Comprehensive Performance Evaluation of Cultural Industry Via Linguistic Two-tuple Model

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Abstract. As an original and emerging industry, cultural industry has increasingly become a new economic growth point and an important pillar of the national economy. In this paper, the practical problem of comprehensive performance evaluation of cultural industry is investigated. Concretely, a new evaluation index system of evaluating performance of cultural industry is presented, then a comprehensive evaluation method for evaluating the performance of cultural industry is proposed via the linguistic two-tuple model, and the detailed implementation steps of this evaluation method is given. Moreover, some related countermeasures and suggestions are given on how to improve the performance levels of cultural industry.

Introduction

With the development of economic globalization, cultural industry has developed into a powerful industrial entity and has increasingly become a new economic growth point and an important pillar of the national economy [1]. Nowadays, cultural industry has become a important thrust to promote regional economic development and to realize the economic growth mode transformation and industrial structure adjustment.

Although the development of the cultural industry contributed to the rapid growth of the total economy, there are some negative issues, for example, China's cultural industry is developing based on resource-based and government-led, and there are some deficiencies in industrial symbiosis cultural integration, integration of resources, resources development and other aspects, and the added value of cultural products is not high [2]. The degree of cultural industry market is not high, the industrial chain is not complete enough, the isomorphic tendencies of industrial clusters is severe, the industrial clusters synergies and tension shortage is deficient [3]. There is some emphasis on economic benefit but not social benefits, even for the pursuit of economic interests and destruction of cultural resources of outstanding issues [4], and so on. Based on above background, some scholars have proposed some methods to evaluate the development level of cultural industry such as the method of GEM, the method of VRIO, the method of DEA, input-output method, and so on. In addition, there are a few scholars used the determinants of cultural industrial competitiveness to evaluate the performance level of cultural industries indirectly.

From the existing literatures, we can see that the evaluation system of cultural industries index selection in many literature are not reasonable [5], and the statistical standards are not uniform, etc; many existing assessment methods focused on a single dimension of assessment, so it is difficult to fully reflect the cultural industries in the aspects of the total growth, industrial structure, social contribution, technical innovation and other multi-dimensional performances; the evaluation index values for a regional cultural industries performance in existing literature are usually taken precise values. However, in the actual statistics, due to the complexity of the decision-making system and decision-making environment, and the ambiguity of human thinking, a lot of index values are difficult to count as a exact number, such as the contribution rate of the national economy, the number of practitioners of cultural industries, mobile phone coverage, etc., as they can only give by a values in a

range (interval number). In this sense, in the practical decision-making, there are maybe hybrid values (the precise values, interval numbers and the linguistic fuzzy numbers coexist). However, there are rare literature discussed this kind of decision-making problems.

Based on the existing results, this paper presents a new evaluation index system of evaluating performance of cultural industry, and then presents a comprehensive evaluation method for evaluating the performance of cultural via the linguistic two-tuple model. The goal is to make the performance level of cultural industries to be more objective and fair, and provide reference to cultural industry management department, and it is of important practical significance for promoting the development of cultural industry.

The Evaluation Index System

In this section, we present a new evaluation index system of evaluating performance of cultural industry based on some relative literatures. The evaluation index system are listed in Table 1.

Table 1. The evaluation index system for evaluating performance of cultural industry

