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Research on the Optimization of DEA Based on the Perspective of Customer Satisfaction

—A Case Study of Compulsory Education Service

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***Abstract*—In order to solve the problem of high efficiency and low satisfaction in the service industry, this paper constructed the CS-DEA model from the perspective of input. From the perspective of customer satisfaction, it could adjust the input to achieve high efficiency and high satisfaction based on DEA-BCC efficiency analysis. Finally, this paper took the compulsory education service of the key cities as an example to verify the effectiveness of the model and put forward corresponding suggestions.**

Keywords—DEA-BCC; Customer Satisfaction; CS-DEA; Compulsory Education

I. INTRODUCTION

The Data Envelopment Analysis Method (DEA) is a nonparametric method based on mathematics and operations research to estimate the relative efficiency of a multi-input and output system. It was first proposed by Charnes, Cooper, and Rhodes in 1978[1]. At present, the DEA model has been adopted by many scholars and applied in various fields, such as fiscal expenditure efficiency assessment, tourism efficiency assessment, energy efficiency assessment, air pollution control efficiency assessment, and education service efficiency assessment. Zhao Qi used the DEA analysis method to evaluate the input-output efficiency of compulsory education resource allocation and conducted an empirical analysis [2]. Zhang Dongchao used the DEA analysis method to evaluate the efficiency of China's listed commercial banks [3]. Zhu Erxi and Liu Jiawei used the DEA method to construct the BCC model and the Malmquist index model to evaluate the efficiency of the cultural financial service system [4].

Domestic and foreign scholars continue to improve the DEA model in the process of using the DEA method to study the efficiency evaluation problem in order to adapt to the development of the times. The DEA model has been combined with many analytical methods to form derivative models such as AHP/DEA model [5] and the fuzzy DEA model [6] in the past 40 years. At the same time, many derivative models such as the super-efficiency DEA model [7], interval DEA model [8], inverse DEA model [9], and network DEA model [10] are also produced.

With the continuous improvement of the economic level, customers not only require efficient services but also demand high service quality. The traditional DEA model mainly evaluates the efficiency of service input and output results without paying attention to customer satisfaction. However, the quality of service is more focused on customer satisfaction in the current customer-centric era. Therefore, this paper improves the DEA-BCC model based on a customer satisfaction perspective. The paper proposes that the CS-DEA model is dedicated to solving the high efficiency-low satisfaction problem existing in the service industry and providing a reliable basis for the optimal allocation of resources based on the input/output efficiency analysis.

II. OPTIMIZATION MECHANISM OF DEA MODEL FROM THE PERSPECTIVE OF CUSTOMER SATISFACTION

A. *Measurement of service efficiency and customer satisfaction*

1) Measurement of the efficiency of the service

Efficiency refers to the ratio of input and output of resources. Efficiency is the most direct purpose of economic behavior in the economy. In addition, the ultimate goal of any economic behavior is to achieve a certain degree of efficiency. Efficiency is usually divided into comprehensive efficiency, pure technical efficiency, and scale efficiency inefficiency research. Service efficiency refers to the ratio of the input of Service efficiency refers to the ratio of the input of enterprise service resources to the output of service effects. Finally, the effectiveness of enterprise service resource allocation is verified by efficiency.

The efficiency scores of the input and output indicators of resources calculated by the DEA model are between [0-1.0]. According to the classification of satisfaction interval, the interval of efficiency score is divided into five levels: low efficiency, low efficiency, general, high efficiency and high efficiency. The results are shown in Table I. However, with the development of technology, various industries in China have gradually developed from a high-speed development stage to a high-quality stage. This paper considers the efficiency score of 1.0 as the high-efficiency unit and the other as the low-efficiency decision-making unit based on a large number of decision-making units [0.8-1.0].

