

## Article

# New Life in the Countryside: Conservation and Sustainability of Vernacular Architectural Facade Characteristics in the Jiangnan Region, China

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**Abstract:** The facade form of vernacular architecture is an outward manifestation of the building structure, which can easily give people an intuitive impression of the building. Most of the existing studies focus on analyzing the construction process and building materials of vernacular architecture in detail, but there are few studies on the characteristic elements in the form of architectural facades. The main objective of this study is to propose a new methodology for objectively analyzing the morphological characteristics of architectural facades with complex networks to support the sustainable development of vernacular architecture. The results of the study show that the vernacular architectural facades in the Jiangnan region are characterized by the richness of details and distinctive layers and that the formal elements that can show the regional characteristics are preserved in the process of the sustainable development of vernacular architecture. The most crucial part of this is the roof shape, followed by the simplification of the detailing and how the vertical form elements are laid out horizontally. The article addresses the protection and continuity of vernacular architectural facade characteristics and proposes a strategic plan to strengthen the vernacular architectural facade characteristics in the Jiangnan region, aiming to protect the traditional characteristics and continue the traditional culture.



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**Keywords:** Jiangnan region; vernacular architecture; architectural facade; architectural form; regional characteristics

## 1. Introduction

Environmental issues in the development of society remain an important issue, and the process of urban and rural construction in China takes an important place in the environmental issues. Local knowledge and traditional building techniques are recognized as being sustainable. As a result, the study of vernacular architecture is of growing interest in related fields of study. The architectural facade is the external manifestation of the architectural structure. The architectural facade studied in this paper mainly refers to the external surface of the building, including walls, roofs, doors, windows, columns, decorative elements, and other constituent elements. The facade form of the building is easy to be observed and perceived; people can understand the architectural style characteristics through the architectural facade form. Therefore, the architectural facade form has a direct impact on people's evaluation and feel of the architectural style [1]. The traditional vernacular facade is an important part of the architectural form. Liang Sicheng's "Qing Style Construction Rules" points out that traditional architecture is usually characterized by a three-part structure, consisting of a lower foundation, a middle wall, and an upper roof. With the development of the times and the improvement of people's living standards, the demand for architectural facades has shifted from structural to design, presenting a

more varied form of facade composition. However, in this series of changes, the irrational factors arising from blind innovation lead to the gradual loss of regional characteristics in contemporary vernacular architecture, and the cultural value contained in contemporary architecture is constantly weakening [2]. Therefore, how to inherit and perpetuate the regional characteristics contained in vernacular architectural facades is one of the focuses of contemporary vernacular architecture research [3].

Vernacular architecture in the Jiangnan region has distinctive regional characteristics; the form of the building's wooden frame structure affects the overall shape of the building, but, also, the traditional craftsmen in the construction process focus on the part, because it determines whether the building is strong and practical, so there is a "wall down the house will not collapse," as the saying goes in China. The architectural facade, on the other hand, is a complement to the traditional vernacular architectural structure with the role of enclosing and separating the internal and external spaces and is an aesthetic consideration based on the fulfillment of the solid and practicality of the building. But, for contemporary architecture, the architectural facade is often a part of the architecture that architects have to focus on as well. The architectural facade form influences people's overall impression of the architectural style, is an intuitive expression of local architectural form characteristics, is the crystallization of local history and culture and people's wisdom of survival, and contains the cultural connotation of regional characteristics [4].

The concept of sustainability originated as early as 1987 by the World Commission on Environment and Development. It is centered on the idea that it is essential to meet the needs of contemporary development without jeopardizing future development, and that continuity is its essential characteristic. The introduction of the concept of sustainability is of great significance to the development of human society. The concept of sustainable development is widely used in all aspects of urban and rural transformation and construction in China. Recycling modes such as old city renovation and building renewal are gradually becoming dominant. In the face of development needs such as climate change, environmental pollution, and academics are increasingly concerned about the sustainability characteristics of vernacular architecture. In the process of remodeling traditional vernacular architecture, special attention needs to be paid to the architectural style, detailed characteristics, and architectural components [5]. The key to the preservation and sustainability of the form characteristics of vernacular architectural facades lies in the combination of traditional and contemporary architectural ideas. During the process of design, the design style of traditional buildings and environmental characteristics are fully considered, and the historical lineage contained in the buildings is continued, so that the traditional vernacular architecture is revitalized [6]. In the past, discussions on architectural facade styles generally approached the issue from the perspective of construction techniques or architectural materials. To objectively analyze the style of the architectural facade, it is converted into the form of a diagram to visualize the topology between the various architectural elements [7]. This study uses complex network theory to define and analyze the network relationships between different elements in an architectural facade, and to explore the hidden rules and order in architectural facades. Tightness centrality is a measure of architectural elements that reveals the hierarchical relationship between different elements in the facade, thus achieving an objective description of the vernacular architectural style. The main contributions of this study are summarized below.

- (1) This study attempts to use mathematical and computational tools to carry out an objective analysis of architectural facade characteristics and to propose an objective and scientific model for identifying and extracting architectural facade form characteristics. It provides an objective way of understanding the architectural facade form characteristics and provides an objective quantitative analysis method for the architectural facade form characteristics.
- (2) This study explores the formal characteristics of vernacular architectural facades and the topological relationships between facade elements through a complex network analysis model. From this, we can draw the similarities and differences between the

characteristics of traditional and contemporary vernacular architectural facade forms, and explore the laws of evolution in the process of the sustainable development of vernacular architectural facade forms.

- (3) Based on the results of the comparison between the traditional and contemporary vernacular architectural facade characteristics in the Jiangnan region, the logic of the composition of the elements of the vernacular architectural facade in the region is explored, sorting out the elements of sustainable inheritance of vernacular architectural facade forms and the cultural connotations implied therein, to provide a scientific basis for the protection of vernacular architectural styles and sustainable renewal.

## 2. Literature Review

### 2.1. Research Relevant to the Form Characteristics of Vernacular Architecture in the Jiangnan Region

Traditional vernacular architecture is found all over the world, and they vary in terms of building appearance, interior space, and decoration, constituting their unique formal characteristics. The UNESCO World Heritage Committee is dedicated to the permanent maintenance of traditional villages [8]. In the 1930s and 1940s, the Society for the Study of Chinese Architecture set up a research path of traditional vernacular architecture with Chinese characteristics, combining documentary excavation and the investigation of relics, and detailed research material on vernacular architecture. Architectural facade as an important form of architectural form characteristics, to a certain extent, can directly reflect the architectural structure characteristics and overall form characteristics, usually by the combination of different component elements together, and is an important means of expression of architectural form and beauty. The traditional vernacular architecture of Jiangnan has a long history, and the wooden structure, as a formal characteristic with extremely rich artistic and cultural connotations, is closely related to the uniqueness of the local culture. Thus, the vernacular architectural forms of the Jiangnan region, as specific cultural symbols, have a positive effect on the sustainable development of contemporary vernacular architecture [9]. Due to the climatic characteristics of the Jiangnan region of China, which affect the form of vernacular architectural construction, to adapt to the environment, the vernacular architecture in the Jiangnan region presents stable formal characteristics in terms of building volume, structure, and color. In the sustainable development of vernacular architecture, the study focuses on those architectural characteristics that can be adapted to the environment, and the sustainable development of vernacular architecture is realized based on full respect for these characteristics [10]. This shows the importance of traditional vernacular architectural characteristics for the construction of contemporary vernacular architecture. Currently, the Jiangnan region of China is facing a period of transition of traditional villages, and how people re-adapt and re-establish the relationship between people and land, which is an important aspect of the integration of tradition and modernity [11].

