Research on the Sustainable Development of the Qiang Architectural Style

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Abstract:

The architectural style of Qiang people is suffering the invasion of outer culture, meanwhile, Qiang ethnic minority have a short understanding of their architectural style, which makes they not integrate into their oneself architectural style in the design of construction. Basing on the perspective of collective memory, for the first time, this paper uses the quantitative research as a tool to study the style of Qiang architecture by combining the method of average number, mode and the clustering analysis. Firstly, combining existing researches acquired by the relevant scholars and experts with the actual architectural style of 7 typical Qiangzhai (Qiang villages), this paper would draw out the representative system of architectural style in the new era. Secondly, the people of 7 typical Qiangzhai are divided into elderly people, middle-aged and young to carry out the fuzzy questionnaire survey and this paper uses those data to obtain the average number, the mode and the coefficient of variation in those people living in 7 typical Qiangzhai. Finally, the results indicate that the factors of Qiang architectural style including 8 central style's factors, 7 important style's factors and 15 general style's factors. On the basis of the results of study, this paper further puts forward some suggestions on the application of the style's factors in the design.

1. Introduction

Under the background of the impact of outer culture, the culture of indigenous architecture is gradually collapsed. Cox believes that architectural art has been local characteristics when it integrates into the indigenous architectural style [1]. Therefore, the protection of indigenous culture, intellectual property and indigenous architecture is not only the respect for indigenous inhabitants but also a part of the future of the country's sustainable development [2]. Traditional architecture represents the certain area of architectural culture, with good geographical features, but there are practical

problems such as the poor of lighting for some traditional buildings. The traditional architecture is facing the native impact of modernization and urbanization, at the same time. Terribly, if the traditional architecture is not given due attention, then the sustainable development of traditional architecture will confront some embarrassing situations. Nowadays, the design of sustainable architecture and indigenous architecture is based on environmental aspects, are a specific style of design [3]. Therefore, style's factors of indigenous architecture are analyzed according to the typology, so that the style of indigenous architecture can be inherited and innovated in the modern architectural style design [4].

The Qiang architecture, a part of the long-standing cultural source of architecture, has become a portion of vital design in building, which has also been integrated into a part of the promotion of beautiful village in Qiang area [5]. Building the system of Qiang architectural style and analyzing these style's factors in the system according to the way of clustering to guide the design of Qiang architecture, which is the significant way for the inheritance of Qiang architecture.

The general methods are as follows: firstly, this article uses the existing conditions of traditional Qiangzhai ruins, inheritors, modern science and technology to establish a complete set of the system of pattern language for Qiang architectural style; secondly, this paper takes the method of fuzzy evaluation to acquire collective memory data of Qiang architecture in those persons living in typical Qiangzhai who divided into three groups of age; thirdly, this paper analyzes these data ahead to gain the average and the mode of every architectural style's factors; finally, with grade standards, this paper transforms the average and the mode by certain principles to get the relationship of cluster of every style's factor.

2. Materials and Methods

2.1. Research Sites and Research Crowds

The collective memory is a kind of social psychological concept proposed by French Halbwachs [6] that is different from personal memory. At the same time, he pointed out that "a place of memory is anything of importance, whether it is material or non-material, because of people's will or the baptism of the times, it becomes the symbolic element of a group's memory heritage." For the collective memory plays an important role in strengthening the self-identity of the members of the ethnic groups, meanwhile the collective memory relies on public participation, which can effectively improve reliability of decision-making [7]. So, from the research results of Qiangzhai in the past 30 years, the study of Qiangzhai has preliminarily formed a multi-angle pattern, and the future research should conduct a special study on Qiangzhai and Qiang architecture from the perspective of the settlement population [8].

Every aspect of human existence occurs in one environment or another [9], the specific environment of a region will affect the psychology of people living in the area for a long time, so as to make corresponding environmental psychological choices in the architectural style. According to the theory of collective memory, this research digs "the collective memory heritage of Qiang architectural style" as the first step of the quantitative analysis of the factors of Qiang architectural style. Meanwhile, this paper clarifies studied areas and studied crowds.

