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ORIGINAL

Adaptation Potential Evaluation of Ornamental Motifs in Huizhou Heritage Buildings under Contemporary Context: An AHP-Fuzzy Comprehensive Evaluation Model Approach

Evaluación del Potencial de Adaptación de Motivos Ornamentales en Edificios Patrimoniales de Huizhou en un Contexto Contemporáneo: Enfoque de Modelo de Evaluación Integral AHP-Fuzzy

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ABSTRACT

The ornamental motifs in the structural elements of traditional Huizhou dwellings, listed as a World Heritage Site, embody the convergence of Confucian philosophy and geomantic principles. They integrated into wooden, stone, and brick carvings, reflect the local populace's aspirations for prosperity, longevity, and familial harmony, possessing important inheritance significance. This study aims to establish a model to evaluate the adaptation potential of ornamental motifs under contemporary context in traditional Huizhou dwellings by investigating their development history, categories, and cultural meanings. This model quantifies the factors influencing the adaptation potential of these ornamental motifs, calculates the weight of each factor. The analysis results indicate that, among all the factors, the most important primary indicator is cultural connotation (0,3118). The secondary indicators are visual appeal (0,2300), compatibility with modern aesthetic needs (0,0988) and noble, elegant (0,0836). Additionally, the overall grade of adaptation potential was determined by scoring and ranking motif samples based on the fuzzy comprehensive evaluation method. This approach enhances the objectivity, scientific rigor, and accuracy of the selection of ornamental motifs, which not only provides theoretical support and practical guidance for the sustainable development of Huizhou cultural symbols, but also serves methodological reference for related fields in other countries and regions.

Keywords: Traditional Huizhou Dwellings; Ornamental Motifs; Adaptation Potential; Analytic Hierarchy Process; Fuzzy Comprehensive Evaluation.

RESUMEN

Los motivos ornamentales en los elementos estructurales de las viviendas tradicionales de Huizhou, catalocomo patrimonio de la humanidad, encarnan la convergencia de la filosofía confuciana y los principios geománticos. Se integraron en las tallas de madera, piedra y ladrillo, reflejan las aspiraciones de la población local para la prosperidad, la longe, y la armonía familiar, que posee un importante significado de la herencia. Este estudio tiene como objetivo establecer un modelo para evaluar el potencial de adaptación de los motivos ornamentales en el contexto contemporáneo de las viviendas Huizhou tradicionales, investigando su historia de desarrollo, categorías y significados culturales. Este modelo cuantifica los factores que influyen en el potencial de adaptación de estos motivos ornamentales, calcula el peso de cada factor. Los resultados

del análisis indican que, entre todos los factores, el indicador primario más importante es la connotación cultural (0,3118). Los indicadores secundarios son el atractivo visual (0,2300), la compatibilidad con las necesidades estéticas modernas (0,0988) y noble, elegante (0,0836). Además, el grado general de potencial de adaptación se determinó mediante la puntuación y la clasificación de las muestras de motivos basados en el método de evaluación integral difusa. Este enfoque mejora la objetividad, el rigor científico y la precisión de la selección de motivos ornamentales, lo que no sólo proporciona apoyo teórico y orientación práctica para el desarrollo sostenible de los símbolos culturales de Huizhou, sino que también sirve de referencia metodológica para campos relacionados en otros países y regiones.

Palabras clave: Las Viviendas Huizhou Tradicionales; Motivos Ornamentales; Potencial de Adaptación; Proceso Analítico Jerárquico; Evaluación Global Difusa.

INTRODUCTION

The ancient villages of Huizhou have a history of over 2200 years and have nurtured the profound Huizhou culture. Xidi and Hongcun villages in Huizhou were listed as UNESCO World Heritage sites in 2000, representing one of the earliest and most significant regional cultures of China to gain global recognition.[1] The Huizhou region is mountainous with limited arable land, so most Huizhou people ventured out for business to make a living. After the Song Dynasty, Huizhou's handicrafts and commerce developed steadily, and by the Ming and Qing Dynasties, Huizhou merchants had formed their own trade associations, reaching the peak of their power and wealth. To fulfill their desires of bringing honor to their ancestors and returning home in glory, most Huizhou merchants funded the construction and renovation of their residences. Under the strict feudal hierarchical system of the time, even the wealthy Huizhou merchants were not allowed to build houses with extravagant exteriors. Therefore, they focused on carving meaningful, diverse, and beautifully composed motifs on interior structural elements like doors, windows, and beams. These motifs were cleverly integrated with the simple and plain exterior, creating a unique and lively Huizhou architectural style (figure 1).[2,3] These motifs reflected the ideologies and aesthetic tastes of the Huizhou people and are an important aspect of Huizhou's regional culture. However, with the rapid urbanization and modernization in China over the past few decades, a large rural population has migrated to urban areas. The traditional Huizhou dwellings, built long ago, have become increasingly dilapidated. Many architectural detail decoration components have been dismantled and sold, causing the traditional ornamental motifs to lose their physical carriers and gradually become disconnected from contemporary needs. Although designers have attempted to apply traditional ornamental motifs to various fields of modern design, they still face many challenges due to differing levels of understanding of traditional culture.[4,5]

Figure 1. The exterior and interior of traditional Huizhou dwellings

The pursuit of identity and cultural recognition is an urgent desire and emotional need in people's daily lives today.[6,7] The ornamental motifs in traditional Huizhou dwellings, as symbols of regional culture, are visual

elements that possess both artistic and functional qualities, making them suitable for reuse in modern design.[8] For designers, the challenge lies in enhancing their understanding and appreciation of Huizhou culture and initially selecting the most relevant ornamental motifs from the vast array of traditional designs that align with contemporary needs.[9] Therefore, this study aims to evaluate the adaptation potential of ornamental motifs in traditional Huizhou dwellings. The Analytic Hierarchy Process (AHP) was employed to quantify the factors influencing the adaptation potential of these motifs, calculating the weight of each factor. Additionally, the Fuzzy Comprehensive Evaluation (FCE) method was used to score, rank, and analyze the motif samples, thereby improving the objectivity, scientific rigor, and accuracy of the motif selection process. This research provides valuable theoretical and practical insights, serving as a reference for the rational and effective application of traditional Huizhou cultural symbols in modern design.

Natural ecology, economic models, ideology, building materials, construction techniques, and the human environment are all crucial factors influencing the formation and development of traditional villages in Huizhou.[10] Traditional Huizhou dwellings primarily use wooden frameworks. Since wood is susceptible to deformation and damage from natural forces, ornamental motifs are mainly concentrated on structural elements under the eaves and within indoor spaces, such as doors, windows, hanging screens, partitions, beams, brackets, railings, and other key components.[11,12] The visual forms and aesthetic tendencies of these ornamental motifs reflect the social landscape of different historical periods, forming a decorative system that is both continuous and characteristic of its era.[13] In the early to mid-Ming Dynasty, the style of ornamental motifs was relatively simple and unadorned, with minimal decoration. However, from the mid-Ming Dynasty onward, as the living environment of Huizhou people became increasingly affluent and comfortable, more emphasis was placed on the enjoyment of life and cultural connotations in house construction. Consequently, ornamental motifs began to appear extensively on various structural elements, gradually evolving towards a more intricate, delicate, and luxurious style. These motifs were often innovated and varied in either figurative or abstract forms according to the homeowner's needs, enhancing the decorative effect of the interior space and establishing a fashionable trend.[14,15]

Classification of Ornamental Motifs in Traditional Huizhou Dwellings

Over several centuries, the ornamental motifs in traditional Huizhou dwellings evolved from simple to intricate, from narrow to expansive, breaking free from rigid conventions and exhibiting a sense of freedom. These motifs are characterized by symmetry, the unity of solid and void, and a contrast between complexity and simplicity. They can be broadly categorized into geometric motifs, plant motifs, animal motifs, human figures, and object motifs.[16] Geometric motifs are often composed using continuous or symmetrical compositions, both of which are rhythmically strong, visually balanced, and stable, offering excellent visual effects. These motifs are usually found in the latticework of doors or windows in traditional Huizhou dwellings, serving multiple functions such as ventilation, lighting, protection, and aesthetics, making them the most remarkable part of the ornamental motifs in Huizhou architecture. The plant, animal, human, and object motifs are heavily influenced by traditional Chinese painting compositions. Typically, these motifs appear as relief carvings on the skirting boards, hanging panels, and latticework of doors or windows, or as round carvings on components like beams and brackets, with most of the designs being realistic in style.[17,18] These richly varied ornamental motifs bring vitality and liveliness to the otherwise heavy and somber wooden structures, adding interest to the daily lives of Huizhou residents and enhancing the overall quality of their living spaces.