Most of the research on the vernacular architectural form characteristics in the Jiangnan region adopts the method of the case study and takes traditional vernacular architecture as the research object to discuss the regionality of architectural form characteristics. This paper adopts the research method of the architectural form, and the mode of binary dynamic analysis to explore the form characteristics of traditional vernacular architecture and contemporary vernacular architecture, respectively. Then, the two are compared and analyzed to derive the similarities and differences in the form and characteristics of traditional and modern architectures in the Jiangnan region. It is not only a reflection on the intrinsic evolution of architectural form characteristics, but also a consideration of the direction of the sustainable development of architectural form characteristics.

### 2.2. Architectural-Façade-Related Research

The research results in the architectural facade aspects of the research of a more complete theoretical foundation is formed, and the relevant theory and application of the research is constantly enriched. German architect Herzog, in his book 'Handbook of Facade

Construction', takes a look at the basic theories of architectural facade construction and summarizes and reflects on the facade design requirements for various types of buildings. The author also introduces wood, glass, plastic, and other material constructions and their detailing through a series of fascinating examples [12]. The Construction of New Buildings Behind Historic Facades, by David Highfield, provides an in-depth analysis of the specific measures, conservation principles, and specific programs for facade preservation in the restoration process of historic buildings, emphasizing the great significance of their preservation and revitalization [13]. Historic Building Facades: The Manual for Maintenance and Rehabilitation, by William Foulks, is more of an operations manual, analyzing the styles and materials of architectural facades from all periods and providing detailed operational plans for the inspection, repair, and maintenance of architectural facades [14]. Malewczyk analyzes examples of contemporary Polish architecture to explore the types of modes of assemblage that are used on local residential architectural facades from the point of view of compositional measures and subject perception [15]. Noaime focuses on the use of geometry and scale on residential facades in Aleppo. Through the study of historical documents, photographs, and drawings, the unique functions performed by windows, doors, and balconies in local architectural facades are analyzed, ultimately uncovering how living spaces interact with their surroundings [16].

There are also research results on the application of new technological tools in the study of architectural facades. Shan adopts advanced image recognition algorithms to construct the CA-MSResNet model to capture the overall structural information of the architectural facade and the characteristics of the local components, and then accurately identifies the form elements and stylistic categories of Harbin buildings [17]. Cheng studies the spatial sequence of architectural elevations of traditional villages in Huizhou, South Anhui Province, uses 3D laser scanning technology to achieve the 3D modeling of architectural elevations, and then explores the regularity of the organization of architectural facades [18]. Shen focuses on the roof portion of architectural facades, identifying the unique functional, hierarchical, and aesthetic elements that characterize the roofs of ancient Chinese wooden buildings through the establishment of a mathematical model [19]. Zhang developed a technique for designing architectural facades for villages and cities using CGAN, which presents valuable design references for developing design solutions for architectural facades and helps to improve the efficiency of designing architectural facades [20]. Tang devises a generative design methodology for architectural facades based on knowledge discovery and digital generation, which quantitatively generates referenceable architectural facades by building a diverse database, quantifying the characteristics of traditional architecture, and abstracting the rules of traditional architectural facades. The methodology provides a viable solution for the conservation and renewal of traditional architectural settlements [21].

The above studies on architectural elevations are usually based on a large collection of case studies and organizations, which, in turn, discuss architectural design, building materials, building forms, and their correlations. With this foundation in mind, this paper considers the use of complex networks to identify the internal logic of architectural forms and to analyze the hidden structural relationships between architectural elements in architectural facades.

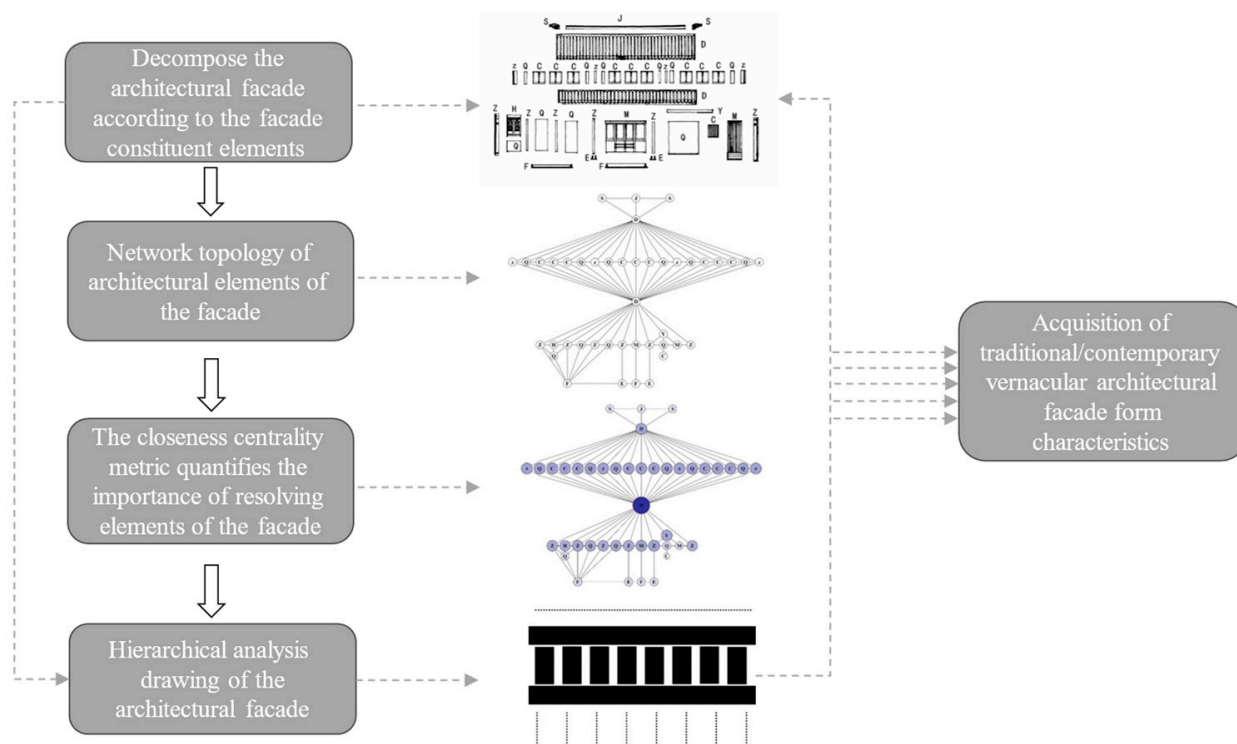
### 3. Methodology

The Jiangnan region of China is an important area of cultural development, where traditional Chinese wooden architecture has performed extremely well. The vernacular architecture in the Jiangnan region occupies an important position in China's architectural history, which is closely related to the regional culture and geographical characteristics of Jiangnan. Both the internal layout of the architecture and the external form of the architecture are extremely rich in cultural meaning [22]. Jiangnan refers to the area south of the middle and lower reaches of the Yangtze River in China, which has a well-developed water system and is known as the "Water Town of Jiangnan". Japanese scholar Yoshinobu Shiba put forward the doctrine of "regional cultural ecological region" based on the doctrine

of “regional cultural region” and delineates the Jiangnan region, which mainly includes Jiangsu, Anhui, and parts of Zhejiang [23]. It is believed that the “Eight Prefectures and One State” in the Ming and Qing Dynasties were the traditional Jiangnan. Nowadays, “Jiangsu, Zhejiang and Shanghai” is the modern Jiangnan, and it is most typical of Jiangsu and Zhejiang. Combined with the above analysis, the architectural facades of Jiangsu and Zhejiang are mainly analyzed in this paper.

