Evaluation Criteria of Outstanding Artisans of Local Architecture Construction Skills based on AHP-TOPSIS

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Abstract. Vernacular architecture is a kind of folk and spontaneous architecture, reflecting the unique regional culture. In recent years, the attention to local culture has gradually increased, and the protection and repair of local architecture has become a hot spot. The construction skills of local architecture are a strong guarantee for the continuation of its vitality, and rural craftsmen play an important role. Therefore, the selection of outstanding craftsmen has been carried out in various places to set an example in the industry to help the protection and repair of local architecture. However, the existing policy documents only describe the selection requirements qualitatively, which is difficult to operate in the actual selection. This paper uses AHP-TOPSIS to construct and optimize evaluation indicators, and finally classifies indicators and puts forward operational evaluation methods. We will promote the construction of a system for protecting the intangible heritage of Chinese vernacular architecture.

Keywords: Artisan Selection; Construction Skills; AHP-TOPSIS; Vernacular Architecture.

1. Introduction

Construction skills are the construction wisdom that ancestors have accumulated for a long time to adapt to the environment. In recent years, more and more vernacular architecture construction skills have been included in the list of China's intangible cultural heritage, and the value of the intangible cultural heritage in vernacular architecture has been recognized. The inheritance of construction skills requires the master to teach the apprentice hand-in-hand and face-to-face, and the inheritor of skills has become the key to the inheritance and development of intangible cultural heritage. So far, 41 inheritors of artificial construction skills have been announced[1], mainly engaged in the construction and restoration of vernacular architecture in various regions of China. At present, there are no clear selection criteria for the selection of famous craftsmen of Chinese traditional architecture, representative inheritors of intangible cultural heritage, and rural artisans, only a qualitative description of the evaluators, and the selection results are determined by expert review through the information provided by the evaluators. This paper intends to adopt The analytic hierarchy process to establish the evaluation index system and weight of outstanding artisans in construction skills, clarify the selection criteria of outstanding artisans, and help the protection of China's intangible cultural heritage.

2. Research Method

2.1 Analytic Hierarchy Process

The analytic hierarchy process is to judge the relative importance of the indicators according to the experience of the decision-maker, and give the weight of each indicator reasonably, and use the weight to find the order of the pros and cons of each scheme, and effectively solve the problem that the quantitative method cannot solve.

2.1.1 Establishment of Evaluation Indicators

According to the "Notice on Carrying out the Work of Recommending Famous Craftsmen of Chinese Traditional Architecture"[2], "Measures for the Identification and Management of Representative Inheritors of National Intangible Cultural Heritage"[3], "Notice of Guangdong Provincial Department of Housing and Urban-Rural Development on carrying out the first"[4] Guangdong Province Traditional Craftsmen "identification work" and other documents, the selection requirements of "outstanding craftsmen" are extracted, and after discussion and summary by the expert group, Establish evaluation criteria (Table 1). Among them, the expert group consists of 3 researchers in related research fields, 3 traditional craftsmen with more than 20 years of work experience, and 3 traditional construction enterprise managers with rich experience.

Table 1. Outstanding Artisan Evaluation System

Target layer	Criterion layer	Index layer
Evaluation System	A. Skill inheritance	A1. Actively teach construction skills
		A2. Collation of documents on construction techniques
		A3. Organize public communication activities such as lectures and exhibitions
	B. Practical experience	B1. Duration of relevant work or number of representative projects
		B2. As an important project technical leader
		B3. Technological breakthroughs, innovations ,or solutions to important problems
	C. Social acceptance	C1. Influence in industry associations
		C2. Peer or owner reputation
		C3. Honors, awards, titles

2.1.2 Construct Judgment Matrix

According to the established evaluation index, a pairwise comparison between factors is adopted, and the quantitative scale between factors is made according to the nine-level scale method (Table 2) according to their importance, and the judgment matrix is obtained. The judgment matrix is denoted as "A".