Cultural Connotation of Ornamental Motifs in Traditional Huizhou Dwellings

The ornamental motifs in traditional Huizhou dwellings are imbued with rich ethical standards, blessings, and an uplifting philosophy of life, all strongly characterized by regional culture.[19] Most of the subjects of these ornamental motifs are common landscapes and flora and fauna found in the Huizhou area. Beyond that, Huizhou people also integrated scenes of daily labor, mythical legends, and folk tales into the artistic creation of these motifs, reflecting their views on life, nature, and values.[20] Symbolism is a common artistic technique used in the creation of these motifs. For example, the "cracked ice" motif resembles cracked ice, symbolizing the melting of ice, the revival of all things, and the natural beauty of spring. As ice melts into water, and water is considered a symbol of wealth by the Huizhou people, the "cracked ice" motif carries connotations of nature and prosperity. The bat motif represents good fortune because the word for bat, "蝠" (fú), is a homophone for "福" (fú), which means blessing. Similarly, the deer motif symbolizes wealth and good fortune due to the homophony between "鹿" (lù) and "禄" (lù), which means prosperity. The bamboo motif, with its straight, graceful, and tall appearance, symbolizes integrity and resilience.[21,22] Moreover, the natural qualities and colors of wood further reflect cultural connotations. For instance, shades of red represent nobility and elegance, brown represents warmth and simplicity, and black represents integrity and stability. These attributes enhance the aesthetic implications of the ornamental motifs in traditional Huizhou dwellings, adding depth to their cultural significance.[23]

Current Status and Advantages of Application of Analytic Hierarchy Process and Fuzzy Comprehensive Evaluation in Field of Cultural Heritage

The Analytic Hierarchy Process (AHP) was proposed by Professor T.L. Saaty in the 1970s as a multi-level weight analysis method that combines qualitative and quantitative analysis. It includes a consistency test to help decision-makers identify any contradictions or unreasonable aspects.[24,25,26] The concept of fuzzy sets was introduced by Professor L.A. Zadeh in 1965 as a mathematical model to represent vague or imprecise phenomena. In 1983, Chinese scholar Wang Peizhuang proposed a specific application method of fuzzy mathematics, known as the Fuzzy Comprehensive Evaluation (FCE) method. This method is suitable for complex decision-making problems, allowing for the comprehensive consideration of various influencing factors, and can be adjusted and customized according to the characteristics of specific issues. It uses fuzzy evaluation language such as "excellent, good, average, poor, very poor," offering high flexibility, and has since been widely applied in various fields, including cultural heritage research.[27,28,29] Li[30] utilized AHP to establish a value evaluation system for the reuse of structural elements in traditional houses in the southern region of the Yangtze River's low reaches, also known as Jiangnan. Then, using the FCE method, evaluation criteria for component samples were formulated based on the previously determined evaluation factors, and the components were graded to produce a ranking of their adaptation potential, providing a rational basis for reuse decisions. Hu et al.[31] applied fuzzy AHP to extract and analyze traditional cultural design elements from cultural heritage images. By integrating the adaptive evaluation process, they determined the weight of each element relative to the evaluation criteria, achieving the goal of extracting design elements from cultural heritage, which supports the application and development of traditional cultural design elements in the cultural and creative design industry. Gu[32] applied AHP and FCE to summarize the meanings, principles, and evaluation methods of traditional residential design elements in the Jiangnan region, providing valuable recommendations for the protection and sustainable development of traditional Jiangnan houses. These studies collectively demonstrate the multifunctionality and effectiveness of combining AHP with FCE in cultural heritage research.

In summary, given the intricate and multifaceted relationships among the factors influencing the ornamental motifs in traditional Huizhou dwellings, the combination of AHP and FCE is beneficial for a more comprehensive, accurate, and objective evaluation of the adaptation potential of these ornamental motifs. This approach aids in the preservation and inheritance of traditional cultural resources while promoting the integration of traditional cultural symbols with modern design.[33,34,35,36]

METHOD

Analytic Hierarchy Process

Method of Constructing a Hierarchy Model

The AHP method decomposes complex decision-making problems into multiple hierarchical structures, consisting of an overall target, criteria, factors, and schemes. This hierarchical structure allows decision-makers to break down the problem step-by-step, making it easier to clarify the relationships and importance of various factors.[37,38,39] The goal of this study is to evaluate the adaptation potential of the ornamental motifs in traditional Huizhou dwellings, which is a clear and quantifiable objective. Based on this goal, the study guides and groups the complex factors influencing the evaluation results, establishing a top-down hierarchical model consisting of the "Target layer—Criterion layer—Factor layer" (figure 2). Since the application of AHP in this study is intended to serve as a reference for the weight values in the subsequent FCE scoring of the adaptation potential of ornamental motif samples, and not to provide decision-making scheme, the scheme layer is not included in the model.

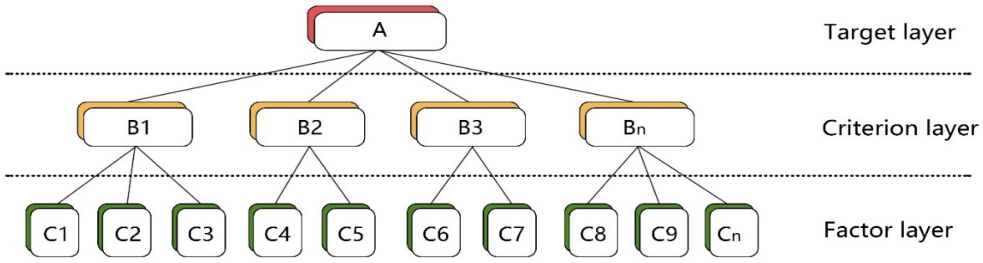

Figure 2. A hierarchical model

To ensure the objectivity and reliability of the model, this study employed the Delphi method, gathering the opinions of 10 experts through anonymous questionnaires (table 1). These experts provided their views and

suggestions on the various factors influencing the adaptation potential of the ornamental motifs in traditional Huizhou dwellings. The study then conducted an anonymous feedback process on the results and sought further opinions to refine and finalize the evaluation factors.

Table 1. Expert information

Expert occupation	Number	Work unit
Designer	1	Architecture Design Co., Ltd.
	2	Decoration Design Co., Ltd.
Researcher of Huizhou culture	1	Huizhou History Museum of Anhui
	1	Huizhou cultural research institutes
Teacher of design major	5	Art and design colleges of Anhui higher education institutions

Method of Constructing a Judgment Matrix

A judgment matrix is a tool used to compare the relative importance of each evaluation factor within the same level of a hierarchy.[40,41] In this study, a scale of 1 to 9 is used, with the scale values determined by each expert based on their evaluations (table 2).

Table 2. Importance comparison rating scale

Numerical Value	Definition
1	Two elements are of equal importance compared to each other
3	Two elements are compared and the former is slightly more important than the latter
5	Two elements are compared and the former is more important than the latter
7	Two elements are compared and the former is significantly more important than the latter
9	Two elements are compared and the former is extremely important than the latter
2, 4, 6, 8	Intermediate values of the above adjacent judgments

Assuming there are n factors, the general formula for the judgment matrix is given by equation 1:

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix} \quad (1)$$

Where A_{ij} represents the importance of the ith factor compared to the jth factor. The judgment matrix in AHP is a positive reciprocal matrix, meaning that $A_{ij} > 0$ and $A_{ij} \times A_{ij} = 1$. When i=j, the comparison is between the same factor, so the diagonal values are 1, as each factor is equally important when compared to itself.[42,43]

Calculation Method of Weights

In this study, the square root method is used to calculate the weights. The process is as follows:

Step 1: Calculate the product of the elements in each row of the judgment matrix. This is done using equation 2:

$$m_i = \prod_{j=1} a_{ij} \quad (2)$$

Step 2: Calculate the nth root of the product (equation 3).

$$w_i^* = \sqrt[n]{m_i} \quad (3)$$

Step 3: Normalize the vectors (equation 4) to derive the weight value of each factor in the judgment matrix.

$$w_i = w_i^* / \sum_{i=1}^{n} w_i^* \quad (4)$$

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To ensure the reliability of the calculated results, a consistency test is necessary for each judgment matrix. The maximum eigenvalue λmax (equation 5) is used as an indicator to evaluate the consistency of the judgment matrix.[44,45] Then, the Consistency Index (CI) is calculated using equation 6, where n is the order of the matrix. Next, the corresponding RI value is found from the RI table, and the R value is calculated (equation 7). If CR≤0,1, the consistency test of the judgment matrix is passed.[46,47]

$$\lambda_{\max} = \frac{1}{n}\sum_{i=1}^{n}\frac{(Aw)i}{w_i} \quad (5)$$

$$CI = \frac{\lambda_{\max} - n}{n-1} \quad (6)$$

$$CR=CI/RI \quad (7)$$

Method of Selecting Motif Samples

In this study, a large number of images of ornamental motifs from traditional Huizhou dwellings of the Ming and Qing dynasties were collected through field research and secondary data collection. To select motifs that are regionally representative and aligned with the research objectives, the Delphi method was employed, and the opinions of experts listed were solicited once again. Initially, a preliminary list of motifs samples was developed based on classification criteria from previous literature studies. Experts were then asked to rank each motif based on its cultural significance, artistic value, and practical relevance, with lower-ranked motifs being eliminated. The revised list of motifs was subsequently resubmitted to the experts for a second round of ranking. After two rounds of surveys, the final motifs samples for fuzzy evaluation in this study were determined.

