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Article

Architectural Culture Memes Sustainability in the Pearl River Delta: A Case Study of Hakka Enclosed Dwellings in Huizhou

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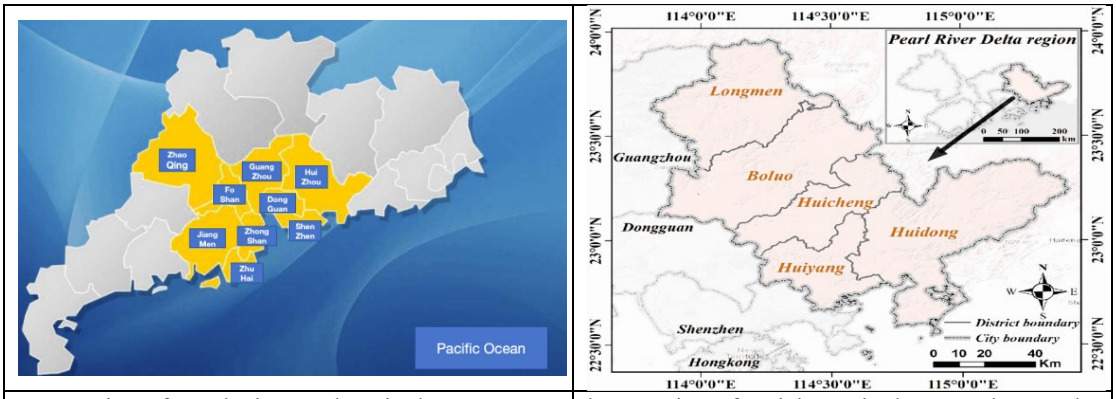
Abstract: The cultural characteristics of traditional residences in the Pearl River Delta are facing the threat of disappearance, posing a severe challenge to the inheritance and development of these architectural cultural genes. To address this crisis, this study selects Hakka traditional enclosed dwellings in Huizhou (HTEDH) as the research object, based on a literature review and field investigations. Through expert interviews, seven experts rated the importance of cultural genes in HTEDH, and a widely-adopted Analytic Hierarchy Process (AHP) was employed to establish a comprehensive memes identification and judgment matrix for HTEDH. The model categorizes the architectural cultural memes of HTEDH into four main clusters: spatial layout, exterior and structure, materials and craftsmanship, and decoration, with 35 sub-genes identified as indicators within these categories. Consistency checks and weight calculations were performed using the AHP method. Based on the calculated weights, the architectural cultural memes were ranked in terms of structure and priority. The results of this study provide an importance ranking of the architectural cultural genes of HTEDH and construct a ranking index system. Additionally, questionnaires were distributed to local residents to obtain the proportion of liking for each architectural cultural gene of HTEDH. The research method and results, which combine importance ranking with public preference, provide a foundation and decision-making reference for protecting residential cultural memes in the Pearl River Delta region. The proposed ranking offers an appropriate evaluation criterion for applying architectural genes in rural landscape conservation and development, facilitating the inheritance and development of traditional residential architectural cultural memes.

Keywords: Architectural Culture Memes; Hakka Enclosed Dwellings; Pearl River Delta

1. Introduction

The tide of globalization has not only elevated people's living standards and reduced cultural disparities but has also influenced local cultural identities, resulting in a trend of cultural homogenization across diverse regions. This poses a challenge to the inheritance and development of regional cultures (Della, 2021). The Pearl River Delta, located in the central and southern parts of Guangdong Province, China (as shown in Figure 1), covers nine major cities including Guangzhou, Foshan, Zhaoqing, Shenzhen, Dongguan, Huizhou, Zhuhai, Zhongshan, and Jiangmen (Ye et al. 2024). The traditional dwellings in this region are renowned for their grand scale, rich variety, and distinctive characteristics. They are not only important carriers of regional culture but also the foundation of cultural landscapes. However, with the changes in economic structure and the influence of global culture, traditional kinship culture and aesthetic culture are being impacted by occupational culture (Cheng, 2021; Wang, 2021). In this process, the cultural landscape and dwellings in the Pearl River Delta are facing a crisis of gradually disappearing regional characteristics (Yang & Tang, 2022; Zhang, 2021; Duan et al., 2021; Yang, 2011; Tu, 2017). Economic development has accelerated urban construction, and many traditional dwellings have been replaced by modern settlement houses. For example, the traditional style of Liede Village has

disappeared (Cheng, 2021). The number of traditional dwellings in rural areas has decreased drastically, and they have not been effectively preserved (Yang, 2022; Zhang, 2021).



a. Location of Pearl River Delta Cited:NDRC. 2008

b. Location of Huizhou Cited: researchnet web

Figure 1. Location of Pearl River Delta as in (**a**) and Huizhou in (**b**), Huizhou is one region in Pearl River Delta.

To address the contradiction between regional cultural characteristics and global cultural homogenization, the Chinese government has issued a series of policies (CPPG, 2020; PGGP, 2019; PGHC, 2022). The government has not only accelerated the micro-renovation of existing rural houses and the shaping of the appearance of new rural houses but also provided guidance on the protection of facades, materials, and cultural elements in rural areas (PGHC, 2022). Driven by the "Beautiful Countryside" initiative in Huizhou, efforts have been made to preserve and develop traditional dwellings, but the results have been limited. Through physical observations, the government has implemented graded and categorized policies for regional dwellings, incorporating some dwellings into protection policies (Yang & Tang, 2022; Lai 2020). Taking Huizhou as an example, both the government and local clan organizations have been dedicated to the preservation of local residential architecture. In this regard, the local government has not only issued the "Regulations on the Protection of Huizhou, a Famous Historic and Cultural City", but also gradually incorporated Hakka residential architecture into this protection framework. However, despite these proactive conservation measures, traditional residences such as Dafu Diwei, Jiufu Diwei, and Yangqiao Diwei still face severe challenges of decline and vacancy. Some ancestral halls have even been repurposed for other uses, while numerous old houses have collapsed due to either human negligence or natural erosion, remaining uninhabited and abandoned in the flow of time,as shown in Figure 2.

Of greater concern is the irreconcilable contradiction between the conservation of these traditional residences as cultural heritage and their development. With the acceleration of modernization, most newly built residences have abandoned traditional styles, embracing instead the trends of Modernism or Neo-Classical European styles (Yang, 2011; Yang, 2022; Wang, 2021). This trend undoubtedly exacerbates the loss of traditional residential cultural stock in the Pearl River Delta region and simultaneously triggers profound concerns among the populace regarding the gradual disappearance of the cultural imagery of traditional dwellings. Therefore, this study aims to safeguard the cultural imagery of traditional dwellings and focuses on addressing the primary research question: how to effectively conserve and transmit the architectural culture of traditional residences in the Pearl River Delta?

Figure 2. The Cultural protection and image Quo of Vernacular Dwellings in Pearl River Delta.

Hence, this scholarly inquiry is grounded in the theoretical framework of cultural genes and

advances from the dual vantage points of expert expertise and public sentiment. The research objectives (ROs), with supporting citations, encompass:

1. RO1: Composition Analysis of Architectural Cultural Memes within the Huizhou Historic and Traditional Environment and Development (HTEDH) Context. Building upon previous research (Costa-Carrapico, Croxford et al., 2022; Rapoport, 2005), this objective aims to meticulously delineate and categorize the constituent elements of architectural cultural memes prevalent in the HTEDH area, facilitating a comprehensive understanding of its unique architectural heritage.
2. RO2: Hierarchical Ranking of Architectural Cultural Memes' Significance in HTEDH. Extending the work of Robinson (1989) and others, this objective seeks to establish a prioritization of these architectural cultural genes based on their historical, cultural, and social significance, thereby identifying those most critical for preservation efforts. The ranking will be guided by expert opinions and grounded in empirical data.
3. RO3: Assessment of Public Opinion on the Preservation of Architectural Cultural Memes in HTEDH. Drawing inspiration from studies on public engagement in heritage conservation (Salingaros, 2002; Li et al., 2023), this objective involves surveying and analyzing the attitudes, preferences, and willingness of local residents towards the preservation of these architectural cultural genes. The findings will offer insights into the community's engagement and support for heritage conservation, thereby informing policy-making and strategy development.

2. Literature Review

2.1. Current Research Status of Architectural Memetics

The concept of memetics originated in the 1970s, first proposed by biologist Richard Dawkins. He believed that culture possesses a genetic pattern similar to biology, which is propagated through the cultural information unit known as a "meme" (Adleman, L. M., 2024). The dissemination of memes does not rely on biological reproduction but rather on social interaction and cultural heritage mechanisms (Le, V. A., & Juan, T. K. N., 2024). As the basic unit of cultural transmission, memes encompass non-material contents such as beliefs, customs, and technologies. They possess the characteristics of replication and dissemination, and can undergo variation during the process of transmission (Fomin, 2024).

