

Evaluation of Compensatory Supply Cultural Products in Chinese Cultural Environment Based on Fuzzy comprehensive Evaluation Model

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Abstract: Cultural products are increasingly becoming a strategic factor in the economic and political development of all countries. Meanwhile, the attendant problems about the value of cultural products have attracted more attentions. The work took compensatory supply cultural products in Chinese cultural environment as the research object. Meanwhile, it considered the main factors that affect the value of paid-for-supply cultural products, such as political orientation, social benefits, product quality, economic benefits, resource value and natural environment through fuzzy comprehensive evaluation method, constructing the evaluation index system. Besides, the indicator weight was determined by analytic hierarchy process, establishing Chinese compensatory supply cultural products' evaluation model under a new era. On the basis, it verified the validity of the model through the simulation experiment.

1. Introduction

Culture presents the identification and the soul of a nation/state, showing the connotation and depth of a country and the entire nation. Cultural products are the materialized achievements of culture, carrying product of a certain spirit through certain material carrier [1,2]. As a part of the superstructure, it maps out national interests and ideologies, reflecting the level of civilization of a country in science and technology, education, economy and social development to a large extent. Meanwhile, its competitive power is directly related to the overall strength of the country [3,4].

In the current era of Internet and under the background of "One Belt, One Road" construction, Chinese cultural products carry important missions with ideologies, artistry and ornamentation, playing a major role in the process of promoting the Chinese culture "going out". Scientific and reasonable evaluation of cultural products is the basic guarantee for the overall improvement of the quality and value of Chinese cultural products [5,6].

Chinese research on the evaluation of cultural products is still in a gradual improving stage, and its evaluation is also a multi-factorial comprehensive problem. At present, the factors affecting the quality of cultural products are largely subjectively judged by people, with the assessment inevitably bring fuzziness on the conclusion. Therefore, we must find a method that can solve the multi-factor, ambiguity and subjective judgments to improve the reliability of cultural product evaluation. As a mathematical method, the fuzzy comprehensive evaluation is a very effective multi-factor decision-making method for the evaluation of a variety of factors. Thus, the work took the supply of cultural products as an example, building its evaluation model through fuzzy comprehensive evaluation method to solve the uncertainty and information incompleteness in the evaluation of cultural products. Subsequently, it provided a reasonable basis for further improvement of Chinese cultural product quality.

2. Comprehensive Evaluation Index System

Public product theory holds that cultural products have public attributes, and compensatory supply cultural products belong to semi-public products. The main suppliers are enterprises and individuals for the public, with a wide range of influence [7]. The government must check it carefully because its value will directly affect the public's spiritual world. Promoting the production of excellent cultural products and pushing out low-value cultural products out of public view play an important role in guiding people's values correctly. Therefore, political orientation is essential in the evaluation of cultural products.

At the same time, according to the theory of utility value, the value of cultural products is not solidified with no real entity, and its value need to be analyzed [8]. Thus, the value of cultural products cannot be directly used as a uniform standard for the comparison between cultural products, only with its utility indicators can be correctly described.

Therefore, based on the research results that scholars have made on the quality standards of cultural products, the characteristics of Chinese compensatory supply cultural products, and the national and social requirements for its achievements [9,10], the work analyzed the basic connotation, key attributes and other elements.

Table 1 Chinese compensatory supply cultural products evaluation index system.

Target layers	Guidelines layers	Indicator layers
Compensatory supply cultural products U	Political orientation U_1	Following the socialist core value system u_{11}
		Adhering to the four basic principles u_{12}
		Implementing "double as" direction and "double hundred" policy u_{13}
		Following the direction of the advanced socialist culture u_{14}
		Complying with national cultural laws and regulations and related policies u_{15}
	Social benefits U_2	Advocating mainstream u_{21}
		Advocating truth, goodness and beauty u_{22}
		Dissemination of advanced u_{23}
		Being educational u_{24}
		With the meaning of heritage u_{25}
		Promoting harmony u_{26}
	Product quality U_3	Content is healthy and positive u_{31}
		Innovativeness u_{32}
		Objectivity/Authenticity u_{33}
		Artistry u_{34}
		Aesthetic u_{35}
		Informative u_{36}
		Professionality u_{37}
		Thoughtfulness u_{38}
	Economic benefits U_4	Listening and audience ratings/Circulation/Sales volume/Box office/Attendance rate/Sales revenue u_{41}
		Industrialization level u_{42}
		Export exchange rate u_{43}
		Brand value u_{44}
Funds tax rate u_{45}		
Resource value U_5	Cost profit rate u_{46}	
	Cultural business scale and efficiency u_{51}	
	Cultural creation talent quality u_{52}	
		Policy support efforts u_{53}

