

Research on Comprehensive Evaluation of Public Cultural Service Level by Using AHP Method

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Abstract

This paper constructs the public cultural service level evaluation index system. And considered with the advantages and disadvantages of AHP method and principal component analysis (pca), the index system is combination weighted by multiplicative integration weighting method. It may overcome the defect of subjective and objective weight of empowerment. Furthermore, the level of public cultural services of 31 provinces, cities and autonomous regions are evaluated with the method of comprehensive evaluation. Therefore, conclusion is that the overall level of public cultural services level is not high, the services are irrelevant to the development of the economy, and there are gaps in various areas.

Keywords: Public Cultural Service, Index System, Comprehensive Evaluation

1. Introduction

With the advancement of the people's livelihood construction in our country, the significance of public culture service, as an important part of public service, for the construction of socialist advanced culture has draw extensive attention of the government [1]. However, with the rapid development of economy, the contradiction in the field of our country public cultural services has been highlighted. The main contradiction is that the public cultural services level seriously lags behind the rapid growth of the people's actual demand and developed countries'. Therefore, the scientific measure on the level of public cultural services for our country performs theoretical and realistic significance for boosting the construction of public cultural services, and promoting sustainability and normalization.

At present, the beneficial attempt for evaluating public cultural services has been carried on several provinces, cities. Some relevant regulations were successively formulated. The regulations provides a perspective and framework for our country to build and perfect the construction of public cultural services [2]. However, the research on public culture service level evaluation of our country is in primary stage. Corresponding construction standards and requirements have not been established and issued in most domestic areas in our nation. There is no authoritative evaluation index system and evaluation method, which need researchers and officers build a scientific normalized, standardized index system. The system may conduct the quantitative analysis on level of public cultural services system and promote evaluation and decision optimization [3]

2. Constructing Evaluation Index System

Constructing scientific and reasonable index system are not only the premise of effective evaluation of public cultural services level, but also can promote the standardization of the public cultural services and sustainable development [4]. Dimensions of building index system , in this paper, are divided into investment, security,

output, and the public participation four aspects, based on the analysis of the influence factors. Due to the supply of public cultural services mainly relies on investment. And the investment type reflect from human resources, finance, goods. Therefore, the investment dimension is divided into finance, infrastructure and human resources the three aspects, namely identified 30 indexes in six dimensions of evaluation system, as shown in table 1.

Table 1. Public Cultural Service Evaluating Index System

Overall objective	Primary target	Third target
Public Culture Service Level Evaluation	Financial investment	Per capita cultural operating expenses (Yuan)
		Proportion of cultural operating expenses in fiscal expenditure (%)
		Per capita public library fiscal appropriation (Yuan)
		Per capita mass cultural organization fiscal appropriation(Yuan)
	Infrastructural investment	The number of public library owned by every one million people (a)
		The number of mass cultural organization owned by every one million people (a)
		The number of museum owned by every one million people (a)
		The number of art institution owned by every one million people (a)
		The number of e-reading room in public library owned by every one million people (a)
	Human resource investment	The number of public librarian in every one million people (a)
		The number of employee from mass cultural organization in every one million people (a)
		The number of employee from museum in every one million people (a)
		The number of employee from artistic industry in every one million people (a)
	Service assurance	Public library construction area owend by every ten thousand people(m ²)
		Mass cultural facility construction area owend by every ten thousand people(m ²)
		Per capita fee of buying books in public library(Yuan)
		Public library technician in erery million people (a)
		Mass cultural organization professional and technical personnel in erery million people (a)
		professional and technical personnel of art in erery million people (a)
	Activity output	professional and technical personnel of museum in erery million people (a)
The number of library and artistic activities organized by mass cultural organization per ten thousand(time)		
		The number of training class organized by mass cultural organization per ten thousand people (time)

		Art performance per ten thousand people(a)
		Exhibition in museum per millionpeople (a)
		Verious lecture organized by public library per million people(a)
	public participation	Public library circulation per person(a)
		Training provided by mass cultueal organization per person (a)
		Art industry watched per person (a)
		Museum visited per person (a)
		Public library lecture attended per million people (a)

3. To Determine the Index Weight

A combination of objective and subjective weighting method is used to performing integrated empowerment of the level of public cultural services evaluation index system. This method may reflect the actual situation as realistically as possible. It can increase the weight of a representative to ensure the scientific nature of the evaluation results [5] .