Memes not only determine the characteristics of culture but also profoundly influence its functions (Rogers & Giorgi, 2024; Yang & Seo, 2022; Holovatiuk, & Leshchenko, 2022). In the field of architecture, memes serve as carriers of traditional and unique regional cultures, embodied in the form, layout, decorative arts, and functional purposes of buildings. They are the core cultural memes distinguishing different regional cultures from others (WANG & FAN, 2019; Li et al., 2022; Ismail, 2015). Particularly in regional vernacular dwellings, architectural memes exhibit the inheritance patterns unique to memes (Salingaros, 2002; WANG et al., 2019). These architectural memes are formed in specific geographical and cultural environments (Nie et al., 2022) and constitute basic information patterns characterized by stability, variability, and inheritance (Jiang, et al., 2023). These memes not only reflect the essential connotations of culture but also possess quantifiable, concrete, and inheritable traits. For instance, structural designs and roof designs of traditional dwellings showcase the cultural memes continued and transmitted in regional dwellings, which exhibit patterns of inheritance and variation These patterns mirror the evolutionary laws of culture in both time and space (Jin et al., 2023).

Against the backdrop of global cultural homogenization, scholars have conducted in-depth research on the patterns and distributions of memes in regional vernacular dwellings. They have explored the cultural connotations and formal differences of traditional regional dwellings, attempting to unveil the essence of their development (Li et al., 2022). In recent years, research on architectural memetics has exhibited an interdisciplinary trend, covering fields such as cultural studies, architectural design, biotechnology, and psychology (Feng et al., 2024; Utaberta, 2017). In terms of research methods, scholars have employed various technical means, including qualitative research techniques like questionnaires and field surveys (Ye et al., 2019), as well as spatial GIS analysis, the KANO model (Ye et al., 2019), and the AHP hierarchical research method (Della, 2021; Li et al., 2022; Ye et al., 2019). Significant progress has been made in the research on architectural memes, yet further exploration is needed to understand their specific manifestations and mechanisms in different geographical and cultural contexts. The inheritance and variation laws of architectural memes provide a scientific basis for the preservation and transmission of traditional architectural culture.

2.2. The Vernacular Architecture Culture Memes in Pearl River Delta

The traditional vernacular dwelling culture of the Pearl River Delta is based on the foundations of Chaoshan culture, Cantonese culture, and Hakka culture, embodying regional cultural memes (Chen,

2022).The traditional residential types in the Pearl River Delta are diverse as illustrated in Figure 3, mainly including Guangfu vernacular dwellings, Chaoshan vernacular dwellings, and Hakka vernacular dwellings (Wang, 2024; Yang, 2011). Guangfu vernacular dwellings, are best represented by guo'er houses and Xiguan grand houses. The gable walls of guo'er houses are shaped like cooking pots' ears, symbolizing "taking the lead". Xiguan grand houses feature compact internal layouts with flexible spaces, adorned with abundant woodcarvings, plaster carvings, brick carvings, and other decorative techniques, exuding an overall sense of grandeur (Wang, 2024; Le et al., 2024; Lin, 2024; Liu, 2023). Chaoshan vernacular dwellings, adopt the layouts of "descending tiger" and "four-point gold", with the latter serving as the basic unit for combination and development. The plan layout of "four-point gold" resembles a patio house, with verandas surrounding the patio under the eaves, reflecting the fusion of Central Plains and southern China's climatic characteristics . Most of them adopt symmetrical layout with three-direction enclosed house with a patio or courtyard (Wen & Fang, 2021; Wang et al., 2020). As for Hakka vernacular dwellings, enclosed dwellings are the most distinctive residential buildings, characterized by high defensibility and practicality. This paper conducts a study with a focus on Hakka traditional enclosed dwelling in Huizhou (HTEDH) as a case. Currently, scholars studying the vernacular dwellings in the Pearl River Delta and Longhe Delta have adopted various research methods, such as questionnaires, ENVI remote sensing image processing based on satellite imagery, spatial analysis techniques using ArcGIS, SketchUp, 3D graphics, and sunlight analysis, to compare differences in geographical features (Cai, 2024; Wang, 2021; Ding & Xiao 2022). Research perspectives encompass typology (Yang, 2011), architectural detail composition (Lu & We, 1990), architectural reuse (Qi, 2024), cultural heritage and design (Zhang, 2021), as well as studies related to landscape genes and village culture (Cai & Xu, 2024; Wang, 2021). However, there has been minimal adoption of the perspective of architectural cultural memes in studying the preservation of vernacular dwelling culture in the Pearl River Delta.

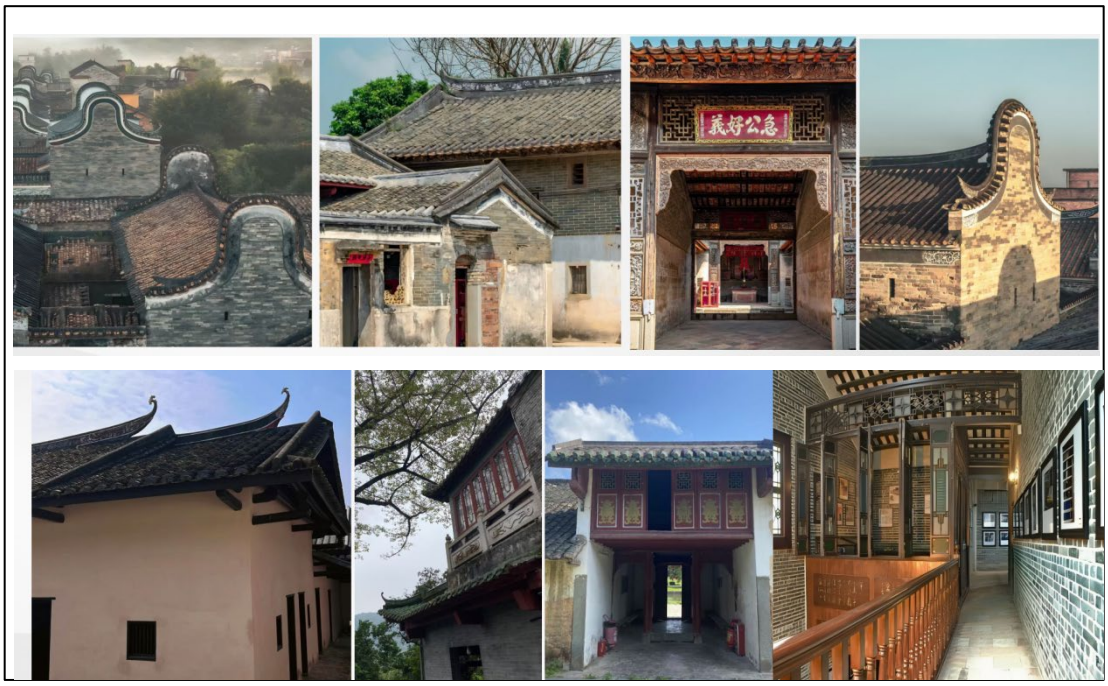


Figure 3. Traditional vernacular dwellings in the Pearl River Delta.

2.3. The Case of Huizhou Hakka Enclosed Dwellings

Hakka enclosed dwellings in Huizhou Hakka settlements (HTEDH), as a unique architectural style in the Pearl River Delta, integrate cultures from the Central Plains, Hakka, Cantonese, and Chaoshan regions, forming a distinctive architectural style and cultural connotation (Huang, 2021; Qi, 2024; Yang & Tang, 2022; Lai, 2020). Hakka dwellings exhibit various forms, including row houses, halls, enclosed dragon houses, and more. Their layouts typically include elements such as main halls, side rooms, altars, and enclosed houses, creating a living environment with Hakka characteristics (Wu, 2008; Wu, 2010). HTEDH adopts symmetrical layouts, with the three-hall enclosed dragon house being a prime example. Based on the orientation of facing south, a north-south central axis is formed, as presented in Figure 4, starting from the fengshui pond, main entrance, lower hall, courtyard, middle hall, courtyard, upper hall,

Huatai mound, and dragon hall. Lateral rooms, courtyards, and enclosed rooms are symmetrically connected on both sides of this axis, embodying a centripetal living space centered on the main halls and reflecting the orderly life philosophy of Hakka patriarchal and Confucian cultures (Yang, 2011; Huang, 2021).