In terms of the classification and definition of cultural products issued by UNESCO, as well as the type of supply of cultural products, cultural goods and cultural services provided in the form of compensation can be named as compensatory supply cultural products [11, 12]. Its major of operation is mainly business or individual investors, with the purpose of profiting [13,14]. It can be obtained by purchasing. Consumer's own cultural needs can be satisfied by monetary expenditure,

such as books, magazines, newspapers, multimedia products, audiovisual publications, records, software, video, audio-visual programs, design works, etc. [15,16]. Then, the index items of compensatory supply cultural products were selected initially by semi-structured interviews, literature analysis, word frequency statistics, expert amendment and other methods. Finally, with the primary evaluation index entry designed as questionnaires, the relevant data were obtained by questionnaire distribution, recycling and sorting. Common factor was derived by the factor analysis method, thus obtaining the evaluation index of cultural products. In the principle that layers are non-overlapping, distinguished and easily understood, the evaluation elements of Chinese compensatory supply cultural products were classified into five aspects: Political orientation, social benefits, product quality, economic benefits and resource value (See Table 1)

3. Modeling of Fuzzy Comprehensive Evaluation

Fuzzy comprehensive evaluation method uses fuzzy mathematics to make an overall evaluation on things or object conditioned by many factors [17,18]. Using fuzzy comprehensive evaluation method to construct Chinese compensatory supply cultural products' evaluation model needs the following steps.

3.1. Determining the Evaluation Factor Set

The evaluation of an object should first be screened out the main factors that characterize the subject clearly according to the purpose of evaluation. Meanwhile, it is measured with corresponding indicator to form a set of evaluation factors. So, the first features set of Chinese compensatory supply cultural products' evaluation is:

$$U = \{U_1, U_2, U_3, U_4, U_5\} \quad (1)$$

The second features set is:

$$U_{ij} = \{U_{i1}, U_{i2}, \dots, U_{ij}\} \quad (I = 1, 2, 3, 4, 5) \quad (j = 1, \dots, n) \quad (2)$$

3.2. Building Weight Set of Evaluation

The work used analytic hierarchy process to determine the weight of each evaluation element. The hierarchical hierarchy was established at first, showing a hierarchical representation of the involved factors with target layer, guideline layer and indicator layer. At the same time, the connections between upper factor and lower factor were marked as well.

The relative importance of the various factors at all levels should be judged after establishing the hierarchy model. These judgments were expressed in value, reflecting as the judgment matrix in the form of matrix.

To guarantee that all the judgments are in harmony without contradictions when judging the importance of indicators, the judgment matrix A needs to meet the consistency test. Then the application of AHP can obtain logical conclusions. The index of judging matrix consistency:

$$CI = \frac{\lambda_{\max} - m}{m - 1} \quad (3)$$

where λ_{\max} is the largest eigenvalue of the judgment matrix A ; m the order of the judgment matrix. Average random consistency index of judgment matrix:

$$CR = \frac{CI}{RI} \quad (4)$$

where RI is the random consistency index. When $CR < 0.1$, judgment matrix is in satisfactory consistency. If $CR > 0.1$, judgment matrix needs to be adjusted to have satisfactory consistency. After passing the consistency test, the judgment matrix is required for single-level sequencing. For judgment matrix A , the eigenvalues and eigenvectors are calculated according to

$$AW = \lambda_{\max} W \quad (5)$$

where W is the normalized eigenvector corresponding to λ_{max} .

3.3. Determining Comment and Grade Set of Evaluation

Comment set is a collection of various general evaluation results that evaluators assess the objects, using V to represent. That is:

$$V = (v_1, v_2, \dots, v_m)(6)$$

Five sets of reviews ensure the effective distinction of evaluation index amount, avoiding difficult evaluation due to the meticulous classification. Meanwhile, it reduces the error caused by different semantic understanding, which is a widely used form of comment set.