1. The analysis of studied areas: the Aba Autonomous Region is located in the northwestern part of Sichuan Province, China, lying in the southeast margin of the

Qinghai-Tibet Plateau and the northern end of the Hengduan Mountains. The landforms are mainly high plateau in southeast and high mountain canyon in middles. Wenchuan, Lixian and Maoxian of Aba Prefecture are the main settlements of Qiang people. In order to truly reflect the style of Qiang indigenous architecture, through field investigation, this paper chooses 7 representative Qiangzhai as the research object and analyzes the factors clustering of Qiang architectural style, as shown in Figure 1.
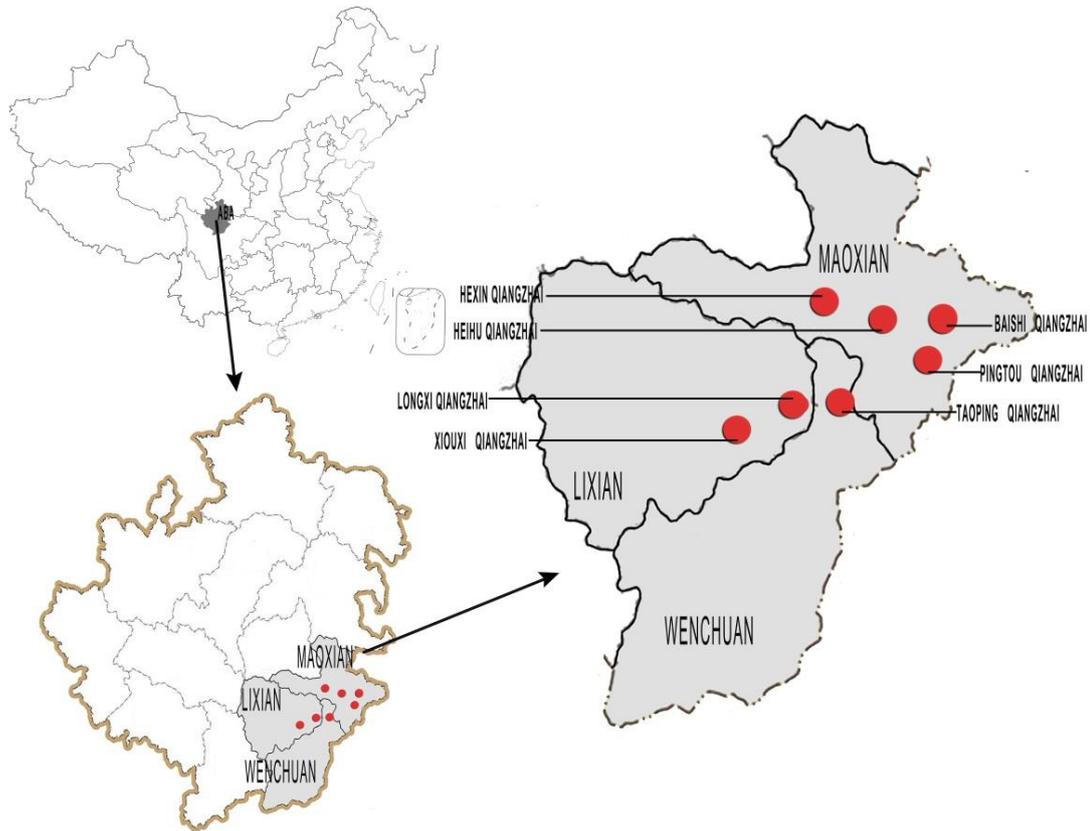
Figure 1. The location of Aba in China and the location of study villages.

2. The analysis of studied crowds: on the one hand, if the traditional method of distributing and repossessing untargeted statistical questionnaires is still used in the survey, it may appear that the Qiang people face some architectural terms that are difficult to understand and can't communicate with investigators on timeliness, on the other hand, some Qiang people do not attach importance to the traditional culture. The above two situations will lead to the low reliability of the statistical data.

At the same time, because these persons locating in Qiangzhai live in different times and have different ages, this study divided them into three age groups of the old people, the middle-aged and the young. With a way of face to face, investigators choose some Qiang persons who are willing to be investigated and attach an important view on them own traditional architectural culture to get the data about evaluation factors, choosing the way to examine in order to enhance the reliability of these data. For guaranteeing continuity of traditional Qiang architectural culture, these persons locating in 7 Qiangzhai must have been lived in traditional architecture (Stone dwellings before Wenchuan earthquake).

2.2. The System Construction

To excavate "the collective memory heritage of Qiang architectural style" should focus on the index system of memory collectively approved by Qiang people. As the product of the years, the style of Qiang architecture is a development process, which not only contains the factors of traditional architecture, but also the factors of architecture in the new period.

