



Research Article

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Comprehensive evaluation and research on China's public culture service system based on AHP method and entropy weight method

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ABSTRACT

In this paper, the evaluation index system for public culture service is constituted and the addition weighting method is applied for the comprehensive weight according to the advantages and disadvantages of AHP method and entropy weight method, so the defect of weighting by the single use of the subjective weighting method and objective weighting method is conquered. Moreover, the aggregative indicator method is used on its basis, to analyze and evaluate the data of China from 2006 to 2010 with the expectation to provide the theoretical reference for the construction of an overall and scientific public culture service index system.

Key words: public culture service, AHP method, entropy weight method, addition weighting method and aggregative indicator method

INTRODUCTION

The public culture is the fundamental factor for the stability, harmony and healthy development of society and formation of social cohesion. In recent years, China has attached great importance to the construction of public culture service and according to the national Outline of the 12th Five-year Plan the Prosperity and Development Cultural Undertaking and Cultural Industry and the Promotion of the Public Culture Product and Service Supply and Establishment and Improvement of Public Culture Service System were emphasized; In February 2012, the Party Central Committee specially developed the Planning Outline of Cultural Reform and Development of the 12th Five-Year Plan and emphasized the rapid development of public culture service system aiming at establishing the public culture service system covering the whole society by 2015, so that the urban and rural residents could enjoy the public culture service conveniently and the cultural rights could be better guaranteed [1-5]. With the issue of the policies relevant to cultural system reform and the liberation of cultural productivity, promotion of the public culture service level will not only be beneficial to improvement of the national cultural quality but also provide a solid function for the vigorous development and the great prosperity of culture [6-8]. To construct the evaluation index system for public culture service fully respecting the characteristics of the public culture and evaluate the level of the public culture service based on the system are the important methods to promote its sustainable and normative development.

CONSTRUCTION OF EVALUATION INDEX SYSTEM

The Nonexcludability and noncompetitive of the public culture decide that the efficiency can not be used as the main objective to evaluate the public culture service and that the social justice, harmony and progress and other value factors and so on shall be combined so that the evaluation becomes an important method to maintain the social basic order, promote the quality of public culture service, realize the interest of public expression and participate into the government management [9]. In this paper, the new public administration evaluation idea and the idea of Citizen-based of the new public service are integrated under the new angle of view of the public administration and the theoretical analysis method and delphi method are combined, with the reference to the experience and successful

practice in performance management and evaluation of domestic and oversea public culture service and based on the principle of scientificity, systematicness, practicability, independence, comparability, and perspectiveness, to select the index and divide the evaluation index system of the public culture service into such four layers as: criterion layer 1, including the three sub-systems of supply of public culture service, guarantee of public culture service and overall effect of public culture service, criterion layer 2, including the eight sub-systems of public culture facility, standard of public culture service, capital public culture service, guarantee of technology and talent of public culture service, organizational management of public culture service, social participation of public culture service, economic development of public culture service, social effect of public culture service and government investment of public culture service, with a total of 23 indexes of the index layer (as shown in table 1) [10].

Table 1: Evaluation index system and weighting coefficient of China's for public culture service