Method of Fuzzy Comprehensive Calculation

In this study, the weighted average M (.,+) fuzzy operator was used for calculations. The advantage of this method is that it comprehensively utilizes information from both the weight vector matrix and the weight judgment matrix.[48] The process is as follows:

Step 1: create a factor set U_i= {U_1,U_2,…U_n}based on the hierarchical structure model mentioned above, and a weight set W_i= {W_1,W_2,…W_n} that has passed the consistency test, where n is the number of factors.

Step 2: establish the fuzzy relation matrix. In this study, a questionnaire survey method was used. Respondents were first asked to evaluate each factor according to a set of comments {high, moderately high, moderate, moderately low, low}. The results were then quantified to obtain the membership degree of the ith factor to the jth evaluation. The membership degree R is calculated as the proportion of the number of people who gave the jth evaluation for the ith factor to the total number of people who participated in the evaluation. This process establishes the fuzzy relation matrix Rij (equation 8).

$$R_{ij} = \begin{bmatrix} R_{i1}^{j1} & R_{i1}^{j2} & \cdots & R_{i1}^{j5} \\ R_{i2}^{j1} & R_{i2}^{j2} & \cdots & R_{i2}^{j5} \\ \cdots & \cdots & \cdots & \cdots \\ R_{in}^{j1} & R_{in}^{j2} & \cdots & R_{in}^{j5} \end{bmatrix} \quad (8)$$

Step 3: perform fuzzy comprehensive calculation. The weight set Wi is combined with the fuzzy matrix Rij through fuzzy operations to obtain the comprehensive evaluation vector Bi (equation 9). Based on Bi, the fuzzy evaluation result B is derived (equation 10). The final score is obtained by multiplying the membership degree values by the corresponding scores of the evaluation comments {100, 80, 60, 40, 20} and then summing the results.

$$B_i = W_i \cdot R_{ij} = [\mathrm{B_i^1}\ \mathrm{B_i^2}\ \mathrm{B_i^3}\ \ldots\ \mathrm{B_i^n}] \quad (9)$$

$$\mathrm{B} = \mathrm{W} \cdot \mathrm{B_i^j} = \begin{bmatrix} \mathrm{B_1^1} & \mathrm{B_1^2} & \cdots & \mathrm{B_1^5} \\ \mathrm{B_2^1} & \mathrm{B_2^2} & \cdots & \mathrm{B_2^5} \end{bmatrix} \quad (10)$$

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In summary, this study uses AHP as the foundation for evaluating the adaptation potential of ornamental motifs in traditional Huizhou dwellings, leveraging the advantages of AHP's hierarchical structure, combination of qualitative and quantitative analysis, and consistency test. Based on the evaluation factors and weight values, a FCE and ranking of the adaptation potential of the ornamental motif samples are conducted. This approach aims to provide a more rational basis for the selection and reuse of these ornamental motifs.

RESULTS

Hierarchical Structure Model

In this study, drawing on cultural heritage value evaluation criteria, previous literature, and current practical needs, a preliminary hierarchy and influencing factors for the adaptation potential of ornamental motifs in traditional Huizhou dwellings were established. The Delphi method was used for screening, and after three rounds of feedback, the accuracy and reliability of the results were ensured.[49] Ultimately, a hierarchical model was established, with criteria including composition form, color, cultural connotation, social adaptability, and visual expressiveness. Based on this model, the factor layer was determined (figure 3).

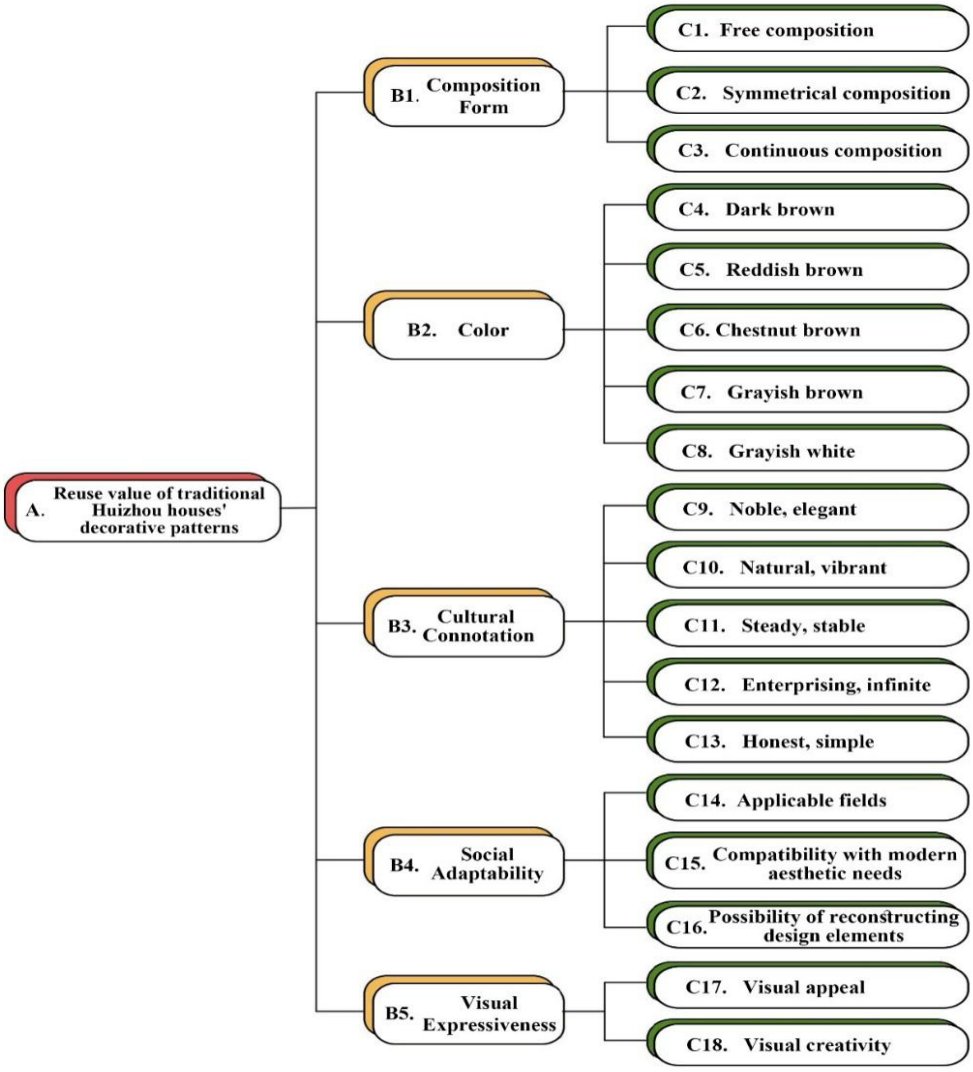


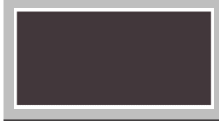
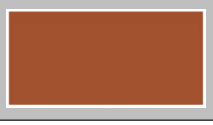
Figure 3. A hierarchical structure model for evaluating the adaptation potential of ornamental motifs in traditional Huizhou dwellings

The descriptions of each criterion layer and its factors are as follows:

B1 "Composition Form" is the most fundamental and direct means of expressing and constructing a visual image. In modern design, the flexible use of various compositional techniques can make visual images more vivid and unique. C1, C2, and C3 represent the most common compositional methods in modern design. These factors are used to evaluate and select motifs that not only retain traditional charm and regional characteristics in their composition but also align with modern design thinking, thereby enhancing their practical adaptation potential.

B2 “Color” refers to the colors associated with the materials of ornamental motifs in traditional Huizhou dwellings. Influenced by the natural environment and construction techniques, traditional Huizhou dwellings predominantly feature wooden structures. For the people of Huizhou, the color of wood is not just a visual experience but also carries deep emotional memories.[50] This study extracts colors from a large number of ornamental motifs in traditional Huizhou dwellings, selecting the most common ones as the factor to evaluate the adaptation potential of the color in these motifs (table 3).

Table 3. Color evaluation factor

C4. Dark brown	C5. Reddish brown	C6. Chestnut brown	C7. Grayish brown	C8. Grayish white
				

B3 “Cultural Connotation” refers to the deeper meanings conveyed by ornamental motifs in traditional Huizhou dwellings, which depict various common local themes in abstract or realistic forms and express characteristics of Huizhou’s regional culture through symbolic artistic techniques. C1 to C5 are connotative factors extracted from the ornamental motifs in traditional Huizhou dwellings that appear relatively frequently, expressed in the form of emotional semantic words. For example, the “ice crack motif” resembles the cracking of ice, symbolizing the beauty of nature and implying the melting of ice and the revival of all things. Therefore, the main connotation extracted from the ice crack motif would be “natural, vibrant”.[51]

B4 “Social Adaptability” includes three factors. C14 evaluates the applicability of ornamental motifs in traditional Huizhou dwellings in modern design fields, determining whether they are suitable for most fields or only a few specific areas. C15 evaluates whether these ornamental motifs align with contemporary aesthetic preferences and needs. C16 evaluates the possibility of reconstructing ornamental motifs in traditional Huizhou dwellings using modern design methods while retaining the original prototypes.

