The Analysis of Architecture Design Elements of Jiangnan Traditional Residence Based on AHP

Xingkai Gu*  

1 Suzhou Art & Technology Institute, Suzhou, 215000, China  
*guxk@sgmart.edu.cn

Abstract: The elements of architectural design of Jiangnan traditional residence are the characteristic form elements of traditional architectural style reflected in the traditional dwellings in the south of the Yangtze River, including the overall structure, characteristic components, material form and spatial style. This paper summarizes the meanings, principles and methods of the evaluation of the design elements of Jiangnan traditional residence. On this basis, the paper constructs the design elements index system of Jiangnan traditional residential buildings, which includes 4 criteria layers and 16 scheme layers. According to the analytic hierarchy process (AHP), the weight of each scheme layer is assigned, and a complete index system of Jiangnan traditional residence design elements is constructed to guide and reference the future architectural design practice and the traditional style shaping of Jiangnan area.

1. Introduction
Jiangnan is a typical area with the water village style located in the south of the Yangtze River. It has been famous for its beautiful scenery and outstanding people since ancient times. Traditional dwellings in the south of the Yangtze River are a kind of architectural type with a large number, a long history and the most widely distributed, and also a shelter for human survival. All kinds of architectural decoration in these dwellings are attached to the buildings, giving them unique personality. If the traditional folk houses in the south of the Yangtze River are a beautiful picture, then these architectural decorations are gorgeous colours, which make the picture more vivid. As an important place for people's daily life, folk houses not only pay attention to the enjoyment of visual beauty, but also pay attention to practicality and atmosphere. Therefore, natural materials are the important material basis for the architectural decoration of traditional dwellings in Jiangnan. In the process of continuous design and manufacturing, people fully understand the characteristics of materials, and inherit a variety of processing skills. The main materials of these building decoration are wood, brick and stone, and they are all local materials. Architectural decoration is rich and diverse, which can be seen everywhere on the doors, beams, windows and roofs of the houses. This excellent Jiangnan traditional residence decoration is not only an art form to meet people's pursuit of beauty, but also a materialized form of traditional culture, reflecting the historical heritage and architectural structure concept of Jiangnan area. But with the acceleration of urban renewal, many traditional houses have been destroyed. Modern architectural design should not blindly abandon these precious treasures, but should integrate these architectural elements into modern architecture in an appropriate way, bringing enlightenment to contemporary architectural design and inheriting these arts at the same time. This paper aims to establish the design elements system of Jiangnan traditional residence based on AHP to clearly evaluate the characteristics of Jiangnan traditional residence.
2. Meaning, principles and methods of construction of the index system of architecture design elements of Jiangnan traditional residence

2.1 Meaning
From the perspective of architectural style, this paper studies and analyses the architectural design of Jiangnan traditional dwellings. Based on the full analysis of the basic characteristics of Jiangnan dwellings and the demand of landscape environment, it points out the problems existing in the current architectural design of Jiangnan traditional dwellings, and summarizes the influencing factors suitable for Huizhou style transformation design. People's evaluation of New Jiangnan architecture mainly comes from whether its appearance can reflect the characteristics of traditional architectural form. Among the various characteristic form elements reflecting the traditional architectural style, different elements do not reflect the traditional style in the view of building users. The selection of traditional elements by architects is not blindly copying and concentrating on each element, but often choosing one or more elements as the motif to form a new architectural form through abstraction, repetition, superposition, fission and deconstruction. Therefore, the reflection of the motif itself to the traditional style determines the reflection of the New Jiangnan architecture to the traditional style. Most of the previous studies focused on the exploration of the design elements of the traditional construction in the south of the Yangtze River. In the appearance design of Jiangnan architecture, the research conclusion of this paper also has reference value for similar types of community transformation.

2.2 Principles
It is also a complex work to construct the design elements index system of traditional residence in the south of the Yangtze River. This complexity is mainly reflected in the complexity of Jiangnan traditional dwellings. The object system of comprehensive evaluation comes from the engineering practice and management practice in the fields of economy, society, science and technology and education. It may be a small system, a complex system or a complex giant system. Generally speaking, the complexity of the evaluation work and the complexity of the object system maintain a strong correlation, but whether it is a small system, a complex system or a complex giant system, the system itself is a complex and dynamic whole. Many evaluation problems in economic and social management are multi-objective decision-making or group decision-making problems. How to balance and synthesize the opinions of multi-objective or multi-agent is also a complex problem in the construction of index system. Therefore, the selection of design elements of traditional residence in South China must follow certain principles.