Target layer	Criterion layer 1	Criterion layer 2	Index name
Evaluation index system for public culture service	Supply of public culture service	Public culture facility	The collection of books per capita in public library(volume)
			Number of the cultural station
			Number of the museum
		Public culture service level	Broadcasting and TV station
			Total circulation person-time of public library (10,000 person-times)
			Number of show of various show choirs (1,000 times)
	Guarantee of public culture service	Guarantee of capital, technology and talent	Number of exhibition of mass cultural undertaking held (times)
			Number of the public culture product achievement (0.1 billion copies of various kinds of books)
			Investment in cultural undertaking (RMB 0.1 billion Yuan)
			Ratio of the staff with the title of a senior professional post to the employee in the national cultural relics protection and scientific research institute (%).
		Organizational management	Comprehensive population coverage rate of TV program (%)
			Number of cultural market operating agency around China
			Number of cultural sector and educational institution around China
Overall effect of public culture service	Social participation	Number of cultural relics protection and management institutions around China.	
		Constitution of nonproductive expenditure per capita of Education and cultural entertainment services of urban resident	
	Economic development	Mass amateur art team of mass cultural institutions in various regions	
		Number of cultural activities organized by the various cultural stations.	
Social effect	Government investment	Added value of national cultural industry (RMB 0.1 billion Yuan)	
		Ration of the added value of national cultural industry to GDP (%)	
			Rate of compulsory education popularization (%)
		Number of patent application authorization (patent for invention, piece/0.1 billion people)	
		National financial investment in public cultural undertakings per capita (Yuan)	
		Actual investment volume of capital construction of cultural undertaking (RMB 10,000 Yuan).	

Standardized processing of data

The indexes in the index system constructed are positive ones and the positive dimensionless processing is adopted in the paper to eliminate the influence to the evaluation resulted from the dimensional difference between various indexes so as to obtain the standard index values [11].

The calculation formula:

$$x_{ij} = \begin{cases} (x_j - x_{\min}) / (x_{\max} - x_{\min}) \\ (x_{\max} - x_j) / (x_{\max} - x_{\min}) \end{cases} \quad (1)$$

Where: $j=1,2,\dots,n$; x_j is the j index number; x_{\max} is the maximum value of the j index number; and x_{\min} is the minimum value of the j index number.

Index weight determined by analytic hierarchy process (AHP)

The relative weights of various indexes are calculated through the method of construction of the two-two judgment matrix. The specific steps: the complex problem is divided into several orderly layers by means of the system

analysis, which are, target layer, base layer and index level. The relevant factors of each layer is compared and judged and the relative importance of various factors is quantified and the order of importance of all factors is determined by the mathematical method and the consistency inspection is carried out to ensure the conformity of the thought judgment of the valuator. The purpose is to endow the corresponding weight respectively according to the relative importance of the next layer of element (index) to the previous layer, and if various basic indexes of the hierarchical structure of index are determined, the analytic hierarchy process may be used to determine its weight. The specific method is shown as follows:

(1) Construction of judgment matrix. The judgment matrix is constructed by the judgment value of the relative importance degree determined by two-two comparison of various indexes of the same layer given by the expert. The scale and its implication of judgment matrix 1~9 is provided in table 2.

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

Table 2: Scale and implication of judgment matrix 1~9

Scale	Implication
1	Indicate that Ci and C have the same importance when the two factors are compared.
3	Indicate that Ci is slightly important than C when the two factors are compared.
5	Indicate that Ci is obviously important than C when the two factors are compared.
7	Indicate that Ci is highly important than C when the two factors are compared
9	Indicate that Ci is extremely important than C when the two factors are compared
2, 4, 6 and 8	Indicate the mid-values of the adjacent judgment values
Reciprocal of the numerical value	Contrary to the significance of 1~9 scales, a_{ij} is obtained by comparison of Ci and Cj and $a_{ji}=1/a_{ij}$ by comparison of Cj and C.

(2) Calculation of the weights of various indexes.

The common calculation methods are shown as follows:

(I) Root method

① The geometrical mean of various rows shall be calculated by the formula below:

$$\bar{W}_i = \sqrt[n]{\prod_{j=1}^n a_{ij}} \quad (i=1, 2, \dots, n) \quad (2)$$

② The vector quantity $\bar{W}_i = (\bar{W}_1, \bar{W}_2, \dots, \bar{W}_n)^T$ is subject to the normalization processing to obtain W_i of the weighting coefficient of various indexes.