3.1 Determine the Index Weights with Hierarchy Process (AHP)

Various indicators of complex problems stratified by AHP through a particular relationship. They are hierarchical orderly hierarchical model which containing affiliations between each level[6]. Specific steps are as follows.

Identifying research questions and constructing judgment matrix, the basic approach is to use nine integers and the corresponding reciprocal between 1-9 construct pairwise comparison between the index judgments matrixes, the scale of the ratio is defined as shown in Table 2:

$$\begin{matrix}
 & C_1 & C_2 & \dots & C_n \\
 \begin{matrix} C_1 \\ C_2 \\ \vdots \\ C_n \end{matrix} & \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & \dots & \vdots \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix} & & &
 \end{matrix} \quad (i,j=1,2, \dots,n) \quad (1)$$

Table 2. Comparison Matrix Scale of 1 to 9 and their Meanings

Scale value	meaning
1	represents two elements compared with equal importance
3	represents two elements compared with each other, A is a bit more important than B
5	represents two elements compared with each other, A is obvious more important than B
7	represents two elements compared with each other, A is intense more important than B
9	represents two elements compared with each other, A is extreme more important than B
2, 4, 6, 8	If the difference between pairs fall in between the two, the intermediate values of the neighboring judgement it is desirable

reciprocal	If the ratio of the significance of the element j and i is a_{ij} , then the ratio of the significance of element i and j is $a_{ji} = 1/a_{ij}$
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2. Calculating the Weight of Each Index

- ① Calculating the element product of each row of judgement matrix

$$M_i = \prod_{j=1}^n a_{ij} \quad (i = 1, 2, \dots, n) \tag{2}$$

- ② Calculating the N^{th} root of M_i

$$\bar{W}_i = \sqrt[n]{M_i} \tag{3}$$

- ③ to make the standardization process of \bar{W}_i

$$W_i = \frac{\bar{W}_i}{\sum_{j=1}^n \bar{W}_j} \tag{4}$$

Among them, W_i is the i th component

3. Consistency Test of Judgment Matrix

When constructing judgment matrix, consistency should always be maintained. Consistency analysis of judgment matrix need to be done, as the following steps:

- ① Biggest feature root of Matrix:

$$\lambda_{\max} = 1/n \sum_{i=1}^n (\sum_{j=1}^n a_{ij} \cdot W_j / W_i) \tag{5}$$

- ② Import consistency index C.I.

$$C.I. = (\lambda_{\max} - n) / (n - 1) \tag{6}$$

- ③ Find corresponding mean random consistency Index R.I., Table 3

Table 3. Mean Random Consistency Index

Matrix order	1	2	3	4	5	6	7	8	9	10	11	12
RI	0	0	0.5 2	0.8 9	1.1 2	1.2 6	1.3 6	1.4 1	1.4 6	1.4 9	1.5 2	1.5 4

- ④ Calculating the ratio of consistency CR

$$CR = CI / RI \tag{7}$$

The size of the consistency of ratios CR is used to reflecting the satisfaction of judgment matrix. When CR = 0, it possesses consistency. When CR < 0.1, it possesses

satisfactory consistency. When $CR > 0.1$, it has a non-satisfactory consistency, need to be adjusted.

4. Calculating the Comprehensive Weight

Combining weight method is used to weighting elements index, namely, using the relative importance of each element on the overall objectives to weight the elements. Finally get comprehensive weight.