Table 2. Expert Rating

significance	grade
A_i is as important as A_j	1
A_i is slightly more important than A_j	3
A_i and A_j are obviously important	5
Ai and Aj are strongly important	7
A_i and A_j are extremely important	9
Between two neighboring judgments	2,4,6,8
Judgment of factor A_i compared with A_j a; Then the judgment of factor Aj compared with A_i =1/a	Count backwards

$$A = \begin{bmatrix} 1 & \cdots & a_{1\text{-}n} \\ \vdots & \ddots & \vdots \\ 1/a_{1\text{-}n} & \cdots & 1 \end{bmatrix} \quad (1)$$

Where, “a” is row “i” and column “j”, and the importance scores of A_i and A_j are denoted as a_{ij} (i, j= 1,2,3.... n)

2.1.3 Determine Index Weight

To determine the index weight, first determine the respective weights of the three criterion layers, then determine the weights of the indicator layers, and obtain the weights scored by 9 experts. The

calculation method is to normalize the "column" of matrix "A", obtain matrix "X", and then normalize the "row", that is, the index weight "W".

$$X_{ij} = \frac{\left(\frac{1}{a_{ij}}\right)}{\sum_{j=1}^{n}\left(\frac{1}{a_{ij}}\right)} \tag{2}$$

$$W_i = \frac{\sum_{j=1} X_{ij}}{\sum_{i=1}^{n}\sum_{j=1}^{n} X_{ij}} \tag{3}$$

2.1.4 Consistency Check

To ensure the rationality of the data, it is necessary to conduct consistency tests on each matrix to make it statistically significant (Table 3).

$$AW = \lambda_{max} W \tag{4}$$

$$\lambda_{max} = \frac{1}{n}\left(\sum_{i=1}^{n}\frac{(AW)_i}{W_i}\right) \tag{5}$$

$$CI = \frac{\lambda_{max} - n}{n - 1} \tag{6}$$

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

Table 3. Parameter list (RI)

Size of the Matrix (n)	1	2	3	4	5	6	7	8	9	10
Random Consistency Index (RI)	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

λ_{max} is the largest eigenvalue of matrix A, and n is the number of evaluation elements. When the value of CI is 0, it indicates that the importance of these n elements is exactly the same under a certain criterion. The smaller the value of CI, the closer the experts' responses were to agreement. It is recommended that the value of CI is less than 0.1.

2.2 Technique for Order Preference by Similarity to Ideal Solution

Technique for Order Preference by Similarity to Ideal Solution is a method commonly used in multi-attribute decision-making problems. It is a multi-objective ranking method that approximates the ideal solution according to the closeness between the optimal solution and the ideal solution.

2.2.1 Optimal Vector and Worst Vector

Since the analytical mechanism of the analytic hierarchy process (AHP) is to compare pair and pair elements, the weight of the judgment result represents its importance. Therefore, the weight value of the index layer can be regarded as an extremely large index, and no positive and standardized processing is required. Construct the optimal value vector "Z^+" and the worst value vector "Z^-" from the optimal value and the worst value.

$$Z^+ = \left(Z_1^+,\ Z_2^+ \cdots Z_b^+\right) \tag{8}$$

$$Z^- = \left(Z_1^-,\ Z_2^- \cdots Z_b^-\right) \tag{9}$$

Where Z is the index weight matrix, and Zab represents the weight of expert an after judging index b.$Z_b^+ = \max\{Z_{1b},\ Z_{2b} \cdots,\ Z_{ab}\},\ Z_b^- = \max\{Z_{1b},\ Z_{2b} \cdots,\ Z_{ab}\}$

2.2.2 Calculated Euclidean Distance

$$D_i^+ = \sqrt{\sum_{b=1}^{n}\left(Z_b^+ - Z_{ab}\right)^2} \tag{10}$$

$$D_i^- = \sqrt{\sum_{b=1}^{n}\left(Z_b^- - Z_{ab}\right)^2} \tag{11}$$

m is the number of experts and n is the number of indicators.