$$W_i = \bar{W}_i / \sum_{j=1}^n \bar{W}_j \quad (i=1, 2, \dots, n) \quad (3)$$

(II) Sum product method

① Each column of element of the judgment matrix is normalized by the formula below:

$$\bar{a}_{ij} = a_{ij} / \sum_{k=1}^n a_{kj} \quad (i, j=1, 2, \dots, n) \quad (4)$$

② Add each column of element normalized by row:

$$\bar{W}_i = \sum_{j=1}^n \bar{a}_{ij} \quad (j=1, 2, \dots, n) \quad (5)$$

③ The same as that of the root method, the vector quantity $\bar{W}_i = (\bar{W}_1, \bar{W}_2, \dots, \bar{W}_n)^T$ is subject to the normalization

processing to obtain the weighting coefficient of various indexes of W_i .

(III) Characteristic root method (EM)

The applied formula:

$$AW_i = \lambda_{\max} W_i, \quad i=1,2, \dots, n \quad (6)$$

Where: λ_{\max} is the characteristic root of A and W is the corresponding vector quantity. The W obtained after normalization may be used as the vector quantity.

(3) The consistency check of judgment matrix is carried out. Because of the complexity of the objective thing and the diversity of people's recognition, the judgment consistency shall be kept in case of construction of the judgment matrix so that the inconsistent condition is avoided. It is inconsistent if the judgment of A is Obviously Important than B, B is Obviously Important than C and C is extremely Important than A appears. If the judgment matrix deviates from the consistency greatly, the degree of reliability of the approximately evaluated is open to doubt. Therefore, the consistency check shall be carried out for the judgment matrix, according to the following steps:

① Calculate the maximum characteristic root λ_{\max} of matrix:

$$\lambda_{\max} = \frac{1}{n} \sum_{i=1}^n (AW_i) / W_i \quad (i=1,2, \dots, n) \quad (7)$$

② Calculate the consistency index (CI)

$$CI = \frac{\lambda_{\max} - n}{n - 1} \quad (8)$$

③ Find out the corresponding mean Random consistency index (RI)

The mean random consistency index of 1~15 is given in table 3.

Table 3: Mean random consistency index (RI)

Matrix order	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0	0	0.52	0.89	1.12	1.26	1.36	1.41	1.46	1.49	1.52	1.54	1.56	1.58	1.59

④ Calculate the consistency ratio (CR)

$$CR = CI / RI \quad (9)$$

If $CR < 0.1$, the consistency of judgment matrix is regarded as acceptable; and if $CR \geq 0.1$, the judgment matrix shall be amended appropriately.

(4) Calculate the comprehensive weight

If is not enough to obtain the weight of a group of element against a certain factor in the previous layer only and ultimately the relative weight of various factors against the general objective, that is, the Synthetic Weight, so as to perform the solution selection. On the basis that the standard parameter values and the relative weight of various indexes are calculated, the total level of sorting may be carried out for the ability of agricultural sustainable development to calculate the comprehensive weight of the indexes of various layers, that is, the weight number of the last layer of weight is multiplied by the weight number of the controlled element of the previous layer by turn, on the basis of the respective relative weight of the subsystem formed, so as to form the absolute weight of various factors against the general objective.

(5) Perform the overall consistency check. The calculation of synthetic weight shall be calculated from up to down to synthesize the weight under the single criterion and perform the general judgment consistency check layer by layer through the applied formula below:

$$CR = \frac{\sum W_j CI_j}{\sum W_j RI_j} \quad (j=1,2,\dots,n) \quad (10)$$

If $CR < 0.1$, it is regarded that the hierarchical total sorting has an overall satisfactory consistency; otherwise, the element value of the judgment matrix shall be regulated again.