5. Overall Consistency Test

Use the following formula to test the overall consistency, namely:

$$CR = \frac{\sum W_j CI_j}{\sum W_j RI_j} \quad (j = 1, 2, \dots, n) \quad (8)$$

The weight value of evaluation system in each dimension W , the weight value of each index value w , and comprehensive weight values w_c are calculated with AHP, (Table 4). Each section past the consistency test, and further sorted consistency test was completed, finally obtained: = 0.018, = 0.625, = 0.029 < 0.1, tested by.

Table 4. Analytic Hierarchy Process to Determine Weight Value

Overall Objective	Primery target	Weight	Secondary target Weight	Overall target
Public Culture Service Level Evaluation	Financial investment	0.1005	0.2934	0.0295
			0.2214	0.0223
			0.2806	0.0282
			0.2046	0.0206
	Infrastructural investment	0.1253	0.2051	0.0257
			0.2920	0.0366
			0.1693	0.0212
			0.1802	0.0226
	Human resource investment	0.1152	0.1534	0.0192
			0.2359	0.0272
			0.2678	0.0309
			0.2858	0.0329
	Service assurance	0.1025	0.2105	0.0242
			0.1052	0.0108
			0.1213	0.0124
			0.1005	0.0103
			0.2104	0.0216
			0.2042	0.0209
			0.1711	0.0175
	Activity output	0.2294	0.0873	0.0089
			0.3216	0.0738
			0.2419	0.0555
			0.2751	0.0631
			0.0982	0.0225
public participation	0.3271	0.0632	0.0145	
		0.2526	0.0826	
			0.2185	0.0715

			0.1282	0.0419
			0.1535	0.0502
			0.2472	0.0809

3.2 To Determine the Index Weights with Principal Component Analysis Method

The main idea of principal component analysis, also known as quantitative analysis, is to reduce the dimension, which means under the condition of rare information lost, p relevant original indicators are regrouped. The new index will be defined as the main component. Each main component F is a linear combination of the original indicators, and the main component F and $F, i \neq j$ are irrelevant, so that the centralization of the information of various indicators could be completed, and the characteristics of objects may displayed clearly [7].

Set there are n variables, and each observes p indicators, denoted with X_1, \dots, X_p ,

$$X_i = (X_{1i}, X_{2i} \dots X_{ni})' \quad i = 1, 2, \dots, p$$

Set random vectors X of the mean value as μ , covariance matrix as Σ , random vector $X = (X_1, \dots, X_p)$ is expressed by the matrix as:

$$X = \begin{pmatrix} X_{11} & X_{12} & \dots & X_{1p} \\ X_{21} & X_{22} & \dots & X_{2p} \\ \vdots & \vdots & \dots & \vdots \\ X_{n1} & X_{n2} & \dots & X_{np} \end{pmatrix} = (X_1, X_2, \dots, X_p) \quad (9)$$

p vectors of data matrix X are used to do linear combination (ie. p indicators vectors $X_1, X_2 \dots X_p$), which are recorded as F , namely:

$$\begin{cases} F_1 = a_{11}X_1 + a_{21}X_2 + \dots + a_{p1}X_p \\ F_2 = a_{12}X_1 + a_{22}X_2 + \dots + a_{p2}X_p \\ \dots\dots\dots \\ F_m = a_{1m}X_1 + a_{2m}X_2 + \dots + a_{pm}X_p \end{cases} \quad (10)$$

The above linear equations are abbreviated as follows:

$$F_i = a_{1i}X_1 + a_{2i}X_2 + \dots + a_{pi}X_p, \quad i = 1, 2, \dots, m \quad (11)$$

Requirements of the above equations:

$$a_{1i}^2 + \dots + a_{mi}^2 = 1 \quad i = 1, 2, \dots, p \quad (12)$$

In order to obtain ideal results, the variance of $F = a_i' X$ should be as large as possible, and each F_i should be independent. Because

$$\text{var}(Y_i) = \text{var}(a_i' X) = a_i' \sum a_i \quad (13)$$

And $\forall c$ (c is constant), $\text{var}(ca_i' X) = ca_i' \sum a_i c = c^2 a_i' \sum a_i \quad (14)$