In the composition of the facade of Huizhou Hakka buildings, the roof serves as a significant visual element, along with walls, doors, and windows, creating a unique and harmonious ensemble. For instance, the stepped roof layout, with a higher middle section and lower sides, emphasizes the three-dimensionality and hierarchy of the architecture. Meanwhile, the meticulous design of detailed components such as the ridge and eaves not only reinforces the roof structure but also enriches the expressive quality of the facade (Lai, 2018; Yang &Tang, 2022; Lai & Yang, 2022). Another important function of Hakka dwellings is defense, and this defensive culture has contributed to the architectural facade cultural characteristics of HTEDH. These include thick walls, loopholes at fixed points on the walls, high and small windows, passages, and rooftop defensive measures. These defensive features are also reflected in the layout, such as corner towers and watchtowers, and the reduction of entrances and exits. In terms of materials, the Hakkas mostly used rammed earth walls, adobe walls, or blue bricks walls before the Qing Dynasty. There are also some brick walls made of mixed materials, but these three types are primarily used. Other flooring materials include rammed earth and cobblestones. Reinforcing materials such as red sandstone and blue slate are also employed. Wood and tiles are mostly used as auxiliary materials for doors and eaves. Notably, HTEDH buildings often employ woodcarvings, stone carvings, ash plastic reliefs, wall paintings, and couplets for decoration (Tang, 2020; Lai, 2018).

Furthermore, HTEDH integrate cultural elements from Cantonese and Chaoshan, adding depth to the architectural cultural connotation (Huang Wenwen, 2021). Therefore, based on the research findings of various scholars, the arcfhitectural cultural elements and sub-cultural elements of HTEDH can be identified and coded with cultural clusters are designated as the indicator layer C, or the secondary indicator layer, consisting of a total of 35 secondary indicators (Table 6), as follows:

The Sub-elements of Spatial Layout Elements cluster (B1) are conducted as: C1 Main Hall, C2 Lateral Rooms,C3 Enclosed Rooms,C4 Memorial Archway/ Gate,C5Corner Tower and Watchtower,C6 Dragon Hall,C7Grain-sunning Ground,C8Patio,C9Cloister,C10 Fengshui Forest and Pond,C11 Huatai Mound.The Sub-elements of Facade and Structure Element cluster (B2) are : C12 Gable Wal, C13 Roof Structure, C14Eaves Roof, C15 Windows, C16 Doors, C17 Column, C18Roof structure, C19 loophole, C20High and thick wall , C21Roof defensive measurement (setting), C22 Evacuation route (setting), C23 Moat and Few Entrances/Exits.The Sub-elements of Material and Technology Element cluster (B3) are:C24 Rammed earth wall or rammed earth wall with lime finished, C25 Adobe earth wall or adobe-earth wall with lime finished, C26 Blue Brick Wall, C27 Tile, C28 Wood, C29 Cobblestone, C30 Red-sands stone/ blue stone. The Sub-elements of Decoration Element cluster (B4) are: C31 Wood Carving, C32 Stone Carving, C33 Lime Plastering, C34 Wall Painting, C35 Couplets .

Figure 4. The Characteristic Architectural Culture Genes of HHTED.

3. Research Methodology

This study employs the case study method along with online questionnaire and Analytic Hierarchy Process (AHP). Case study is particularly suited for in-depth exploration of specific architectural cultural phenomena by researchers. It facilitates a profound understanding of the essence and characteristics of architectural culture, revealing its uniqueness and diversity (An et al., 2023). AHP within the quantitative analysis approach is a common data analysis method especially for multiple layer of aspects and

indicators on social phenomenon or management (Della, 2021). it was generally deployed in landscape analysis in Table 1. (Li et al., 2022; Ye et al., 2019). Here it can solve different expert evaluation scoring on the indicators.

Online questionnaires were utilized in this research. Since the survey participants were all Chinese respondents familiar with HTEDH, the questionnaires were distributed through a Chinese online questionnaire platform (Wenjuanxing). Two questionnaires were issued: one for experts and the other for the general public. Initially, seven experts were invited to complete the expert questionnaire survey, which involved rating the importance of cultural gene clusters and sub-cultural memes related to HTEDH. Generally, 3-7 experts are sufficient to accurately determine indicator weights (Liu et al., 2023; Khaznadar & Baper, 2023), thus the questionnaires completed by seven experts are valid. Experts were selected based on their achievements in the field of Hakka culture research in Huizhou. The questionnaire structure was divided into two parts: demographic information and evaluation questions regarding the cultural genes of character elements. Given people's post-pandemic preference for the location flexibility of online questionnaires (Visuddho et al., 2023; Li et al., 2023).

Table 1. The judgment matrix of landscape gene sequencing indicator system (Li et al., 2022).

Target Layer	**Criterion Layer**	**Sub-Criterion Layer**	**Indicator Layer**
landscape gene sequence A	Environmental gen B1	Natural environment C1	Landform D1
			Landscape pattern D2
			Land resources D3
		Human environment C2	Transportation location D4
			Geographical culture D5
	Layout gene B2	Village road morphology C3	Spatial layout D6
			Architectural form D7
		Spatial type C4	Alley space D8
			Nodal space D9
			River space D10
	Architectural gene B3	Residential building C5	Architectural structures D11
		Commericial building C8	Plan layout D12
		Temples and ancestral halls C7	Spatial structure D13
			Architectural materials D14
			Architectural color D15
			Architectural decoration D16

The other online questionnaire was designed to collect the public's preferences for architectural cultural elements of HTEDH. The target audience was local residents of Huizhou with more than ten years of residence experience and knowledge of Hakka culture and HTEDH. Although the actual target group consisted of 1,136 individuals, only 214 considered themselves eligible and willing to participate. However, the number of valid questionnaires that met the criteria was 174. Previous research papers indicate that typical sample sizes for public questionnaires range from 136 to 374 (Lund, 2023). This aligns with the standard sample size for questionnaires in academic research. Additionally, among the permanent residents of the city, those aged 0-59 account for 89.95%, while those aged 60 and above number 607,392, representing 10.05% of the population. In this survey, individuals aged 60 and above comprised the smallest group, accounting for only 10.75% of the total, which is less than 1% different from the official data (Figure 5). The questionnaire was pre-tested by two experts and piloted with feedback from ten respondents. Prior to official distribution, adjustments were made to the content and structure of the questionnaire. The distribution map of participants, revealing that the majority were concentrated in Guangdong Province with 140 participants, where Huizhou is located. Furthermore, this study validated the questionnaire's reliability and validity data analysis (Figure 6).Thus, the principles and calculation progress (Figure 7) and the whole research flow are presented below (Figure 8).

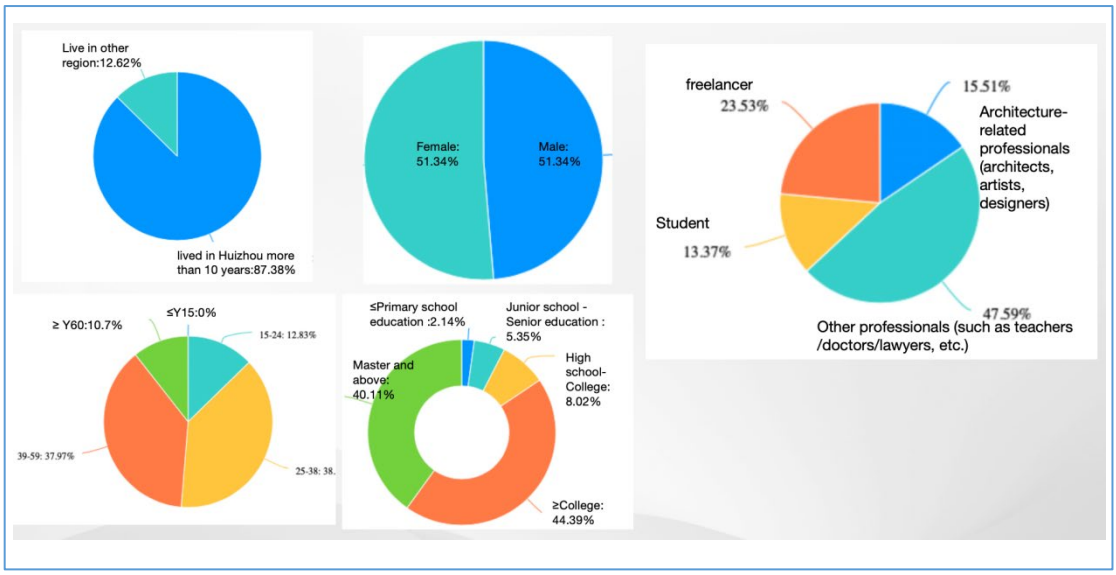


Figure 5. The Participants Census Data of The Public Survey.