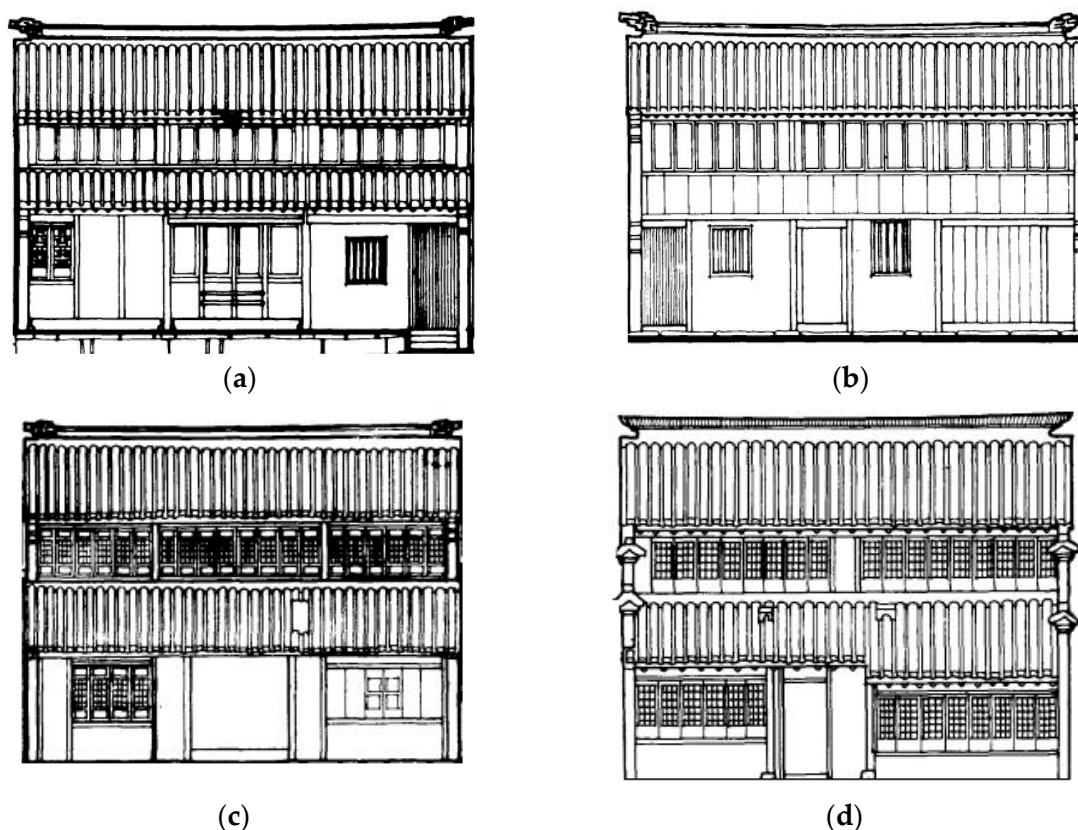
In most of the research results on vernacular architecture, vernacular architectures in the same spatial and temporal contexts have similar form characteristics and compositional elements, which are referred to as “cultural genes” [24]. Architectural facades with these characteristics are often more complex. Fundamentally, the architectural facade form consists of a variety of structural elements and shows the different stages of vernacular architecture.

The facade form of vernacular architecture in Jiangnan region has unique local characteristics which is an important part of the aesthetic expression of vernacular architectural form in Jiangnan region. The architectural facade has an important role in showing the overall image of the architecture. Architectural facade brings different formal aesthetics and increases the imagery characteristics of the architecture through the changes of virtual and real, hierarchy, etc. The potential mathematical and proportional relationships in architectural facades are explored by analyzing and summarizing the topological characteristics as well as form characteristics of architectural elements [25]. The characteristic extraction of the architectural facade is divided into four main stages (Figure 1). First, the architectural facade is decomposed into different architectural elements. Then, the architectural facade is represented as a topological network based on the association relationship of the architectural elements. Finally, the facade elements are measured with the closeness centrality in the complex network, which objectively quantifies the importance of the facade elements in the facade. In the fourth stage, based on the results of the topology and importance analyses, a hierarchical analysis map of the architectural facade is formed.



**Figure 1.** Flowchart for identifying and extracting architectural facade form characteristics. (S: ridge beast, J: roof ridge, D: roof, C: window, Z: long column, z: short column, Q: Wall, Y: eaves board, M: door, H: lattice window, E: cliff-ledge, F: wooden frame). Source(s): Prepared by authors.

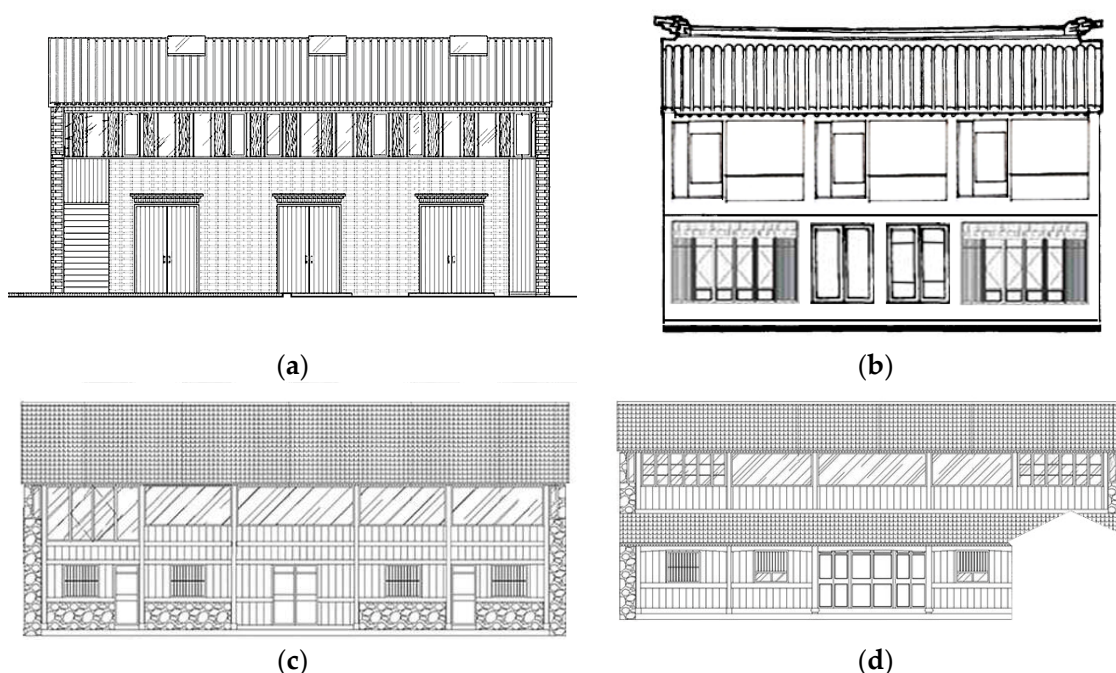
According to the morphological approach, the architectural form is often viewed as a complex system, which can be analyzed by the internal logic of the architectural form using mathematical tools. Considering architectural facades as spatial structures with orderliness, the form characteristics of architectural facades are analyzed [26]. The selection of research objects needs to satisfy the characteristics of originality, universality, and locality to ensure the rationality of the research results [27,28]. According to the above principles, the traditional vernacular architecture and contemporary vernacular architecture in the Jiangnan region are taken as the research objects. More than 400 traditional and contemporary vernacular buildings are selected, and more than 2000 architectural facade images are collected to constitute the dataset of vernacular architectural facades. To facilitate the detailed introduction of the research method, four of the representative architectural facades are selected to be decomposed and analyzed in this paper (Figures 2 and 3).