The selection principle of style's factors: according to the analysis of the urban image by Lynch [10], the reference to three aspects of the social effect, ecological quality and aesthetic effect of landscape factors in the landscape evaluation theory [11], and, the reference to the principle of determining the landscape evaluation factors [12] to guide the selection principle of style's factors. This paper finally adopts the five principles of comprehensiveness, typicality, science, hierarchy and feasibility.

The selection ideas of style's factors: according to the above identified the selection principle of architectural style's factors, 3 steps are used to evaluate and finally determine the characteristic factors of architectural style.

1. Through the reference and the collection of literature to get the traditional and new period architectural style's factors, this paper sums up the factors of architectural style and professional terms that need to be studied preliminarily.

2. In this paper, the architectural style's factors of seven Qiangzhai are analyzed, and the preliminary architectural style's factors would be once again modified.

Table 1. Index system of Qiang architectural style approved by Qiang people.

Target layer	Control layer	Factor layer
A: The system of ethnic factors in Qiang architectural style	B1:Architectural forms	C1: Form's contraction, C2: Overhang balcony , C3: Set-back model, C4:Semi-masking roof , C5:Lese(the mascot of house roof corner) , C6: climbing, C7: Stacking platform
	B2:Architectural walls	C8: Gray-stone group wall, C9: Wooden wall
	B3:Architectural entrances	C10: Festooned door, C11: Shigandang (Stone tablet at entrance)
	B4:Architectural windows	C12: Lattice window, C13: Cross window, C14: Bucket window , C15: Ethnic window , C16: Window place white stone
	B5:Architectural balustrades	C17: Mullion balustrade, C18: Wooden plank balustrade
	B6:Architectural eaves	C19:Transverse-ring eaves , C20: White-stone eaves , C21: wooden eaves
	B7:Architectural roofs	C22:White-stone decorated roof, C23: Flat roof
	B8:Architectural decorations	C24:Sheep totem, C25: Fire totem, C26: Back-type pattern , C27: Snowflake pattern, C28: Moon and star patterns , C29: Animal and plant patterns , C30: Human pattern

B1: Architectural forms		
C1: Form's contraction	Floor plan	Profile
	Contraction	Contraction
C2: Overhang balcony	Floor plan	Profile
	Floor plan	3F 3F / Overhang balcony / 2F 2F / 1F 1F
C3: Set-back model	Floor plan	Profile
	Roof / 1F 2F	3F Platform / 2F / 1F
C4: Semi-masking roof	Floor plan	Profile
	Cover Platform	3F Platform / 2F / 1F
C5: Lese	Floor plan	Profile
	Parapet / Lese	Lese 30° / Parapet
C6: Climbing	Floor plan	Profile
	Roof / Steps	Roof / 2F / 1F
C7: Stacking platform	Floor plan	Profile
	Platform / Roof	2F / 1F / Platform

B2: Architectural walls	
C8: Gray-stone group wall	C9: Wooden wall

B3: Architectural entrances	
C10: Festooned door	C11: Stone tablet at entrance

B4: Architectural windows		
C12: Lattice window	C13: Cross window	C14: Bucket window
C15: Ethnic window		C16: Window place white

B5: Architectural balustrades	
C17: Mullion balustrade	C18: Wooden plank balustrade

B6: Architectural eaves		
C19: Transverse-ring	C20: White-stone	C21: wooden

B7: Architectural roofs	
C22: White-stone decorated roof	C23: Flat roof

B8: Architectural decorations		
C24: Sheep totem	C25: Fire totem	
C26: Back-type pattern		C27: Snowflake pattern
C28: Moon and star	C29: Animal and plant	C30: Human

Figure 2. Sketch map of style's factors in Qiang architecture.

3. On the basis of the above two steps, then 5 experts in the study of Qiang architectural style are invited to evaluate the rationality of the inquisitional factors, and finally 30 factors representing the Qiang architectural style are determined. Meanwhile this paper refers to Wang Renyu [13] aiming at the design method of architectural style and Zhou Hongyu [14] aiming at the extraction method of facade factors of traditional architecture, and classifies 30 evaluation index architecture factors by methods of architecture style. According to the theory of analytic hierarchy process [15], this paper divides the analytical elements into three levels and divides the factors of Qiang architectural style into three levels of seven categories of 30 subcategories (see Table 1).