B5 “Visual Expressiveness” refers to the overall visual performance of ornamental motifs in traditional Huizhou dwellings and includes two factors. C17 evaluates whether these motifs have the ability to capture attention and provide a pleasing experience. C18 evaluates whether the motifs possess unique and innovative visual expressiveness.

Weight for Each Factor

Table 4. Judgement matrix for target layer (A)

A	B1	B2	B3	B4	B5	Wi
B1	1	3	1/3	1/3	1/2	0,1223
B2	1/3	1	1/3	1/3	1/3	0,0727
B3	3	3	1	2	1	0,3118
B4	3	3	1/2	1	1/2	0,2057
B5	2	3	1	2	1	0,2875

Table 5. Judgement matrix for criterion layer (B1)

B1	C1	C2	C3	Wi
C1	1	1/2	1/2	0,1958
C2	2	1	1/2	0,3108
C3	2	2	1	0,4934

Table 6. Judgement matrix for criterion layer (B2)

B2	C4	C5	C6	C7	C8	Wi
C4	1	1/4	1/4	2	3	0,1325
C5	4	1	1	3	5	0,3657
C6	4	1	1	2	4	0,3225
C7	1/2	1/3	1/2	1	3	0,1222
C8	1/3	1/5	1/4	1/3	1	0,0571

After clarifying the influencing factors and their meanings in the evaluation system for the adaptation

potential of ornamental motifs in traditional Huizhou dwellings, based on the hierarchical model shown in figure 4, the judgment matrices constructed by ten experts were calculated following the sequence of target layer—criterion layer—factor layer (table 4–table 9). These matrices passed consistency test, with each judgment matrix having a CR ≤ 0,1 (table 4).

Table 7. Judgement matrix for criterion layer (B3)

B3	C9	C10	C11	C12	C13	Wi
C9	1	1	2	1	3	0,2681
C10	1	1	2	1	2	0,2482
C11	1/2	1/2	1	1	2	0,1663
C12	1	1	1	1	2	0,2174
C13	1/3	1/2	1/2	1/2	1	0,1000

Table 8. Judgement matrix for criterion layer (B4)

B4	C14	C15	C16	Wi
C14	1	1/5	1/3	0,1140
C15	5	1	1	0,4806
C16	3	1	1	0,4054

Table 9. Judgement matrix for criterion layer (B5)

B5	C17	C18	Wi
C17	1	4	0,8000
C18	1/4	1	0,2000

Table 10. Consistency test results

Consistency indicators	A	B1	B2	B3	B4	B5
λmax	5,233	3,054	5,247	5,074	3,029	2,000
CI	0,058	0,027	0,062	0,019	0,015	0,000
RI	1,120	0,520	1,120	1,120	0,520	0,000
CR	0,052	0,052	0,055	0,017	0,028	null

Table 11. Weight for each factor

B. Criterion layer	Relative weight	C.Factor layer	Relative weight	Absolute weight
B1. Composition Form	0,1223	C1. Free composition	0,1958	0,0240
		C2. Symmetrical composition	0,3108	0,0380
		C3. Continuous composition	0,4934	0,0603
B2. Color	0,0727	C4. Dark brown	0,1325	0,0096
		C5. Reddish brown	0,3657	0,0266
		C6. Chestnut brown	0,3225	0,0234
		C7. Grayish brown	0,1222	0,0089
		C8. Grayish white	0,0571	0,0042
B3. Cultural Connotation	0,3118	C9. Noble, elegant	0,2681	0,0836
		C10. Natural, vibrant	0,2482	0,0774
		C11. Steady, stable	0,1663	0,0518
		C12. Enterprising, infinite	0,2174	0,0678
		C13. Honest, simple	0,1000	0,0312
B4. Social Adaptability	0,2057	C14. Applicable fields	0,1140	0,0235
		C15. Compatibility with modern aesthetic needs	0,4806	0,0988
		C16. Possibility of reconstructing design elements	0,4054	0,0834
B5. Visual Expressiveness	0,2875	C17. Visual appeal	0,8000	0,2300
		C18. Visual creativity	0,2000	0,0575

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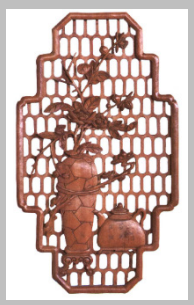
Motif Samples Selection

The final selected motifs samples in this study include geometric motifs, plant motifs, animal motifs, and artifact motifs, while figure motifs, which are also common, were not included. Figure motifs are rich and diverse in content and depend on concrete depictions (figure 4). They are often narrative, featuring themes such as stories from famous works, folk tales, myths, legends, operatic stories, and moral stories reflecting Confucian ideals like loyalty, filial piety, integrity, and righteousness. These motifs have strong aesthetic and educational functions and are more suitable for presentation as traditional artworks.[52] For figure motifs that express connotations through storylines, the use of modern design techniques such as extraction, deformation, abstraction, and deconstruction can affect the completeness and coherence of the story. Therefore, their reuse and redesign value in the modern design field are relatively low.[53] Ultimately, the following 12 motifs were identified as typical samples for FCE (table 12).

Figure 4. Figure motifs

Table 12. Typical samples

S1	S2	S3	S4	S5	S6
					
S7	**S8**	**S9**	**S10**	**S11**	**S12**
					

Fuzzy Comprehensive Evaluation of Motif Samples

In this study, the adaptation potential of 12 samples was evaluated using FCE based on the hierarchical model shown. The evaluation was conducted through an anonymous questionnaire, with questions designed based on each factor. Due to the special nature of the samples in this study, the respondents needed to have an understanding of Huizhou traditional culture. Therefore, students from universities in the Huizhou region were

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chosen as the survey participants, as they are important potential users and inheritors of Huizhou culture (table 13). A total of 200 questionnaires were distributed, and 188 valid responses were collected. Among these, 152 questionnaires were from respondents whose household registration is in the Huizhou region. These 152 responses can relatively accurately reflect the relationship between ornamental motifs in traditional Huizhou dwellings and the needs of the current younger generation.

Table 13. Respondent information

Category		Number of people	Percentage
Gender	Female	104	55,32
	Male	84	44,68
Household registration location	Six Huizhou counties	152	80,85
	Other regions in Anhui Province	26	13,83
	Other domestic regions outside Anhui	10	5,32

Based on the questionnaire results, equations 8-10 and table 14, the comprehensive evaluation values of the target, criterion and factor layers were calculated and the results are shown in table 15.

Table 14. Comment set of adaptation potential factors of ornamental motifs in traditional Huizhou dwellings

Grade	I	II	III	IV	V
Comment	High	Moderately high	Moderate	Moderately low	Low
Score range	90-100	70-89	50-69	30-49	0-29

Table 15. FCE of motif samples

Sample No.	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
B1	82,4	81,8	92,6	75,3	83,3	90,8	82,9	67,1	35,5	37,1	51,8	36,9
B2	72,1	42,0	55,2	71,5	72,6	73,3	72,9	36,4	72,4	72,2	73,2	72,4
B3	77,7	81,5	86,3	62,7	85,1	82,6	83,6	61,2	81,2	85,0	53,7	53,4
B4	94,7	97,1	97,9	77,0	95,6	90,2	92,9	73,2	51,0	48,3	33,4	40,0
B5	87,7	97,5	98,1	66,0	98,0	96,5	95,1	63,9	59,0	51,5	40,4	46,7
C1	80,4	99,6	63,2	48,4	70,4	64,0	68,8	36,0	99,2	100	53,2	100
C2	58,8	48,0	100,0	100,0	66,8	100,0	66,0	100,0	20,0	20,0	100,0	20,0
C3	98,0	96,0	99,6	70,4	98,8	95,6	99,2	58,8	20,0	22,8	20,8	22,4
C4	20,8	22,4	68,0	36,8	20,8	20,8	20,8	100,0	20,8	20,8	20,8	20,8
C5	97,2	20,0	28,4	74,0	98,8	99,2	97,6	20,0	98,0	98,4	99,2	97,6
C6	88,0	45,2	58,8	98,4	88,8	89,6	91,2	28,4	89,2	88,0	89,2	89,6
C7	34,8	94,0	96,0	54,4	32,0	34,8	32,0	45,2	32,0	32,0	34,8	32,0
C8	20,0	99,6	89,6	20,8	20,0	20,0	20,0	20,0	20,0	20,0	20,0	20,0
C9	43,6	68,4	99,2	26,4	91,2	90,0	86,4	26,4	80,0	88,0	44,8	46,8
C10	94,4	98,8	91,2	59,6	89,6	86,4	84,0	58,4	91,6	93,6	72,4	66,0
C11	90,8	72,8	80,4	96,8	72,4	70,4	74,4	94,0	88,4	73,2	56,0	58,4
C12	83,6	87,6	72,4	68,8	88,8	83,2	86,4	64,8	66,0	80,0	44,8	45,6
C13	92,8	75,2	80,0	98,0	70,4	72,4	84,0	98,8	79,6	85,6	46,4	48,0
C14	98,4	93,6	92,8	98,4	90,0	85,2	93,2	97,6	59,6	58,8	41,6	53,2
C15	94,8	97,6	98,4	77,2	95,2	89,2	94,0	72,8	51,2	48,4	32,0	44,0
C16	93,6	97,6	98,8	70,8	97,6	92,8	91,6	66,8	48,4	45,2	32,8	31,6
C17	88,0	98,0	98,4	64,8	98,8	97,2	95,6	62,8	60,0	51,2	39,2	46,4
C18	86,4	95,6	96,8	70,8	94,8	93,6	93,2	68,4	55,2	52,8	45,2	48,0
Total score	84,2	86,5	90,6	68,8	89,8	88,5	88,0	63,4	62,4	61,0	46,9	48,1
Overall grade	II	II	I	III	I	II	II	III	III	III	IV	IV