**Figure 2.** Architectural facades of traditional vernacular architecture: (a) riverine houses in the water network area; (b) commercial house with shop; (c) lower-shop upper-house building overhang; (d) traditional houses (non-commercial type). Source(s): Prepared by authors.

The Jiangnan region is also known as the “Jiangnan Water Town” in China. Due to the well-developed water system, abundant rainfall, and convenient water transport in the south of the Jiangnan region, a unique architectural style of water townships such as residential houses along the river and building overhangs are formed. In traditional Chinese architecture, wooden beams are commonly used for load-bearing, mostly in the form of piercing and lifting beams, which is reflected in the architectural form of the roof dominated by sloping roofs. Carving and beam painting are the main means of decoration in traditional architecture. However, there are fewer decorative carved beams in the vernacular architecture of the Jiangnan region. Detailed decorations are mostly found on ridge beasts, balustrades, columns of porches, window panes, door cores, and other parts. The traditional vernacular architecture of the Jiangnan region is built by the geomorphology of mountains and waters, in harmony with the environment and following the basic principles of sustainable development. Residences along the river in the water

network area, commercial houses with shops, lower-shop upper-house building overhangs (also known as “gable-floor” buildings) and general non-commercial residential houses are the most representative architecture forms of traditional vernacular architecture in the Jiangnan region (Figure 2).

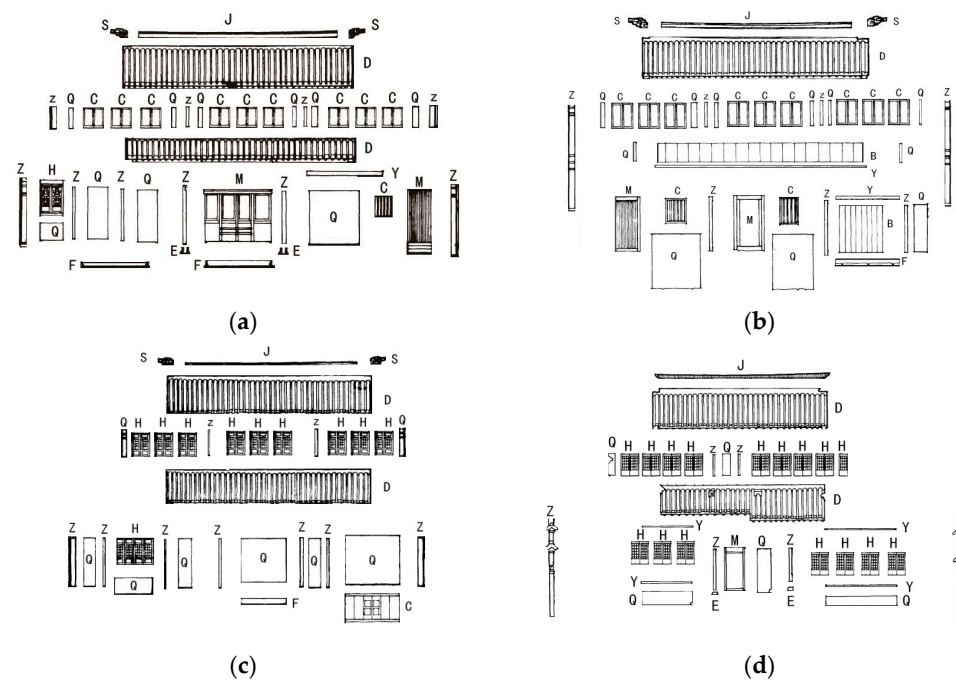


**Figure 3.** Architectural facades of contemporary vernacular architecture: (a) inheriting the cultural genes of traditional vernacular architecture; (b) partial renewal of vernacular architecture; (c) inheriting the traditional vernacular architecture in partial form; (d) continuation of traditional structures. Source(s): Prepared by authors.

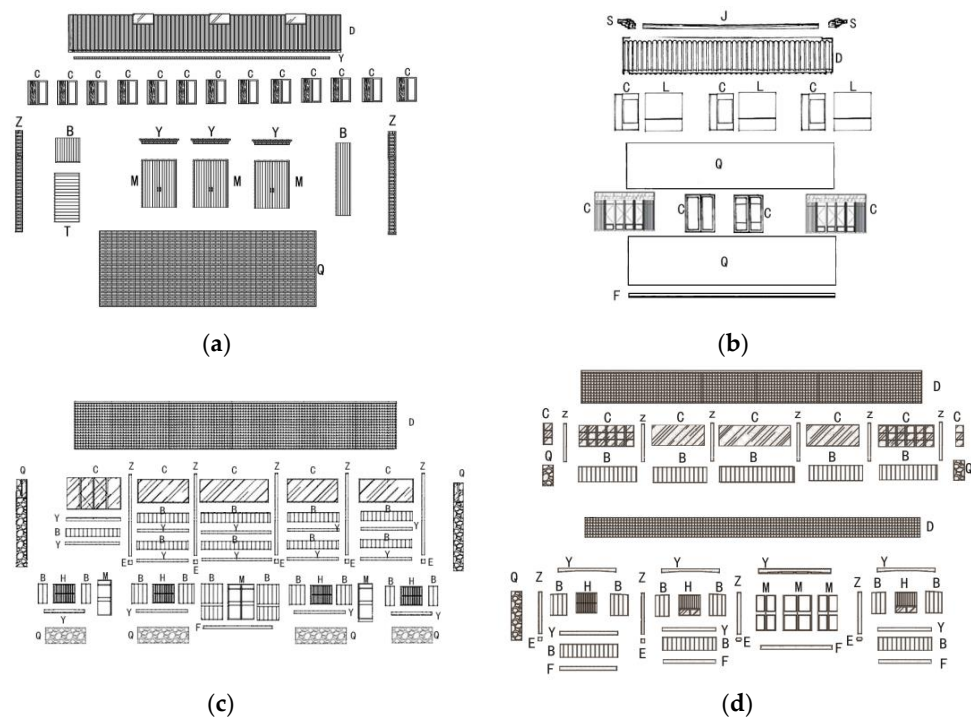
Contemporary vernacular architecture in the Jiangnan region often involves the remodeling, updating, or reconstruction of architecture in traditional vernacular environments. In the process of contemporary vernacular architecture construction, the sustainable development of traditional vernacular architecture is achieved mainly through the preservation of traditional characteristics. Construction methods include inheriting the traditional vernacular architecture in partial form, inheriting the cultural genes of traditional vernacular architecture, partially renewing the traditional vernacular architecture, and continuing to use the traditional architectural structures. Therefore, the most representative architectural elevations were selected from each of the above four approaches for presentation (Figure 3).

### 3.1. Decomposition of the Architectural Facade

The number and form of different elements in the architectural facade are different, and there are also a variety of correlations between architectural elements. The architectural facade of vernacular architecture in the Jiangnan region mainly consists of elements such as roofs, doors, windows, columns, picket floors, railings, and so on. Moreover, the roof includes parts such as a roof and ridge. Doors and windows include parts such as door frames, window frames, and grilles. Columns are divided into column bases, column bodies, and column heads. Therefore, subdividing the architectural facade into different architectural elements helps to discover the direct topological relationship and arrangement of the different elements to better analyze the internal structure of the architectural facade. With the principle of discontinuity as the boundary between architectural elements, the architectural facade is decomposed into different parts, and a specialized symbol is assigned to each type of architectural element [29,30]. After decomposition, the facade structures of four traditional vernacular architecture and four contemporary vernacular architecture are shown in Figures 4 and 5.