Attribute	Sub-attribute
Cultural resources	A_1 Number of national intangible cultural heritage; A_2 Number of national 4A level scenic spots; A_3 National Nature Reserve; A_4 Number of heritage collections (pieces) A_5 Number of books (volume)
Capital resources	A_6 Fixed asset investment (million Yuan); A_7 Fiscal appropriation (million Yuan) A_8 Foreign investment (million Yuan)
Manpower resource	A_9 Number of practitioners in cultural industry (people); A_{10} Number of researchers
Developmental level	A_{11} Output of cultural industry (Ten million Yuan); A_{12} Per capita of cultural industry (Yuan/person); A_{13} Total revenue of tourism (Ten million Yuan)
Economic contribution	A_{14} Contribution Rate of national economy (%); A_{15} Employment contribution rate of tertiary industry (%); A_{16} Pulling rate of national economy rate (%); A_{17} Contribution rate of tax (%)
Construction of cultural facilities	A_{18} Number of culture scientific research institutions; A_{19} Number of educational institutions of cultural sector; A_{20} Comprehensive population coverage rate of TV (%); A_{21})Coverage rate of mobile phone (%); A_{22} Coverage rate of Internet (%)
Construction of cultural policies and regulations	A_{23} Transparency and effectiveness of cultural industry policy; A_{24} Protection degree of government intellectual property; A_{25} Law enforcement of cultural industry
Cultural consumption	A_{26} Per consumption expenditures of education, cultural and recreation (Yuan / person); A_{27} Per published copies of books, newspapers and periodicals (Copies / person); A_{28} Per publication quantity of video and audio products (Pieces / person)
Research on culture	A_{29} Number of research project on cultural relics protection and research institutions of culture and art; A_{30} Number of awards of Scientific research project
Cultural participation	A_{31} Number of people in arts venue audience (Ten thousand); A_{32} Circulation Number of public library (Ten thousand); A_{33} Number of total visitors in cultural institutions (Ten thousand); A_{34} Total number of tourism (Ten thousand) A_{35} Number of cultural activities in public arts and cultural centers (Times)

We denote the values of above 45 attributes as $a_1, a_2, \cdots a_{45}$. These attribute values can be divided into three types. The first one is the precise numbers, which includes $a_1, a_2, \cdots, a_{22}, a_{26}, a_{27}, \cdots, a_{35}$. The second one is linguistic fuzzy variable such as "Very low, Low, Medium, High, Very high" or "Very poor, Poor, Medium, Good, Very good", which includes $a_{23}, a_{24}, \cdots a_{25}$. We suppose that there are m cities participate in the performance evaluation of cultural industry. The attribute in Table 1 are used to evaluate the performance level of cultural industry for these m cities. The evaluation attribute

set is denoted as $P=\{p_1, p_2, \cdots, p_{35}\}$, and the weight of attribute A_j is denoted as w_j, where w_j satisfies $0 \le w_j \le 1, \sum_{j=1}^{35} w_j = 1$.

The original data matrix formed by $a_1, a_2, \cdots a_{45}$ for m cities are denoted as $A=(a_{ij})_{m\times 35}$. Now our task is rank order of performance level of cultural industry for these m cities.

Performance Evaluation Method of Cultural Industry Via Linguistic two-tuple Model

In this section, we will presented a Performance evaluation method of Cultural Industry Via Linguistic two-tuple Model. The linguistic two-tuple model proposed by Herre-ra and Martínez in 2000 [6]. Now we give the detailed decision steps.

Step 1: The expert group gives the original decision matrix $A=(a_{ij})_{m\times 35}$ for m cities.

Step 2: Use the transformation method given by the following definition 1 and definition 2 to transform the original decision matrix $A=(a_{ij})_{m\times 35}$ into linguistic two-tuple decision matrix $\tilde{R}=((r_{ij}, b_{ij}))_{m\times 35}$.

Definition 1 [7]. Let $S=\{s_0, s_1, \ldots, s_t\}$ be a known linguistic evaluation set, and $\beta \in [0,t]$ be a real number which is a value supporting the result of a symbolic aggregation operation, then $\beta \in [0,t]$ can be transformed into an equivalent linguistic two-tuple by the following function Δ:

$\Delta : [0,t] \to S \times [-0.5, 0.5)$, $\Delta(\beta) = (s_k, a_k)$,

$$\begin{cases} k = round(\beta) \\ a_k = \beta - k, \quad a_k \in [-0.5, 0.5), \end{cases}$$

and "round" is the usual rounding operation. Conversely, for a known linguistic two-tuple (s_k, a_k), there is an inverse function Δ^{-1} such that from a two-tuple (s_k, a_k) it returns its equivalent numerical value $\beta \in [0,t]$, i.e.,

$\Delta^{-1} : S \times [-0.5, 0.5) \to [0,t], \quad \Delta^{-1}(s_k, a_k) = k + a_k = \beta$.