The principle of completeness. The principle of completeness is the description and depiction of a certain feature of the object system, and the evaluation index set should be able to comprehensively reflect the overall performance and characteristics of the traditional residence system in Jiangnan, and comprehensively measure the attributes of the object system from multiple dimensions and levels. Of course, this completeness does not require that the evaluation index system can completely express all the characteristics of the object system. Usually, the evaluation index system is only required to express the main characteristics and main information of Jiangnan traditional residence.

The principle of independence. Independence requires that each index should have a clear connotation and be independent of each other as far as possible. The indexes of the same level should not overlap, cross, cause and effect, and contradict each other as far as possible, so as to ensure the independence of traditional residence in the south of the Yangtze River. For the multi-level comprehensive evaluation index system of Jiangnan traditional residence, it should be based on the category and hierarchy of the index. In order to keep the independence of traditional residence in the south of the Yangtze River, mutual feedback and interdependence should be avoided between the index set and the index set, and among the traditional residence in the south of the Yangtze River.

The principle of significance. In the design process of the evaluation index system, it is not that the more the number of indicators, the better, the more the number of indicators. On the one hand, the higher the cost of evaluation data acquisition and information integration, on the other hand, it is also likely to lead to data redundancy. In general, in the comprehensive index system, the main key indicators should
be retained and the secondary non-key indicators should be eliminated. The main basis to determine whether an indicator is critical is its contribution to the overall evaluation. The greater the contribution, the stronger the significance of the indicator, which can be a key indicator; on the contrary, the lower the significance, which may be a non-key indicator.

The principle of hierarchy. The traditional residence in Jiangnan can be divided into several subsystems. Therefore, the index system should be divided into corresponding levels according to the needs of measurement purposes and the different functions of indicators, and have a clear corresponding relationship. The indicators should be integrated upward and specific downward. This study divides the development index system of Jiangnan traditional residence into three levels: the first level is the target level; the second level is the comprehensive index level; the third level is the composite index level.

2.3 Methods
In this paper, frequency analysis method and expert consultation method are used to determine the index system. First of all, we investigate the frequency of the design elements of Jiangnan traditional dwellings in various references, and arrange them from high to low. Then through expert consultation to adjust the indicators, the final standard system. According to the above principles and methods, the index system of architectural design elements of Jiangnan traditional dwellings established in this paper is shown in the figure. According to the results of expert research, we selected and established a set of university accounting information disclosure indexes shown in Figure 1.

Figure 1. Index system of architecture design elements of Jiangnan traditional residence
3. Construction of index system of architecture design elements of Jiangnan traditional residence

3.1 Overall structure
In terms of overall structure, the traditional dwellings in the south of the Yangtze River include not only tall residence of Hui style, but also ordinary dwellings in the south of the Yangtze River. The general layout of the courtyard in Jiangnan is similar to that of the quadrangle in the north, except that the layout is compact and the courtyard covers a small area, so as to adapt to the characteristics of high population density and less farmland. The front door of the residence is mostly opened on the central axis. The main room is the hall facing the house, and the two-story building is often built in the back yard. Among the folk houses in the south of the Yangtze River, Huizhou residents have their own characteristics. Conforming to the nature, making use of the nature and decorating the nature are the unique features of the overall layout. The houses are close to the mountains and rivers, the streams pass through the villages, the open corridors built by the residents on both sides of the river, the flying chairs set along the stream, and various stone or wooden bridges connecting the two sides, all of which are full of poetic and picturesque. There is also a kind of building form of Jiangnan folk houses, which is a two-story brick and wood structure. Usually, there is a room for each household, and a long lane will be opened by about ten households. This is due to the dense river network, prosperous and crowded towns in the south of the Yangtze River, and the lack of spacious homesteads. Therefore, there is no fixed pattern in the architectural layout and the direction of the streets. According to the size and terrain of the base, the residence are arranged flexibly, and the ventilation, lighting and room orientation are solved by installing patios. Streets and lanes often extend with the trend of the river. After meeting the conditions for people to pass through, they do not pursue the broad style of the streets, but zigzag along the terrain from time to time, forming a completely different architectural structure from the northern dwellings.