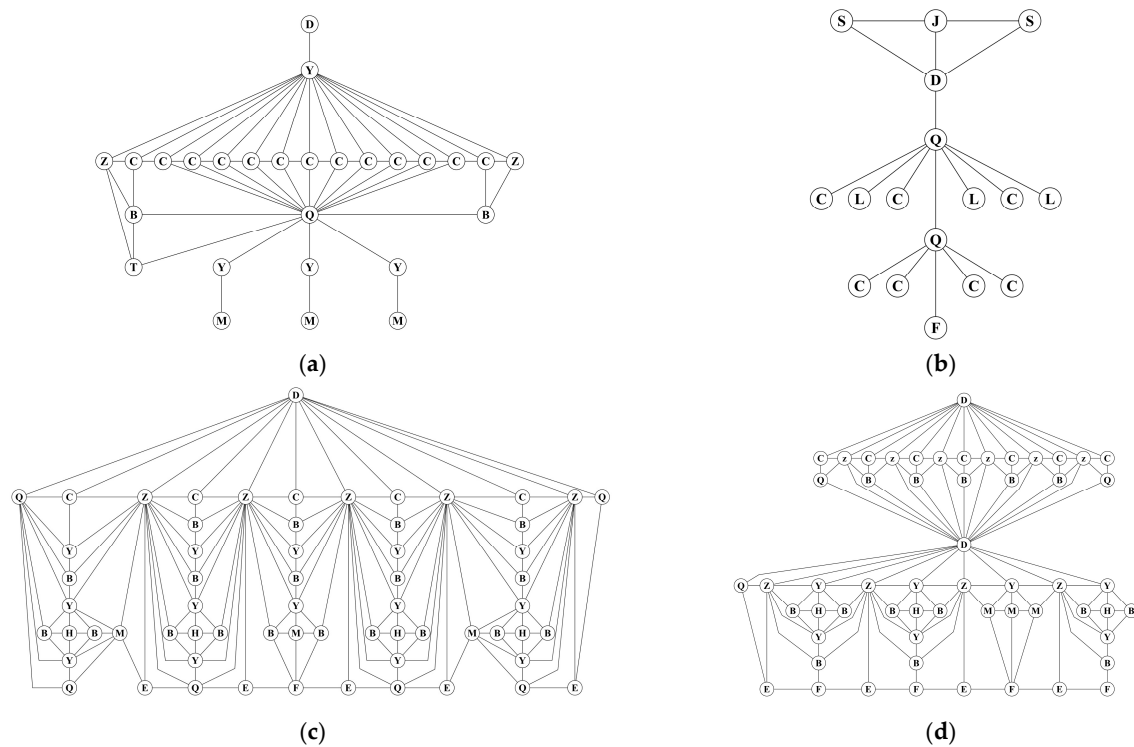


**Figure 4.** Facade decomposition of traditional vernacular architecture: (a) riverine houses in the water network area; (b) commercial house with shop; (c) lower-shop upper-house building overhang; (d) traditional houses (non-commercial type). (S: ridge beast, J: roof ridge, D: roof, C: window, Z: long column, z: short column, Q: Wall, B: board, Y: eaves board, M: door, H: lattice window, E: cliff-ledge, F: wooden frame). Source(s): Prepared by authors.



**Figure 5.** Facade decomposition of contemporary vernacular architecture: (a) inheriting the cultural genes of traditional vernacular architecture; (b) partial renewal of vernacular architecture; (c) inheriting the traditional vernacular architecture in partial form; (d) continuation of traditional structures. (S: ridge beast, T: step, J: roof ridge, D: roof, C: window, L: verandah, Z: long column, z: short column, Q: Wall, B: board, Y: eaves board, M: door, H: lattice window, E: cliff-ledge, F: wooden frame). Source(s): Prepared by authors.

Nodes in figures represent different architectural elements and are represented by proprietary symbols. Edges represent the association relationship between architectural elements. Depending on the position of the architectural elements in the architectural facade, the corresponding nodes are placed according to the virtual vertical or horizontal lines. Through observation and analysis, it can be found that the network topology of each architectural facade has a very obvious symmetry as a whole, and usually realizes axial symmetry with the virtual vertical line residing in the middle as the axis. In addition, there are some special asymmetric structures in localized areas of the network topology.



**Figure 7.** Network topology of contemporary vernacular architecture facades: (a) inheriting the cultural genes of traditional vernacular architecture; (b) partial renewal of vernacular architecture; (c) inheriting the traditional vernacular architecture in partial form; (d) continuation of traditional structures. (S: ridge beast, T: step, J: roof ridge, D: roof, C: window, L: verandah, Z: long column, z: short column, Q: Wall, B: board, Y: eaves board, M: door, H: lattice window, E: cliff-ledge, F: wooden frame). Source(s): Prepared by authors.

### 3.3. Closeness Centrality Measure

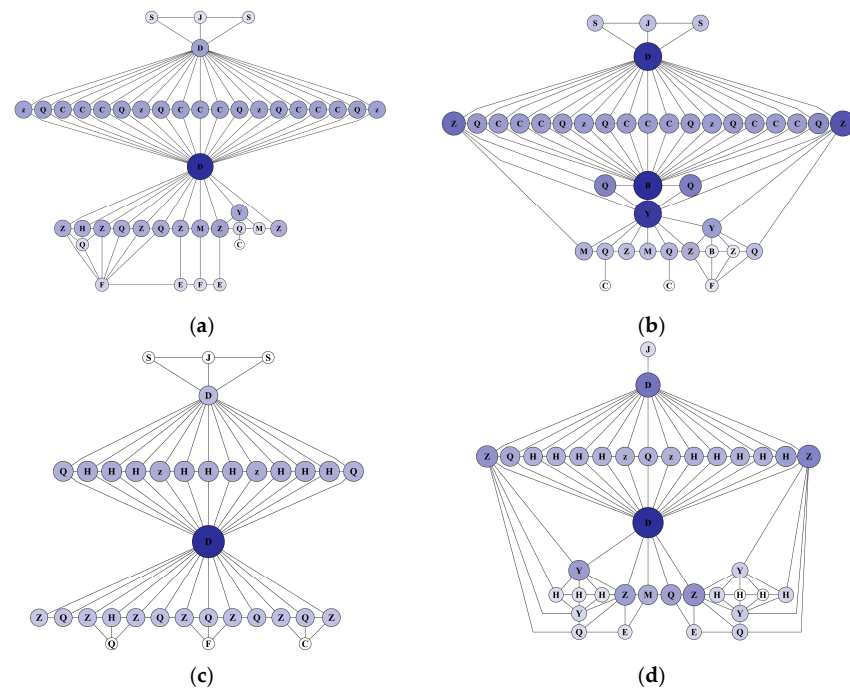
After the above steps, it is found that the architectural elements in the architectural facade are interconnected to form a network with a hierarchical structure. Importantly, certain nodes are in the global center or local center of the network topology in the architectural facade. To better quantify the importance of architectural elements in architectural facades, closeness centrality is exploited to measure the structural importance of architectural elements.

Closeness centrality assesses the node's importance from a global perspective. Closeness centrality measures the position of a node in the network by calculating the inverse of the sum of the distances from the current node to the other nodes in the network, and it reflects the closeness of the node to the other nodes [32]. Higher closeness centrality indicates that the location of the architectural element represented by the node is at the core of the building and it has a higher chance of being directly associated with other architectural elements. Therefore, the closeness centrality of node  $i$  is defined as shown as follows.