This paper briefly introduces the basic features of Qiang architectural style factor, and draws the reference Figure 2 in order to understand the factors of architectural style more intuitively.

Architectural forms: the traditional forms of the shape of Qiang architecture are made up of semi-masking roof, overhang balcony, Set-back model, form's contraction, and Lese(the mascot of house roof corner), and so on. Through the local concave and convex of the architectural form, the roof alternating with height and falls are combined with the watchtower to form a unique building facade and roof line[16]; Architectural walls: the traditional Qiang architectural folk residence walls is mainly composed of gray tone stone, and its appearance is rough, hard, texture clear, dislocation splicing to reflect the thick stone and hard texture[17]; Architectural entrances: the festooned door of Qiang buildings after regional integration combines with the stone wall which is very harmonious. The entrance of the gate of Shigandang, belong to the residence of evil spirits is an important cultural symbol of the Qiang people. Generally speaking, there are double doors more than single doors in Qiang building[18]; Architectural windows: Qiang-style windows with distinct characteristics, mainly made up of wooden window, bucket window, cross window, national window. Qiang wooden lattice window is formed by adding the shape of goat horn and ox-rib on the basis of Han-style wooden lattice window, and the bucket window and cross window are mainly used in the gable as decoration [19]. And as a national decoration affixed to the wall, the national window is mainly composed of sheep totem as a basic element; Architectural railings: generally speaking, Qiang-syle railings mainly include two types about mullion balustrade and wooden plank balustrade. Actually, the whole structure is relatively simple; Architectural eaves: there are two main ways to decorate the eaves, one is to palindromes or triangular patterns as the matrix appear in the eaves, the other is arched patterns or wooden strips neatly arrange in the eaves; Architectural roofs: due to the lack of rainfall in Qiang area and Qiang people need more platforms to dry grains, Qiang buildings are usually flat roofs. At the same time, many traditional Qiang buildings also piled on the roof of white-stone, enriched the shape of the roof; Decorative symbols: the decorative symbols of Qiang architecture are divided into natural symbols, animal symbols, humanistic symbols, plant symbols, but the common decorative symbols are sheep totem, fire totem, palindrome and snowflake pattern.

2.3. Method

In the design process of Qiang architecture, the choice of its factors is highly subjective. If the mathematical model is used to evaluate these factors, so in the modern Qiang architectural style design can reflect the Qiang collective memory of architectural style.

This study will build the following model of evaluation:

1. The numerical standardized model of evaluation system: according to the fuzzy evaluation method [20], taking the Qiang architectural style as the object of study, the paper determines the level of fuzzy hierarchy: extremely important, important, general, unimportant, and extremely unimportant and converts it to be the corresponding number V = (5, 4, 3, 2, 1).

2. The statistical model of data: in mathematical statistics, the average reflects the general view of a group of data, but the average will change because of any data changing in a group of data, which is greatly affected by the extreme value in the data [21]. The formula for calculating the average is as follows:

$$An = \frac{a1 + a2 + a3 + \cdots + an}{n} \tag{1}$$

The word "An" is the average number, "an" represents the scores of every person and "n" is the total population.

Mode refers to the maximum number of occurrences in a set of data, and mode can reflect the majority opinion of a set of data. When the frequency of mode is more than half of a group of data, the mode has the advantage of representing the majority. But the disadvantage of mode is that it is not unique.

The average and the mode are concentrative trends that reflect a set of data. In order to reflect the centralized trend of a group of data more reasonably and scientifically, this paper starts with the correlation between them to confirm the Qiang people's collective cognition of Qiang architecture on the basis of analyzing the advantages and disadvantages of average and mode.

The coefficient of variation can judge the degree of deviation of the opinion of persons investigated, simultaneously, this paper can also analyze the difference of opinion on the same factor in the crowd by coefficient of variation, which reflects the feasibility of average and mode statistics. When the coefficient of variation doesn't change much, it proves the degree of deviation of the data not be changed much and the research data will have a higher s scientific nature, finally. The coefficient of variation is calculated as follows:

$$E = \sum_{1}^{n} \left| Xi - An \right|^{2} \tag{2}$$

$$CV = E/An \tag{3}$$

In the formula "E" is the standard deviation; "n" is the number of people; "Xi" is the score given by each of the respondents; "CV" represents the coefficient of variation.