Definition 2 [8]. Let $s_k \in S$ be a linguistic fuzzy variable, then the corresponding linguistic 2-tuple can be obtained by the following function θ.

$\theta : S \to S \times [-0.5, 0.5)$, $\theta(s_k) = (s_k, 0), \ s_k \in S$

For the attributes $a_1, a_2, \cdots, a_{22}, a_{26}, a_{27}, \cdots, a_{35}$, their attribute values are all the precise numbers, and they are all benefit type attributes, we can use Eqn (1) to transform there values in the range [0,1].

$$c_{ij} = \frac{a_{ij} - \min\limits_i a_{ij}}{\max\limits_i a_{ij} - \min\limits_i a_{ij}} \quad i = 1,2,\ldots,n, \ j = 2$$

then we can use Definition 1 to transformed their values into an equivalent linguistic two-tuple.

For the attributes $a_{23}, a_{24}, \cdots a_{25}$, we can use Definition 2 to transformed their values into an equivalent linguistic two-tuple.

Step 3: Use the *TWA* operator given in Definition 3 to aggregate all evaluation values under 35 evaluation attributes in matrix $\tilde{R}$ into one comprehensive evaluation value r_i of city *i*.

Definition 3 [8]. Let (s_1, a_1), (s_2, a_2), …, (s_n, a_n) be *n* linguistic 2-tuples, then the 2-tuple weighted averaging (*TWA)* operator is defined as

$$r_i = (s_i, a_i) = TWA_w((s_1, a_1), (s_2, a_2), \ldots, (s_n, a_n)) = \Delta\left(\sum_{j=1}^{n} w_j \Delta^{-1}(s_j, a_j)\right) \tag{4}$$

where $w=\{w_1,w_2,\ldots,w_n\}$ is the weight vector of 2-tuples (s_j,a_j), $j=1,2,\ldots,n$, such that $0\le w_j\le 1$ and $\sum_{j=1}^{n} w_j=1$.

Step 4: Use the comparasion methods given by the following Definition 4 to rank the order for comprehensive evaluation value r_i (i=1, 2, …, m).

Definition 4 [9]. Let (s_k,a_k) and (s_l,a_l) be two linguistic 2-tuples, with each one representing a counting of information, then: If $k>l$, then $(s_k,a_k)>(s_l,a_l)$. If $k=l$, then (i) If $a_k=a_l$, then $(s_k,a_k)=(s_l,a_l)$; (ii) If $a_k<a_l$, then $(s_k,a_k)<(s_l,a_l)$. (iii) If $a_k>a_l$, then $(s_k,a_k)>(s_l,a_l)$.

Step 5: Rank the performance level of cultural industry for these m cities according to the values of 2-tuple $r_i=(s_i,a_i)$ (i=1, 2, …, m). The greater the value of $r_i=(s_i,a_i)$, the higher is the performance level of cultural industry for city i.

Conclusions and related countermeasures

This paper constructs a new performance evaluation index system of cultural industry, and then proposed a new performance evaluation method of cultural industries based on the linguistic two-tuple model, which provides new methods and approaches for evaluating the performance level of our regional cultural industries. In order to improve the development level of cultural industries, here we give some related countermeasures and suggestions. First, the government must increase the investment of capital resources and strengthen technological innovation. Secondly, the government must greatly strengthen the investment in human resources. Thirdly, the government must strengthen the software and hardware construction of cultural industry. Software construction refers to the construction of cultural policies and regulations, and hardware construction is the construction of infrastructure in cultural industries. Finally, the government must vigorously promote the integration symbiosis development between the cultural industry and related industries.

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