TABLE I. EFFICIENCY SCORE AND DIVISION SCALE

effectiveness	meaning
(0-0.2)	Very inefficient
[0.2-0.4)	inefficient
[0.4-0.6)	general
[0.6-0.8)	efficient
[0.8-1.0)	Very efficient

TABLE II. SATISFACTION SCORE CONVERSION AND RATING TABLE

Five-point Likert scale	Adjusted quality score intervals equivalent	meaning
(0-1)	(0-0.2)	Very dissatisfied
[1-2)	[0.2-0.4)	dissatisfied
[2-3)	[0.4-0.6)	general
[3-4)	[0.6-0.8)	satisfied
[4-5]	[0.8-1.0)	Very satisfied

2) Measurement of service effect

The effect is to measure the degree to which the company achieves its intended goals and targets after implementing various business activities. The service effect of the enterprise is also the extent to which the services provided by the enterprise reach their expectations. The theory of the service chain ultimately improves revenue and profitability. It includes improving internal management to deliver valuable services and then achieving customer satisfaction to customer loyalty. Therefore, in order to achieve the economic goals of improving profitability and profitability, it is necessary to improve customer satisfaction and make customers loyal to the company.

The satisfaction degree of the service is divided into five parts: the dissatisfaction, the dissatisfaction, the general, the satisfaction, and the satisfaction based on the five-point Likert scale. The average satisfaction score for services under these conditions is [1-5]. The five-point scoring interval is converted into the [0-1.0] interval in order to correspond to the efficiency score. The results are shown in Table II. The specific calculation method is the interval value of the five-point Likert scale multiplied by 0.2. The article identified the unit satisfaction score [0.8-1.0] as a high satisfaction unit and below 0.8 as a low satisfaction level.

B. *Relationship between service efficiency and effectiveness*

In the article, service efficiency refers to the input and output of the service and the effect is the customer satisfaction of the service. This paper divides the efficiency and effectiveness of services into four areas based on the two dimensions of service efficiency and customer satisfaction. These four areas include high efficiency - high satisfaction, high efficiency - low satisfaction, low efficiency - high satisfaction and low efficiency - low satisfaction. The article assumes that service efficiency and service effectiveness(customer satisfaction) are inverse relationships and can be converted to each other. In other words, companies can improve customer satisfaction by adjusting inputs to reduce service efficiency. Satisfaction (S) and efficiency (E) are represented by the X-axis and the Y-axis of Cartesian coordinates, respectively. At this point, efficiency and satisfaction determine the collection location of the service unit. The efficiency and satisfaction are divided into four parts according to the dividing line: HE-HS (high efficiency - high satisfaction), HE-LS (high efficiency - low satisfaction), LE-HS (low efficiency - high satisfaction), LE-LS (low efficiency - low satisfaction). The result is shown in Fig. 1.

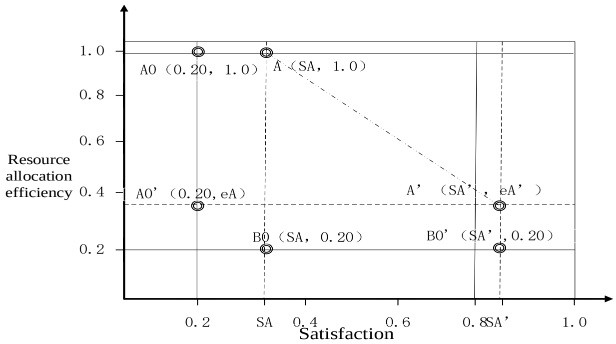

Fig. 1. Analysis of the relationship between service efficiency and satisfaction in the plane Cartesian coordinate system

III. PROCESS OF CS-DEA MODEL CONSTRUCTION

This paper optimizes the DEA model based on the BC2 model. This part proposes the concrete steps of the CS-DEA model construction based on the introduction of the BC^2 model.

A. *BC^2 model*

The BC^2 model removes the important premise assumption that the scale return is unchanged of the C^2R model. Moreover, the BC^2 model introduces constraints based on the C^2R model [11]. The model structure is as follows:

$$\left.\begin{array}{c} \min\theta \\ \text{s.t.}\sum_{j=1}^{n} x_j\lambda_j + s^+ = \theta x_0 \\ \sum_{j=1}^{n} y_j\lambda_j - s^- = \theta y_0 \\ \sum_{j=1}^{n}\lambda_j = 1 \\ s^- \geq 0, s^+ \geq 0, \lambda_j \geq 0, j = 1,2\cdots n \end{array}\right\} \quad (1)$$

The result of the objective function measurement is called pure technical efficiency. Scale efficiency (SE) is obtained by dividing technical efficiency (TE) by pure technical efficiency (PTE). The article adjusts the constraint $\sum_{j=1}^{n}\lambda_j = 1$ in the above model to $\sum_{j=1}^{n}\lambda_j \leq 1$. It can be judged whether the decision-making unit is in the stage of increasing or decreasing the scale of returns based on the established model. The improvement direction of scale efficiency is analyzed based on the above judgment results.