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DISCUSSION

Interpretation and Analysis of Weighted Values

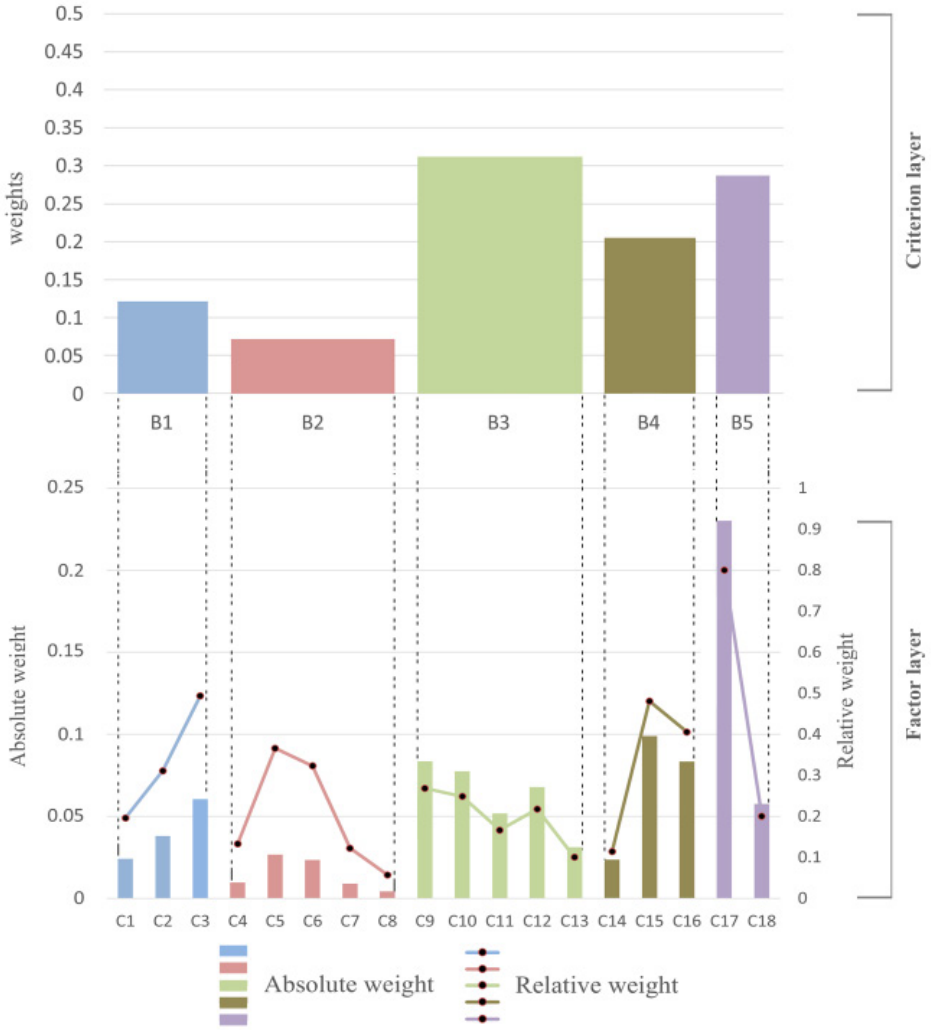

Figure 5. Comparison of relative and absolute weights of each factor

The absolute and relative weights from table 11 were organized and ranked to determine the importance of each factor affecting the adaptation potential of ornamental motifs in traditional Huizhou dwellings, as shown in figure 5.

From the figure, it can be seen that C17 “Visual Appeal” which belongs to the criterion layer B5 “Visual Expressiveness” has the highest relative and absolute weights. This indicates that, in the hierarchical model established in this study, “Visual Appeal” is the most important factor influencing the adaptation potential of ornamental motifs in traditional Huizhou dwellings. Vision is one of the most important ways for people to perceive the world. Thomas Reid conducted an in-depth analysis of senses such as vision, hearing, and touch, highlighting the importance of vision. In fact, over 80 % of external information is obtained through vision.[54,55] Vision provides people with a wealth of information, which is transmitted to the brain through sensory organs, leading to perception. As the core of the cognitive process, vision mainly relies on people’s perception of the shape of things, including understanding their natural properties and cultural meanings.[56,57] Thus, the factor “Visual Appeal” is strongly related to the criterion layers B1 “Composition Form” and B3 “Cultural Connotation.” The factor C3 “Continuous Composition,” which belongs to B1 “Composition Form” and the factor C9 “Noble, Elegant” which belongs to B3, have the highest relative weights, indicating that motifs with direct or indirect characteristics of continuous composition have the highest adaptation potential, and “Noble, Elegant” best reflects the charm and cultural temperament of ornamental motifs in traditional Huizhou dwellings. These provide a basis and direction for the modern transformation and innovation of traditional motifs. In modern design practice, ornamental motifs in traditional Huizhou dwellings with continuous composition and noble, elegant characteristics can be prioritized for reuse to ensure that the design scheme not only evokes Huizhou traditional culture but also provides a pleasant visual experience, enhancing people’s affection and recognition

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for Huizhou traditional culture, which is fundamental for cultural heritage. It is important to note that although the weight of the criterion layer B2 "Color" ranks last, its importance should not be overlooked. Numerous studies have shown that there is a close relationship between color and human psychological activities, and certain colors may trigger emotional responses in people influenced by specific environments and cultural atmospheres.[58] The factor C5 "Reddish brown" which belongs to B2 "Color" has the highest relative weight. In modern design practice, choosing this color can further enhance the emotional expression and attractiveness of ornamental motifs in traditional Huizhou dwellings, achieving better design effects and improving the adaptation potential of motifs. Additionally, the weight values of C15 "Compatibility with Modern Aesthetic Needs" and C16 "Possibility of Reconstructing Design Elements" which belong to the criterion layer B4 "Social Adaptability" rank high and are also important indicators for evaluating and comparing the adaptation potential of motifs.

In summary, determining the relative and absolute weights of the factors in the hierarchical model enhances the operability and accuracy of the sample's fuzzy evaluation, while also providing a reasonable and effective comparative analysis system for the comprehensive evaluation of the adaptation potential of ornamental motifs in traditional Huizhou dwellings.

Interpretation and Analysis of Fuzzy Evaluation Results

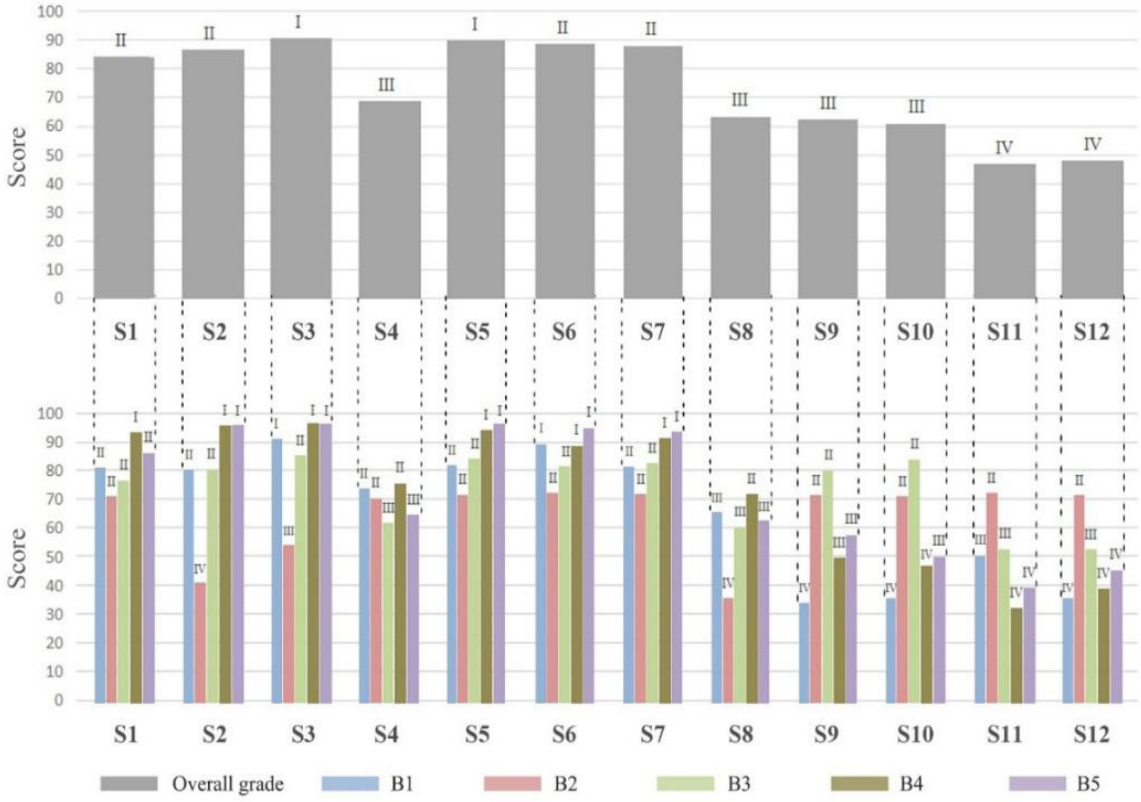

Figure 6. Comparison of adaptation potentials of motif samples

Based on the evaluation set of adaptation potential factors for ornamental motifs in traditional Huizhou dwellings (table 14), a fuzzy evaluation was conducted on the criterion layer and factor layer of the 12 motif samples. The comprehensive rating for each motif sample was then calculated (table 15). The following paragraph provides a comparative analysis of the evaluation results, as shown in figure 6.

