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Application of Value Assessment Weights in Conservation of Modern Architectural Heritage

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Abstract

This study presents the weights of various indicators in the integrated conservation of our modern architectural heritage. In the AHP (Analytic Hierarchy Process), the Delphi method and Entropy method are integrally adopted to set up the evaluation indicator system of the conservation efforts, and the weight coefficient of evaluation indicators. Through the analysis, we can find that modern architectural heritages not only have the three basic values historical, artistic and scientific values, but also have significant environmental, cultural emotional and real estate values. In the assessment system, artistic and historical values are the priorities among those first-level indicators, and the real estate value is the last one. Among the second-level indicators, representative architectural art is the most important factor. Consequently, the emphases should be placed on the artistic and historical values of modern architectural heritages.

Keywords: *architectural history, historic conservation, analytic hierarchy process, Delphi method, value assessment*

1. Introduction

Nowadays, in the common process of assessing and conserving modern architectural heritages, the values of modern architectural heritages are not really distinguished from ancient architectural heritages, as the specialties of modern architectural heritages have not been fully realized. Therefore, people tend to apply concepts and technologies derived from ancient heritage conservation to modern architectural heritage conservation projects, thus an inaccurate value assessment system is formed in the integrated conservation [1, 2]. It's definitely necessary to reconsider the value composition of the modern architectural heritages.

In the protecting or restoring modern architectural heritages, we should carefully evaluate the architectural values, so as to determine which values must be preserved, which ones can be adjusted or abandoned [3, 4]. So in order to realize the purpose of preserving and reusing architectural heritages by appropriate technical proposals, a thorough study and understanding of the values, weights of assessment indicators, and their interrelationships is necessary [5, 6].

2. Research Purpose and Methorolgy

Purpose and significance: as an interdisciplinary research focusing on application, this study attempts to establish an initial assessment system for the integrated conservation of modern architectural heritages. A new architectural perspective, together with a unique, multi-disciplinary method will play an important role in the integrated conservation of these heritages and their environments, while at the same time maximizing the additional values of the heritages [7, 8].

Research methodology: using interdisciplinary research methods, this paper integrated AHP, the Delphi Method and Entropy Method to establish a hierarchy model of the evaluation system in integrated conservation of modern architectural heritage, and then calculated the various weights of the value assessment indicators [9, 10].

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3. Multople Values of Modern Architecture Heritages

Three basic values of modern architectural heritages: Principles for the Conservation of Heritage Sites in China" (issued by China ICOMOS1, October 2000, Chengde, approved by the State Administration of Cultural Heritage) stated in Article 3: The heritage values of a site comprise its historical, artistic, and scientific values.

Integrating related researches, the three basic values of architectural heritages historical, artistic and scientific values can be described as follows:

1) Historical value: architectural heritages are embodied with specific, clear and authentic historical information due to their unique dimensions, pattern, layout, details and spatial interrelationships (or relationships with the environment).

2) Artistic value: that refers to the aesthetic value of an architectural heritage due to its spatial composition, color and plan patterns, facades and decoration style, material textures, landscape and sculptural arts, fine details, and the structure rhythm.

3) Scientific value: the specific building structures, constructions, materials, techniques, architecture and construction concepts of architectural heritages are inspiring for modern architects and engineers.

The additional values: the Declaration of Amsterdam (Congress on the European Architectural Heritage, October 21-25, 1975) proposed: "The conservation effort to be made must be measured not only against the cultural value of the buildings but also against their use-value. The social problems of integrated conservation can be properly posed only by simultaneous reference to both those scales of values."

"Principles for the Conservation of Heritage Sites in China" also stated in Commentary 2.3: "Recognition of a site's heritage values is a continuous and open-ended process that deepens as society develops and its scientific and cultural awareness increases."

Considering the unique architectural functions, building size and special position in the urban context, modern architectural heritages not only have the three basic values shared by other common cultural heritages, but also have more additional values, including environmental, cultural/emotional and real estate values. Moreover, since most of them are still in use, modern architectural heritages are generally inseparable from the urban spaces and urban lives.

As a summary of prior research outcomes, the three additional values of modern architectural heritages can be defined as:

1) Cultural/emotional value: the ability of an architectural heritage to influence/ lead/ represent/ symbolize/ restrict specific contemporary public culture and value orientation (including religious beliefs and corporate culture), or to serve as spiritual sustenance and educational materials.

2) Environmental value: the ability of an architectural heritage to make urban space and landscape, or to form the city image.

3) Real estate value: the architectural heritages' ability to provide suitable interior or exterior spaces for specific social activities.