B. CS-DEA-BC^2 model

This paper optimizes the DEA-BC^2 model from the perspective of customer satisfaction on the basis of the DEA-BC^2 model. It mainly solves the problem of high efficiency and low satisfaction of the current service industry. Specific steps are as follows:

Step1: DEAP2.1 is used to calculate the efficiency of a unit.

Step2: The satisfaction measurement of the service industry is based on the five-point Likert scale and converted to [0-1.0].

Step3: The decision unit is divided according to the efficiency score and the satisfaction score. The classification levels include HE-HS (high efficiency and high satisfaction), HE-LS (high efficiency-low satisfaction), LE-HS (low efficiency-high satisfaction), and LE-LS (low efficiency and low satisfaction).

Step 4: The efficiency of the HE-LS unit is adjusted. The input index value of the HE-LS unit is recalculated under the premise of ensuring that the output of the decision unit is unchanged. The adjusted indicator data will then be re-submitted into the DEAP2.1 software for calculation and ultimately converted to HE-HS units. If the number of HE-LS unit is null, then stop.

This article takes the actual points and hypothetical points in Figure 1 as an example. s_A' and e_A' are assumed to be arbitrary values between [0.8-1.0] and [0.2-1.0], respectively. The relationship equation is as follows.

$$\frac{(A_0B_0)}{(A_0'B_0')}=\frac{(s_A-0.20)(0.20-1.0)}{(s_A'-0.20)(0.20-e_A')} \tag{2}$$

Given the distance function formula: $(AB)=\sqrt{(x_2-x_1)^2+(y_2-y_1)^2}$ and substituting in (2) we take:

$$\sqrt{\frac{(s_A-0.20)^2+(0.20-1.0)^2}{(s_A'-0.20)^2+(0.20-e_A')^2}}=\frac{(s_A-0.20)(0.20-1.0)}{(s_A'-0.20)(0.20-e_A')} \tag{3}$$

In general, even if diverse quality and efficiency cut-off points are chosen (cut-off points ¹ 0.2), (3) is expressed by the following equation:

$$\sqrt{\frac{(s_A-s_0)^2+(e_0-1.0)^2}{(s_A'-s_0)^2+(e_0-e_A')^2}}=\frac{(s_A-s_0)(e_0-1.0)}{(s_A'-s_0)(e_0-e_A')} \tag{4}$$

Formula (5) can be obtained a base on Formula (4).

$$e_A'=e_0+\sqrt{\frac{\left[(s_A-s_0)^2(e_0-1.0)^2\right](s_A'-s_0)^2}{\left[(s_A-s_0)^2+(e_0-1.0)^2\right](s_A'-s_0)^2-(s_A-s_0)^2(e_0-1.0)^2}} \tag{5}$$

Since the new efficiency score (e_A') has been calculated, the inputs of the hypothetical operational units should be adjusted holding the outputs fixed (input orientation). Its efficiency score is expressed as formula (6)

$$e=\frac{\sum_{r=1}^{n}\alpha_r y_r}{\sum_{r=1}^{n}\beta_i x_i}=\frac{\alpha_1 y_1+\alpha_2 y_2+\cdots+\alpha_n y_n}{\beta_1 x_1+\beta_2 x_2+\cdots\beta_i x_m} \tag{6}$$

Where: e = efficiency score

y_r = amount of output

α_r = weight assigned to output r

x_i = amount of input i

β_i = weight assigned to input i

Alternatively, the precedent equation (6) is expressed in matrix form:

$$e=\frac{\sum_{r=1}^{n}u_r y_r}{\sum_{r=1}^{n}v_i x_i'}=\frac{[y_1,y_2,\cdots y_n]\begin{bmatrix}\alpha_1\\ \alpha_2\\ \vdots\\ \alpha_n\end{bmatrix}}{[x_1,x_2,\cdots x_m]\begin{bmatrix}\beta_1\\ \beta_2\\ \vdots\\ \beta_m\end{bmatrix}} \tag{7}$$