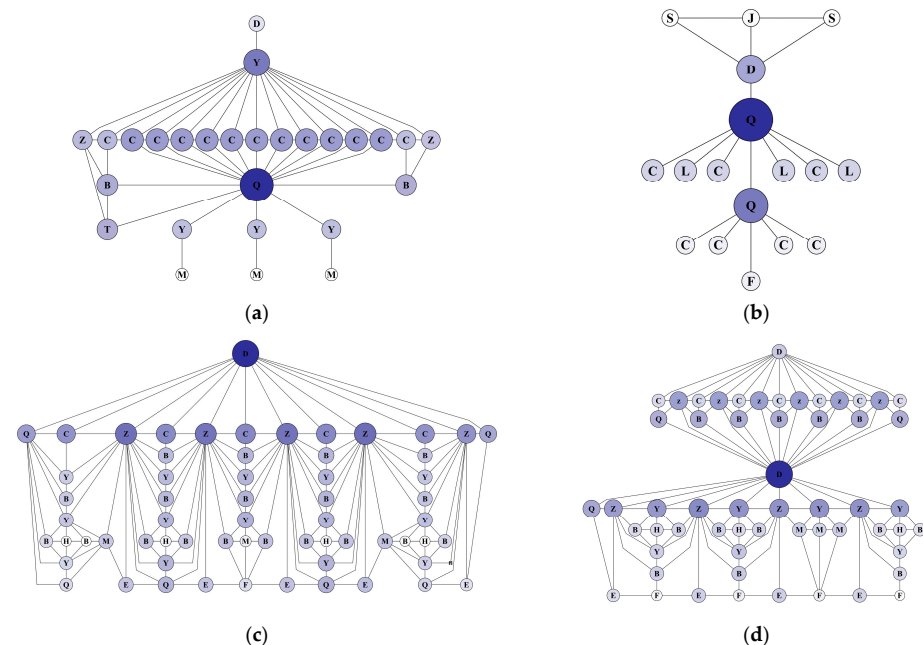
$$CC(i) = \frac{N-1}{\sum_{j \neq i} l_{ij}} \quad (1)$$

where  $l_{ij}$  denotes the shortest path length from node  $i$  to  $j$ .  $N$  denotes the number of nodes in the network topology.

The closeness centrality of the nodes in the network topology of each architectural facade is shown in Figures 8 and 9. In the figures, the closeness centrality of a node is visualized with the size of the circle and the darkness of the color. The larger the circle and the darker the color, the higher the closeness centrality of the node. It helps to identify the important architectural elements in each architectural facade visually and efficiently.



**Figure 8.** Closeness centrality of nodes in network topology (traditional vernacular architecture): (a) riverine houses in the water network area; (b) commercial house with shop; (c) lower-shop upper-house building overhang; (d) traditional houses (non-commercial type). (S: ridge beast, J: roof ridge, D: roof, C: window, Z: long column, z: short column, Q: Wall, B: board, Y: eaves board, M: door, H: lattice window, E: cliff-ledge, F: wooden frame). (The larger the circle and the darker the color, the more important the node is). Source(s): Prepared by authors.


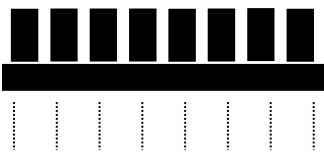
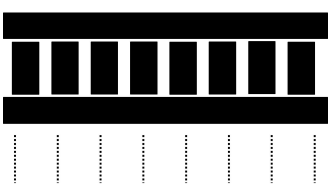




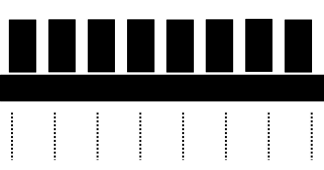
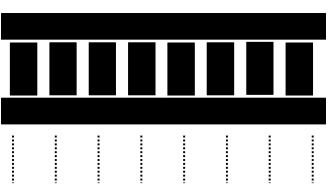


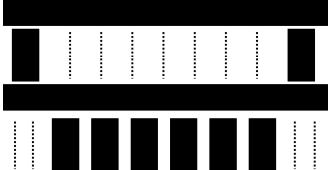


**Figure 9.** Closeness centrality of nodes in network topology (contemporary vernacular architecture): (a) inheriting the cultural genes of traditional vernacular architecture; (b) partial renewal of vernacular architecture; (c) inheriting the traditional vernacular architecture in partial form; (d) continuation of traditional structures. (S: ridge beast, T: step, J: roof ridge, D: roof, C: window, L: verandah Z: long column, z: short column, Q: Wall, B: board, Y: eaves board, M: door, H: lattice window, E: cliff-ledge, F: wooden frame). (The larger the circle and the darker the color, the more important the node is). Source(s): Prepared by authors.

### 3.4. Hierarchical Analysis of Architectural Facade

The closeness centrality of nodes in a network topology can visually quantify the importance of different nodes. Nodes with high importance are usually the global or local centers of the network topology, and their corresponding architectural elements play the role of core and bridge in the architectural facade. Depending on the differences in the importance degrees of the constituent elements of the architectural facade forms and the basic shapes of the elements, the global center, local center, and sub-local center elements in the architectural facade are represented by the thickness and virtual and real of the graphs, as shown in Tables 1 and 2.

**Table 1.** Hierarchical analysis of traditional vernacular architecture facades. Source(s): Prepared by authors.

Type of Architectural Facades	First Floor (Global Center)	Second Floor (Local Center)	Third Floor (Sub-Local Center)
Riverine houses in the water network area			
Commercial house with shop			
Lower-shop upper-house building overhang			
Traditional houses (non-commercial type)			

**Table 2.** Hierarchical analysis of contemporary vernacular architecture facades. Source(s): Prepared by authors.



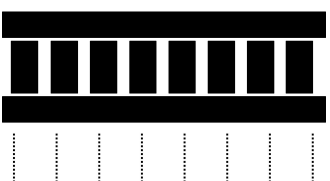













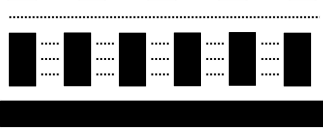







Type of Architectural Facades	First Floor (Global Center)	Second Floor (Local Center)	Third Floor (Sub-Local Center)
Inheriting the cultural genes of traditional vernacular architecture			

Table 2. Cont.

Type of Architectural Facades	First Floor (Global Center)	Second Floor (Local Center)	Third Floor (Sub-Local Center)
Partial renewal of vernacular architecture			
			
			
Inheriting the traditional vernacular architecture in partial form			
			
			
Continuation of traditional structures			
			
			

#### 4. Results and Discussion

The tightness centrality metric expresses the hierarchical nature of the form structure of the architectural facade, and the results of the analysis can be expressed in terms of different compositional forms. The first level is the central element of the overall form of the architectural facade. The second level is the local center, which can also be understood as the secondary center of the architectural facade. The third level is the other central elements, which are less important in comparison to the previous two levels but are also more important form elements for the overall view of the architectural facade.

Through the decomposition of the architectural facade, topological network analysis, compactness centrality measure, and hierarchical analysis, it can be seen that the architectural facade form implies a topological arrangement and that the different elements constituting the architectural facade are, at the same time, a combination of central elements of different hierarchical structures. There is a similarity and consistency between the traditional and contemporary vernacular architectural facade forms, so, even though there are many ways to compose the elements of contemporary vernacular architectural facades, the overall form of the vernacular architectural facade is still complete and harmonious. Due to the contemporary vernacular architecture facade elements of the composition of the composition of way to change, the vernacular architectural facade form has complexity and diversity, which is different from the traditional vernacular architecture [33].