So, the linear equations should be constructed based on the following principles

$$(1) a_i a_i' = 1 \quad \text{mean} \quad a_{i1}^2 + \dots + a_{mi}^2 = 1 \quad i = 1, 2, \dots, p$$

(2) F_i and F_j ($i \neq j, i, j = 1, 2, \dots, p$) are irrelevant.

(3) F_1 is the greatest variance among the linear combination of X_1, \dots, X_p , X_p is the greatest variance of all linear combinations which are not related with X_1, \dots, X_{p-1} .

Based on these principles, we can build the main ingredient. The cumulative variance contribution rate of each main ingredient gradually decreased. In real life, normally the main component of the cumulative variance contribution rate above 85% would be selected for data analysis. According to principal component analysis, the index weights are shown in Table 5.

Table 5. Principal Component Analysis to Determine Weights

Overall Objective	Primary target	Weight	Secondary target Weight	Overall target
Public Culture Service Level Evaluation	Financial investment	0.1769	0.2921	0.0517
			0.2659	0.0470
			0.1806	0.0320
			0.2615	0.0463
	Infrastructural investment	0.2132	0.0952	0.0203
			0.1523	0.0325
			0.2592	0.0553
			0.1235	0.0263
	Human resource investment	0.1528	0.3698	0.0789
			0.2935	0.0449
			0.4061	0.0621
			0.0990	0.0151
	Service assurance	0.2271	0.2013	0.0308
			0.1074	0.0244
			0.1461	0.0332
			0.0275	0.0062
			0.2040	0.0463
			0.3227	0.0733
	Activity output	0.1291	0.1349	0.0306
			0.0572	0.0130
			0.3085	0.0398
			0.0560	0.0072
	public participation	0.1008	0.2853	0.0368
			0.2981	0.0385
0.0521			0.0067	
0.0356			0.0036	
			0.1360	0.0137
			0.5378	0.0542
			0.1342	0.0135
			0.1563	0.158

3.3 Multiplication Weighting Method

As the weight determining method, subjective weight and objective weighting have their shortcomings and limitation. Combining them together to determine the weights can simultaneously reflect both subjective and objective information, which is more scientific reasonable. Multiplication is used to calculate comprehensive weight of public cultural service evaluation system [8].

The formula of multiplication Integrated method is expressed as:

$$W_j = p_j q_j / \sum_{i=1}^n p_i q_i \quad (j = 1 \cdots n) \quad (15)$$

Using the formula above, comprehensive weight values W of each evaluation index system are obtained, shown in Table 6.

Table 6. Multiplication Integrated to Determine the Comprehensive Evaluation Weights

Index	p_j	q_j	$p_j q_j$	W_j	Weight
C_1	0.0295	0.0517	0.00153	0.0511	0.3443
C_2	0.0223	0.0470	0.00105	0.0351	0.2366
C_3	0.0282	0.0320	0.00090	0.0302	0.2037
C_4	0.0206	0.0463	0.00095	0.0319	0.2153
C_5	0.0257	0.0203	0.00052	0.0175	0.1045
C_6	0.0366	0.0325	0.00119	0.0398	0.2382
C_7	0.0212	0.0553	0.00117	0.0393	0.2348
C_8	0.0226	0.0263	0.00059	0.0199	0.1190
C_9	0.0192	0.0789	0.00151	0.0507	0.3034
C_{10}	0.0272	0.0449	0.00122	0.0409	0.2787
C_{11}	0.0309	0.0621	0.00192	0.0643	0.4379
C_{12}	0.0329	0.0151	0.00050	0.0166	0.1134
C_{13}	0.0242	0.0308	0.00075	0.0250	0.1701
C_{14}	0.0108	0.0244	0.00026	0.0088	0.0672
C_{15}	0.0124	0.0332	0.00041	0.0138	0.1050
C_{16}	0.0103	0.0062	0.00006	0.0021	0.0163
C_{17}	0.0216	0.0463	0.00100	0.0335	0.2550
C_{18}	0.0209	0.0733	0.00153	0.0513	0.3906
C_{19}	0.0175	0.0306	0.00054	0.0179	0.1365
C_{20}	0.0089	0.0130	0.00012	0.0039	0.0295
C_{21}	0.0738	0.0398	0.00294	0.0984	0.4435
C_{22}	0.0555	0.0072	0.00040	0.0134	0.0603
C_{23}	0.0631	0.0368	0.00232	0.0778	0.3506
C_{24}	0.0225	0.0385	0.00087	0.0290	0.1308
C_{25}	0.0145	0.0067	0.00010	0.0033	0.0147

