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## Weights of the Value Assessment Indicators in Integrated Conservation of Modern Architectural Heritage

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**Abstract:** The values of modern architectural heritage have not yet been clearly discriminated from the values of ancient architectural heritage. This study presents the weights of various indicators to improve the integrated conservation of our modern architectural heritage. AHP (Analytic Hierarchy Process), the Delphi method and Entropy method were integrally used to set up the evaluation indicator system of the conservation efforts and calculate the weight coefficient of evaluation indicators. Based upon the analysis, 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, while real estate value is the last one. Among the second-level indicators, representative architectural art is the most important factor. Consequently, emphases should be placed on the artistic and historical values of modern architectural heritages.

**Key words:** Architectural history, historic conservation, analytic hierarchy process, delphi method, entropy method, value assessment

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### 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 (Zhang and Zhou, 2005; Chen and Hu, 2005). Each organization/researcher has his/her own version of value composition/assessment system (Donaghey, 2001; Agnew and Demas, 2002; Huang, 2006; Xiao, 2009; Somek, 2010; Zhang, 2010a, b, 2011; Liu and Chu, 2011; Zheng *et al.*, 2011; Jin, 2012). Therefore, people tend to apply concepts and technologies derived from ancient heritage conservation to modern architectural heritage conservation projects, resulting in an inaccurate value assessment system in the integrated conservation. It's definitely necessary to reconsider the value composition of the modern architectural heritages.

While protecting or restoring modern architectural heritages, one should carefully evaluate the architectural values, so as to determine which values must be preserved which ones can be adjusted or abandoned over time. That calls for a thorough study and understanding

of the values, the weights of assessment indicators and their interrelationships, for the purpose of preserving and reusing modern architectural heritages by appropriate technical proposals.

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.

### MATERIALS AND METHODS

Using interdisciplinary research methods, this paper integrated AHP (Analytic Hierarchy Process, the same as below), 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 (Li *et al.*, 2005; Li, 2006; Zhang *et al.*, 2009; Gai, 2010; Jin, 2012; Yang *et al.*, 2012).

## **MULTIPLE VALUES OF MODERN ARCHITECTURAL HERITAGES**

### **Three basic values of modern architectural heritages:**

"Principles for the Conservation of Heritage Sites in China" (issued by China ICOMOS, 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:

- **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)
- **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
- **Scientific value:** The specific building structures, constructions, materials, techniques, architecture and construction concepts of architectural heritages are inspiring for the architects and engineers of present age

**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

(Donaghey, 2001; Lahoud, 2008; Somek, 2010; Zhang, 2010a, b, 2011; Kianicka *et al.*, 2010). 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:

- **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
- **Environmental value:** The ability of an architectural heritage to make urban space and landscape, or to form the city image
- **Real estate value:** The architectural heritages' ability to provide suitable interior or exterior spaces for specific social activities

## **ASSESSMENT SYSTEM OF MODERN ARCHITECTURAL HERITAGE**

**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:

- Integrity and representativeness
- Comparability and operability
- Scientificity and systematicness
- Openness and scalability
- Qualitative and quantitative methods

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

- Establish a hierarchy model of modern architectural heritage values
- Apply Delphi Method to design the questionnaire "The importance of indicators in the value assessment of modern architectural heritages"
- 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
- Based on the result of step 3, a matrix of pairwise comparison ratio can be constructed as follows

<sup>1</sup>ICOMOS (International Council On Monuments and Sites) is a non-governmental international organization dedicated to the conservation of the world's monuments and sites

Table 1: AHP comparison ratio scales

Scale	Meaning
1	i-factor has the importance equal to j-factor
3	i-factor is slightly more important than j-factor (reciprocal otherwise)
5	i-factor is obviously more important than j-factor (reciprocal otherwise)
7	i-factor is much more important than j-factor (reciprocal otherwise)
9	i-factor is absolutely more important than j-factor and j-factor might be ignored (reciprocal otherwise)

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

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.