Assuming technical efficiency prevails, then:

$$1.0=\frac{[y_1,y_2,\cdots y_n]\begin{bmatrix}\alpha_1\\ \alpha_2\\ \vdots\\ \alpha_n\end{bmatrix}}{[x_1,x_2,\cdots x_m]\begin{bmatrix}\beta_1\\ \beta_2\\ \vdots\\ \beta_m\end{bmatrix}} \tag{8}$$

Therefore,

$$[x_1,x_2,\cdots x_m]\begin{bmatrix}\beta_1\\ \beta_2\\ \vdots\\ \beta_s\end{bmatrix}=[y_1,y_2,\cdots y_n]\begin{bmatrix}\alpha_1\\ \alpha_2\\ \vdots\\ \alpha_n\end{bmatrix} \tag{9}$$

According to the changes of formulas (6)-(8), the adjusted efficiency can be expressed as:

$$e'=\frac{\sum_{r=1}^{n}\alpha_r y_r}{\sum_{r=1}^{n}\beta_i x_i'} \tag{10}$$

where e’≠ e and x_i’≠ x_i, The formula (10) is transformed into a matrix form as shown below.

$$e'=\frac{\sum_{r=1}^{n}u_r y_r}{\sum_{r=1}^{n}v_i x_i'}=\frac{[y_1,y_2,\cdots y_n]\begin{bmatrix}\alpha_1\\ \alpha_2\\ \vdots\\ \alpha_n\end{bmatrix}}{[x_1',x_2',\cdots x_m']\begin{bmatrix}\beta_1\\ \beta_2\\ \vdots\\ \beta_m\end{bmatrix}} \tag{11}$$

The formula (11) is divided by 1/e’ and the results are as follows.

$$1=\frac{[y_1,y_2,\cdots y_n]\begin{bmatrix}\alpha_1\\ \alpha_2\\ \vdots\\ \alpha_n\end{bmatrix}}{e'[x_1',x_2',\cdots x_m']\begin{bmatrix}\beta_1\\ \beta_2\\ \vdots\\ \beta_m\end{bmatrix}} \tag{12}$$

The formula (12) is brought into the formula (11) and the results are as follows.

$$[e'x_1',e'x_2',\cdots e'x_m']\begin{bmatrix}v_1\\ v_2\\ \vdots\\ v_s\end{bmatrix}=[x_1,x_2,\cdots x_m]\begin{bmatrix}v_1\\ v_2\\ \vdots\\ v_s\end{bmatrix} \tag{13}$$

Therefore,

$$\left.\begin{array}{l} x_1' = \frac{1}{e'} x \\ x_1' = \frac{1}{e'} x \\ \vdots \\ x_1' = \frac{1}{e'} x \end{array}\right\} \quad (14)$$

In the above system of equations, e’ is the ordinate of A’ and e’ is also the ordinate of each LE-HS. X represents the actual input index of the HE-LS and it is known. The adjusted input value can be calculated based on the above conditions. It is substituted into the DEAP.2.1 software to get the adjusted new efficiency value. Finally, the category of the decision unit can be re-identified.

IV. MODEL VERIFICATION

A. Construction of compulsory education resource allocation indicators and the sources of indicator data

1) Compulsory education resource allocation indicator system

When using the DEA model to evaluate efficiency, it is necessary to establish a set of realistic input-output index systems. Education is a special service industry. The basic input indicators for measuring the efficiency of education should include human, material and financial aspects [12]. Its output indicators should include both direct output and affect output. Considering the scientific nature of indicators and the availability of data, this paper constructs an index system for the efficiency of China's compulsory education resource allocation from the perspective of input and output. It includes 2 first-level indicators, 5 second-level indicators, and 16 third-level indicators. The results are shown in Table III.