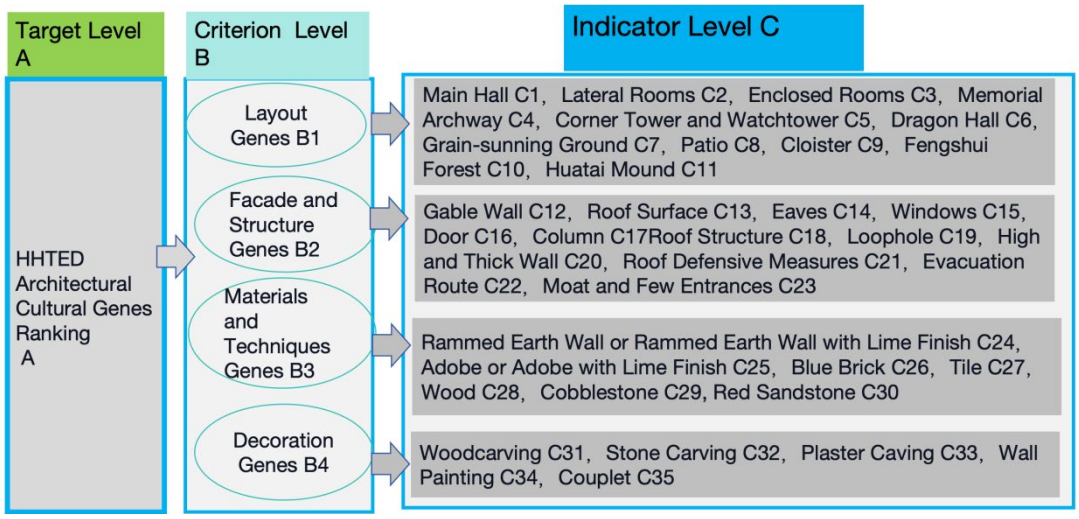


Figure 6. The Relationship of AHP Calculation Data Category of HTEDH.

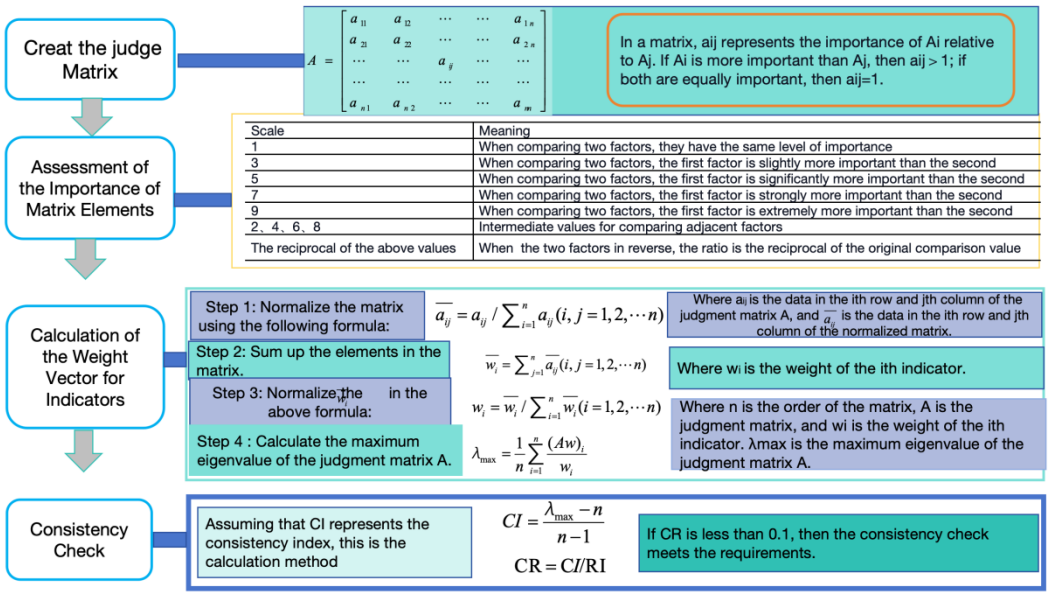


Figure 7. The Principle and Process of AHP.

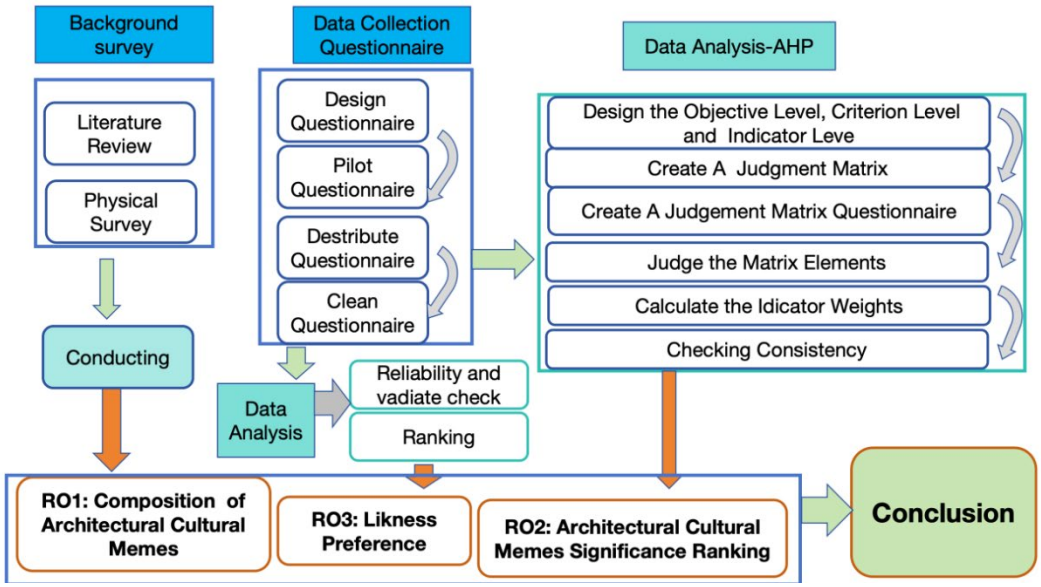


Figure 8. Research Flow.

3.1. Expert Questionnaire Survey

Questionnaire data collected from experts, the general public, and seasoned technicians revealed disparities in the composition of cultural genes within HTEDH and the attitudes. Generally, the attitudes were positive and future-oriented. When experts rated the significance of architectural cultural memes in HTEDH, the results indicated that C1 Main Hall was deemed equally important to C4 Memorial Archway/ Gate,C7Grain-sunning Ground, and C8 Patio, as evidenced by their low pairwise comparison values. Similarly, there was minimal difference in perceived importance between these pairs. Conversely, the comparison values for C2 Lateral Rooms against C4 Memorial Archway/ Gate,C5 Corner Tower and Watchtower, C7Grain-sunning Ground, and C8 Patio were notably higher, indicating that C2 was considered substantially more important than these counterparts. Furthermore, the substantial discrepancies in values for C4:C8, C12:C19, and C5:C11 reflected varying expert opinions on the relative importance of these pairs of elements.

3.2. Public Questionnaire Survey

The public questionnaire survey also finds the current popularity of the cultural memes of HTEDH among the people (Figure 5). The response data from the public willingness questionnaire surveyed 86.78% of respondents who had lived in HTEDH, indicating the local population's perceived level of familiarity of HTEDH. Among them, 94.83% of respondents believed that HTEDH showcases the Hakka culture of Huizhou. Additionally, 93.68% of the public liked HTEDH, and as many as 98.28% of respondents thought that HTEDH needs protection. The public survey on preferences for the elements revealed that 74.14% of people liked or very much liked the spatial layout (B1) of traditional residences. 70.11% of people liked or very much liked the architectural facade and structure of HTEDH, indicating that the architectural facade holds relatively high importance among traditional residential elements. Regarding the materials, craftsmanship, and decoration of traditional residences, 64.37% and 60.92% of people liked them, respectively. Comparing the data, in terms of the degree of preference for the cultural elements of HTEDH, the ranking is as follows: Spatial layout, Facade and structure, materials and technology, and Decoration. As shown in the Table 2, the two most popular residential elements are spatial layout and architectural facade.

Table 2. The Liking Preference on Culture Meme Cluster of Hakka Traditional Enclosed Dwelling in Huizhou (HTEDH).

Options	**Subtotal**	**Ratio**
Spatial layout	129	74. 14%
Facade and structure	122	70. 11%
Materials and technology	112	64.37%
Decorations	106	60.92%
This question is valid to fill in	174	

There exist variations in the populace's preferences towards the constituent elements of different spatial layouts (B1), according to the questionnaire data (Figure 9). Notably,C1the main hall (75.29%) and C8Patio (66.09%) emerged as the most preferred elements, the C1-C11 are shown in Figure 9.In the survey exploring preferences for the facade and structure culture memes (B2) of Hakka architecture, while listed in Figure 9. The results indicate that C12 gable wall (74.71%) and C19 loophole (72.99%) are the most favored Furthermore, elements such as C14 eaves (66.67%) , C15 windows (66.67%), C20 thick walls (59.2%), and C16 doors (55.75%) were also highly preferred.Preference rate of illustration are shown in Figure 10 with C13 roof surface (54.02%) C17 columns46.55%, C23 moat and limited entrances/exits 45.4%, C18 roof structure (44.25%), C22 evacuation settings (35.63%).

