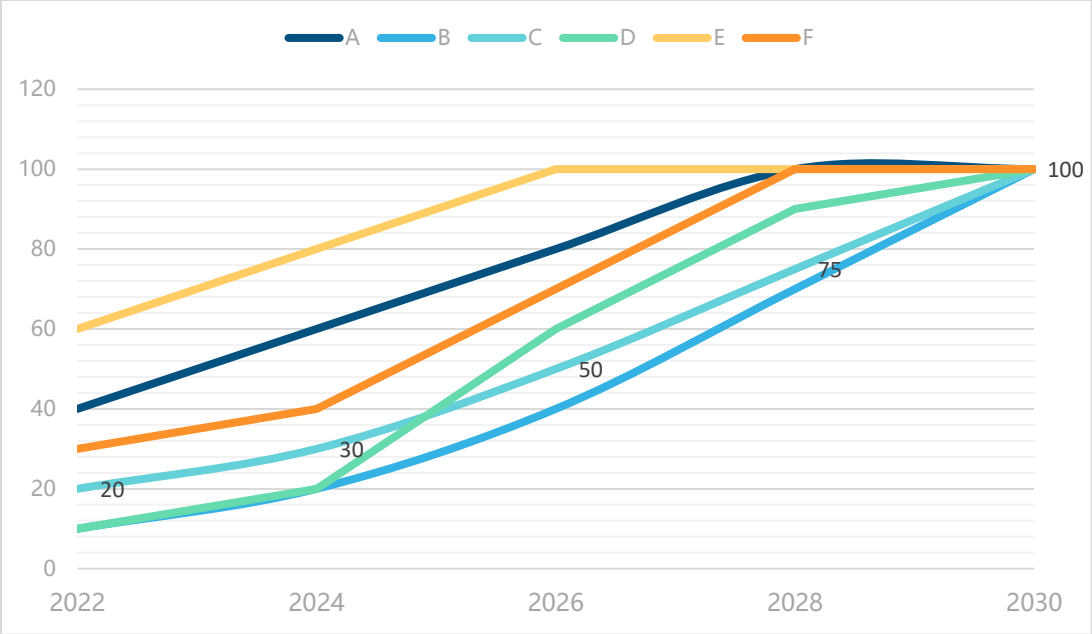

Figure 6. Anticipated fulfilling percentage on policies (%)

It can be seen that during the policy implementation period, most policies have basically reached a very good completion status by 2030.

In terms of efficiency and benefit, B's efficiency is the slowest, combined with the most efficient E, From the formula: benefit=efficiency x effect, under certain conditions, it can be analyzed that the benefits of the two are almost the same. Therefore, the most efficient and least efficient policies have the same benefits, and it can be obtained that the policy performs well in terms of efficiency and effectiveness.

C_{17}'s weight	**0.03671056**
C_{14}'s weight	**0.043622656**
C_{13}'s weight	**0.043982814**

Table 3. Weight on some indicators

Corresponding to the fundamental evaluation of effectiveness, it is implemented in students: the quality of education received by students is enhanced, the general competitiveness of students is enhanced, students have the ability to internationalize, and at the same time, students can get better employment.

Finally, combined with the model, C_{17} increased, C_{19} increased, C_{14} increased, C_{12} increased, C_2 increased, C_4 increased, C_5 increased, C6 increased, combined with the weight w_i, we can get that the education level evaluation index will also increase. So overall, the effectiveness of the policy is good.

(2) How to modify the policies based on the model：

We see that A, B, C, D, and F are all indicators that directly increase the model. However, in E, it will reduce the C_{13} index to a certain extent, but it will also improve the quality of graduate students who have not appeared in the index mentioned above, and promote C_9 and C_{10} to a certain extent. According to the weight analysis, assuming C_9, the same situation is affected, as shown in Table 3. When the weight of $C_9+C_{10}>C_{13}$, it can be obtained that E is scientific to a certain extent; if the impact is not the same, for example, when the graduate student is removed, C_9 and C_{10} do not equivalently offset the decline of C_{13}, so E's policy should be appropriately cleared within a certain range, and cannot exceed a certain measure.

3.3.4 Ideality and reality

If the above policies can be implemented, it will have some impact on the real world, and in the process of implementation, all aspects of this country will undergo some changes, whether it is for individual students or some educational institutions in the higher education system. Next, we will discuss the possible impact of the implementation of the above policies from both the "micro" and "macro" perspectives.

(1)Micro level

For students, teachers and other individuals, the early implementation of these policies may make everyone a little uncomfortable, and due to changes in some system requirements, it may even lead to changes in students' mentality, such as increasing the strength of the research level of graduate students and strict Requiring the entry threshold and graduation threshold of higher education institutions may put more pressure on students, thereby changing the environment of higher education. With the passage of time, everyone will gradually adapt to this process, and due to the influence of some incentive policies, the enthusiasm of students and teachers will be greatly improved.