The index weight shall be determined by the analytic hierarchy process and the matrix shall be judged by the consistency check to obtain that $CI=0.11$, $RI=0.381$, $CR=0.029 < 0.1$. See table 4 for the index weight values of various levels are determined ultimately through the consistency check

Table 4: Weighted value in various layers of evaluation index system for public culture service calculated by AHP method

Target layer A	Criterion layer B	Criterion layer C	Index level D	Weight Wij	Comprehensive weight Wi	
Evaluation index system for public culture service	Supply of public culture service(0.346)	Public culture facility (0.178)	D1	0.393	0.070	
			D2	0.191	0.034	
			D3	0.247	0.044	
		Public culture service(0.168)	D4	0.169	0.030	
			D5	0.292	0.049	
			D6	0.238	0.040	
			D7	0.262	0.044	
			D8	0.208	0.035	
			D9	0.235	0.040	
			D10	0.306	0.052	
	Guarantee of capital, technology and talent (0.170)	D11	0.182	0.031		
		D12	0.276	0.047		
		D13	0.364	0.040		
	Guarantee of public culture service(0.380)	Organizational management (0.110)	D14	0.364	0.040	
			D15	0.273	0.030	
			D16	0.500	0.050	
		Social participation (0.100)	D17	0.500	0.050	
			D18	0.500	0.040	
		Economic development (0.080)	D19	0.500	0.040	
			D20	0.516	0.048	
		Overall effect of public culture service (0.274)	Social effect (0.093)	D21	0.484	0.045
				D22	0.535	0.054
			Government investment (0.101)	D23	0.465	0.047

Determination of index weight based on entropy weight method

The entropy weight method is adopted to determine the index weight after the actual data is converted to the standard data. The entropy evaluation method is a kind of objective weighting method in which the objective weighting method is determined by the index variability of variability of the weight is determined and the index weight is determined by the indicating the influence of the relative variation extent of the information entropy on the general system. In general, a small information entropy of a certain index indicate a large variation degree of the index value, more information provided, a great role in comprehensive evaluation and a large weight. On the contrary, a large information entropy of a certain index indicate a small variation degree of the index value, less information provided, a little role in comprehensive evaluation and a small weight. The calculation formula of the entropy weight method is shown as follows:

(1) Calculate the ration of index value of i year of j:

$$y_{ij} = \frac{x_{ij}}{\sum_{i=1}^m x_{ij}} \quad (i=1,2,\dots,m; 0 \leq y_{ij} \leq 1) \quad (11)$$

(2) Calculate the information entropy value E_{ij} of index j

$$E_j = -\frac{1}{\ln m} \sum_{i=1}^m y_{ij} \ln y_{ij} \quad (12)$$

(3) Calculate the information utility value d_j

$$d_j = 1 - E_j \quad (13)$$

The information utility value has a direct influence on the weight and the larger value accounts for a higher importance to evaluation and a higher weight.

(4) Calculate the index weight

$$w_j = \frac{d_j}{\sum_{i=1}^m d_i} \quad (14)$$

See table 5 for various indexes and subsystem weights through the processing of the original data

Table 5: Weighted value in various layers of evaluation index system for public culture service calculated by entropy weight method

Target layer A	Criterion layer B	Criterion layer C	Index level D	Weight W _{ij}	Comprehensive weight W _i	
Evaluation index system for public culture service	Supply of public culture service(0.336)	Public culture facility (0.207)	D1	0.190	0.039	
			D2	0.345	0.072	
			D3	0.194	0.040	
			D4	0.271	0.056	
			D5	0.319	0.041	
		Public culture service(0.129)	D6	0.199	0.025	
			D7	0.272	0.035	
			D8	0.210	0.027	
			D9	0.203	0.030	
			D10	0.339	0.051	
	Guarantee of public culture service(0.413)	Guarantee of capital, technology and talent (0.150)	D11	0.191	0.028	
			D12	0.267	0.040	
			D13	0.196	0.033	
		Organizational management (0.167)	D14	0.385	0.064	
			D15	0.419	0.070	
			D16	0.683	0.066	
		Social participation (0.096)	D17	0.317	0.030	
			D18	0.431	0.033	
			D19	0.567	0.044	
		Overall effect of public culture service(0.251)	Economic development (0.077)	D20	0.575	0.051
				D21	0.425	0.038
			Social effect (0.089)	D22	0.356	0.030
				D23	0.644	0.054

Addition weighting method

The subjective weighting method is easy to calculate, but it has a certain subjective assumption; and the actual influence degree of various indexes is not considered for the objective weighting method and the index weight will be changed with the variation of sample data. Therefore, the addition weighting method may conquer the defect of the objective weighting method and achieve a rational evaluation result.