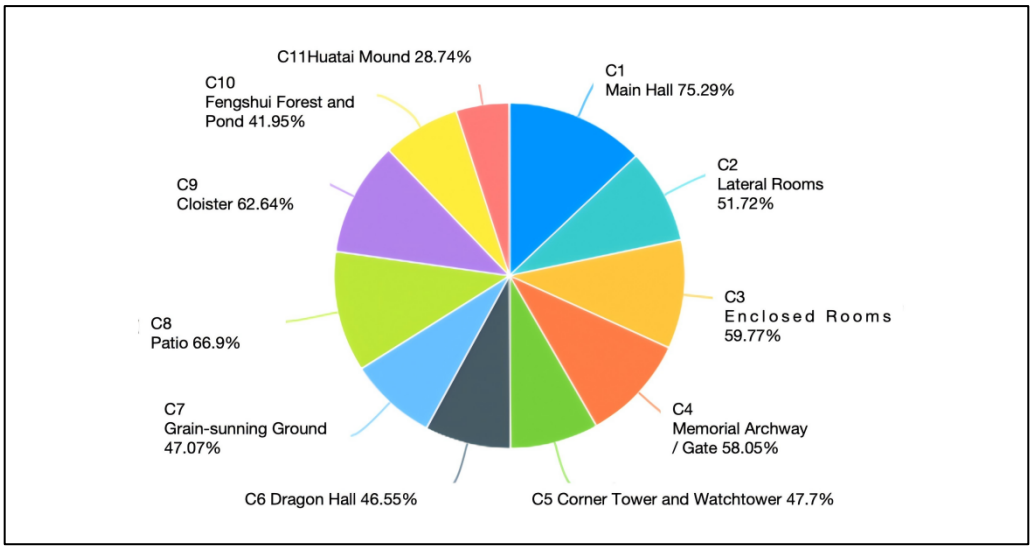


Figure 9. The Liking Preference on Culture Memes of Spatial Layout Cluster (B1).

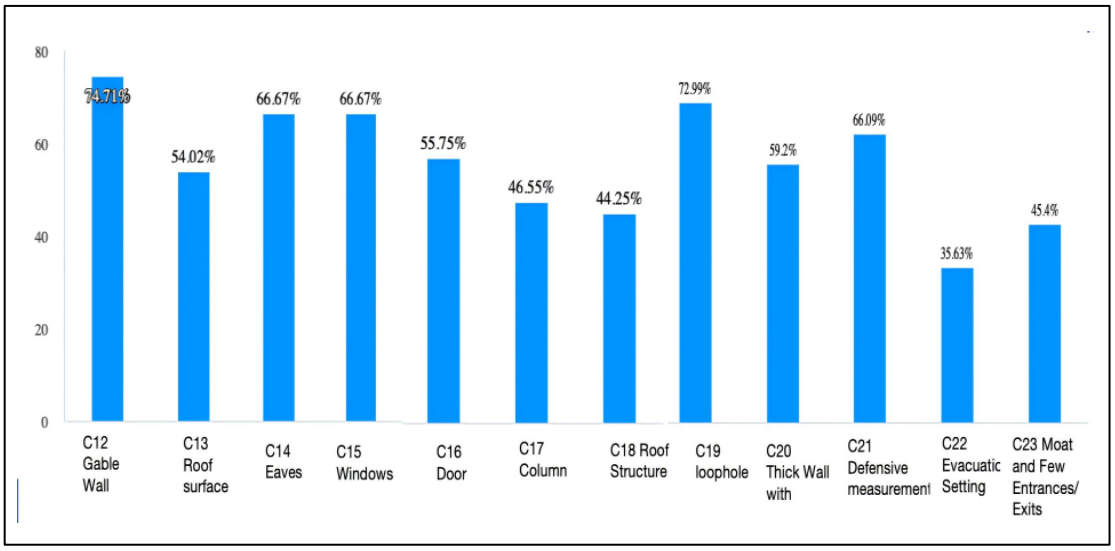


Figure 10. The Liking Preference on Culture Memes of Facade and Structure Cluster (B2).

Questionnaire data were showed likeness on Material and technology (B3) from the respondents as (Figure 11): C26 blue brick, C27 Tile, C28 wood, C29 Cobblestone (58.62%), C24 Rammed earth or with lime finished (41.95%), C25 Adobe wall or with lime finished (41.95%). The preferences for elements within the decoration culture cluster (B4), it is evident that 86.21% of respondents demonstrated a strong inclination for C31 Wood Carving. Similarly, C32 Stone Carving garnered a high level of popularity, with 83.91% of participants expressing a preference for it. The preference for C33 Plaster Carving stood at 74.14%, and for C34 Wall Painting, it was 74.71%. Conversely, the preference for C35 Couplets and Accessories was relatively moderate, with 50% of respondents indicating a liking for this element (Figure 12).

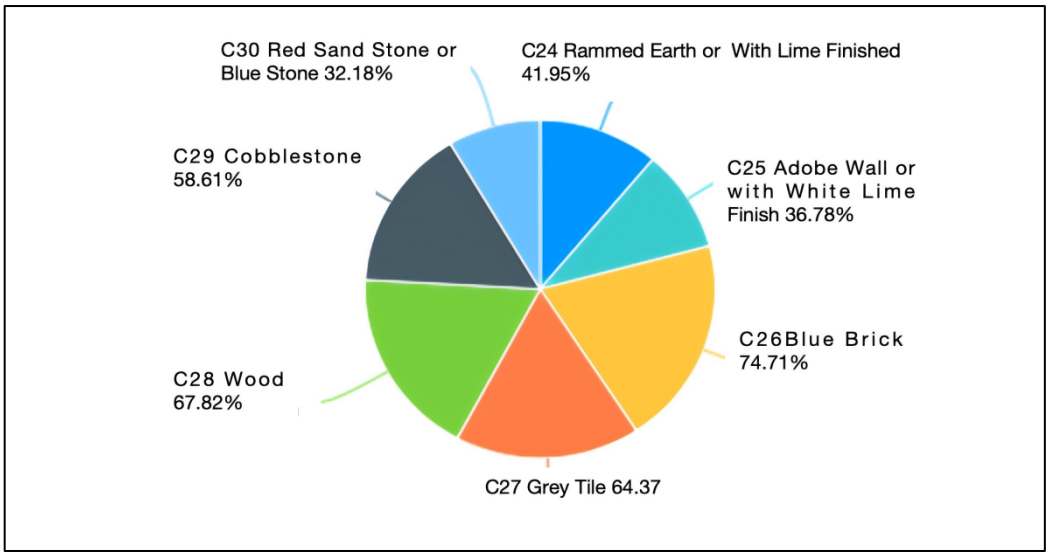


Figure 11. The Liking Preference on Culture Memes of Material and Technology Cluster (B3).

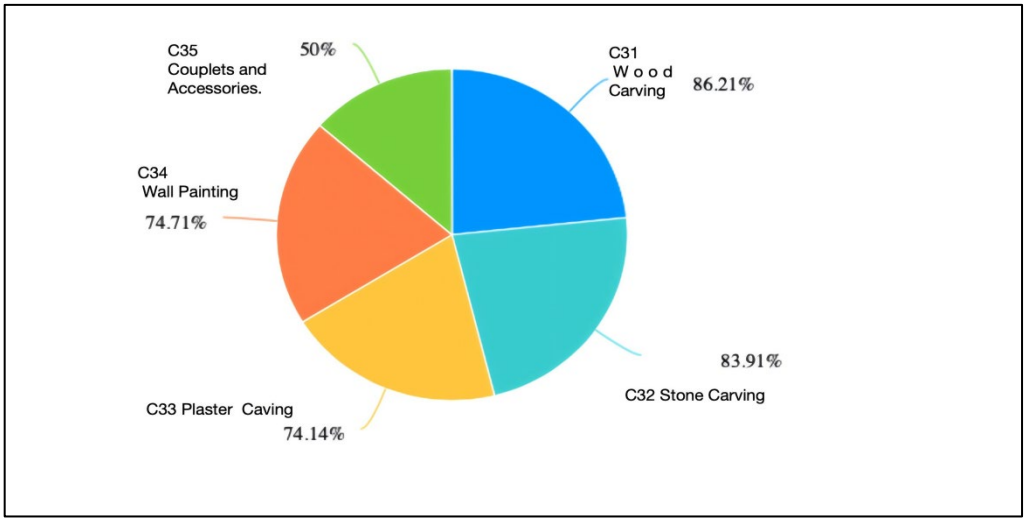


Figure 12. The Liking Preference on Culture Memes of Material and Technology Cluster (B4).