(2)Macro level

For some higher education institutions, the implementation of these policies and the ten-year plan will enable some colleges and universities to truly play their role and make the education atmosphere in society better. But in fact, for a country, higher education is not an isolated system, it affects all levels including economy, cultural industry, military, etc., and these are also affecting higher education itself, they are interactive.

As we all know, the formulation of policies does not only need to consider some objective factors. It is often necessary to make corresponding adjustments according to changes in specific

circumstances, and also to comply with democratic proposals and make a one-sided macroscopic approach to a certain problem. It is of course possible to adjust the policy, but relevant agencies should also take some specific measures and specific implementation methods to face the problems that may be encountered in the future.

Of course, China has also formulated a lot of decisions related to the above policies, and they have indeed played a certain role, but the specific impact is not so obvious. Taking Hong Kong, China as an example, we use the data provided by[2] U21（21 University Alliance）,The following figure is made for the four evaluation results：

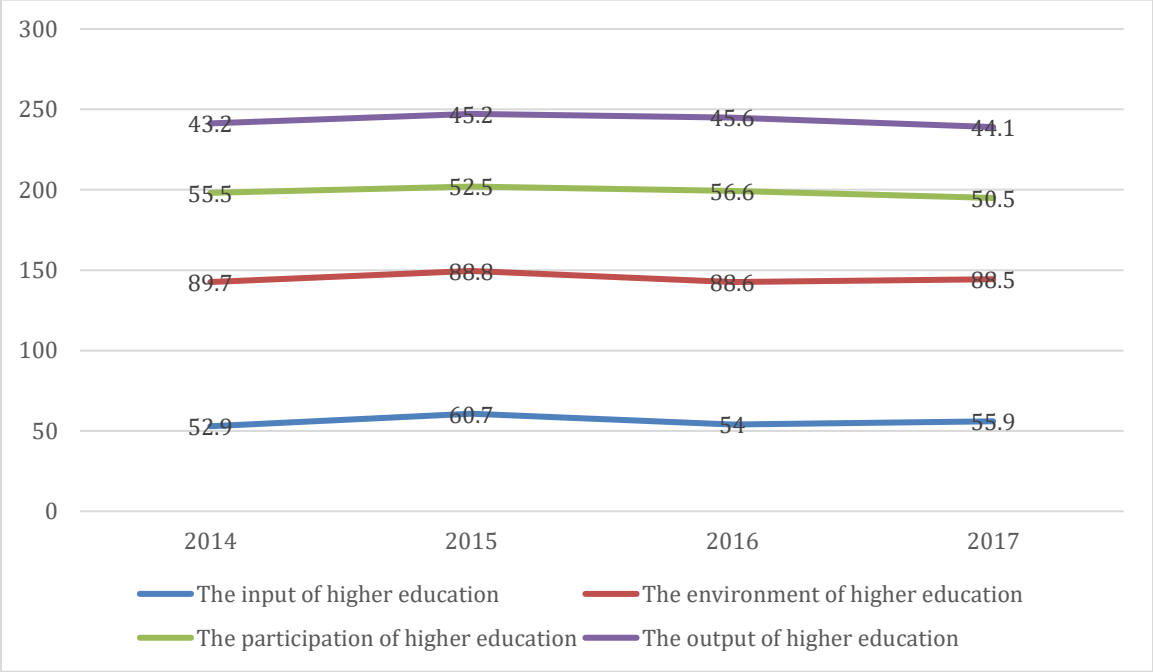

Figure 7. The change of Hong Kong's higher education

From the above figure, we can also see that although the results of education policy planning are very good and may cause some changes in the real world, these changes are not only large, so we can consider acknowledging the reality that change is hard.

IV. Model Testing

4.1 Error Analysis

1. The influence of population base: Some indicators are greatly affected by the population base, such as the number of full-time teachers and the number of higher education institutions. Due to the population base of 1.3 billion in China and 126 million in Japan, the final result may be affected greatly.
2. The subjective feelings of higher education participants are not considered: The model only considers the data of objective indicators, but the data does not fully reflect the current status of higher education in a country. The subjective experience and satisfaction of higher education participants are also important when judging higher education system.
3. Differences in cultural and social systems: Because of differences in cultural background and social systems, certain indicators may be affected accordingly.
4. The amount of data is still relatively small, and the accuracy of the results cannot be guaranteed.

4.2 Sensitivity Analysis

Because there may be unavoidable errors in the actual data collection and statistics process, sensitivity analysis of our model is necessary.