C_{26}	0.0826	0.0036	0.00030	0.0100	0.0540
C_{27}	0.0715	0.0137	0.00098	0.0328	0.1780
C_{28}	0.0419	0.0542	0.00227	0.0761	0.4126
C_{29}	0.0502	0.0135	0.00068	0.0227	0.1231
C_{30}	0.0809	0.0158	0.00128	0.0428	0.2322

4. Comprehensive Evaluation of the Public Cultural Services Level

Comprehensive evaluation method is to use multiple indicators to test a plurality of evaluation unit mainly through changing the various indicators into comprehensive evaluation indicators [9], This paper selects composite index method to evaluate, as follow steps:

(1) The formula of the comprehensive evaluation on the base layer of each subsystem:

$$B_j = \sum_{i=1}^n W_{ij} Y_{ij} \quad (16)$$

(2) The formula of the target layer comprehensive evaluation A

$$A = \sum_{j=1}^n W_j B_j \quad (j = 1 \dots n) \quad (17)$$

31 provinces index value of the public cultural services level caculated with the final weight value through comprehensive index method combined with comprehensive integrated weight, see Table 7. Composite scores of public cultural service level are positive or negative, which indicates that the overall level of public cultural services, is higher or lower than the average level [10].

Table 7. 31 Provinces Index Value of Public Cultural Services Level

Region	Financia l	Infrastru cture	Human resource	Service assurance	Output	particip ation	Combined index
Beijing	1.5982	-0.3290	0.3166	0.1789	1.8235	0.8499	0.8135
Tianjin	0.2982	-0.3549	-0.1353	0.2757	-0.3346	-0.3622	-0.1399
Hebei	-1.0075	-0.7084	-0.7829	-0.8016	-0.5115	-0.4499	-0.6845
Shanxi	-0.1619	0.2309	0.1690	-0.0298	0.1096	0.7908	0.2057
Inner Mongolia	0.7707	0.4019	1.0709	1.3194	-0.4852	-0.2426	0.3596
Liaoning	-0.3897	-0.4684	0.1852	0.2756	-0.2628	-0.0859	-0.1469
Jilin	-0.2650	-0.2556	0.1667	0.5166	-0.4139	-0.5046	-0.1746
Heilongjia ng	-0.7693	0.0090	-0.1944	-0.0502	-0.4385	-0.7644	-0.3860
Shanghai	2.9498	-0.1698	2.0391	1.2188	2.4311	1.8593	1.7508
Jiangsu	-0.1321	-0.3334	-0.6030	-0.2445	0.9538	0.3831	0.0864
Zhejiang	1.5591	0.0842	0.2679	0.7429	1.0116	1.8415	0.9463
Anhui	-1.0247	-0.2139	-0.6291	-0.5091	0.4270	0.7389	-0.1159