For each factor in the concentration of evaluation factors u_i ($i = 1, 2, \dots, m$), the work analyzes its affiliation level r_{ij} to the evaluation rating set v_j ($j = 1, 2, \dots, n$), and obtains single factor evaluation results of the i -th factor:

$$r_i = \{ r_{i1}, r_{i2}, \dots, r_{in} \}(7)$$

$r_{ij} > 0$ is set for analysis, with r_i normalized in general. That is $\sum_{j=1}^n r_{ij} = 1$.

3.4. Constructing Evaluation Matrix

Regarding m elements, r_i is viewed as line i after single factor evaluation. A evaluation matrix R_m is established, combining m elements and n ratings.

$$R_m = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix} (8)$$

3.5. Fuzzy Synthesis

The indicator layer factors are synthesized vaguely based on Formula (9). The weighted average of the evaluation model is used.

$$S_i = W_i \circ R_i (9)$$

where $W_i \circ$ is fuzzy operator symbol; $i = 1, 2, \dots, m$.

Then, the calculated S_i is used to form fuzzy comprehensive evaluation matrix R of guidelines layer factor.

$$R = [R_1; R_2; \cdots; R_n] (10)$$

Finally, fuzzy comprehensive evaluation matrix R synthesized by the weight vector W . As a result, we obtain affiliation level towards each rating level of the objects. Fuzzy comprehensive evaluation result vector is defined as

$$S = (s_1, s_2, \dots, s_n), (11)$$

$$S = W * R (12)$$

3.6. Making Decision

According to the evaluation model, weight f_j is set for each evaluation grade comments, reflecting the importance procedure of comments at all levels. The weighted average of each component in \tilde{S} is derived as the final results. Thus, the decision is made. With the use of Y ,

$$Y = F * S (13)$$

4. Analysis of Simulation Example

To verify the objectivity and practicality of evaluation index system of Chinese compensatory

supply cultural products and fuzzy comprehensive evaluation model, the evaluation of a Chinese public documentary is taken as an example, simulating with matlab software.

Based on the scale of relative importance between factors, and the evaluation index system of Chinese compensatory supply cultural products (See Table 1), the data were collected by consulting domestic experts. Then, we obtained the judge matrix A of five guidelines U_i ($i = 1, 2, 3, 4$ and 5) to target layer U , as well as judgment matrix A_i ($i = 1, 2, 3, 4$ and 5) of the indicators for the elements in guideline layer.

$$A = [1,4,1,2,6;1/4,1/1/4,1/3,3;1,4,1,2,6;1/2,3,1/2,1,4;1/6,1/3,1/6,1/4,1]$$

$$A_1=[1,1,1,1,1/3;1,1,1,1,1/3; 1,1,1,1,1/3; 1,1,1,1,1/3;3,3,3,3,1]$$

$$A_2=[1,1/5,1,1/3,1/3,4;5,1,5,7,7,8;1,1/5,1,1/3,1/3,4;3,1/7,3,1,1,5;3,1/7,3,1,1,5;1/4,1/8,1/4,1/5,1/5,1]$$

$$A_3=[1,2,7,4,4,5,6,4;1/2,1,6,3,3,4,5,3;1/7,1/6,1,1/4,1/4,1/3,1/2,1/4;1/4,1/3,4,1,1,2,3,1;1/4,1/3,4,1,1,2,3,1;1/5,1/4,3,1/2,1/2,1,2,1/2;1/6,1/4,2,1/3,1/3,1/2,1,1/3;1/4,1/3,4,1,1,2,3,1]$$

$$A_4=[1,3,5,1/3,4,4;1/3,1,4,1/5,2,2;1/5,1/4,1,1/7,1/2,1;3,5,7,1,6,6;1/4,1/2,2,1/6,1,1;1/4,1/2,2,1/6,1,1]$$

$$A_5=[1,1/4,2;4,1,6;1/2,1/6,1]$$

Then, the data was processed through matlab software, with the consistency test on judgment matrix according to Formula (3) and (4). After passing the consistency test, W 's component W_i was obtained by Formula (5). To facilitate calculation, weights are rounded down to integral numbers in the case of percentiles.

$$W = [0.33, 0.09, 0.33, 0.20, 0.05]$$

Similarly,

$$W_1 = [0.14, 0.14, 0.14, 0.14, 0.44]$$

$$W_2 = [0.07, 0.53, 0.07, 0.15, 0.15, 0.03]$$

$$W_3 = [0.34, 0.23, 0.03, 0.10, 0.10, 0.06, 0.04, 0.10]$$

$$W_4 = [0.24, 0.12, 0.04, 0.46, 0.07, 0.07]$$

$$W_5 = [0.19, 0.70, 0.11]$$

Afterwards, scoring people (each enterprise, government, academia, media and the public select one) graded the evaluation objects according to the rule of five comments set $V =$ (Very good, Better, Medium, Qualified and Unqualified) (See Table 2).