4. Analysis and Results

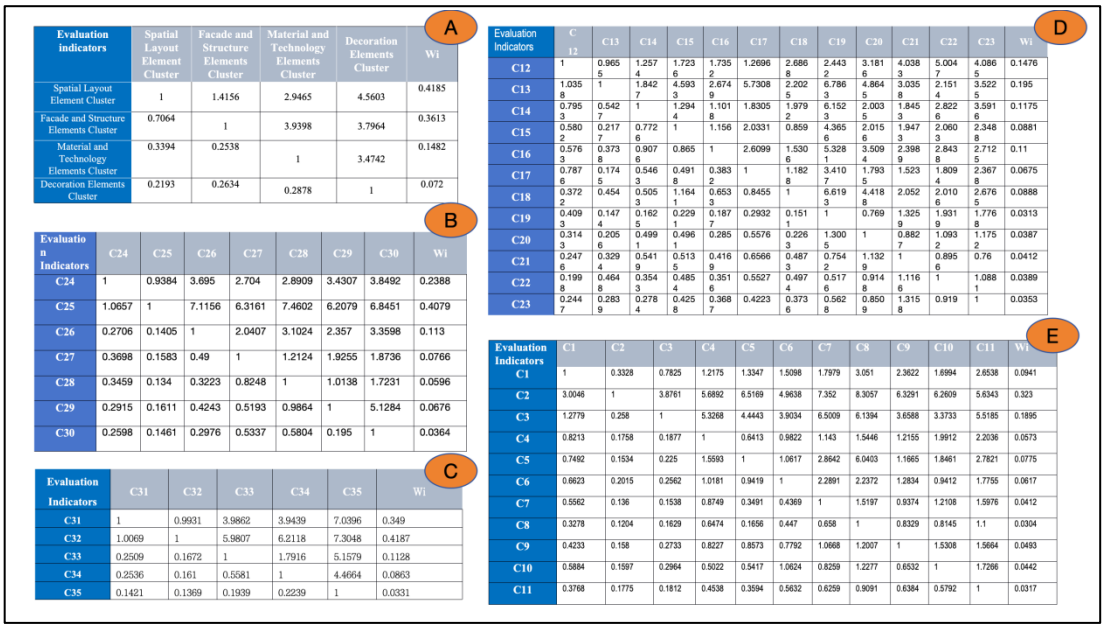
4.1. Significance Analysis and Result

Utilizing the HTEDH architectural cultural gene ranking indicator system in Table 1, the expert questionnaire were analyzed through the AHP method. With the assistance of SPASS Statistic software, based on the indicator system and the aforementioned scaling method, a questionnaire survey was conducted through expert consultation. Experts in the field were selected to score the importance of each indicator using group decision-making functionality. Subsequently, internal discussions and generalizations were conducted on the scoring results to obtain pairwise comparison matrices as shown in Table 2. Firstly, the maximum eigenvalue $\lambda_{max} = 4.1737$. of the judgment matrix is calculated. Then, a consistency check is conducted, which requires the calculation of the consistency index $CI = \frac{\lambda_{max}-n}{n-1} = \frac{4.1737-4}{4-1} = 0.0579$. Average random consistency index $RI = 0.9$. Random consistency ratio: $CR = \frac{CI}{RI} = \frac{0.0579}{0.9} = 0.0651 < 0.10$. After calculation, since CR is less than 0.1, it can be considered that the construction of the judgment matrix is reasonable. Therefore, the weights of the indicators calculated (Figure 13A).

The hierarchical analysis of evaluation data for the application of HTEDH architectural cultural memes in modern residential buildings shows that the weight of memes of spatial layout, material and craftsmanship, material and technology, and decorative clusters ranking conducted by sequence are: 0.4185, 0.3613, 0.1482. 0.072.

By Apply the weights of the criterion layer, the weights of the indicator layer are calculated. Firstly, the maximum eigenvalue of the judgment matrix is determined. Then, a consistency check is conducted, and the consistency ratio (CR) is found to be less than 0.1 for all matrices. Therefore, it can be considered that the construction of the judgment matrices is reasonable. Subsequently, the weights of the indicators are calculated and presented in the following Figure 13. Judgment matrices are constructed and weights are obtained accordingly.

Firstly, the maximum eigenvalue $\lambda_{max} = 11.4483$ of the judgment matrix is calculated. Then, a consistency check is conducted, which requires the calculation of the consistency index $CI = \frac{\lambda_{max}-n}{n-1} = \frac{11.4483-11}{11-1} = 0.0448$. Average random consistency index $RI = 1.52$. Random consistency ratio: $CR = \frac{CI}{RI} = \frac{0.0448}{1.52} = 0.0295 < 0.10$. After calculation, since CR is less than 0.1, it can be considered that the construction of the judgment matrix is reasonable. Similarly,Therefore, all the relative weights of the indicators C1-C11 belonging to B1 Spatial layout cultural meme cluster (Figure 13E), indicators C12-C23 of B2 Facade and structure culture clusters (Figure 13D), indicators C24-C30 of B3 Material and technology culture meme clusters (Figure 13B), indicators C31-C35 of Decoration cultural meme clusters calculated (Figure 13C) . Finally the absolute weight is calculated and significance ranking listed in Figure 14.



Evaluation indicators	Spatial Layout Element Cluster	Facade and Structure Elements Cluster	Material and Technology Elements Cluster	Decoration Elements Cluster	Wi
Spatial Layout Element Cluster	1	1.4156	2.9465	4.5603	0.4185
Facade and Structure Elements Cluster	0.7064	1	3.9398	3.7964	0.3613
Material and Technology Elements Cluster	0.3394	0.2538	1	3.4742	0.1482
Decoration Elements Cluster	0.2193	0.2634	0.2878	1	0.072

Evaluation Indicators	C24	C25	C26	C27	C28	C29	C30	Wi
C24	1	0.9384	3.695	2.704	2.8909	3.4307	3.8492	0.2388
C25	1.0657	1	7.1156	6.3161	7.4602	6.2079	6.8451	0.4079
C26	0.2706	0.1405	1	2.0407	3.1024	2.357	3.3598	0.113
C27	0.3698	0.1583	0.49	1	1.2124	1.9255	1.8736	0.0766
C28	0.3459	0.134	0.3223	0.8248	1	1.0138	1.7231	0.0596
C29	0.2915	0.1611	0.4243	0.5193	0.9864	1	5.1284	0.0676
C30	0.2598	0.1461	0.2976	0.5337	0.5804	0.195	1	0.0364

Evaluation Indicators	C31	C32	C33	C34	C35	Wi
C31	1	0.9931	3.9862	3.9439	7.0396	0.349
C32	1.0069	1	5.9807	6.2118	7.3048	0.4187
C33	0.2509	0.1672	1	1.7916	5.1579	0.1128
C34	0.2536	0.161	0.5581	1	4.4664	0.0863
C35	0.1421	0.1369	0.1939	0.2239	1	0.0331

Evaluation Indicators	C 12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	Wi
C12	1	0.9655	1.2574	1.7236	1.7352	1.2696	2.6868	2.4432	3.1816	4.0383	5.0047	4.086	0.1476
C13	1.0358	1	1.8427	4.5933	2.6749	5.7308	2.2025	6.7863	4.8645	3.0358	2.1514	3.5225	0.195
C14	0.7953	0.5427	1	1.2944	1.1018	1.8305	1.9792	6.1523	2.0035	1.8453	2.8226	3.5916	0.1175
C15	0.5803	0.2177	0.7726	1	1.156	2.0331	0.859	4.3656	2.0156	1.9473	2.0603	2.3486	0.0881
C16	0.5763	0.3738	0.9076	0.865	1	2.6099	1.5306	5.3281	3.5094	2.3989	2.8438	2.7125	0.11
C17	0.7876	0.1745	0.5463	0.4918	0.3832	1	1.1828	3.4107	1.7935	1.523	1.8094	2.3678	0.0675
C18	0.3722	0.4548	0.5053	1.1641	0.6533	0.8455	1	6.6193	4.4188	2.052	2.0106	2.6765	0.0888
C19	0.4093	0.1474	0.1625	0.2291	0.1877	0.2932	0.1511	1	0.7691	1.3259	1.9319	1.7768	0.0313
C20	0.3143	0.2056	0.4991	0.4961	0.2853	0.5576	0.2263	1.3005	1	0.8827	1.0931	1.1752	0.0387
C21	0.2476	0.3294	0.5419	0.5135	0.4169	0.6566	0.4873	0.7542	1.1329	1	0.8956	0.76	0.0412
C22	0.1998	0.4648	0.3544	0.4854	0.3516	0.5527	0.4974	0.5176	0.9148	1.1166	1	1.0881	0.0389
C23	0.2447	0.2839	0.2784	0.4258	0.3687	0.4223	0.3736	0.5628	0.8509	1.3158	0.919	1	0.0353