##### 4.1. Analysis of the Traditional Vernacular Architectural Facade Characteristics

As seen through the results of the architectural facade characteristics extraction, the first level of the traditional vernacular architectural facade corresponds to the roof elements of the architectural facade, including the roof of the ground floor and the roof of the upper floor. This illustrates the important part the roof plays in the form of the architectural facade. The roof is an extremely important constituent element in the architectural facade of Jiangnan architecture, and it is also the uppermost architectural component in traditional Chinese architecture, which can attract people's attention, so it is one of the iconic elements in traditional Chinese architecture. The roof forms of traditional Chinese architecture are mainly classified into the hip roof, saddle roof, suspension roof, pointed roof, and gabled roof, with different types of buildings adopting corresponding roof forms [34]. In Chinese vernacular architecture, the double-pitched roof is the major roof form. Jiangnan traditional

vernacular architectural roofs are mainly double-slope roof forms, and the gabled roof and the addle roof are dominated by the side of the herringbone; the form is relatively single. The roofs of traditional vernacular architecture are mainly influenced by building structures, construction techniques, and building materials. On the whole, it seems that the roofs of the vernacular architecture in the Jiangnan region are staggered, which is also a prominent characteristic of the Jiangnan architectural style.

The second level of the traditional vernacular architectural facade takes two main forms: one is the horizontal laying down of vertical elements, and the other is the horizontal extension of horizontal elements. In conjunction with the constituent elements of the architectural facade, the vertical elements in the first form are the windows in the architectural facade. Because of the humid climate in the south of the Jiangnan region, the function of the window is not only for light; the role of ventilation is also very important. Windows in the vernacular architectural facades of the Jiangnan region are usually in the form of long windows, half windows, horizontal wind windows, and combined windows. The distribution of windows is balanced and symmetrical, which is influenced by the layout of the architectural facade. Generally, long windows and half-windows are opened in even numbers, with the exact number of openings and how the windows are opened to be determined by the width of the architectural facade. Nowadays, it appears that this has become one of the characteristics of the traditional vernacular architectural facade form. Another form of the second level is in showing the particularity of the double roof form in the traditional vernacular architectural facade. Jiangnan traditional vernacular architecture has the form of the upper floor pick out, the rational use of the upper space, increasing the indoor space and the use of the area. The outwardly protruding floors also provide shelter from the wind and rain, and, aesthetically, add layers to the architectural form.

The third level of the traditional vernacular architectural facade has consistency with the first and second levels, mainly the expansion of windows and roofs, eaves, and other parts of the architectural facade, so the architectural facade ultimately forms a three-part composition form. The three important levels are more consistent and show a clear pattern. From the results of the analysis, the horizontal elements in the traditional vernacular architectural facade are more prominent than the vertical elements, mainly including the roof elements and the way of laying doors and windows. The decorative elements in traditional architecture, such as beams, cornices, hanging down, etc., here only play the role of connection and are not very important in the overall form of the architectural facade.

#### *4.2. Analysis of the Contemporary Vernacular Architectural Facade Characteristics*

The first level of the contemporary vernacular architectural facade is similar to the traditional vernacular architectural facade, but, unlike the traditional architectural facade, the center of the whole picture lies mainly in the roof and the walls of the ground floor. Contemporary vernacular architecture also differs from traditional vernacular forms due to the changes in building technology, construction structures, and building materials. From the outside, the walls of the ground floor and upper floors of contemporary vernacular architecture are the same. As a result, in contrast to traditional vernacular buildings, the roof element no longer appears on the ground floor, while the wall becomes larger and becomes the central node connecting the various parts of the architectural facade. And, because of this, the center of the whole picture shifted to the wall part of the ground floor. In this way, it seems that the first level of the traditional and contemporary vernacular architectural facade is the same, and the roof element is still very important. When breaking down the architectural facade, it can be noticed that the roof form of the contemporary vernacular architectural facade is simpler than the traditional roof, in that it is a simplification of the double-sloped roof form, or even into a flat roof. Roof styles in contemporary vernacular architectural facade forms are simpler and more varied.

The results of the second level of analysis show that elements such as windows and columns have a greater share in the contemporary vernacular architectural facade. In the results of the first level of analysis, it is learned that the increase in the area of the wall

provides a richer combination of detail elements such as doors, windows, and columns, which are no longer set up by the even-numbered pattern in the traditional facade. In addition, in modern architectural design, the functionality of building components is gradually weakened, while their decorative nature is gradually on the rise. That is to say, to a certain extent, components such as doors, windows, and columns are detached from their roles of ventilation, lighting, and structural support, and become decorative to the architectural facade to meet the compositional needs of the wall layout. It can be seen that the elements of the architectural facade, such as doors, windows, columns, etc., have to consider the layout of the architectural facade based on meeting the functional requirements. The results of the analysis of the architectural facade show that the vertical elements of the second level have a variety of forms. This illustrates the fact that the style of elements such as doors, windows, and columns can appear in a variety of forms, and is also designed to meet the requirements of the layout of different forms of walls.

The third level of the contemporary vernacular architectural facade contains an increased variety of elements, and a wealth of formal variations compared to the first and second levels, and there are no uniform and strict rules. However, the results of the decomposition of the architectural facade show that the form elements in the third level are still mainly elements such as windows and columns. Overall, there is consistency in the elements of the second and third levels, based on the first level, but with a flexible and varied presentation and combination. In addition, the overall trend in architectural facades is still dominated by horizontal elements.

#### *4.3. Comparative Analysis of Traditional and Contemporary Vernacular Architectural Facade Characteristics*

In the first level, traditional and contemporary vernacular architectural facade forms have similar topological forms. According to the results of the analysis, the horizontally oriented form elements are the tight centers of the whole picture, and the architectural facade forms show a tendency to extend horizontally. It can be seen that the horizontal form elements of the first level influence the overall form of the architectural facade and, based on this, expand to the upper and lower parts, respectively.

At the second level, different structural forms emerge, but there are still similarities. The form structure of the second level can be divided into two schemes, a horizontal replication of a single vertical element and a horizontal extension of the horizontal element. However, the comparison of traditional and contemporary vernacular architectural facade forms shows that the vertical elements on the second level of the traditional vernacular facade are located in the area above the global center. The second level of vertical elements in the contemporary vernacular architectural facade is located below the global center and the size of the vertical elements is differentiated. These local centers, subordinate to the global center, extend horizontally along the area to which they belong and are connected by sub-elements. The compact center acts as a bridge in the form of an architectural facade, connecting the various elements of the parts using different structural combination schemes. Traditional and contemporary vernacular architectural facades have similarities in the form in which the first and second levels are constituted.

But, by the third level, the form of the architectural facade has changed more. In the results of the third level of analysis, it can be seen that the traditional vernacular architectural facade form has a certain regularity and is arranged more regularly. Within this hierarchy, the location of the vertical sub-elements of the traditional vernacular architectural facade forms varies but is similar in size. Contemporary vernacular architectural facade forms, on the other hand, are much more varied, not only in their combined forms but also in the size and shape of the elements.

The results of the analyses show that there is a consistency between the contemporary and traditional vernacular architectural facade structures. The roof is a central element in both and both focus on the horizontal laying of form elements. This illustrates that, while

contemporary vernacular architectures are more massive than traditional, the architectural facade perpetuates some of the traditional form characteristics of the architectural facade.