3. Systematic cluster processing model: due to the difference of age, Qiang people are bound to be affected by the environment of different periods, which will lead them to have different impressions of Qiang architectural style. Therefore, it is necessary to carry out systematic clustering analysis according to the correlation degree of different age groups, so as to obtain a more reasonable and scientific clustering of evaluation factors.

In this study, Ward's method of systematic cluster analysis was used. The specific algorithm is as follows: divide numbers of samples (the word "N" shows this figure)

into many of classes (the word "m" shows this figure), which express as "G_1, G_2, G_3 … G_m" to define the cubic square sum of class word "I" as follows:

$$S_i^{(m)} = \sum_{j=1}^{N_j} (x_{ij} - \bar{x}_i)^T (x_{ij} - \bar{x}_i) \tag{4}$$

In the formula " $\bar{X}_i$" is the average of sample "X_{ij}", and "N_i" symbolizes the number of samples of class "I". Assuming that there are two categories of "G_p" and "G_q" in the sample, if "G_p" and "G_q" are combined into category "G_k", then the sum of squares of deviations added after the merging is as follows:

$$D_{pq}^2 = S_k - (S_p + S_q) \tag{5}$$

In the formula "S_P" and "S_q" are the sum of the squared deviations of "G_P" and "G_q" respectively, and "S_K" is the sum of the squared deviations of "G_K". Before the systematic clustering analysis, the method combining the average and the mode to get evaluation criteria is proposed (see Table 2) and the score range of values in Table 2 is determined by both the average and the mode. If in this paper, the minimum range is taken when the average and the mode exceed the criterion of the score determined in the table, in order to improve the scientific clustering of the factors, for example, An = 2.1, Mode = 5 or An = 5, Mode = 2.1 , the selection of score range is 1 ∼ 3 that is the general factor.

Table 2. *Evaluating method for grade standard.*

Grade standard	Central factor	Important factor	General factor
Grade quantification	5	3	1
Score range	4 ∼ 5	3 ∼ 4	1 ∼ 3

3. Results and Discussion

In this study, a total of 103 Qiang people are obtained from the Qiangzhai investigated, of which 29 are the elderly (all of whom know Chinese, including 7 craftsmen and 2 immaterial cultural inheritors), 41 middle-aged (all of whom know Chinese, including 18 craftsmen and 6 immaterial cultural inheritors), 33 young people (all of whom know Chinese, education level is junior high school and above, 6 of them are craftsmen). The proportions of population structure are 28.2, 39.8% and 32%respectively, there is little difference in the proportions of population structure, and the statistical effect on the average and the mode are slight, so authors can carry on the statistical analysis of relevant data.

3.1. The Coefficient of Variation Analysis

In this paper, the data of the survey population are analyzed and the variation coefficient of architectural style's factors under the collective memory of the Qiang people is obtained (see Figure 3), with a high sense of identity. The coefficient of variation of architectural factors in the overall population is concentrated in the range less than or equal to the value of the number 0.3. At the same time, because which is different from the age of people of different eras, the architectural appearance factors C6, C7, C14, C17, C18, C19, C20 are greater than 0.5, and have great variability.

Based on the analysis of the coefficient of variation of architectural style and features among the surveyed all population, it is necessary to analyze the three groups of age groups separately in order to better reflect the factors of architectural style and

features recognized by the Qiang people collectively. In the analysis, it was found that the factors of variation of architectural factors of the three age groups, except for individual ones, were mainly within the range of 0.3 or less (see Figure 3). Which indicates that people of the same age tend to the same point of view on the same factor of style and appearance, and can carry out relevant data analysis.