Set p_i and q_i as the weights of index C_j determined by the subjective assignment method and objective assignment method, and then the comprehensive integration weighting coefficient is:

$$W_j = k_1 p_j + k_2 q_j \quad (j=1, 2, \dots, n) \quad (15)$$

$k_1, k_2 (k_1, k_2 > 0, k_1 + k_2 = 1)$ is the composite coefficient and is determined according to the subjective preference. We take $k_1 = 0.3$ and $k_2 = 0.7$ and get the final weight as shown in table 6.

Table 6: comprehensive index weight determined by addition comprehensive weight method

Index	Comprehensive weight Wj	Index	Comprehensive weight Wj
D1	0.0483	D13	0.0351
D2	0.0606	D14	0.0568
D3	0.0412	D15	0.058
D4	0.0482	D16	0.0612
D5	0.0434	D17	0.036
D6	0.0295	D18	0.0351
D7	0.0377	D19	0.0428
D8	0.0294	D20	0.0501
D9	0.033	D21	0.0401
D10	0.0513	D22	0.0372
D11	0.0289	D23	0.0519
D12	0.0421		

DETERMINATION OF VARIOUS SUBSYSTEMS AND COMPREHENSIVE EVALUATION VALUE

The synthetical index method performs the weighted mean of the weighting coefficient of each index and the individual index number of evaluation index (obtained through the comparison of the actual value of the evaluation index with the correspondingly certain numerical value) to calculate the average index number of the comprehensive evaluation value. The advantage of the method is to use the unified standard as the judgment scale, so that the comprehensive evaluation indexes have the comparability in different regions and the limitation of the dimensional evaluation is conquered. The method is applicable to the calculation of the comprehensive evaluation in multiple time quantum of various subsystems in the index system mentioned above.

The concrete steps are:

(1) Calculate the individual index;

(2) The evaluation model adopted for the comprehensive evaluation value B_j of various subsystems in the base layer:

$$B_k = \sum_i^s w_j y_{ij} \quad (16)$$

Where: B_k —comprehensive evaluation value of subsystem k in base layer 2; s —number of evaluation index included in subsystem k ; w_j —weight of index j ; y_{ij} —proportion of index value of year i of item j .

(3) The evaluation model adopted for comprehensive evaluation value A in the target layer:

$$A = \sum_{j=1}^n W_j B_j \quad (j=1,2,\dots,n) \quad (17)$$

Where: A —comprehensive evaluation value; W_j —weight of subsystem k ; B_k —comprehensive evaluation value of subsystem k .

s —number of subsystems in the base layer

According to the weight in table 6 and formula 16 and 17, various subsystems and comprehensive evaluation value of public culture service are obtained (see table 7).

Table 7: Various subsystems and comprehensive evaluation value of public culture service

Index	2006	2007	2008	2009	2010
Public culture facility	0.00001	0.03895	0.09249	0.06074	0.20737
Public culture service	0.03495	0.02641	0.05052	0.09212	0.11215
Guarantee of capital, technology and talent	0.04014	0.04632	0.05015	0.02638	0.03406
Organizational management	0.00050	0.00722	0.00553	0.01646	0.06432
Social participation	0.00001	0.03110	0.00986	0.06153	0.07315
Economic development	0.00274	0.03050	0.01404	0.03752	0.07702
Social effect	0.05149	0.05625	0.04413	0.03540	0.03813
Government investment	0.00001	0.01127	0.02549	0.07866	0.07613
Comprehensive evaluation value	0.01542	0.03096	0.04225	0.04976	0.09608

The evaluation value of the public culture service takes on a rising trend, but the number of exhibition of national mass cultural undertaking held was reduced by 16.9% when compared with that in the preliminary period and the role of exhibition in enriching the mass cultural life, guaranteeing the mass basic cultural rights and improving the public culture service and other aspects are to be strengthened.