3.2 Characteristic component
On the premise of ensuring the structural function, structural decoration carries out appropriate process treatment on the building component body, which has the characteristics of stylization, organic, suitability and integrity. Therefore, the structural decoration of traditional dwellings in the south of the Yangtze River is mainly located in the components used for bearing and connecting. And these components are directly exposed, so they have a certain decorative beauty. In order to pursue further formal beauty, people will also add decoration on it. The large wooden works in Jiangnan folk houses determine the appearance and size of buildings, and imply the spirit of seeking beauty and truth. Therefore, the structural decoration is natural and simple, and the artistic treatment according to the material characteristics will not damage the function of the components. The hanging and falling of folk houses usually do not have complicated patterns. The shape of the pillars is simple and neat. They can only be carved on the main beams, and the joints of the structure are decorated with some exquisite small wood carvings. In these buildings, the carving of beams and columns is mainly plain carving, which is relatively elegant. Therefore, the vernacular dwellings in the south of the Yangtze River are different from many buildings in the north, which are more magnificent and elegant, and can reflect the literati atmosphere in the south of the Yangtze River. The large components of Jiangnan folk houses have their own unique appearance after some special treatment, such as moon beam, bucket arch and so on. Then they are supported by beams and columns and combined by mortise and structure. The overall housing frame skilfully shows the beauty of the structure itself. In order not to affect the function, the load-bearing part usually does not have too much decoration craft, at most only adds some succinct and bright line carving. Pure decorative carving will also adjust the carving process according to the function of the components. The components of Jiangnan dwellings are simple and honest, and the details of connection are exquisite. These structural decorations pay attention to the combination of components. By combining the texture of materials and the special shape of components, people can feel the aesthetic feeling contained in them, and echo the concise and atmospheric structural style of Jiangnan residence.
3.3 Material form
Material is the carrier of colour, different colours and colour matching can bring people different psychological hints and experience, so the full and reasonable use of the colour of building materials is the best reflection of the local humanities and art. The main colours of the overall layout of Huizhou ancient residence are black, white and gray. The materials are mostly local materials, mainly stone and wood. The primary colours of the materials are adopted, and the colour, pattern and texture of the materials are paid attention to, so as to learn from nature and integrate the buildings with the surrounding environment. Wood is the most used in the overall architecture of Hui style, which can give people a warm and comfortable feeling. At the same time, different kinds of wood will send out unique fragrance with time and environment changes, refreshing people's heart, making residents more close to nature. Although the hardness of stone gives people a cold feeling, it can reflect its strong and deep emotion. Some stone materials have passed in the light of light, will project a sense of solemnity, highlighting a solemn; green brick and green tile have not been polished as smooth as stone, they present a kind of classical and simple feeling. Through repetition, superposition and combination, and with the continuous replacement of history and external environment, these building materials constantly produce new visual and texture feelings, enriching the artistic characteristics of Hui style residence. The climate of Huizhou is suitable for the growth of trees, and the local pine wood land is excellent, which provides a continuous supply of raw materials for Huizhou residence. In Huizhou residence, the choice of wood should be strictly based on its own texture and size. For example, the grain of Chinese fir is straight and not easy to bend, which is commonly used in the construction of large wood members; while for beams, Fang and other components that are easy to bend, pine with better bending resistance is the majority, and the materials are processed through specific process methods; small wood parts are mostly used for doors and windows, which are light and not easy to deform.