#### 4.4. *Strategies for Strengthening the Character of Vernacular Architectural Facades*

##### 4.4.1. Perpetuate the Traditional Roof Form and Accentuate the Form Characteristics

The roof form of traditional vernacular architecture in the Jiangnan region has obvious regional characteristics, and perpetuating the roof form of traditional vernacular architecture is a more intuitive way to highlight the form characteristics. The importance of the roof element is shown in both traditional and contemporary vernacular architectural facade form characteristics, so it becomes one of the characteristics of vernacular architectural facade forms in the Jiangnan region. This is also evidenced in contemporary Chinese architectural design, where many Chinese buildings use the roof shape as one of their hallmarks. Because “heaven” is one of the main objects of people’s understanding of the world in ancient China, the roof shape contains the cosmic concepts of the Chinese people since ancient times. The traditional vernacular architectures of Jiangnan are all hyperbolic roofs, not only in terms of function, but also, from an aesthetic viewpoint, it has a unique regional character. From a distance, the undulating, rolling roofs harmonize with the contours of the mountains. That is to say, some people in China believe that the roofs of traditional vernacular architecture in Jiangnan are a perpetuation of the mountains and a recreation of the slopes. Geographically, Jiangnan receives a lot of rain because of the peaks of the Tibetan Plateau, and the double-sloped roofs are designed to cater to the local climate. The choice of the traditional architectural roof form as the main roof shape for contemporary vernacular architecture is a way of highlighting the main characteristics of the traditional vernacular architectural form.

##### 4.4.2. Enrichment of the Facade Hierarchy to Improve Characteristic Recognition

The most impressive thing about the vernacular architectural facade of the Jiangnan region is its cascading undulations, so emphasizing the rich layers of the architectural facade can effectively improve the recognition of the local architectural form characteristics. In Chinese characters, the word “wall” for a building consists of two parts, one of which is “earth” and the other is “harvest”, so, early on, people often refer to a wall as the skeleton of a house that grows out of the earth. In the concept of many Chinese people, the traditional architecture of the architectural structure is more important: it does not matter if the wall falls; the skeleton of the house cannot collapse. Many people think of walls as complementary to the wood-framed structure of a building, as an appendage to the structure of the building. As a result, it is relatively more relaxed in the creation of traditional architectural facades. The vernacular architectural facade in the Jiangnan region forms a continuous undulating hierarchy due to the topography and the specificity of the architectural form. When it comes to traditional vernacular architecture in China’s Jiangnan region, those familiar with it think of overlapping roofs and continuous walls. Contemporary vernacular architecture has fewer types of decorative components than traditional vernacular facades, so the architectural form is more concise. To strengthen the vernacular architectural facade characteristics of the Jiangnan region, the hierarchy of the architectural facade should be highlighted, which can improve the identification of regional characteristics.

##### 4.4.3. The Use of Vertical Form Elements to Compose a Diverse Range of Facade Forms

The structural elements of the vernacular architectural facade in the Jiangnan region are in various forms, and the characteristics of the vertical form elements are obvious. On the visual level, the treatment of the architectural facade is, in a way, the treatment of the figure–ground relationship, and the traditional vernacular architectural facade is often enriched by the detailed decorative components of the architectural facade. The doors and windows in the facade of traditional vernacular architecture are laid in the same way and show a regular symmetry in the horizontal composition of the facade, but there are a

wide variety of decorative components such as doors, windows, columns, balustrades, and hangings, and the style of carvings is very diverse. Jiangnan region's vernacular architecture facade level is very rich, the architectural facade is not a single planarized layout, the traditional architectural facade form mainly includes doors, windows, columns, and other decorative components. From the point of view of the figure-ground relationship, the vernacular architectural facade of the Jiangnan region is a complete and rich compositional way. Contemporary vernacular facades form the visual center of the wall mainly through simplified windows and doors. Compared with traditional vernacular architecture, the carved decorations of doors, windows, and columns in contemporary vernacular facades are reduced, but the styles of doors and windows are altered. Traditionally, windows and doors on architectural facades are predominantly rectangular and square, but, nowadays, they come in a variety of styles that can be adapted to the designer's program. Therefore, the architectural facade decorates and embellishes the walls through window and door styles, and makes use of vertical form elements to constitute diverse facade forms.

The purpose of reinforcing the vernacular architectural facade form characteristics is to preserve the traditional characteristics and to achieve the sustainable development of the tradition. Traditional vernacular architecture has historical and cultural connotations, and its facade form is characteristic of the corresponding period. Tradition and modernity can co-exist in the design of contemporary vernacular architectural facades. This contributes to the sustainability of the regional character of vernacular architecture.

## 5. Conclusions

Contemporary vernacular architectural forms inherit the characteristics of traditional vernacular facade forms, and specific characteristic elements can be regarded as cultural genes, which are often used in modern architectural design. Firstly, the form characteristics of traditional vernacular architectural facades are extracted to constitute inherited design elements. The design elements are then combined with contemporary vernacular architectural forms. Finally, a new architectural facade form is produced, resulting in the design of an architectural form with traditional aesthetic implications. Such an approach promotes designing from the overall form of the building, rather than a random collage of traditional and modern elements.

The objective analysis tool for identifying and extracting architectural facade form characteristics proposed in this study helps to quantitatively resolve architectural facade form characteristics for the same style or the same geographical area. From the results of the study, the elements of the building facade can be presented in topological form, which can help people objectively analyze the morphological characteristics of the architectural facade and explore the laws of evolution. The decomposition of the elements of vernacular architectural facade form can produce different topological relationships, so it is possible to observe the rules of composition of traditional and contemporary vernacular architectural facades, and it is possible to quantify the form characteristics of architectural facades.

Through the objective display of the Jiangnan vernacular architectural facade characteristics, it can be found that the roof is the global center of the architectural facade form, which is a very important structural element. The continuation of the traditional double-slope roof form emphasizes the regional character of the architectural form. Secondly, there is a noticeable reduction in decorative detailing in contemporary vernacular facades. However, the facade elements are composed more flexibly, enriching the compositional form of the architectural facade. Finally, the horizontal way of laying vertical elements such as windows and doors can retain the traditional facade topology, which preserves the traditional vernacular architectural facade form characteristics.

In general, the traditional vernacular architecture facade composition mode rules are more obvious, while the contemporary vernacular architecture facade composition form is more variable, but there are similarities between the two. This means that traditional vernacular architectural form characteristics have a great influence on contemporary vernacular architectural design and are one of the indications of the sustainability of vernacular

architecture. At the same time, these similarities are an objective demonstration of the traditional characteristics inherited in the contemporary vernacular architectural facades. Identifying and extracting the morphological characteristics of vernacular architectural facades can provide important design elements and a formal basis for contemporary vernacular architectural forms. On the one hand, it helps contemporary vernacular architecture to realize the return of the spirit of the place. On the other hand, it enables tradition to continue in another manner. Enriching the external form of vernacular architecture also furthers the cultural connotation of vernacular architecture, thus realizing the sustainable development of vernacular architecture.

From the key elements of the overall form or facade form of vernacular architecture, the form elements are applied to the contemporary design of vernacular architectural forms, including architectural details, building materials, and architectural colors. This is a contemporary vernacular architectural design of innovative thinking; its key significance is the continuation of the aesthetic connotation of vernacular architecture. Although contemporary vernacular architectural forms are complex and varied, the presence of the characteristics gives consistency to traditional and contemporary vernacular architectural forms. Therefore, identifying characteristics and preserving them is an important way of preserving traditions. This has a positive effect on the continuity of the inheritance of the regional characteristics of vernacular architecture.

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