Evaluation Indicators	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	Wi
C1	1	0.3328	0.7825	1.2175	1.3347	1.5098	1.7979	3.051	2.3622	1.6994	2.6538	0.0941
C2	3.0046	1	3.8761	5.6892	6.5169	4.9638	7.352	8.3057	6.3291	6.2609	5.6343	0.323
C3	1.2779	0.258	1	5.3268	4.4443	3.9034	6.5009	6.1394	3.6588	3.3733	5.5185	0.1895
C4	0.8213	0.1758	0.1877	1	0.8413	0.9822	1.143	1.5446	1.2155	1.9912	2.2036	0.0573
C5	0.7492	0.1534	0.225	1.5593	1	1.0617	2.8642	6.0403	1.1665	1.8461	2.7821	0.0775
C6	0.6623	0.2015	0.2562	1.0181	0.9419	1	2.2891	2.2372	1.2834	0.9412	1.7755	0.0617
C7	0.5562	0.136	0.1538	0.8749	0.3491	0.4369	1	1.5197	0.9374	1.2108	1.5976	0.0412
C8	0.3278	0.1204	0.1629	0.6474	0.1656	0.447	0.658	1	0.8329	0.8145	1.1	0.0304
C9	0.4233	0.158	0.2733	0.8227	0.8573	0.7792	1.0668	1.2007	1	1.5308	1.5664	0.0493
C10	0.5884	0.1597	0.2964	0.5022	0.5417	1.0624	0.8259	1.2277	0.6532	1	1.7266	0.0442
C11	0.3768	0.1775	0.1812	0.4538	0.3594	0.5632	0.6259	0.9091	0.6384	0.5792	1	0.0317

Figure 13. The Judgement Matrix of Culture Memes and Sub-elements Culture Memes.

Based on the operational principles of AHP, the comprehensive weights of each indicator are derived by multiplying the weights of the indicator layer with the corresponding weights of the criterion layer. AHP are applied to analyze the weights of various evaluation indicators at different levels of HTEDH (Figure 7). A higher comprehensive weight represents a more important role of the sub-memes among all indicators. From the perspective of the comprehensive weights of the indicator layer, or the secondary indicators, the whole sequence of the architecture memes are illustrated in Figure 14. Based on the calculations, the comprehensive weights, which represent the experts' ranking of the importance of each cultural gene bundle from B1 to B4, are obtained as follows in order of priority: Spatial Layout, Facade and Structure , Material and Technology,Decoration. Among the criterion layer, the Spatial layout meme cluster have the highest weight value. This reflects that the layout is the most distinctive and important aspects of HTEDH in Huizhou Hakka settlements. The characteristics and importance of facade and structure memes are also valued much significant. However, the weights of material and technology memes, as well as decoration memes are relatively low, indicating that their positions in the inheritance and protection consideration ranking of architectural cultural memes are relatively weak.

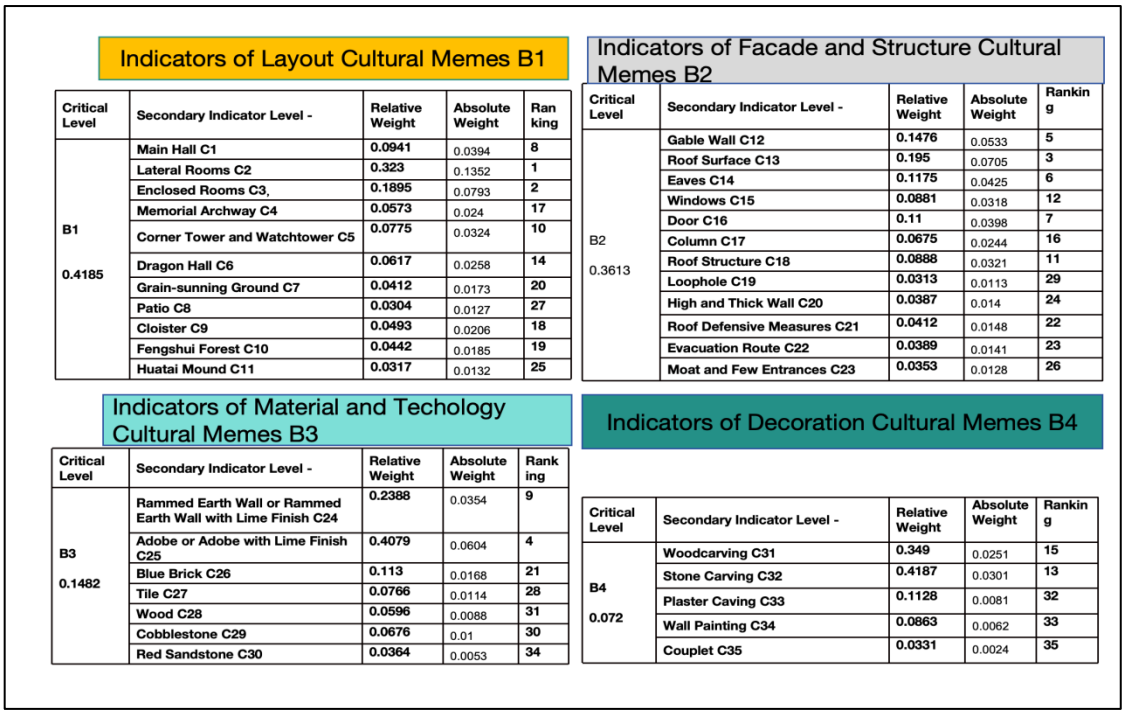


Figure 14. The Absolute Weight and Significant Ranking of Sub-elements Culture Memes.

Based on the calculations, the comprehensive weights, which represent the experts' ranking of the importance of the sub-elements from C1 to C35, are obtained as follows in order of priority: C2, C3, C13, C25, C12, C14, C16, C1, C24, and C5. Among these, the top ten sub-memes with the highest weights, indicating their highest importance to HHTED according to the experts, are as follows:： C2 Lateral Rooms,C3 Enclosed Rooms, C13 Roof Structure, C25 Adobe earth wall or adobeearth wall with lime finished, C12 Gable Wall,C14Eaves Roof, C16 Doors, C1 Main Hall,C24 Rammed earth wall or rammed earth wall with lime finished.

4.2. Likeness Preference Analysis and Result

Before embarking on the ranking analysis, the questionnaire and personal information have been analyzed previously. In measuring the willingness to apply elements of architectural identity in HHTED, the options are "strongly disagree", "disagree", "neutral", "agree", and "strongly agree". According to the Likert scale, these options correspond to index scores of 1-5 points. IBM SPSS Statistics 25.0 software is adopted for statistical analysis of the data. Mean ± standard deviation, frequency, and composition ratio are applied for statistical description of general information. Invalid data has been excluded. Reliability testing refers to the reliability of the questionnaire, which is measured by Cronbach's Alpha value. The overall Cronbach's Alpha coefficient is 0.995, with 44 items which including 5 census questions data, 35 sub-elements culture indicators and 4 culture element cluster indicators, and indicating that the questionnaire has high reliability in Table 4, Generally, the Cronbach's alpha coefficient of a scale should be at least 0.6. If it is lower than 0.6, it indicates that the reliability of the scale is poor, and the items need to be revised or the questionnaire needs to be redistributed. This questionnaire Cronbach's Alpha is 0.995 in Table 3, which is very good according to the numerical correspondence of Cronbach's alpha values.

Table 3. Reliability Analysis Result (source: Drawn by author).

Cronbach's Alpha	Number of Items
0.995	44

Validity analysis refers to the validity of the questionnaire, which is measured by the significance level of the Bartlett's Test of Sphericity and the cumulative variance contribution rate of factors. Generally, the Kaiser-Meyer-Olkin (KMO) value should be at least 0.6. If it is lower than 0.6, it indicates that the items need to be revised or the questionnaire needs to be redistributed. The overall KMO value is greater than 0.984, and the significance level is less than 0.001 (Table 4). Therefore, the questionnaire is considered valid. By sorting the comprehensive voting percentages of the people in descending order,

we can obtain their ranking of preference (Table 5).

Table 4. Validity Analysis Result.

KMO (Kaiser-Meyer-Olkin) Measure of Sampling Adequacy		0.984
Bartlett's Test of Sphericity	Approximate Chi-Square	23055.581
	Degrees of Freedom	946
	Significance	<.0.001

Table 5. Preference Ratio and Ranking.