3.4 Spatial Style
The basic layout of the traditional buildings in the south of the Yangtze River is mostly an introverted and closed square inner courtyard, surrounded by important elements such as wing rooms, patio and main hall. The plane form of Hui style architecture has certain characteristics, among which the common one is three Bay. Along the depth direction of the building, there are three parts: entrance space, patio and main hall. The two sides of the main hall are wing rooms. All these constitute the basic plane form of Huizhou architecture. Among them, there are layers, veranda space, garden space and water environment. The traditional architecture in the south of the Yangtze River takes into account the characteristics of the architecture and the geographical environment. The plane of Huizhou architecture is generally obtained through certain deformation on the basis of the above, and the common layout of various architectural functional spaces is centered on the patio. There are two common ways of layout with patio as the centre, one is the surrounding layout with patio as the centre. Another common layout is that the whole building is arranged along the longitudinal direction, entering from the main entrance of the building, first passing through the inverted space, then the square courtyard space, and then the main hall. The whole building space is arranged along the longitudinal axis, with obvious axis relationship. Although there is a strong axis control layout, the building is still around the courtyard from the plane. The courtyard is surrounded by inverted seats, corridors or wing rooms on both sides, and the main hall at the back. The falling horse head wall is high and tilted, the wall is uniformly decorated with white, and the roof is covered with blue grey tiles, which together build the simple and elegant plastic art style of Huizhou architecture. The blue grey tiles and white walls, in the sun is particularly prominent contrast, but also very unified and harmonious, and then into the gorgeous natural environment around the building colour to achieve a natural visual art effect.
4. Analysis of architecture design elements of Jiangnan traditional residence based on AHP

4.1 Concept of AHP

T. L. Saaty, an American operational research scientist, put forward the analytic hierarchy process (AHP) in the mid-1970s. It is a multi-objective decision-making analysis method which is good at organizing and hierarchical complex problems. AHP combines qualitative analysis with quantitative analysis, uses the experience of decision-makers to judge the relative importance between the standards of whether each index can be achieved, and reasonably assigns values to each index element, and uses the assignment data to calculate the priority order of each scheme, which can be effectively applied to the problems that are difficult to be solved by quantitative analysis. The basic idea of AHP is to take the research object as a system and divide it into different hierarchies according to the order of objective layer, criterion layer and scheme layer. According to the subjective judgment of certain objective reality, the index elements listed in the structural model are quantitatively described layer by layer through the way of “pairwise comparison of importance”. Using the method of calculating the eigenvector of judgment matrix, the relative weight value of each index element at each level is obtained to obtain the ranking result of the importance of each index level to the overall goal. Starting from the second layer of the hierarchical structure model, for the elements of the same layer belonging to each index element of the upper layer, the judgment matrix is constructed by using the paired comparison method to evaluate the importance of the relevant elements in the layer relative to a certain element in the upper layer. The purpose of single level sorting is to determine the weight value of the importance order of each element in the upper level. The practical operation process can be reduced to the problem of calculating the eigenvalues and eigenvectors of the judgment matrix. In this paper, the relative weight is calculated by AHP and Yaahp software. Finally, the consistency was tested.

4.2 Results

After we establish the hierarchical structure, the subordinate relationship between the upper and lower elements has been determined. In the evaluation of the importance of this subject, the top layer is the function of each element to the appearance of Jiangnan architecture shows the traditional style; the middle layer is the main type of the appearance design elements of Jiangnan architecture, namely B1 overall form structural elements, B2 characteristic component form elements, B3 material characteristic form elements, B4 The lowest layer is the specific type of the feature form elements contained in the middle layer, and the specific elements are (C1, C2, C3 ...., C16). The upper, middle and lower levels together form the AHP evaluation hierarchy model. Compare the elements in each level of the established hierarchical structure model, make a scoring questionnaire, invite relevant professionals to score, construct a judgment matrix according to the scoring results, and establish a basic database. The specific step is to determine the judgment matrix by comparing the criteria at the same level with a criterion at the upper level. In the comparison, the expert scoring method of 1-9 scale score is used to compare and score the indicators of each level in the hierarchical structure model, and the corresponding judgment matrix is constructed respectively. The judgment matrix results obtained by pairwise comparison of indicators of each level. We take the scoring results of relevant professionals into the AHP evaluation software Yaahp for data integration calculation. Each judgment matrix passed the consistency test. Analytic hierarchy process can measure the proportion of each index in the performance evaluation. The results are shown in Table 1:

| Table 1. Results of indexes in rule level and scheme level |
|-----------------------------------------------------------|
| **Level** | **B1** | **B2** | **B3** | **B4** | **Weight** |
|----------|-------|-------|-------|-------|-----------|
| **Weight** | 0.263 | 0.368 | 0.225 | 0.144 |
| C1 | 0.275 | | | |
| C2 | 0.725 | | | |
| C3 | | 0.138 | | |
| C4 | | | 0.213 | |
| | | | | 0.072 |
| | | | | 0.191 |
| | | | | 0.051 |
| | | | | 0.078 |
C5 | 0.223 | 0.082
C6 | 0.227 | 0.084
C7 | 0.106 | 0.039
C8 | 0.093 | 0.034
C9 | 0.336 | 0.076
C10 | 0.278 | 0.063
C11 | 0.167 | 0.038
C12 | 0.219 | 0.049
C13 | 0.126 | 0.018
C14 | 0.573 | 0.083
C15 | 0.211 | 0.030
C16 | 0.090 | 0.013