Table 2 Score statistics of a Chinese compensatory supply cultural products' evaluation.

Evaluation index	Comment grade and proportion (%)				
	Very good	Better	Medium	Qualified	Unqualified
Following the socialist core value system	60%	40%	0	0	0
Adhering to the four basic principles	0	60%	40%	0	0
Implementing "double as" direction and "double hundred" policy	0	40%	60%	0	0
Following the direction of the advanced socialist culture	20%	20%	60%	0	0
Complying with national cultural laws and regulations and related policies	100%	0	0	0	0
Advocating mainstream	0	100%	0	0	0
Advocating truth, goodness and beauty	0	100%	0	0	0
Dissemination of advanced	20%	60%	20%	0	0
Being educational	20%	60%	20%	0	0
With the meaning of heritage	40%	20%	40%	0	0
Promoting harmony	40%	40%	20%	0	0
Content is healthy and positive	60%	40%	0	0	0
Innovativeness	40%	20%	40%	0	0
Objectivity/Authenticity	0	60%	0	40%	0
Artistry	80%	20%	0	0	0
Aesthetic	80%	20%	0	0	0
Informative	0	80%	20%	0	0
Professionalism	0	80%	20%	0	0

Thoughtfulness	0	60%	40%	0	0
Listening and audience ratings/Circulation/Sales volume/Box office/Attendance rate /Sales revenue	0	100%	0	0	0
Industrialization level	0	60%	40%	0	0
Export exchange rate	0	0	100%	0	0
Brand value	0	80%	20%	0	0
Funds tax rate	0	100%	0	0	0
Cost profit rate	0	100%	0	0	0
Cultural business scale and efficiency	0	0	100%	0	0
Cultural creation talent quality	0	100%	0	0	0
Policy support efforts	0	100%	0	0	0

Data are substituted into Formula (8) to form fuzzy comprehensive evaluation matrix R_1, R_2, R_3, R_4 and R_5 of evaluation guideline layer factor U_m of Chinese compensatory supply cultural products.

Then it is substituted into Formula (9) and (10) to perform fuzzy comprehensive operation for the evaluation matrixes of guideline and target layers.

Political guidance comprehensive evaluation matrix is

$$S_1 = W_1 * R_1 = (0.14 \quad 0.14 \quad 0.14 \quad 0.14 \quad 0.44) * \begin{pmatrix} 0.6 & 0.4 & 0 & 0 & 0 \\ 0 & 0.6 & 0.4 & 0 & 0 \\ 0 & 0.4 & 0.6 & 0 & 0 \\ 0.2 & 0.2 & 0.6 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \end{pmatrix}$$

$$= (0.552 \quad 0.224 \quad 0.224 \quad 0 \quad 0)$$

Comprehensive evaluation matrix of social benefit is

$$S_2 = W_2 * R_2 = (0.07 \quad 0.53 \quad 0.07 \quad 0.15 \quad 0.15 \quad 0.03) * \begin{pmatrix} 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0.2 & 0.6 & 0.2 & 0 & 0 \\ 0.2 & 0.6 & 0.2 & 0 & 0 \\ 0.4 & 0.2 & 0.4 & 0 & 0 \\ 0.4 & 0.4 & 0.2 & 0 & 0 \end{pmatrix}$$

$$= (0.116 \quad 0.774 \quad 0.11 \quad 0 \quad 0)$$

Comprehensive evaluation matrix of product quality is

$$S_3 = W_3 * R_3 = (0.34 \quad 0.23 \quad 0.03 \quad 0.1 \quad 0.1 \quad 0.06 \quad 0.04 \quad 0.1) * \begin{pmatrix} 0.6 & 0.4 & 0 & 0 & 0 \\ 0.4 & 0.2 & 0.4 & 0 & 0 \\ 0 & 0.6 & 0 & 0.4 & 0 \\ 0.8 & 0.2 & 0 & 0 & 0 \\ 0.8 & 0.2 & 0 & 0 & 0 \\ 0 & 0.8 & 0.2 & 0 & 0 \\ 0 & 0.8 & 0.2 & 0 & 0 \\ 0 & 0.6 & 0.4 & 0 & 0 \end{pmatrix}$$