2.2.3 The Relative Progress is Calculated and Normalized

$$S_i = \frac{D_i^-}{D_i^+ + D_i^-} \tag{12}$$

$$\bar{S}_i = \frac{S_i}{\sum_{i=1}^{m} S_i} \tag{13}$$

3. Result

Table 4. Indicator weights, sorting, and types

Target layer	Criterion layer	weights	Index layer	weights	sorting	types
Evaluation System	A. Skill inheritance	48.55%	A1. Actively teach construction skills	29.93%	1	absolute
			A2. Collation of documents on construction techniques	11.83%	4	fuzzy
			A3. Organize public communication activities such as lectures and exhibitions	6.79%	6	absolute
	B. Practical experience	29.94%	B1. Duration of relevant work or number of representative projects	6%	7	absolute
			B2. As an important project technical leader	9.5%	5	fuzzy
			B3. Technological breakthroughs, innovations, or solutions to important problems	14.44%	2	absolute
	C. Social acceptance	21.29%	C1. Influence in industry associations	2.13%	9	fuzzy
			C2. Peer or owner reputation	13.95%	3	fuzzy
			C3. Honors, awards, titles	5.21%	8	fuzzy

According to the weights of each index obtained in the analytic hierarchy process (Table 4), the first weight is "A1" actively teaching construction skills, indicating that the continuation, inheritance ,and development of traditional construction skills are the basic requirements of outstanding craftsmen, and it also reflects that the evaluation of outstanding craftsmen takes "craftsman spirit" as the core, while the second weight is "B3" technology creation and conquering. It is still an evaluation of the technical excellence of outstanding craftsmen. Weight third "C2" reputation evaluation reflects the ability of expertise, and "B3" is related. The ranking of the evaluation index "C1" industry influence, due to the competition among peers, the evaluation has certain subjective factors, so experts think it is not very important, similarly, "C3" honor, title, etc. in

the opinion of experts do not substantively help the inheritance and development of construction skills, experts believe that the focus of evaluation of outstanding craftsmen lies in industry development, technology dissemination and innovation.

There are two types of evaluation indicators, the absolute index is measured by numerical value, and the fuzzy index is not measured by numerical value, which needs to be scored by the expert group. Among them, A1, A3, B1, and B3 are "absolute" indicators, A1 is a full mark with the number of apprentices 10, multiplied by A1 weight; A3 is full marks for lectures and exhibitions more than 10 times, multiplied by A3 weight; B1 20 years of relevant working experience; B2 as a technical leader of 10 representative projects.

The rest are "fuzzy" indicators, and the evaluation set of the expert group is divided into 5 levels, as follows:

$$Y = \{A/\text{very good}, B/\text{good}, C/\text{general}, D/\text{bad}, E/\text{very bad}\}$$

$$U = \{A/1, B/0.85, C/0.70, D/0.50, E/0.15\}$$

By determining the weight of each indicator and assigning the corresponding score value, the absolute indicator can be obtained by multiplying the weight of the real and effective data of the participants. The fuzzy index obtained the index score by multiplying the expert evaluation grade by the weight through the relevant data of the participants.

4. Summary

In this paper, through sorting out the policy documents for the selection of outstanding artisans, expert review, and judgment, AHP-TOPSIS is used to determine the weight and ranking of each indicator, classify the indicators, and provide practical scoring methods, changing the current status of only qualitative evaluation in the existing evaluation, and achieving quantitative evaluation of outstanding artisans with traditional construction skills. Among them, the weight of some indicators is too low, such as C1, which on one hand indicates that it does not exist as an evaluation indicator; on the other hand, it also indicates that the importance of each evaluation requirement in qualitative evaluation is not reflected in the policy document, highlighting the advantages of qualitative evaluation. If you want to further optimize the weight of evaluation indicators, the Delphi expert inquiry method can be used again. According to the Kendall coefficient has been optimized selection requirements, can finally form a good evaluation method.

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