Ratio	C31 Wood Carving (86.21%),C32 Stone Carving (83.91%), C1 Main Hal 了(75.29%) C34 Wall Painting (74.71%) = C12 Gable Wall = C26 Blue Brick, C33 Lime Plastering (74.14%), C19 loophole (72.99%),C28 Wood (67.82%),C14 Eaves Roof = C15 Windows(66.67%),C8 Patio (66.09%) = C21Roof defensive measurement (setting), C27 Tile (64.37%),C9 Cloister (62.64%),C3 Enclosed Rooms (59.77%), C20 High and thick wall (59.2%), C29 Cobblestone (58.62%), C4 Memorial Archway/ Gate(58.05%),C16 Doors(55.75%), C13 Roof Structure (54.02%), C2 Lateral Rooms(51.72%), C35 Couplets(50.0%), C5 Corner Tower and Watchtower (47.7%) = C7 Grain-sunning Ground, C17 Column = C6 Dragon Hall (46.55%),C23 Moat and Few Entrances/Exits(45.4%),C18 Roof structure (44.25%),C24 Rammed earth wall or rammed earth wall with lime finished = C10 Fengshui Forest and Pond (41.95%),C25 Adobe earth wall or adobeearth wall with lime finished(36.78%), C22 Evacuation route (35.63%), C30 Red-sands stone/ blue stone (32.18%), C11 Huatai Mound (28.74%).
Ranking	The comprehensive weights for the importance of the sub-elements are C2, C3, C13, C25, C12, C14, C16, C1, C24, C5, C18, C15, C32, C6, C31, C17, C4, C9, C10, C7, C26, C21, C22, C20, C11, C23, C8, C27, C19, C29, C28, C33, C34, C30, and C35.

5. Discussion

5.1. Significance Ranking of Sub-Element Culture Memes

Based on the overall evaluation derived from the expert questionnaire analysis, the percentage of votes cast by the public indicating their preference (both liking and greatly liking) for items C1-C35, presented in descending order, is as follows: C2, C3, C13, C25, C12, C14, C16, C1, C24, C5, C18, C15, C32, C6, C31, C17, C4, C9, C10, C7, C26, C21, C22, C20, C21, C23, C8, C27, C19, C29, C28, C33, C30, C35.

Furthermore, it is observable that within the spatial layout cultural meme cluster, the top four elements are: C2 Lateral Rooms, C1 Main Hall, C3 Enclosed Rooms, and C5 Corner Tower and Watchtower; within the decoration cultural memecluster, the top four elements are: C32 Stone Carving, C31 Wood Carving, C33 Lime Plastering, and C34 Wall Painting; within the facade and structural cultural meme cluster, the top four sub-cultural meme are: C13 Roof Structure, C12 Gable Wall, C14 Eaves Roof, and C16 Doors; and within the material and craftsmanship element cluster, the top four sub-elements are: C25 Adobe earth wall or adobe earth wall with lime finish, C24 Rammed earth wall or rammed earth wall with lime finish, C26 Blue Brick Wall, and C27 Tile. Based on the weight scores, the top 10 elements with the highest importance are classified as the first protection level: C2, C3, C13, C25, C12, C14, C16, C1, C24, C5; the elements with the lowest rankings are classified as the third protection level: C23, C8, C27, C19, C29, C28, C33, C34, C30, C35; the remaining elements in the middle are classified as the second protection level: C18, C15, C32, C6, C31, C17, C4, C9, C10, C7, C26, C21, C22, C20, C21 (note: C21 is repeated here, which may be an error unless there are two distinct elements labeled as C21 with different weights, otherwise it should be corrected). Accordingly, the protection levels (Table 6) and the ranking of element weight levels (Figure 14) can be derived.

Table 6. the Significance Class of Sub-element Culture Memes Class.

Significance Priority	**First Class**	**Second Class**	**Third Class**
Sub-element Culture Memes and the Codes	C2, C3, C13, C25, C12, C14, C16, C1, C24, C5	C18, C15, C32, C6, C31, C17, C4, C9, C10, C7, C26, C21, C22, C20, C21	C23, C8, C27, C19, C29, C28, C33, C34,C30, C35

5.2. Preference Ranking of Sub-Element Culture Memes

The alignment of public preference for architectural cultural gene bundles with the expert-assigned importance levels is noteworthy. In terms of preference rankings, the elements are sequentially ordered as Spatial layout(B1), Facade and structure(B2), materials and technology(B3), and Decoration(B4)。 Specifically, a selection of elements has garnered substantial favor, with over 70% of surveyed individuals expressing their appreciation: C31, C32, C1, C34, C12, C26, C33, and C19. Additionally, C28, C14, C15, C8, C21, C27, and C9 have also received considerable support, with endorsement rates exceeding 60%. Conversely, elements such as C3, C20, C29, C4, C16, C13, C2, C35, C5, C7, C17, C6, C23, C18, C24, C10, C25, C22, C30, and C11 have relatively limited popularity, failing to secure the affection of more than half of the surveyed respondents.

An examination of both the importance ranking (Figure 14) and preference ranking (Table 5) reveals that only C1 Main Hal and C12 Gable Wall occupy positions within the top 10 lists for both popularity and importance. C30 Red-sands stone/Blue stone not only occupies a lower position in popularity rankings but also in terms of its assessed importance. It is worth highlighting that elements such as C28, C33, and C34, which experts have deemed to hold lesser significance within architectural culture, are nevertheless highly valued by the local populace. Furthermore, elements like C31, C32, C26, C19, and C14 enjoy widespread popularity but are rated as moderately important by experts. Cultural memes such as C23, C8, C27, C19 (repeated due to potential variations in its performance across different dimensions), C29, C30, and C35 possess lower importance ratings yet enjoy moderate levels of popularity. The remaining elements occupy a middle ground in terms of both their assessed importance and popularity among the surveyed public.

6. Conclusion

The residential architecture of the Pearl River Delta embodies a wealth of regional cultural characteristics. In response to the dwindling cultural identity within this region, the present study utilized a case-study methodology, focusing specifically on the traditional Hakka enclosed dwellings in Huizhou (HTEDH) . By integrating cultural meme theory with a literature review, we delineated that the architectural culture of HTEDH comprises four cultural meme clusters and 35 subordinate cultural memes which response to RO1. To facilitate further analysis, we devised targeted online questionnaires. Firstly, we gathered weighted scoring data from seven experts regarding the cultural meme clusters and their sub-cultural memes within HTEDH. Secondly, we distributed questionnaires to local residents to ascertain their preferences towards various cultural memes of HTEDH.

Adopting the Analytic Hierarchy Process (AHP), this study conducted an in-depth analysis of the expert questionnaire data, yielding both relative and absolute weights for each cultural meme cluster and the sub-cultural memes. Based on their importance ranking, the protection priority order for the architectural cultural memes of HTEDH (Figure 14) and three protection levels of these cultural memes can be determined response tong RO2. Additionally, by analyzing the proportion of votes indicating liking or strong liking for various elements of HTEDH among the public, the degree of popularity for these elements was obtained. By arranging these elements in descending order of popularity (Table 5), a public opinion assessment method and implementation foundation for the protection of each cultural meme were established.Concurrently, we analyzed the results of the resident questionnaire. By assessing the proportion of votes indicating a liking or strong liking for each element of HTEDH, we derived the popularity of these cultural memes among the residents and organized them in descending order of popularity with response with RO3. This outcome not only furnishes a practical reference for the preservation of HTEDH architectural culture but also reinforces the rationale behind the importance ranking of cultural memes.

In summation, this study not only identified the constituents of residential cultural memes but also resolved the research questions through importance ranking and public opinion surveys, thereby establishing a foundational basis and strategic guidance for the prioritization of residential cultural preservation and inheritance. Although this study is a case study limited in Huizhou area, but, the research approach which involves prioritizing cultural memes importance and conducting public opinion surveys, is equally applicable to other regions within the Pearl River Delta in the future. Consequently, this study offers insightful recommendations for the management of residential communities, the transmission and evolution of architectural cultural meme, and the sustainable development of vernacular dwellings in the Pearl River Delta.

Author Contributions
Y.J.Z. was engaged in the whole research process, including conceptualization ; methodology ,funding acquisition, Validation from Y.J.Z., N.Z.; writing—review and editing,data curation from N.U., N.Z. All authors have read and agreed to the published version of the manuscript.

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Conflict of Interest Statement
The authors have no competing interests to declare.

Data Availability Statement
The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Abbreviation and Symbols

HTEDH	Hakka Traditional Enclosed Dwelling Huizhou
AHP	The analytic hierarchy process
CI	Matrix Consistency Index
CR	Consistency Ratio of Matrix
λmax	Maximum Eigenvalue of The Composite Matrix
RI	Average Random Consistency Index
$m_i = \prod_{j=1} a_{ij}$	The Product of the Elements in Each Row of the Judgment Matrix
$w_i^* = \sqrt[n]{m_i} =$	The N-th Root of mi
$w_i = w_i^* / \sum_{i=1}^{n} w_i^*$	Normalization of the Vector to Obtain
$\lambda_{\max} = \frac{1}{n} \sum_{i=1}^{n} \frac{(Aw)i}{w_i}$	The Calculation of the Maximum Eigenvalue

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