$$= (0.456 \quad 0.38 \quad 0.152 \quad 0.012 \quad 0)$$

Comprehensive evaluation matrix of economic benefits is

$$S_4 = W_4 * R_4 = (0.24 \quad 0.12 \quad 0.04 \quad 0.46 \quad 0.07 \quad 0.07) * \begin{pmatrix} 0 & 1 & 0 & 0 & 0 \\ 0 & 0.6 & 0.4 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0.8 & 0.2 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \end{pmatrix}$$

$$= (0 \quad 0.82 \quad 0.18 \quad 0 \quad 0)$$

Comprehensive evaluation matrix of resource value is

$$S_5 = W_5 * R_5 = (0.19 \quad 0.7 \quad 0.11) * \begin{pmatrix} 0 & 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \end{pmatrix} = (0 \quad 0.81 \quad 0.19 \quad 0 \quad 0)$$

General comprehensive evaluation matrix of leadership level is

$$S = W * R = (0.33 \quad 0.09 \quad 0.33 \quad 0.2 \quad 0.05) * \begin{pmatrix} 0.552 & 0.224 & 0.224 & 0 & 0 \\ 0.116 & 0.774 & 0.11 & 0 & 0 \\ 0.456 & 0.38 & 0.152 & 0.012 & 0 \\ 0 & 0.82 & 0.18 & 0 & 0 \\ 0 & 0.81 & 0.19 & 0 & 0 \end{pmatrix}$$

$$= (0.343 \quad 0.473 \quad 0.179 \quad 0.004 \quad 0)$$

Finally, the sub-items and overall score evaluation of Chinese compensatory supply cultural products are calculated by Formula (13).

$$Y_1 = F * S_1 = (95 \quad 85 \quad 75 \quad 65 \quad 50) * (0.552 \quad 0.224 \quad 0.224 \quad 0 \quad 0) = 88(\text{scores})$$

$$Y_2 = F * S_2 = (95 \quad 85 \quad 75 \quad 65 \quad 50) * (0.116 \quad 0.774 \quad 0.11 \quad 0 \quad 0) = 85(\text{scores})$$

$$Y_3 = F * S_3 = (95 \quad 85 \quad 75 \quad 65 \quad 50) * (0.456 \quad 0.38 \quad 0.152 \quad 0.012 \quad 0) = 88(\text{scores})$$

$$Y_4 = F * S_4 = (95 \quad 85 \quad 75 \quad 65 \quad 50) * (0 \quad 0.82 \quad 0.18 \quad 0 \quad 0) = 83(\text{scores})$$

$$Y_5 = F * S_5 = (95 \quad 85 \quad 75 \quad 65 \quad 50) * (0 \quad 0.81 \quad 0.19 \quad 0 \quad 0) = 83(\text{scores})$$

$$Y = F * S = (95 \quad 85 \quad 75 \quad 65 \quad 50) * (0.343 \quad 0.473 \quad 0.179 \quad 0.004 \quad 0) = 87(\text{scores})$$

Calculation results indicate that the political orientation, social benefits, product quality of this compensatory supply cultural product are at the upper-better level. Meanwhile, the economic and resource values are good, with the better overall evaluation.

5. Conclusion

Cultural product evaluation is a comprehensive evaluation involving many factors. Combined with the characteristics and requirements of Chinese cultural products, its evaluation is attached with strong subjective judgments. Based on analyzing the basic connotation and key attributes of Chinese compensatory supply cultural products, fuzzy comprehensive evaluation method was used to construct the evaluation model. The work tried to solve the uncertainty and incomplete information in the evaluation of cultural products, providing useful exploration for the further improvement of cultural products quality.

However, it still needs to be noticed that cultural product evaluation indicators are not immutable. To reflect the value of cultural products more accurately, the background of the times, cultural environment and the requirements of national strategy need to be followed in the process of implementation. At the same time, the index system of cultural products requires to be appraised timely under certain guiding ideology and evaluation principle, thus improving the practicability and effectiveness of the index system.

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