TABLE III. COMPULSORY EDUCATION RESOURCE ALLOCATION INDICATOR SYSTEM

Primary indicator	Secondary indicators	Three-level indicator
Input indicator	Human input	Number of full-time teachers in primary schools
		Number of full-time teachers in middle schools
		Number of primary school teachers with a college degree or above or above
		Number of middle school per capita school building area school teachers with a bachelor degree or above
	Material input	Primary school per capita school building area(m2)
		Middle school per capita school building area(m2)
		Number of books per capita in primary schools
		Number of books per capita in middle schools
		Number of computers per 100 primary school students
		Number of computers per 100 middle school students
	Financial investment	Education funds as a percentage of financial expenditure
Output indicator	Direct output	Number of students in primary schools
		Number of students in middle schools
		Primary school consolidation rate (%)
		Middle school consolidation rate (%)
	Effect output	Number of years of education per capita

2) Compulsory education resource allocation indicator system

Combined with the authenticity and availability of the data, the article selects Qingdao, Hangzhou, Jinan, The educational resource allocation efficiency of the seven major cities of Shenyang, Changchun, Guangzhou and Xi'an is the research object Based on the results of the *China Education Development Report (2016)*, which was formed by the 21st Century Institute of Education's monitoring of the balanced development of compulsory education in 19 key cities. The statistics of Qingdao and Jinan are derived from the *Qingdao Statistical Yearbook, the Jinan Education Statistics Briefing in the 2012 Year, the Shandong Statistical Yearbook* and *the “2015 Shandong Education Statistics Bulletin*. The data of Hangzhou City comes from the *Zhejiang Statistical Yearbook, Hangzhou Statistical Yearbook and 2015 Zhejiang Education Industry Statistics Bulletin*. The data of Changchun City comes from the *Statistical Bulletin of Education in Changchun City*. The data of Shenyang City comes from *the 2015 Liaoning Provincial Education Statistics Bulletin, Liaoning Province Statistical Yearbook* and *Shenyang City Statistical Yearbook*. The data of Guangzhou City comes from t*he 2015 Guangzhou Education Statistics Manual*. The data of Xi'an is derived from the *2015 Shaanxi Provincial Education Statistics Bulletin* and the *Xi'an Statistical Yearbook*. The per capita years of education in each city are derived from the data of each province. The input and output indicator data of compulsory education resource allocation in major cities are shown in Tables IV and V.

TABLE IV. COMPULSORY EDUCATION INPUT DATA SHEET FOR SEVEN MAJOR CITIES

indicators	Qing dao	Hang zhou	Jinan	Shen yang	Chang chun	Guang zhou	Xi'an
X1	34457	31280	25795	22321	26301	49336	30579
X2	38042	18909	30239	14862	30521	27534	19306
X3	30949	30423	23097	21160	24171	48367	29212
X4	20936	17752	14800	13108	26974	24881	17180
X5	6	8.2	6.3	7.2	6.46	7.14	7.26
X6	13.39	18.3	13.39	11.1	13.3	19.87	14.81
X7	24.7	26.8	29.02	19.71	24.35	24.56	29.53
X8	41.2	45.7	51.58	30.19	41	53.17	45.98
X9	13.81	17.1	16.8	16.67	12.06	15.28	11.68
X10	20.33	28.3	27.5	20.83	15	30.78	16.72
X11	2340 929	2234 425	1163 590	1075 909	1068 000	2870 733	1183 865

TABLE V. COMPULSORY EDUCATION OUTPUT DATA SHEETS FOR SEVEN MAJOR CITIES

City	Y1	Y2	Y3	Y4	Y5
Qingdao	536492	238715	90.83	90.29	9.033
Hangzhou	524513	211323	74.24	99.48	8.977
Jinan	414424	187956	87.26	92.01	9.033
Shenyang	365148	162601	85.05	95.58	9.840
Changchun	396000	298603	77.21	96.45	9.393
Guangzhou	937870	336664	97.82	94.84	9.496
Xi'an	566200	413700	90.86	96.20	9.546

B. Construction of Compulsory Education Satisfaction Index and Source of Indicator Data

1) Construction of the satisfaction index of compulsory education

The article establishes a satisfaction evaluation index system based on the perspective of the local people based on the results of the China Education Development Report (2016). It mainly includes the distance to school, the choice of schools and Inter-school differences.

2) Construction of the satisfaction index of compulsory education

The total enrollment of primary and middle schools is divided into three points, including full realization, partial realization, and basic failure. The total score for school selection and inter-school differences is 5 points. The effect of policy implementation is divided into five levels, including very satisfied, relatively satisfied, general, dissatisfied and very dissatisfied. The overall satisfaction of compulsory education is 16 points for the sum of these four scores [13]. The results are shown in Table VI.