5. Conclusions
According to the concept and connotation of Jiangnan traditional residence, this paper designs a set of index system of Jiangnan traditional residence design elements based on AHP. This paper expounds the principles and methods of the index system construction, and draws the index system structure diagram. We decompose the target layer of Jiangnan traditional residence design elements into 4 criteria layers and 16 scheme layers, and explain and explain the scheme layer. In this paper, AHP is used to determine the weight of each index layer and scheme layer. Among them, the element of C2, C6 and C16 has a higher effect on “Jiangnan architecture showing traditional style” than other elements. We can select the above elements in the future design to inherit and develop the traditional architecture.

References
[1] Brunswicker S, Almirall E, Majchrzak A. Optimizing and Satisficing: The Interplay Between Platform Architecture and Producers' Design Strategies for Platform Performance[J]. MIS quarterly, 2019, 43(4):1249-1277.
[2] Jinglei S. Research on Humanization of Space in Chemical Engineering Architecture Design[J]. Modern Manufacturing Technology and Equipment, 2019(9): 76-78.
[3] Guangzong L. The Parametric Design Method in Architecture Design Practice[J]. Urbanism and Architecture, 2019, 16(6): 34-35.
[4] Girginkaya S A. Revitalization and Adaptive Re-use in Cappadocia: A Taxonomy of Creative Design Solutions for Uhissar Boutique Hotels[J]. Journal of Contemporary Urban Affairs (JCUA), 2019, 4(2):37-50.
[5] Distefano J G, Murthy A A, Hao S, et al. Topology of transition metal dichalcogenides: the case of the core–shell architecture[J]. Nanoscale, 2020, 12 (47): 23897-23919.
[6] Vacev T, Zori A, Mili M, et al. Stressed Skin Design Versus Braced Frame Design Through Efficient Numerical Modelling[J]. International Journal of Steel Structures, 2020, 20(4):1209-1229.
[7] Kksal, Tekinerdogan B. Architecture design approach for IoT-based farm management information systems[J]. Precision Agriculture, 2019, 20(4): 926-958.
[8] Majerowitz M, Allweil Y. Housing in the Neoliberal City: Large Urban Developments and the Role of Architecture[J]. Urban Planning, 2019, 4(4): 43-61.
[9] Se, Jin, Woo. A Study on the Application of AHP to Design Decision Model on Fuzzy System[J]. Journal of Korean Institute of Intelligent Systems, 2006, 16(3):309-314.
[10] Ersoy Y, Nuri Özgür Dogan. An Integrated Model of Fuzzy AHP/Fuzzy DEA for Measurement of Supplier Performance: A Case Study in Textile Sector[J]. International Journal of Supply and Operations Management, 2020, 7(1):17-38.
[11] Seth D, Hamouda A M, Sayed A Y A. Prioritisation of lean construction barriers in Qatari context: A fuzzy AHP approach[J]. International Journal of Business Excellence, 2019, 19(4): 503-510.
[12] Benslimane N, Biara R W. The urban sustainable structure of the vernacular city and its modern transformation: A case study of the popular architecture in the saharian Region[J]. Energy Procedia, 2019(157):1241-1252.
[13] Permatasari C K. Penerapan Analitical Hierarchy Process (AHP) dalam Menentukan Lokasi Pabrik Tempe[J]. Journal of Applied Science, 2020, 2(2):24-33.
[14] Sweeting B. Applying ethics to itself: recursive ethical questioning in architecture and second-order cybernetics[J]. Kybernetes, 2019, 48(4):805-815.
[15] Eddy F, Harahap M B. Post Modern Architecture Application on One Tree Hill Hotel Resort[J]. International Journal of Architecture and Urbanism, 2019, 3(2):224-231.