Research on the Innovative Design of Contemporary Chinese Architecture Based on Analytic Hierarchy Process (AHP)

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Abstract

Architectural design is a process of keeping pace with the times. People’s understanding and aesthetic tendency in different periods are also different. The concept of modern architecture has been developed in China for a hundred years. No matter in which period, there have always been outstanding architects and their contemporary architecture to meet the aesthetics of the times. After reform and opening up, there has been drastic changes in understanding of aesthetics, which also leads to research on the new architectural design. As an inalienable part of the history of human civilization, China has 5,000 years history of civilization and boosts brilliant achievements. At present, it has become an important trend to integrate contemporary architectural design with traditional cultural elements. In this way, traditional Chinese culture is inherited and improved and people’s aesthetic needs are satisfied at the same time. In return, contemporary Chinese architecture design has been enhanced. Therefore, this study first puts forward the evaluation index of Chinese contemporary architectural design, discusses the ethos contained in traditional Chinese architecture, analyzes the application of traditional cultural elements in them, and serves as a reference for the innovative design of Chinese contemporary architecture.

Keywords: Traditional Culture, Contemporary Architecture, Architectural Design.

1. LITERATURE REVIEW

1.1 Research background

With the continuous development of information technology and economic globalization, cooperation among countries has become intense. Meanwhile, there have been exchanges and interactions between cultures. In the field of architecture, the interaction of different cultures is obvious since more and more buildings with exotic styles have built in China. Although they lead to the diversification of Chinese culture, the traditional elements of architectural culture in China has been impacted. People cannot explore the cultural connotation in many avant-garde buildings, which also leads to a vicious circle of China’s contemporary architectural design. Chinese culture enjoys a time-honored history which covers a wide range of contents and has always been the key aspect of research in the field of architecture in China. Under different research directions and backgrounds, it is possible to gain different insights in the study of Chinese traditional culture. With the research and study of traditional architectural elements by architects from generation to generation, China has accumulated solid theoretical foundations in the field of architectural design. The combination of traditional culture and modern architectural design can not only effectively enhance the architectural design in our country, but also promote the inheritance and development of traditional culture, which is of great practical significance.

1.2 Literature review

China’s traditional architecture mainly consists of three parts: concrete form, artistic conception and internal spirit. Among them, material form indicates the rational use of color, building materials, architectural design elements, layout and so on, so as to make the design of contemporary architecture similar to the traditional ones in appearance and meet people’s aesthetic needs. Artistic conception requires that spatial layouts of contemporary architecture should be designed by learning traditional culture and traditional architectural rules in order to improve the space quality of buildings and reflect our traditional culture. Internal spirit means that modern architectural design should not be limited to the concrete forms of traditional architecture but shows culture ideology and enriches the cultural connotation so as to enhance contemporary Chinese architecture design (Liu, 2015). After the founding of New China, many architectural design cultures have been absorbed.
For example, architectural design was integrated with national architectural elements at the very beginning. After that, we learned from the Soviet and later was influenced by postmodernism which resulted in many buildings with distinct postmodernist colors. These buildings had once prospered but most of them have disappeared nowadays. However, the study of national architectural elements is a key area of our research. According to the research and efforts of several generations of architects, it is found that most national architectural elements are not suitable for modern architecture. The utilization of traditional national architectural elements without consideration will impede modern architectural design. On the other hand, it also leads to indifference of the study of national architecture (Chen and Sui, 2015).

2. RESEARCH ON THE QUALITY EVALUATION OF CHINESE CONTEMPORARY ARCHITECTURAL DESIGN

2.1 Determine the weight of quality evaluation index of Chinese contemporary architectural design with the use of AHP

AHP is a common way to determine the weight of indicators, the core of which is to establish an index evaluation model. Through the comparison of different influencing factors, the weights of different influencing factors are determined. The influencing factors with the highest weights are the main factors affecting the quality of contemporary Chinese architectural design. AHP is used to determine the quality evaluation indicator weight of Chinese contemporary architectural design (Lin, 2016) with the following steps:

First of all, establish proportional scale. The schematic diagram of proportional scale of AHP through the comparison between main influencing indicators is shown in Table 1:

<table>
<thead>
<tr>
<th>Scale</th>
<th>Importance</th>
<th>Explain</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Equally important</td>
<td>The two are equally important</td>
</tr>
<tr>
<td>3</td>
<td>Slightly important</td>
<td>One is a little more important than the other</td>
</tr>
<tr>
<td>5</td>
<td>Obviously important</td>
<td>One is obviously more important than the other</td>
</tr>
<tr>
<td>7</td>
<td>Strongly important</td>
<td>One is more important than the other</td>
</tr>
<tr>
<td>9</td>
<td>Absolutely important</td>
<td>One is more important than the other</td>
</tr>
<tr>
<td>2, 4, 6, 8</td>
<td>Intermediate value</td>
<td>Between the two scales</td>
</tr>
</tbody>
</table>

Secondly, construct a judgment matrix. A judgment matrix through classification and comparison of different influencing indicators is established as follows:

\[
[A] = \begin{bmatrix}
    a_{11} & a_{12} & \cdots & a_{1n} \\
    a_{21} & a_{22} & \cdots & a_{2n} \\
    \vdots & \vdots & \ddots & \vdots \\
    a_{n1} & a_{n2} & \cdots & a_{nn}
\end{bmatrix} = \begin{bmatrix}
    \frac{a_1}{a_{11}} & \frac{a_1}{a_{12}} & \cdots & \frac{a_1}{a_{1n}} \\
    \frac{a_2}{a_{21}} & \frac{a_2}{a_{22}} & \cdots & \frac{a_2}{a_{2n}} \\
    \vdots & \vdots & \ddots & \vdots \\
    \frac{a_n}{a_{n1}} & \frac{a_n}{a_{n2}} & \cdots & \frac{a_n}{a_{nn}}
\end{bmatrix}
\]

(1)

This judgment matrix should meet the condition that (1) \( a_{ij} = 1 \) (2) \( a = \frac{1}{a_{ij}} \) (i, j = 1, 2, 3, ..., n).

Finally, the weight coefficient will be obtained through standardized calculation of the matrix.

After that, the consistency of quality evaluation matrices of Chinese contemporary architecture design should be checked: bring the mutual comparison of each indicator into the matrix, calculate the highest feature vector and test the consistency. If the consistency test is successful, it is proved that the vector is a weight vector. Otherwise, reconstruct the matrix and conduct comparison again. Suppose the highest eigen value is \( \lambda_{max} \), then its formula is \( CR = \frac{\lambda_{max/n}-1}{n-1} \). CR represents consistency ratio while CI represents coincidence indicator. The formula is:

\[
CR = \frac{\lambda_{max/n}-1}{n-1}, \quad \lambda_{max} = \frac{1}{n} \sum (Aw)_j / w_j
\]

(2)

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Then the consistency test of the matrix is conducted. $\lambda$ is obtained and brought into the next formula:

$$CI = \frac{i-n}{n-1}$$

Then CI is brought into the formula $CR = \frac{CI}{CR}$. In $CI = \frac{(i_{\text{max}} - n)}{(n-1)}$, $n$ represents the order of the formula. RI represents the average random consistency indicator (He, 2017). The values of RI are shown in Table 2.

<table>
<thead>
<tr>
<th>Order number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>RI</td>
<td>0.00</td>
<td>0.00</td>
<td>0.58</td>
<td>0.90</td>
<td>1.12</td>
<td>1.24</td>
<td>1.32</td>
<td>1.41</td>
<td>1.45</td>
<td>1.49</td>
<td>1.52</td>
<td>1.54</td>
</tr>
</tbody>
</table>

The results obtained can be divided into two different situations. When $CR<0.1$, it can be proved that the matrix is consistent with the quality evaluation index of contemporary Chinese architectural design and the weights obtained have great affects. If $CR<0.1$, adjust the matrix until the two are consistent (Li, 2017).

2.2 Extension superiority evaluation method of Chinese contemporary architectural design

The design quality of Chinese contemporary architecture is affected by many factors, where many factors cannot be quantified. It is difficult to judge the design quality of Chinese contemporary architecture through traditional calculation and analysis. The extension superiority evaluation method is a scientific evaluation method which can quantify abstract indicators. This method can effectively specify the quality evaluation index of Chinese contemporary architectural design. The steps of extension superiority evaluation method are as follows:

First of all, determine the measurement indicators and matter-elements to be evaluated of Chinese contemporary architecture. The basic logic of extension theory is the triple relationship between affair element, matter-element and relation-element. The analysis also contains these three elements represented as $R=(N,c,v)$. This evaluation method can subjectively reflect the intrinsic relationship between quality and quantity, and analyze the changing process of the index as well.