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

Pick the largest eigenvalue of judgment matrix normalized eigenvectors:

$$\{w_1, w_2, \dots, w_n\} \sum_{i=1}^n w_i = 1$$

as evaluation index  $w_i$  weights. Wherein 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:

$$CR = \frac{CI}{RI} < 0.1$$

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 values are shown in Table 2:

Table 2: Numerical random consistency index value

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

- Revise the weights from AHP with the Entropy method

The basic steps of Entropy method are described below:

- The original data of the matrix are normalized to be

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

- Calculate the proportion of the indicators  $r_{ij}$

$$H_{ij} = \frac{r_{ij}}{\sum_{j=1}^n r_{ij}} \quad (4)$$

- 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)

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

- Calculate the entropy weights of indicators:

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

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

**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 (Li, 2006; Sousa *et al.*, 2011; Zheng *et al.*, 2011; Jin, 2012).

### INDICATORS' WEIGHTS IN THE VALUE ASSESSMENT

The questionnaire of Indicators' importance:

- **The principles of selecting the questionnaire respondents**

**Table 3: Hierarchy model of the evaluation system of modern architectural heritage**

First level	Second level
<b>Basic values</b>	
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
<b>Other values</b>	
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
Environmental 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 Applicability after rebuilding/reconstruction

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

Comparison ratio of each respondent	I <sub>1</sub>	I <sub>2</sub>	I <sub>3</sub>	I <sub>4</sub>	I <sub>5</sub>	I <sub>6</sub>	I <sub>7</sub>	I <sub>8</sub>	I <sub>9</sub>	I <sub>10</sub>	Total ratio of pairwise indicators
a <sub>12</sub>	1	1	5	7	7	9	1	1	5	3	4
a <sub>14</sub>	1	7	3	1	5	1	1/5	3	3	5	15/7
a <sub>15</sub>	1/9	1/9	7	5	3	1/5	1/5	3	5	7	1
a <sub>16</sub>	9	9	1/7	5	9	5	5	5	3	9	15/4
a <sub>23</sub>	1/7	1/9	1/5	1	1/7	1/7	1/5	1	1/5	1/3	1/5
a <sub>25</sub>	1	7	3	1/5	1/5	1	5	7	1/3	5	8/5
a <sub>26</sub>	1	1/5	3	1	5	3	1/5	7	1/5	7	15/11
a <sub>34</sub>	7	7	5	5	3	1	5	3	3	3	21/5
a <sub>35</sub>	9	9	5	5	3	5	5	1	5	5	26/5
a <sub>36</sub>	9	9	3	5	9	3	5	3	3	7	28/5
a <sub>45</sub>	1/5	1/5	1	1	1	1/3	5	1	1	3	4/5
a <sub>46</sub>	5	5	5	5	9	5	5	3	1/3	5	25/6
a <sub>56</sub>	1	1	5	1	9	5	5	3	1	3	17/5

- 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
- In addition, considering the cost and efficiency of the questionnaire, the number of the respondents has been limited to 10
- **Design of the questionnaires**
  - The 7 questionnaires used in this study have been omitted due to limited space
  - 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<sub>1</sub>~I<sub>10</sub>" are the comparison ratios given by 10 respondents; while "Total ratio of pair wise indicators" are the ratios of total numerators divided by total denominators in each row

**RESULTS AND DISCUSSION**

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 Fig. 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 of modern architectural heritage value assessment

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 After rebuilding reconstruction	0.0100
In total	1.0000

■ Historical value: 0.2469    ■ Emotional/cultural value: 0.117  
■ Scientific value: 0.2469    ■ Environmental value: 0.1197  
■ Artistic value: 0.3773    ■ Real estate value: 0.0492

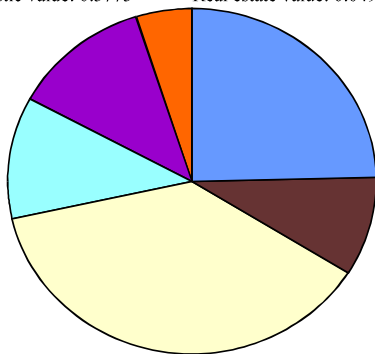


Fig. 1: Weights of first-level indicators of modern architectural heritage value assessment

**CONCLUSION**

The following conclusions can be drawn from the calculation results listed in Fig. 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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