Overall, Sample 3 and Sample 5 have the highest adaptation potential. They exhibit strong social adaptability and visual expressiveness, along with composition forms and deep cultural connotations that align well with modern design thinking. Sample 3 features symmetrical and continuous crabapple motifs. The crabapple, with its lush and vibrant blossoms, is revered as a divine flower, symbolizing family prosperity and wealth. Sample 5 features continuous but asymmetrical windmill-shaped motifs. The windmill harnesses wind energy and converts it into power, serving as a tangible object representing the acquisition of wealth. Samples 1, 2, 6, and 7 also have relatively high adaptation potential. They share similar symbolic core elements with Samples 3 and 5 (table 16) and can be reinterpreted through modern design techniques to create new symbolic languages, thereby establishing an intrinsic connection with the essence of traditional culture.

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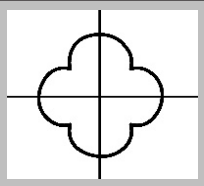
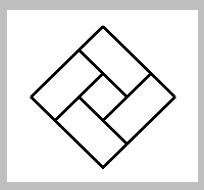
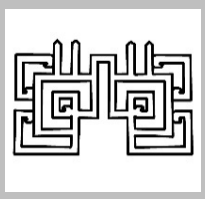
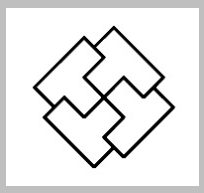
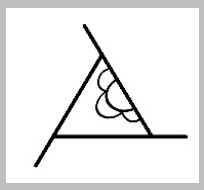
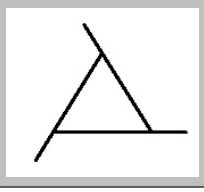
Table 16. Symbols and connotations of high-value motif samples

Sample No.	Score (Grade)	Core element (symbol)	Signifier	Signified
S3	90,6 (I)		Crabapple motif	Symbolizes nobility and elegance, a happy and beautiful life.
S5	89,8 (I)		Windmill motif	Symbolizes the endless power and wealth bestowed by nature.
S6	88,5 (II)		Loong motif	Symbolizes continuity and lasting prosperity.
S7	88,0 (II)		Swastika motif	Symbolizes good fortune and auspiciousness, with life renewing endlessly.
S2	86,5 (II)		Ice plum motif	Symbolizes unique beauty and vitality, signifying noble character and strong will.
S1	84,2 (II)		Ice crack motif	As the ice melts and all things revive, it symbolizes vitality and the beauty of nature.

Samples 4, 8, 9, and 10 have moderate overall adaptation potential, while samples 11 and 12 have lower overall adaptation potential. Samples 4 and 8 belong to linear geometric motifs. Although they have strong social adaptability and meet modern aesthetic needs, they lack visual expressiveness and do not contain core elements with clear symbolic meanings, making them ineffective in conveying cultural connotations. Samples 9, 10, 11, and 12 feature traditional realistic styles with vases, bamboo and rocks, bats, and deer as core elements, clearly conveying deep meanings of peace and stability, integrity and resilience, and wealth and happiness. However, in the context of modern design, the awareness and acceptance of such motifs, which use traditional expression methods, are evidently limited among younger groups. Therefore, the fuzzy evaluation results of this study also partially indicate the market demand and application potential of traditional Huizhou motifs. This is an important factor that designers need to consider when selecting traditional motifs for reuse.[59]

In conclusion, geometric motifs with symbolic meanings and connotations have the highest adaptation potential in the modern design field. These motifs, based on core elements and using continuous and/or symmetrical compositions, exhibit characteristics of regionalization, standardization, and systematization. They have a strong sense of rhythm, balanced and stable imagery, profound cultural connotations, and a simple, natural decorative effect, aligning with the practical needs of Huizhou cultural inheritance.[60] On the other hand, ornamental motifs that use traditional expression methods, due to their relatively free and complex imagery, have limited reuse possibilities. Currently, most of these ornamental motifs are displayed as artworks in museums or published in academic research collections, with their professional nature limiting a broader audience. This has led to these traditional motifs gradually fading from the daily lives of the public, facing challenges in heritage and sustainable development.

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CONCLUSIONS

Establishing an adaptation potential evaluation system for ornamental motifs in traditional Huizhou dwellings allows complex issues to become quantifiable and measurable, enhancing designers' understanding and selection efficiency of these ornamental motifs, and enabling them to master correct redesign methods based on practical needs. The Analytic Hierarchy Process (AHP), as one of the most comprehensive multi-criteria decision-making tools available today, laid the foundation for achieving fuzzy comprehensive evaluation (FCE) in this study. Based on five criteria—composition form, color, cultural connotation, social adaptability, and visual expressiveness—and 18 influencing factors, this study constructed a hierarchical model for evaluating the adaptation potential of ornamental motifs in traditional Huizhou dwellings. The weights were obtained using expert judgment and passed a consistency test. Since there may be certain differences between expert cognition and user needs, to better achieve the practical goal of Huizhou cultural inheritance, this study conducted a comprehensive and factor evaluation of ornamental motif samples using students from universities in the Huizhou region as the survey respondents. The research results provide designers with clearer and more practical design guidance, making it easier for the target audience to understand and accept.

However, this study still has certain limitations. First, the fuzzy evaluation questionnaire used in this study is based on evaluation criteria derived from expert opinions. Since the respondents' levels of understanding and attention to Huizhou traditional culture vary, there may be bias in the evaluation ratings of certain factors in the ornamental motif samples. Second, this study broadly evaluated the adaptation potential of ornamental motifs in traditional Huizhou dwellings in modern design, which has general practical significance for preliminary screening. However, different design fields may require adjustments to the selection and redesign methods of traditional motifs based on practical needs. This also provides a broader perspective for establishing more specific and detailed evaluation systems for the adaptation potential of ornamental motifs in traditional Huizhou dwellings in various design fields. Additionally, the number of experts and respondents involved in this study was relatively small. Although this does not affect the primary findings, increasing the number of survey participants would enhance the accuracy and persuasiveness of the results.

In future research, the hierarchical model established in this study requires further optimization and validation through specific design projects. Traditional Huizhou dwellings serve as living spaces that embody cultural significance through the use of symbolism, metaphor, narrative, and signs. The ornamental motifs in traditional Huizhou dwellings elucidate the multiple meanings of the "home" as a living space, making them a crucial element in understanding Huizhou culture and holding special significance. Therefore, while these ornamental motifs have broad adaptation potential in modern design, their application is inherently directional and purposeful from the perspective of spatial production and cultural representation. The application and promotion of the regional uniqueness and design rules of ornamental motifs in traditional Huizhou dwellings in the field of interior design, especially within urban residential spaces, should be a key focus for future research.

BIBLIOGRAPHIC REFERENCES

1. Fang XB. The cultural representation of Huizhou residential space based on the theory of space production. J Anhui Univ Sci Technol (Soc Sci Ed). 2023;(3):90–5.

2. Chen JK, Liu RY. On the value of Confucianism in the construction of Huizhou traditional settlement space. J Southwest For Univ (Soc Sci). 2024;(1):23–30.

3. He XN, Wang XJ, Guo YY. Features and expression of Huizhou architectural window lattice decorative art. Ind Des. 2022;12:137–9. https://kns.cnki.net/kcms2/article/abstract?v=bTgd32KJj6uiS9jyPvtHiZoP5NnQqolMjBAbFagYtuC4MRwoI0AjhJFFhtvb03iluesJeLGb0QSgjxJjbHdUnnH0q2UKC0FA8Sy-dLGX6beVHRHpr2uVfHMgaF9SWS65SFbNqWgI3XVLsDp6v3BvEu7qYjxR_XyaX5qzllMXlJARelHjOjhMSA==&uniplatform=NZKPT&language=CHS

4. Li LS, Deng YJ, Lu JH. The rhetorical techniques and narrative value of visual elements in Huizhou wood carving. J Fuyang Norm Univ (Soc Sci Ed). 2022;(5):37–43. doi:10.14096/j.cnki.cn34-1333/c.2022.05.06.