The measurement conditions are in the set $M=(m_1, m_2, ..., m_n), M_i=(c_i, V_i)$ represents the characteristic element while $V_i$ represents the field values ($i=1, 2, ..., n$) after quantified. The object $N$ and the data or result related to $N$ can be expressed in the form of matter-element as follows:

$$\begin{pmatrix} n C_1 v_1 \\ C_2 v_2 \\ M M \\ C_n v_n \end{pmatrix}$$

This matter-element is also the matter-element to be evaluated of $N$. $N$ represents a matter-element in Chinese contemporary architectural design quality while $V_i$ represents the magnitude of $N$, that is, the actual data obtained through the investigation of $N$. After collecting all the indicators of contemporary Chinese architecture, the weight coefficient of each indicator is determined. The formula is as follows:

$$a = (a_1, a_2, ..., a_n), \sum_{i=1}^{n} a_i = 1$$

$a_i$ represents the weight coefficient of $C_i$. Then the preference value should be set. It is assumed that $X=(A, B), M \in (a, b)$, then $k(x) = \frac{b-x}{b-a}$. The function $K(x)$ means the correlation function of $x$ in $X=(a, b), M \in X$. It is assumed that the correlation function of the object $N_i$ on $M_j$ is $k_i(N_j)$, then it is proved that the correlation function of $N_i, N_2, ..., N_m$ on $M_i$ is $K_i=[k_i(N_j), k_i(N_2), ..., k_i(N_m)]$ when $i=1, 2, ..., n$.

After the normalization calculation, the formula is:

$$k_{ij} = \frac{k_i(N_j)}{\max K_i(x)}, (i = 1, 2, ..., m)$$
After the analysis of the formula, the value of $N_j$ after the normalization calculation of $M_i$ is $k_i = (k_{ij_1}, k_{ij_2}, ..., k_{ij_6})$, $(i=1, 2, ..., n)$.

Finally, the preference value should be calculated. The normalized degree of $N_j$ under different conditions $M_1, M_2, ..., M_n$ is as follows:

$$K(N_j) = \left( \frac{k_{j1}}{k_{j1}}, \frac{k_{j2}}{k_{j2}}, ..., \frac{k_{jm}}{k_{jm}} \right) (j = 1, 2, ..., m) \quad (7)$$

The preference value of $N_j$ is:

$$C(N_j) = aK(N_j) = (a_1, a_2, L, a_n) \left( \frac{k_{j1}}{k_{j1}}, \frac{k_{j2}}{k_{j2}}, ..., \frac{k_{jm}}{k_{jm}} \right) (j = 1, 2, ..., m) \quad (8)$$

The result of comparison between different objects is:

$$C(N_0) = max\{C(N_j)\} (j \in 1, 2, ..., m) \quad (9)$$

According to the analysis and calculation of the above formulas, it can be proved that $N_0$ is the best (Huang and Wei, 2012).

3. TRADITIONAL CHINESE ARCHITECTURAL FORMS

3.1 Traditional Chinese cultural spirit in traditional Chinese architecture

3.1.1 Cultural spirit in traditional Chinese architecture

Tradition refers to the cultural spirit with conventional characteristics under the influence of many subjective or objective factors such as culture, ideology and social system in the continuous development of history. Tradition contains all the material and non-material culture, which is inherited by people. Its internal logic is clear. Traditions will be different in various regions and nationalities. Traditional architecture is an important part of traditional culture, which directly reflects the various spirits contained in traditional culture. Traditional architecture shows some differences in different periods. This also shows that the traditional architecture is essentially the traditional old architectural design culture combined with the current aesthetics under the social situation at that time. Moreover, architectural design is influenced by factors such as geography, climate and so on, which are not under unified planning (Gao, 2012).