TABLE VI. THE SATISFACTION OF BALANCED DEVELOPMENT OF COMPULSORY EDUCATION IN SEVEN MAJOR CITIES

City	Distance of school	Distance of middle school	The choice of schools	Inter-school differences	Total Score
Qingdao	2.537	2.465	3.479	2.302	10.783
Hangzhou	2.346	2.342	3.361	2.113	10.162
Jinan	2.434	2.350	3.264	2.084	10.132
Shenyang	2.408	2.392	3.045	1.933	9.778
Changchun	2.354	2.336	2.994	1.747	9.431
Guangzhou	2.155	2.168	3.163	1.937	9.423
Xi'an	2.066	2.079	2.808	1.692	8.645

The article converts it into [0-5] base on the classification of satisfaction in Table II. The results are shown in Table VII.

TABLE VII. SATISFACTION SCORE CONVERSION AND RATING TABLE

City	Total Score	Satisfaction score
Qingdao	10.783	0.674
Hangzhou	10.162	0.635
Jinan	10.132	0.633
Shenyang	9.778	0.611
Changchun	9.431	0.589
Guangzhou	9.423	0.589
Xi'an	8.645	0.540

It can be seen from Table VII that the satisfaction of compulsory education services in seven major cities is below 0.8 based on the classification of satisfaction levels. It shows that compulsory education services in the seven major cities are in a state of low satisfaction.

C. Compulsory Education Service Optimization Based on CS-DEA Model

According to the CS-DEA model, the article adjusts the allocation efficiency of compulsory education service resources in seven major cities in China. The purpose of the adjustment is to convert the decision unit of HE-LS into HE-HS unit. The specific calculation results are as follows.

1) Calculation of compulsory education efficiency

The calculation results obtained by importing the input and output data in Tables IV and V into the DEAP2.1 software are shown in Table VIII.

TABLE VIII. COMPULSORY EDUCATION RESOURCE ALLOCATION EFFICIENCY

City	Comprehensive efficiency	Pure technical efficiency	Scale efficiency
Qingdao	1.00	1.00	1.00
Hangzhou	0.986	1.00	0.986
Jinan	1.00	1.00	1.00
Shenyang	1.00	1.00	1.00
Changchun	1.00	1.00	1.00
Guangzhou	1.00	1.00	1.00
Xi'an	1.00	1.00	1.00

It can be seen from Table VIII that the pure technical efficiency of the seven major cities is 1. When considering scale efficiency, only Hangzhou's Comprehensive efficiency is in an inefficient state of 0.986.

2) Adjustment of compulsory education service resource allocation efficiency from the perspective of satisfaction

According to the classification of Table I and Table II, the article classifies the efficiency and satisfaction of 7 major cities by HE-LS, HE-LS, HE-LS and HE-LS. The results are shown in Table IX.

TABLE IX. CLASSIFICATION OF DECISION UNITS

City	Comprehensive efficiency	Satisfaction score	classification
Qingdao	1.00	0.674	HE-LS
Hangzhou	0.986	0.635	LE-LS
Jinan	1.00	0.633	HE-LS
Shenyang	1.00	0.611	HE-LS
Changchun	1.00	0.589	HE-LS
Guangzhou	1.00	0.589	HE-LS
Xi'an	1.00	0.540	HE-LS

It can be seen from Table IX that the compulsory education services of the other six cities in China are in the HE-LS stage except for Hangzhou. Therefore, it is necessary to adjust the compulsory education efficiency of the six major cities of Qingdao, Jinan, Shenyang, Changchun, Guangzhou and Xi'an according to formula (3.6). The results are shown in Table X.

TABLE X. ADJUSTED EFFICIENCY AND SATISFACTION SCORES

City	Comprehensive efficiency	Satisfaction score	classification
Qingdao	0.756	0.800	LE-HS
Jinan	0.693	0.800	LE-HS
Shenyang	0.661	0.800	LE-HS
Changchun	0.631	0.800	LE-HS
Guangzhou	0.631	0.800	LE-HS
Xi'an	0.567	0.800	LE-HS

It can be seen from Table X that the six major cities are all adjusted from the state of HE-LS to the LE-HS state. According to the formula (3.15), the values of the resource allocation input indicators of the six major cities can be calculated. The results are shown in Table XI.