5. Yang L. An analysis of the symbolic attributes of decorative components in Huizhou architectural carvings. J Hubei Norm Univ (Philos Soc Sci Ed). 2022;(5):93–8. https://kns.cnki.net/kcms2/article/abstract?v=bTgd32KJj6v3tr5L1PNJnSBqAticfQOEJD5CjtiJmL4faGdY3QogoJnjxv9uuNZwR4KgnQNXyMCsUEP0UHyJt9naGx1GQRFYBW-iJGr7uCVJgy1sMp7lWy-fYxXtz8vO5S9nVH-Nyvmw6N7aby7LHFZF6raXtNwZAySNQ9hAg2UhexZyd7o3wpw==&uniplatform=NZKPT&language=CHS

6. Cao Z, Mustafa M, Mohd Isa MH. Regional Architecture Building Identity: The Mediating Role of Authentic Pride. Buildings. 2024 Apr 10;14(4):1059.DOI: 10.3390/buildings14041059

7. Ren K, Xu J. Formation Process and Spatial Representation of Tourist Destination Personality from the Perspective of Cultural Heritage: Application in Traditional Villages in Ancient Huizhou, China. Land. 2024 Mar 27;13(4):423.DOI: 10.3390/land13040423.

8. Gao S, He XC, Jiang LL. Analysis of geometric decoration in ancient Huizhou architecture decoration. J Huangshan Univ. 2022;(4):25–9. https://kns.cnki.net/kcms2/article/abstract?v=bTgd32KJj6upQAFzTeXNdqIN4cC2KDx9AmkMgRrquhbstyDET1o1PutA44_a9Lrx3WTj_e5xcYr5sRx94j2oBWNCiWegL17Ol2MSpVeXFbJey8xfqiETsCNXfKnI5UZWyb-f4Jb2azuF3q5H_MOWJ1M7XieKXIiHJoZdVY3nzwC1D5J21Z4-4g==&uniplatform=NZKPT&language=CHS

9. Yang T. Research on the application of Huizhou ancient architectural symbols in interior design. J Xinjiang Arts Univ. 2022;(1):36–44.

10. Xie L, Wang GR, Guo YL. From carrier and function to materialization: an examination of the interior decoration design of Chengzhi Hall in Hongcun, a Huizhou ancient residence. J Jilin Acad Arts. 2022;(1):38–44. doi:10.13867/j.cnki.1674-5442.2022.01.005.

11. Wang J. Research on the application of traditional lattice window decoration in modern interior design. J Bengbu Univ. 2021;(6):48–51. doi:10.13900/j.cnki.jbc.2021.06.010.

12. Lu XB, Zhang XY, Wu R. A study on spatial image and decorative image narration of Huizhou residence. J Anhui Jianzhu Univ. 2021;(5):36–44. https://kns.cnki.net/kcms2/article/abstract?v=bTgd32KJj6smitGVxaRZyRrBXPFtug6tECIOeKJ71XiiXXiRwwnWRaQwLgJZ_Rwy-vE0ScNQSstr6twyAjwz_J1c1AwhPT0-ry0iEPRJ4841-69zaAempRuOxad-1EUV9KGpLj7zpxB1uGUVL4LFlQiggg2CJ_a4kwZPxVUiF1zvou9vQ4jSBA==&uniplatform=NZKPT&language=CHS

13. Wang C. The cultural connotation of decorative wood-carving images in Huizhou ancient residences. J Yancheng Teach Univ (Humanit Soc Sci Ed). 2016;(5):53–6. doi:10.16401/j.cnki.ysxb.1003-6873.2016.05.125.

14. Xie T. Architecture and decorative style of ancient dwellings in Huizhou. Hundr Sch Arts. 2013;(2):241–3. https://kns.cnki.net/kcms2/article/abstract?v=bTgd32KJj6sn90CVBgv9B-ePLf0qAtyOZJb5Ul3kgFcAAtZ6nZkvg3P_28n-2HhfW7_duiC7lR2PhJphDruMhG4NFYUpSyOaVb_PzcyU7wewOhBMbkhiTy5OpjDRfFSYvH_gDeGBUjJ2dRoJnEAB8sJ5W-DGkY2aSQ9uilO9NB40Mwrn3gc6KA==&uniplatform=NZKPT&language=CHS

15. Li LS. Research on the art of wood carving ornamental motifs in Huizhou ancient buildings. J Anhui Univ Technol (Soc Sci Ed). 2012;(2):46–7,160.

16. Zhang Q, Chen G, Zhang XR. Study on the Decorative Art of Huizhou Ancient Folk Houses. AMM. 2011 Jul;71–78:531–6. doi:10.4028/www.scientific.net/AMM.71-78.531.

17. Li Y, Wang X, Lin S. Enlightenment of Huizhou-style houses on the modern building design. In: Proceedings of the 2nd International Conference on Culture, Education and Economic Development of Modern Society (ICCESE 2018); 2018 Mar 29–30; Moscow, Russia. Paris: Atlantis Press; 2018. p. 762–6. doi:10.2991/iccese-18.2018.171.

18. Cao Z, Mustafa MB. A study of ornamental craftsmanship in doors and windows of Hui-style architecture: the Huizhou three carvings (brick, stone, and wood carvings). Buildings. 2023;13:351. doi:10.3390/buildings13020351.

19. Cheng G, Li Z, Xia S, Gao M, Ye M, Shi T. Research on the spatial sequence of building facades in Huizhou regional traditional villages. Buildings. 2023;13:174. doi:10.3390/buildings13010174.

20. Cao Z, Mustafa M, Zhang C, Mohd Isa MH. Historical perspective on the preservation of production techniques and material applications in the carved architectural ornamentation of Hui-style architecture. Mediterr Archaeol Archaeom. 2024;24:74–96. doi:10.5281/ZENODO.10591919.

21. Fang X, Li L, Gao Y, Liu N, Cheng L. Expressing the spatial concepts of interior spaces in residential buildings of Huizhou, China: narrative methods of wood-carving imagery. Buildings. 2024;14:1414. doi:10.3390/buildings14051414.

22. Huang Z, Zhao W, Wang C, Lu Y, Zhang Y. Inheritance design of residence based on Huizhou traditional dwellings. J Asian Archit Build Eng. 2025;24:835–50. doi:10.1080/13467581.2023.2299719.

23. Wang DC, Miao JJ. Characteristics of architectural color order in Hongcun, Huizhou: a case study based on Yuezhao area. South Archit. 2023;6:76–85. https://kns.cnki.net/kcms2/article/abstract?v=bTgd32KJj6uTG3Zd-RlybZNNAtQPFO_UvSOEhqpLKxTeK8SsT6aA3nzkDxTNlYYDJ4pc3IRkdt3o7_gy_tpCaX7hEBniGMmZVYwzOCl_4pKCwAnhnBE-xcZWpOPFV-eGkoLc6TUROyJt3KjGTvb9I6A5rh3jrC4tg2AtCjghXTZx86WiLA-kOw==&uniplatform=NZKPT&language=CHS

24. Yuan N, Huang N, Zhang L, Fan WJ, Sun KQ. Evaluation of tourism resources based on AHP method in ancient villages—a case of World Heritage Site of Xidi and Hongcun. Resour Dev Mark. 2012;(2):179–81. https://kns.cnki.net/kcms2/article/abstract?v=bTgd32KJj6v-RpvBK3ULuMldKWiZyYOfKZWkxCnEUQhZeryEy2D3qtcc3eiQZIjaXGL-PKBqehWZLWmOd6Z4PTTBcbPmaGYBVqUEz_A7TrtvRhMiCR5AX_pnixQ_6Spxz2VjOh0yAEPnAPpVTL67QYyzf-lFAdTWn4jcWp7EfY0hxn8OGMN0ow==&uniplatform=NZKPT&language=CHS

25. Li TJ, Wei YJ. Study on the evaluation of public space interior landscape design based on AHP-weighted average operator fuzzy comprehensive evaluation method. Heilongjiang Sci. 2022;20:45–7. https://kns.cnki.net/kcms2/article/abstract?v=bTgd32KJj6uYKiTuaunp0PAVJ6QX8sXoHVfy3QdQtSUWsZ9ZTlpDIznbRbqGNAPlZc9l1jto9jDt-Alxabuz6OUdsWSDr-z2PCQk4-QWSgF7G9L3m3026cdO43wBmJ_ssLJsfg8WBUyxV73b9HBnS1g_eVUJb3f3_OReW9yG4xapPg9JWCT6iA==&uniplatform=NZKPT&language=CHS

26. Awad J, Jung C. Extracting the planning elements for sustainable urban regeneration in Dubai with AHP (analytic hierarchy process). Sustain Cities Soc. 2022;76:103496. doi:10.1016/j.scs.2021.103496.

27. Li WL, Sun YH, Gou R. Design of graphic symbols for subway station names based on the fuzzy hierarchical analysis method. Packag Eng. 2021;14:277–83. doi:10.19554/j.cnki.1001-3563.2021.14.036.