4. Assessment Ssystem of Modern Achitectural Heritage

4.1. Principles of set up the Assessment System

In order to establish an accurate and scientific assessment index system, these principles should be taken into account during the process:

1) Integrity and representativeness; \
2) Comparability and operability;
3) Scientificity and systematicness;
4) Openness and scalability;
5) Qualitative and quantitative methods

4.2. Steps to Calculate Evaluation Indicators Weights

In this study, the following steps to calculate the evaluation indicator weights were taken:

1) Establish a hierarchy model of modern architectural heritage values.

2) Apply Delphi Method to design the questionnaire "The importance of indicators in the value assessment of modern architectural heritages ".

3) Analyze the result of the questionnaire; compare one with each other to get the original data input. The scales of AHP comparison ratio in this study are listed in Table 1:

4) Based on the result of step 3, a matrix of pairwise comparison ratio can be constructed as follows:

$$A = \left(a_{ij}\right)_{n\times n} = \begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{pmatrix} \quad (1)$$

Table 1. AHP comparison ratio scales

Scale	Meaning	Comparison Category
1	*i*-factor has the importance equal to *j*-factor	I
3	*i*-factor is slightly more important than *j*-factor（reciprocal otherwise）	II
5	*i*-factor is obviously more important than *j*-factor（reciprocal otherwise）	III
7	*i*-factor is much more important than *j*-factor（reciprocal otherwise）	IV
9	*i*-factor is absolutely more important than *j*-factor, and *j*-factor might be ignored（reciprocal otherwise）	V

Element a_{ij} is set as the importance comparison ratio of *i*-factor to *j*-factor. Use software such as EXCEL or SPSS to calculate the matrixes to get each evaluation indicator weights on the basis of previous step.

5) Hierarchical sorting and consistency verification (including single level sort and total sort).

Pick the largest eigenvalue of judgment matrix normalized eigenvectors $\{w_1, w_2, \cdots, w_n\}$ $\sum_{i=1}^{n} w_i = 1$ as evaluation index weights.Where in is the weight of a factor on lower level with respect to the superstratum. After that, the consistency must be verified. Usually when the consistency ratio $CR = CI/RI < 0.1$, the inconsistency of matrix *A* will be admitted and its normalized eigenvectors will be considered as the weight vectors. Otherwise, a new round of questionnaire survey will be conducted to construct a new matrix of the pairwise comparison ratio and recalculate the weights.

Formula of consistency index *CI* :

$$CI = \frac{\lambda - n}{n - 1} \quad (2)$$

N is the sum of the diagonal factors in matrix *A*.Numerical random consistency index valuesare shown in Table 2:

Table 2. Numerical random consistency index value

n	1	2	3	4	5
RI	0	0	0.58	0.9	1.12
n	6	7	8	9	10
RI	1.24	1.32	1.41	1.45	1.49

6) Revise the weights from AHP with the Entropy method. The basic steps of Entropy method are described below:

a. The original data of the matrix are normalized to be:

$$R = (r_{ij})_{m \times n} \tag{3}$$

b.Calculate the proportion of the indicators r_{ij} ;

$$H_{ij} = \frac{r_{ij}}{\sum_{j=1}^{n} r_{ij}} \tag{4}$$

c. With n be the number of the superstrata on upper level, calculated the entropy of indicator i -th (from the 1st to *m*-th indicators).

$$E_i = -k \sum_{j=1}^{n} H_{ij} \ln H_{ij} \quad , \quad k = 1 / \ln n \ ; \tag{5}$$

d. Calculate the entropy weights of indicators:

$$w_i = \frac{1 - E_i}{m - \sum_{i=1}^{m} E_i} (0 \le w_i \le 1, \sum_{1}^{m} w_i = 1) \tag{6}$$

e. Finally, calculate weight averages at the corresponding proportion of 3:1 with the data from both AHP and Entropy method.

4.3. Hierarchy Model of the Evaluation System

The hierarchy model of the evaluation system in the integrated conservation of modern architectural heritage is shown in Table 3.

Table 3. The hierarchy model of the evaluation system of modern architectural heritage

First level	Second level
historical value	empirical validity and completeness
	uniqueness of the historical information
	importance of the historical information
scientific value	ingenuity of the architectural techs
	economical efficiency and reasonableness
	practical technical reference value
artistic value	representative architectural art
	fame of the architect
	completeness of the artistic features
	practical artistic reference value
emotional /cultural value	as a site for important state affairs
	as a memorial site
	as a religion site
	as a site for folk/minorities festivals
	as a leisure site for common people
	as a Stadium or Museum
environm-ental value	importance in the urban planning
	being as the city's symbol or not
	landscape value
real estate value	the safety/reliability of the structure
	integrity of supporting facilities
	integrity of decoration
	superiority of the location

5. Indicators' Weights in Value Assessment

5.1. Questionnaire of Indicators' importance:

1) The principles of selecting the questionnaire respondents

a. The questionnaire respondents are expected to be professionals with the following qualifications: Relevant education background;

Practical experience and abundant expertise of modern architectural heritage conservation/ displaying/ rebuilding;

Having been in the relevant fields for a long time;

Senior professional titles, or first grade state registered qualification, or relevant professional doctorate.

b.In addition, considering the cost and efficiency of the questionnaire, the number of the respondents has been limited to 10.