TABLE XI. ADJUSTED INDICATORS OF COMPULSORY EDUCATION SERVICE INPUT IN THE SIX MAJOR CITIES

City	Qing dao	Jinan	Shen yang	Chang chun	Guang zhou	Xi'an
X1	45578	37222	33769	41681	78187	53931
X2	50320	43635	22484	48369	43635	34049
X3	40938	33329	32012	38306	76651	51520
X4	27693	21356	19831	42748	39431	30300
X5	7.93	9.09	10.89	10.24	11.32	12.8
X6	17.72	19.33	16.79	21.08	31.48	26.12
X7	32.67	41.88	29.82	38.59	38.92	52.08
X8	54.5	74.43	45.67	64.98	84.26	81.09
X9	18.27	24.24	25.21	19.11	24.22	20.6
X10	26.88	39.68	31.52	23.77	48.78	29.49
X11	3096467	1679062	1627699	1692552	4549498	2087945

It can be seen from Table XI that the value of the adjusted input index has increased. In addition, the added value of the investment in major cities is a multiple of the adjusted efficiency. Under the premise of keeping the output unchanged, the adjusted index value of the compulsory education service resource allocation of the six major cities and the original data value of Hangzhou are substituted into the DEAP.2.1 software for recalculation. The results are shown in Table XII.

TABLE XII. ADJUSTED EFFICIENCY AND SATISFACTION SCORES

City	Comprehensive efficiency	Satisfaction score	classification
Qingdao	1.000	0.800	HE-HS
Hangzhou	1.000	0.635	HE-LS
Jinan	1.000	0.800	HE-HS
Shenyang	1.000	0.800	HE-HS
Changchun	1.000	0.800	HE-HS
Guangzhou	1.000	0.800	HE-HS
Xi'an	1.000	0.800	HE-HS

It can be seen from the above table that the HE-LS status of the compulsory education services of the six major cities becomes the effective unit state of the HE-HS after being adjusted by the CS-DEA model. In addition, the compulsory education service in Hangzhou was converted from the original LE-LS to the HE-LS status. It shows that after the adjustment of the compulsory education service in Hangzhou in other cities through the CS-DEA model, its efficiency has also been improved. The data of compulsory education in Hangzhou can be reapplied to the CS-DEA model for a new round of calculation until the final transformation of HE-HS status. The calculation process is the same as above.

V. CONCLUSION

In order to solve the problem of high efficiency-low satisfaction in the current service industry, this paper builds the CS-DEA model based on the DEA-BCC efficiency analysis, which pays more attention to customer satisfaction. The model divides the four levels of HE-HS, HE-LS, LE-HS, and LE-LS based on the critical values of efficiency and satisfaction. It transforms the decision unit of the HE-LS into a HE-HS unit by adjusting the input parameters of the decision unit. In addition, the efficiency of other decision-making units has also increased. This paper selects the compulsory education satisfaction value and the resource allocation input-output value of the seven major cities in the China Education Development Report (2016) to verify the model. It can be seen from the calculation results that the current 7 cities are in the HE-LS state except for Hangzhou. The input indicators of the 6 cities are converted into HE-HS status through the adjustment of the CS-DEA model. The value of Hangzhou City has also been converted to HE-HS status after a new round of adjustment. The above results finally verify the validity of the model.

The CS-DEA model not only solves the problem of high efficiency - low satisfaction, but also improves the overall efficiency of inefficient decision making units. In addition, the model can also provide a reference for the adjustment of HE-LS (Inefficient - High Satisfaction) and LE-LS (Inefficient - Low Satisfaction) decision-making units. In this way, the LE-HS and LE-LS decision-making units can be adjusted according to the weights and values of the input indicators of the effective unit HE-HS (high efficiency a- high satisfaction). It can improve the efficiency and satisfaction of LE-HS and LE-LS decision-making units. In the case, the problem of HE-LS only exists in addition to Hangzhou City. The final result did not appear in the LE-HS and LE-LS decision units after the adjustment. Therefore, the article does not use the effective unit as a standard to adjust the LE-HS and LE-LS input indicators. It should be noted that the CS-DEA model can adjust to this situation.

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