28. Li WL, Sun YH, Gou R. Design of graphic symbols for subway station names based on the fuzzy hierarchical analysis method. Packag Eng. 2021;14:277–83. doi:10.19554/j.cnki.1001-3563.2021.14.036.

29. Kabassi K, Karydis C, Botonis A. AHP, Fuzzy SAW, and Fuzzy WPM for the evaluation of cultural websites. Multimodal Technol Interact. 2020;4:5. doi:10.3390/mti4010005.

30. Li Y, Guo HY. The reuse of the traditional residential building components in Jiangnan area. Southeast Cult. 2020;(6):21–9. https://kns.cnki.net/kcms2/article/abstract?v=bTgd32KJj6uO8b09g42GRorpm02OUFAmxe-dqTAN4yP1yxcPUoIedijcCpg-0_nS2VfD1MEQIRf4wD7ds3Xns_xd_JiwQtv6fDksGQsS5UUe-VozRH3lLWsJ6fOCJfnTyuBDCBS4KZkf1CSNLG4IUucu8ur3i8srD8N8vZqseRhZHwD6D6ZqKA==&uniplatform=NZKPT&language=CHS

31. Hu Y, Yu S, Qin S, Chen D, Chu J, Yang Y. How to extract traditional cultural design elements from a set of images of cultural relics based on F-AHP and entropy. Multimed Tools Appl. 2021;80:5833–56. doi:10.1007/s11042-020-09348-w.

32. Gu X. The analysis of architecture design elements of Jiangnan traditional residence based on AHP. IOP Conf Ser Earth Environ Sci. 2021;768:012137. doi:10.1088/1755-1315/768/1/012137.

33. Claver J, García-Domínguez A, Sebastián MA. Multicriteria decision tool for sustainable reuse of industrial heritage into its urban and social environment. Case studies. Sustainability. 2020;12:7430. doi:10.3390/su12187430.

34. Zhu S, Choi B, Kang C. Establishing and applying a value evaluation model for traditional pit kiln villages in the Henan Province of China. J Asian Archit Build Eng. 2022;21:1262–74. doi:10.1080/13467581.2021.1929242.

35. Sun N, He Y, Wang C, Zhang J. Research on sustainable design of consumers' influence factors of Huaihe willow weaving based on AHP. Sustainability. 2023;15:11115. doi:10.3390/su151411115.

36. Lai W-H, Vinh NQ. An application of AHP approach to investigate tourism promotional effectiveness. Tour Hosp Manag. 2013;19:1–22. doi:10.20867/thm.19.1.1.

37. Crouch GI, Ritchie JRB. Application of the analytic hierarchy process to tourism choice and decision

making: a review and illustration applied to destination competitiveness. Tour Anal. 2005;10:17–25. doi:10.3727/1083542054547930.

38. Chen C-F. Applying the analytical hierarchy process (AHP) approach to convention site selection. J Travel Res. 2006;45:167–74. doi:10.1177/0047287506291593.

39. Li J, Peng X, Li C, Luo Q, Peng S, Tang H, Tang R. Renovation of traditional residential buildings in Lijiang based on AHP-QFD methodology: a case study of the Wenzhi Village. Buildings. 2023;13:2055. doi:10.3390/buildings13082055.

40. Bertolini M, Braglia M, Carmignani G. Application of the AHP methodology in making a proposal for a public work contract. Int J Proj Manag. 2006;24:422–30. doi:10.1016/j.ijproman.2006.01.005.

41. Wang T, Chen H, Hamat B, Zhao Y. Research on cultural and creative design method of 2022 World Cup lamps based on AHP-FCE. PLoS One. 2023;18:e0286682. doi:10.1371/journal.pone.0286682.

42. Guo S, Zheng X, Heath T. Research on the design of community museums based on the fuzzy comprehensive evaluation method. Sustainability. 2022;14:10802. doi:10.3390/su141710802.

43. Feng X, Yu L, Chen G. The deconstruction of emotional identity of recreation for ethnic cultural heritage in the geo-cultural perspective: a fuzzy set qualitative comparative analysis on Wuqiang new year paintings. Herit Sci. 2023;11:71. doi:10.1186/s40494-023-00921-8.

44. Liu M, Zhu X, Chen Y, Kong Q. Evaluation and design of dining room chair based on analytic hierarchy process (AHP) and fuzzy AHP. BioResources. 2023;18:2574–88. doi:10.15376/biores.18.2.2574-2588.

45. Otay İ. Tech-center location selection by interval-valued spherical fuzzy AHP based MULTIMOORA methodology. Soft Comput. 2023;27:10941–60. doi:10.1007/s00500-023-08082-3.

46. Song P, Liu Y, Sun J. Research on the copyright value evaluation model of online movies based on the fuzzy evaluation method and analytic hierarchy process. Systems. 2023;11:405. doi:10.3390/systems11080405.

47. Hu Y, Zhang Y, Xia X, Li Q, Ji Y, Wang R, Li Y, Zhang Y. Research on the evaluation of the livability of outdoor space in old residential areas based on the AHP and fuzzy comprehensive evaluation: a case study of Suzhou City, China. J Asian Archit Build Eng. 2024;23:1808–25. doi:10.1080/13467581.2023.2278456.

48. Li Y, Wang J, Ju K, Wei S, Wang Z, Hu J. Assessing the susceptibility of the Xiangka debris flow using analytic hierarchy process, fuzzy comprehensive evaluation method, and cloud model. Sustainability. 2024;16:5392. doi:10.3390/su16135392.

49. Fang Q, Li Z. Cultural ecology cognition and heritage value of Huizhou traditional villages. Heliyon. 2022;8:e12627. doi:10.1016/j.heliyon.2022.e12627.

50. Li LS, Qian CC. An analysis of the emotional value of “Huizhou wood carving art” in interior design. J Anhui Univ Technol (Soc Sci Ed). 2019;(1):17–9. https://kns.cnki.net/kcms2/article/abstract?v=bTgd32KJj6vdn8EXHVeyEIiWb2ntL8V0f27s6tm3a-gZNXmSbqkkW06QWijDiESpsqtTxLyDf45647wWL9nQYS8HbpAybc7NG3itE3Q6wKfz6DvEHHT3XaSilUf8L1ddIIzfRdc_XzLdAITGR-kvn3yjquaOUYFfnaOQLTNzo--_D2NJ_oDlmA==&uniplatform=NZKPT&language=CHS

51. Tang GL. Symbolic expression and system construction of Hui culture: taking ancient villages and ancient architectural culture in Huizhou as examples. Jianghuai Forum. 2019;2019(4):180–6. doi:10.16064/j.cnki.cn34-1003/g0.2019.04.028.

52. Tang JY. Exploration of the development and inheritance of Huizhou wood carving in Anhui Province. J Anqing Norm Univ (Soc Sci Ed). 2020;2020(3):95–9. doi:10.13757/j.cnki.cn34-1329/c.2020.03.019.

53. Wang C. Interpretation of the symbolic meaning and imagery of auspicious motifs in Huizhou wood carving. J Qiqihar Univ (Philos Soc Sci Ed). 2020;2020(4):145–8. doi:10.13971/j.cnki.cn23-1435/c.2020.04.038.

54. Zhou X. Visual construction, visual representation, and visuality: an examination of three core concepts in visual culture. Lit Rev. 2017;3:17–24. https://kns.cnki.net/kcms2/article/abstract?v=bTgd32KJj6v2T5Yg_nVsSa5k-N3Lyjcg_YeP6eatlZGaJ-4sQGgTliMX-igpW8Mbg2M8L2K3_w1Tc0LME9K7uyzpQx0EGMXBYlVWYdQM4pzo14wi3p_4SU-aa5IWx5U5RC3WahcUCGhxhV-mYFNpjB-3wl_OG_JNH7SzXPda9lFXzOQPT99vmw==&uniplatform=NZKPT&language=CHS

55. Zhang Y. An innovative development model for combining visual communication and art design based on the integration of multilevel features. Appl Math Nonlinear Sci. 2024;9:20240156. doi:10.2478/amns-2024-0156.

56. Lan H. Influencing factors of modern and contemporary decorative motif design on users' visual perception characteristics. Appl Math Nonlinear Sci. 2024;9:20230168. doi:10.2478/amns.2023.1.00168.

57. Shynu RV, Suseelan A. Human cognition and emotional response towards visual environmental features in an urban built context: a systematic review on perception-based studies. Archit Sci Rev. 2023;66:468–78. doi:10.1080/00038628.2023.2232339.

58. Feng L. Column carving art in ancient Huizhou architecture. In: Proceedings of the 2018 8th International Conference on Social Science and Education Research (SSER 2018); 2018; Xi, China. Atlantis Press; 2018. p. 87–91. doi:10.2991/sser-18.2018.20.

59. Shou T. Hierarchy and order: constructive rationality in the decoration of Huizhou vernacular architecture. Archit Herit. 2021;1:68–77. doi:10.19673/j.cnki.ha.2021.01.007.

60. Li L, Wang XJ, Zhang Q. Research on innovative design of Huizhou folk furniture based on design semiotics. Ind Des. 2020;(09):125–6.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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