Evaluation for the guarantee of capital, technology and talent has been maintained in a low-level and small-scale variation. The original data shows that the total capital investment is insufficient and the ratio of cultural undertaking

expense to the national total financial expenditure has been lower than 0.4% and reached the new lowest record in history in 2010; moreover, the average annual growth rate of the cultural undertaking is lower than that of the fiscal expenditure of the same period and is obviously lower than that of other social operating expenses, so the distance between the culture and other social undertakings is rapidly widened; and in the three low indexes of the organizational management, the ratio and the number of cultural department and educational institutions and the education and cultural entertainment services of the urban resident to the personally average nonproductive expenditure is reduced by 18.8% and 12.7% respectively, except that the number of cultural relics protection institution in various regions is increased by 10.5% when compared with that in the preliminary period.

The evaluation value of the economic development level is reduced in 2008 and had been around 2.5% during the Eleventh Five-Year, so a long-term effort shall be turned to turn the cultural industry into the pillar industry of national economy; and the practical investment in the capital construction of the cultural undertaking was greatly raised in 2009 and 2010, but it is far from that of the developed countries, which will restrict the healthy development of the public culture undertakings and still fails to meet the demand of the residents for the public culture service.

The comprehensive evaluation value in table 7 shows that China's public culture service had been improved during the Eleventh Five-Year and the annual growth multiple of the comprehensive evaluation value was 2.00, 1.36, 1.18 and 1.93 respectively. The comprehensive evaluation value was raised obviously in 2010 and was about 6.23 times of that in 2006, which was relevant to the continuous improvement of public culture facility, public culture level, organizational management ability and social participation and other factors by the government in 2010.

CONCLUSION

Different to the Natural Growth road of the western developed countries, a reform and transformation path must be created for the construction of the public culture service system of China. The construction essence shall be a system structure innovation based on the traditional cultural undertaking system but must exceed the traditional cultural undertaking, and it is a reconstruction of the development mode of the public culture based on the market economy environment and is definitely not a Minor Repair and Mending or upgrading of function of the traditional cultural undertaking system². Therefore, the construction of the evaluation index system for public culture service is the key to China's cultural construction, carrier of deepening reform and necessary link of public culture construction in the new period and the institutional environment necessary to public culture construction is certainly influenced by China's cultural system reform and macro-background. The public culture service evaluation system based on the entropy weight method is a kind of objective method. According to the evaluation result, it is regarded in this paper that the governmental functions are highly correlated to the public culture service system and the public culture service system is difficult to break out the current short of development without the governmental promotion and guide. Therefore, the government shall place the emphasis on promotion of economic development, improvement of public culture facility construction, enriching the supply form of public culture service, guaranteeing the special fund for public culture and fully arousing the enthusiasm of the cultural persons. Moreover, the market and competitive mechanisms shall be introduced to solve the high cost and low efficiency exists in the public culture service provided by the government and the society.

With the consideration for the innovation and unique form of the public culture service, only the exploratory research on the construction of the index system of the public culture service is made in this paper and the theoretical evaluation and quantitative evaluation are still for further improvement. In the further research, more attention will be paid to the index items and the research on improvement of the relevant matching measures will be carried out for promoting the standardization and institutionalization of the public culture service. In practice, the trial evaluation made for the pilot point is recommended and then the overall evaluation may be carried out in combination with the features of various subsystems of the public culture service and after appropriate adjustment for the index system.

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