2) Design of the questionnaires

The 7 questionnaires used in this study have been omitted due to limited space.

3) The statistics of the first-level indicators is shown in Table.4 (in next page). The results of the second-level indicators have been omitted for space consideration. It should be noted that " $I_1 \sim I_{10}$" are the comparison ratios given by10 respondents; while "Total ratio of pairwise indicators" are the ratios of total numerators divided by total denominators in each row.

Table 4. Total importance ratio of pairwise indicators for modern architectural heritage value assessment

comparison ratio of each respondent	I_1	I_2	I_3	I_4	I_5	I_6	I_7	I_8	I_9	I_{10}	total ratio of pairwise indicators
a_{12}	1	1	5	7	7	9	1	1	5	3	4
a_{13}	1	1	1/7	1	3	7	5	1/3	1	1	11/9
a_{14}	1	7	3	1	5	1	1/5	3	3	5	15/7
a_{15}	1/9	1/9	7	5	3	1/5	1/5	3	5	7	1
a_{16}	9	9	1/7	5	9	5	5	5	3	9	15/4
a_{23}	1/7	1/9	1/5	1	1/7	1/7	1/5	1	1/5	1/3	1/5
a_{24}	1	7	1	1/5	1	1/5	1/5	3	1/3	3	5/6
a_{25}	1	7	3	1/5	1/5	1	5	7	1/3	5	8/5
a_{26}	1	1/5	3	1	5	3	1/5	7	1/5	7	15/11
a_{34}	7	7	5	5	3	1	5	3	3	3	21/5
a_{35}	9	9	5	5	3	5	5	1	5	5	26/5
a_{36}	9	9	3	5	9	3	5	3	3	7	28/5
a_{45}	1/5	1/5	1	1	1	1/3	5	1	1	3	4/5
a_{46}	5	5	5	5	9	5	5	3	1/3	5	25/6
a_{56}	1	1	5	1	9	5	5	3	1	3	17/5

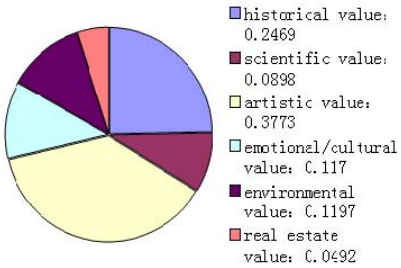

Figure 1. Weights of first-level indicators （CR=0.0368）

5.2. Results

Based on the statistical results shown in Section 4.1, and in accordance with the calculation steps in section 3.2, the final weights of modern architectural heritage value

assessment indicators were obtained (listed in Figure 1 and Table 5) with consistency verified (including single level sort and total sort, details omitted for limited space).

Table 5. Weights of second-level indicators（CR=0.0368）

Indicators	Weights
empirical validity and completeness	0.0814
uniqueness of the historical information	0.0783
importance of the historical information	0.0872
ingenuity of the architectural techs	0.0583
economical efficiency and reasonableness	0.0193
Practical technical reference value	0.0123
representative architectural art	0.2035
fame of the architect	0.0504
completeness of the artistic features	0.0896
Practical artistic reference value	0.0338
as a site for important state affairs	0.0328
as a memorial site	0.0364
as a religion site	0.0164
as a site for folk/minorities festivals	0.0135
as a leisure site for common people	0.0072
as a stadiums or museums	0.0108
importance in the urban planning	0.0155
being as the city's symbol or not	0.0894
landscape value	0.0148
safety of structure	0.0234
integrity of supporting facilities	0.0033
integrity of decoration	0.0054
superiority of the location	0.0071
applicability rebuilding/reconstruction	0.0100

6. Conclusion

The following conclusions can be drawn from the calculation results listed in Figure 1 and Table 5 the majority of the selected experts believe that artistic and historical values are the most important first-level indicators in the modern architectural heritage value assessment, while real estate value is the least important one. Besides, representative architectural art is the most important second-level indicator. In this case, the artistic and historical values should receive more attention in modern architectural heritage value assessments, as well as the representative architectural art.

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