3.1.2 Cultural spirit in contemporary architecture

Traditional architecture is preserved by ancestors as historical and cultural treasure with rich cultural connotation. Many traditional buildings are designed to meet the needs of people’s life and be more functional. These buildings cannot adapt to the contemporary society. However, the architectural elements contained in them can be extracted to improve contemporary architecture in China. It mainly contains two features:

The first is the easy-to-identify feature. The forms of traditional Chinese buildings vary and have some features. The inheritance of architectural design culture is characterized with stability so that the inherited elements must be easy to study and remember. Therefore, the traditional cultural elements in architecture must be easy to identify (Liu et al., 2012). Traditional architectural elements in contemporary architecture should consist of several symbols as shown in Table 3:
<table>
<thead>
<tr>
<th>Different architectural forms</th>
<th>Wu</th>
<th>Xie Shan</th>
<th>Rolling tarpaulin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hanging Hill</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hard mountain</td>
<td></td>
<td></td>
<td>Paul top</td>
</tr>
<tr>
<td>Eaves</td>
<td></td>
<td>skull</td>
<td>Illicium verum</td>
</tr>
<tr>
<td>Single slope</td>
<td></td>
<td>Round tip</td>
<td>Hot wall</td>
</tr>
</tbody>
</table>

**Figure 1.** Different Forms of Traditional Building Roofs

Secondly, it is practical. No matter which form buildings apply, its most central role is to be used by people. Heritage inherited to modernity is a tradition, but if the building has only historical significance and but no use value, it can only appear in the exhibition. However, contemporary architectural design does not need buildings as exhibits. Therefore, in architectural design, the practicality of buildings should be highlighted. Traditional Chinese Courtyard House, mostly located in Beijing, is an important form of traditional architecture in China. Its architectural style perfectly inherits the elements of traditional Chinese culture and has its practical functions (Chen and Dong, 2014). The specific form is shown in Figure 2:
However, in today’s society, the form of Traditional Courtyard House occupies a large area but accommodates a relatively small population. Although it has unique aesthetic and application characteristics, reform is necessary so as to meet the needs of the contemporary society (Sun, 2016). Residential community is different from traditional Chinese Courtyard House as shown in Figure 3:

Residential communities generally cover a larger area but the buildings inside are high-rise so that within a very small-scale district, dozens of residents live together through spatial dislocation so as to meet people’s living needs. At the same time, upscale residential communities also have artificial hills, pools and greens, which effectively raise people’s living standards. This also shows that although traditional architecture has its aesthetic superiority and rich traditional cultural connotation, reforms to solve its shortcomings is needed so that the contemporary architectural design can be improved (Qi, 2016).

4. APPLICATION OF TRADITIONAL CULTURAL SPIRIT IN CONTEMPORARY ARCHITECTURAL DESIGN IN CHINA

4.1 Inheritance of architectural forms

Form refers to a series of extrinsic factors such as building colors, building materials and building forms. The form of buildings can amuse people visually. The design quality of forms reflects the design quality of buildings. Traditional architecture is an important source of inspiration for contemporary architectural design. Many forms in traditional buildings can be applied to contemporary architectural design with outstanding results. In the very beginning, architectural design combined with the traditional cultural spirit was mainly piling of traditional
architectural elements focusing on traditional eave without appropriate function. However, windows and doors used in many traditional buildings still have important implications in architectural design (Hou, 2015).

Figure 4 is the exterior of Nantong Abacus Museum, where there are traditional architectural elements including eave, classical doors and windows as well as abacus, reflecting the characters and excellent design of Nantong Abacus Museum.

4.2 Inheritance of colors

In ancient Chinese culture, there are five elements namely “gold, wood, water, fire and soil” where each color represents a direction and a specific meaning. For example, palaces are usually in red and yellow while garden buildings are mostly elegant black and white. The integration of color into the contemporary architectural design effectively improves the design quality (Liu et al., 2011).

4.3 Inheritance of traditional ideologies

China’s contemporary architectural design integrates with traditional culture, showing rich cultural connotation. Many elements in Chinese culture can be used in architectural design, for example, the harmony between man and nature as well as following the nature in Daoism. The ancients consider the heaven round and the earth square. Although this idea was proved to be wrong after the great development of astronomy, the philosophical thought about moisture shows the idea of harmony between man and nature. In architectural design, it is considered that architecture is also a part of nature. Therefore, architectural design should strive to be close to nature and has a high correlation with the style of the surrounding environment so as to avoid the incongruity between them (Li and Tian, 2017).

REFERENCES