Sensitivity analysis method is to find out the sensitivity factors that have an important influence on the model output from many uncertain factors, analyze and calculate the degree of influence and sensitivity on the model output, and then judge the stability of the model.。

For the model we established in Task 1, we select four first-level indicators of education supply, education participation, education achievement, education participation and related parameters for sensitivity analysis. Increase the parameters related to these four indicators by 5%, 10%, 15%, and 20% respectively, and the final output result is as shown in the figure below (the ordinate is the result of the change in the percentage of the output result after changing the parameter and the result of 10000 times magnification)

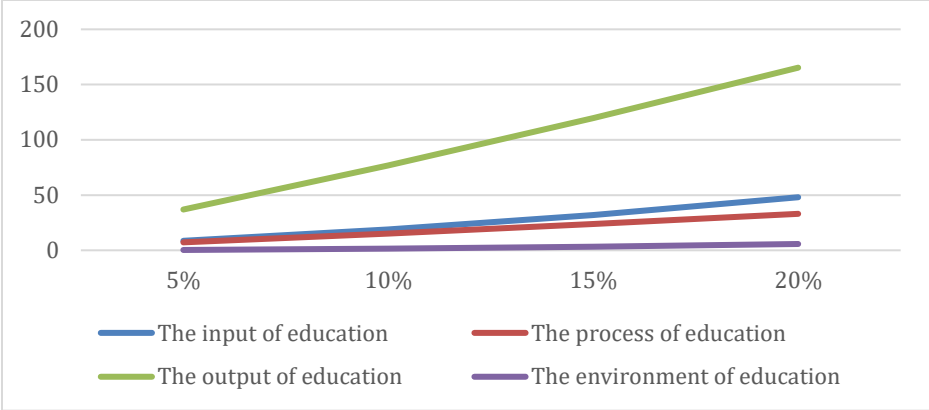

Figure 8. The result of sensitivity analysis

From the results of this analysis, it can be seen that the sensitivity of education output is high while the sensitivity of education environment is relatively low, which is consistent with the actual situation.

The most intuitive way to evaluate a country's higher education system is the education achievement-related indicators. If more top papers and scientific research results are produced, the higher education level is relatively advanced; while the education environment-related indicators are related to the national environment, etc. Which have no direct connection with the higher education system itself, so its sensitivity is low.

V. Strengths and Weaknesses

5.1 Strengths

1. We divide the indicators that affect the education system into four categories: education supply, education participation, education achievements, and education environment. It embodies the hierarchical structure of the higher education system more intuitively and has a certain logic.
2. The selected indicators cover a wide range, meet the requirements of actual education, and can fully reflect the actual status of a country's higher education system.

5.2 Weakness:

1. This evaluation method requires a large amount of data to support the model, and it is difficult to collect and organize large amounts of data in the actual evaluation process.
2. Although our model considers various factors, it cannot guarantee the complete accuracy of the model's prediction results. And the policies we put forward cannot guarantee that they conform to the actual national conditions of the country.

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VII. Appendix

1.The weight of indicators

Indicator	Weight
C1	0.066910857
C10	0.084724078
C11	0.083460515
C12	0.099409174
C13	0.043982814
C14	0.043622656
C15	0.096731493
C16	0.089801678
C17	0.03671056
C18	-0.053659888
C19	0.022685198
C2	0.048536104
C3	0.036549772
C4	0.03698214
C5	0.075611731
C6	0.056349118
C7	0.083334894
C8	0.038268058
C9	0.009824

2.Core code(TOPSIS)

```
W0 = [0.066911, 0.048536104, 0.036549772,
0.03698214,0.075611731,0.056349118,0.083
334894,0.038268058,0.009824,0.084724078,
0.083460515,0.099409174,0.043982814,0.04
3622656,0.096731493,0.089801678,0.036710
56,-0.053659888,0.022685198]
W = np.ones([A1.shape[1], A1.shape[1]], floa
t)
    for i in range(len(W)):
        for j in range(len(W)):
            if i == j:
                W[i, j] = W0[j]
            else:
                W[i, j] = 0
    Z = np.ones([A1.shape[0], A1.shape[1]], fl
oat)
    Z = np.dot(A1, W)
    Zmax = np.ones([1, A1.shape[1]], float)
    Zmin = np.ones([1, A1.shape[1]], float)
    for j in range(A1.shape[1]):
        if j == 17:
            Zmax[0, j] = min(Z[:, j])
            Zmin[0, j] = max(Z[:, j])
        else:

                Zmax[0, j] = max(Z[:, j])
                Zmin[0, j] = min(Z[:, j])
      C = []
    for i in range(A1.shape[0]):
        Smax = np.sqrt(np.sum(np.square(Z[i, :]
- Zmax[0, :])))
        Smin = np.sqrt(np.sum(np.square(Z[i, :]
- Zmin[0, :])))
        C.append(Smin / (Smax + Smin))
         a=['China','United
States','Japan','INdia']
    C = pd.DataFrame(C, index=[i for i in a])
    return C
```