Fujian	-0.2415	-0.0996	-0.6492	-0.4541	0.1770	0.2936	-0.1139
Jiangxi	-0.9676	0.0621	-0.5158	-0.6999	-0.6601	0.1860	-0.4130
Shandong	-0.7481	-0.6482	-0.9566	-0.4892	-0.4935	-0.4943	-0.6247
Henan	-0.9639	-0.6154	-0.3918	-1.0940	-0.4669	-0.1480	-0.5779
Hubei	-0.6507	-0.2909	-0.6373	-0.3290	-0.5533	-0.1378	-0.4301
Hunan	-0.8541	-0.4903	-0.5212	-0.8106	-0.5911	-0.3194	-0.5817
Guangdong	0.1155	-0.7520	-0.6128	-0.5922	-0.5256	0.5535	-0.2908
Guangxi	-0.5843	-0.4946	-0.7551	-0.4451	-0.4418	-0.5089	-0.5305
Hainan	0.7650	-0.1886	-0.5985	-0.6590	-0.5155	-0.6736	-0.3311
Chongqing	-0.0430	-0.3897	0.0100	-0.5211	-0.3182	0.1120	-0.1885
Sichuan	-0.0992	-0.0210	-0.5238	-0.6605	-0.1581	-0.0961	-0.2347
Guizhou	-0.5981	-0.2150	-0.1952	-0.3071	-0.8277	-0.6924	-0.5050
Yunnan	-0.4911	-0.1387	-0.1904	0.6973	-0.3010	-0.1785	-0.1321
Xizang	0.3058	1.3799	0.2287	0.2195	0.3742	-0.8762	0.2600
Shanxi	-0.0531	0.6014	1.3523	0.2442	-0.3539	0.0241	0.2492
Gansu	-0.1718	1.0053	0.9930	-0.1313	-0.1421	-0.0553	0.2294
Qinghai	0.7253	2.0329	0.6365	0.6730	1.8235	-0.4795	0.5672
Ningxia	0.8751	0.5626	0.9145	1.6367	-0.3346	-0.6260	0.4958
Tibet	0.2540	0.8073	0.5422	0.8296	-0.5115	0.0629	0.6382

From Table 7, the public cultural services level regional gap is large. Only Shanghai, Zhejiang and Beijing three regions' Public cultural service levels are relatively high. the others maintain huge regional disparities; national public cultural service investment overall performance is poor. There are 13 regions' financial investment achieve or above the average. And public cultural services performance a larger gap between them; public cultural service activities outputs and public participation are underperforming.

5. Conclusions

The indicator system and evaluation provide unified reference standards to measure the level of public cultural services. Index system constructed in this paper can build a more comprehensive, scientific, systematic evaluation of the overall level of public cultural services. It may provide a reference for improving the level of public cultural services effectively, and meeting people's real need.

Whether the evaluation conclusions are objective and reasonable, the key is the evaluation method choosing and weight determination. This selects the comprehensive index value method to evaluate. Meanwhile, AHP and principal component analysis method are used to complete the objective and subjective comprehensive weight. This may overcome the inaccuracy of a simple method, so that the evaluation results are more objective and rational.

Analyzing and solving the "weak part" of public cultural services in provinces and autonomous regions to explore the upgrade method to improve the level of public cultural services. Through the analysis we can see that the level of economic development and the level of public cultural services development in 31 provinces are imbalance. Public cultural services in the western region gained more attention from the government,

showing a boosting situation. And in eastern part, the public cultural services and economic development performs poorly, which should attract the attention of the government; the overall level of public cultural services needs to be improved, government investment should be increased. Except Shanghai, Zhejiang and Beijing, the overall level of public cultural services performed poorly. Great regional disparities overall level of public cultural services appeared. The equalization of public cultural service needs to be improved. And public participation and activities output mechanisms should be strengthened. Government should put efforts to organizing and propaganda delivering.

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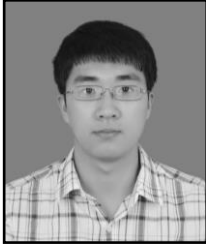
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