Figure 3. *Internal variation coefficient of crowds under collective memory.*
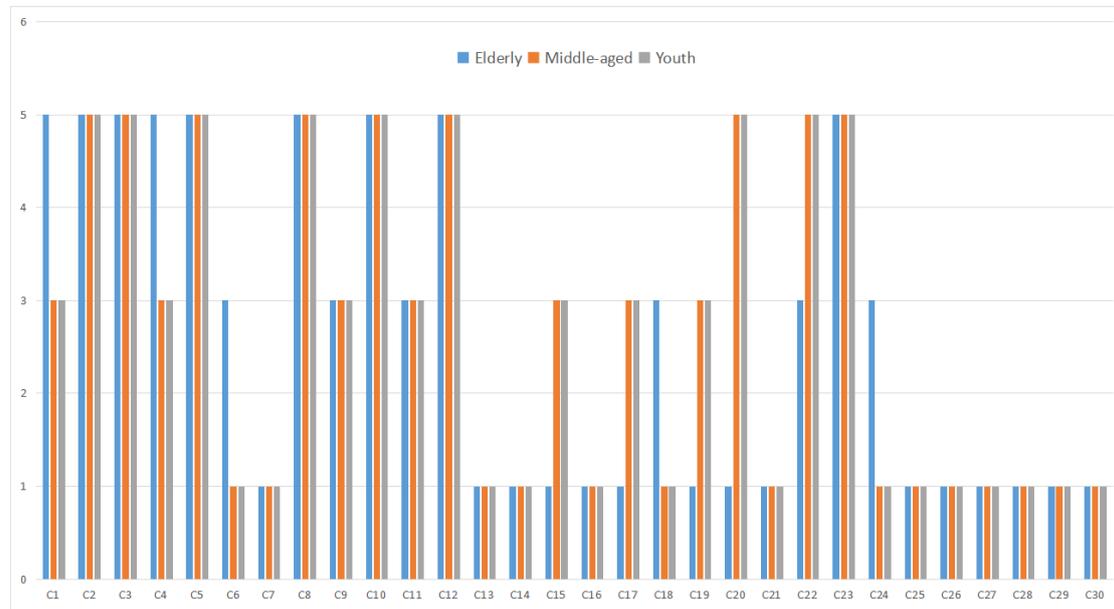
Figure 4. *Grade quantification for three groups of age people.*

3.2. The Statistical Analysis of Data

In mathematical statistics, in order to solve practical problems, people often collect as much information as possible from the study subjects to have a comprehensive and comprehensive understanding of the problem. However, due to the limitations to theoretical development and application technology, a large amount of information has become an obstacle to the analysis and solution of the problem [22]. For the purpose of solving this problem, this paper adopts the method of combining the

average and the mode. According to the above model of evaluation, the average and the mode of three groups of population are obtained (see Table 3, 4 and 5), and converted into grade standard according to the range of score(see Table 2), and the Figure 4 is obtained.

Table 3. *The average and the mode of data statistics for elderly People.*

Factor	Average	Mode	Factor	Average	Mode	Factor	Average	Mode
C1	5.00	5.00	C11	3.97	5.00	C21	2.24	2.00
C2	4.55	5.00	C12	4.93	5.00	C22	3.86	4.00
C3	5.00	5.00	C13	2.21	3.00	C23	4.97	5.00
C4	4.28	5.00	C14	2.48	3.00	C24	3.07	3.00
C5	4.07	5.00	C15	1.86	1.00	C25	1.76	1.00
C6	3.14	3.00	C16	2.14	1.00	C26	1.10	1.00
C7	2.86	3.00	C17	1.76	1.00	C27	1.21	1.00
C8	5.00	5.00	C18	3.03	3.00	C28	1.21	1.00
C9	3.69	3.00	C19	2.34	1.00	C29	1.34	1.00
C10	4.07	5.00	C20	1.79	1.00	C30	1.24	1.00

Table 4. *The average and the mode of data statistics for middle-aged People.*

Factor	Average	Mode	Factor	Average	Mode	Factor	Average	Mode
C1	3.59	3.00	C11	3.12	3.00	C21	1.78	1.00
C2	4.15	4.00	C12	4.49	5.00	C22	4.15	5.00
C3	4.83	5.00	C13	1.68	1.00	C23	4.90	5.00
C4	3.34	3.00	C14	2.05	1.00	C24	2.93	3.00
C5	4.56	5.00	C15	3.51	3.00	C25	2.59	3.00
C6	1.78	1.00	C16	1.90	2.00	C26	1.71	1.00
C7	1.37	1.00	C17	3.85	3.00	C27	1.32	1.00
C8	5.00	5.00	C18	2.46	3.00	C28	1.46	1.00
C9	3.95	5.00	C19	3.49	3.00	C29	1.76	1.00
C10	4.27	5.00	C20	4.12	5.00	C30	1.41	1.00

Table 5. *The average and the mode of data statistics for young People.*

Factor	Average	Mode	Factor	Average	Mode	Factor	Average	Mode
C1	3.67	3.00	C11	2.27	3.00	C21	2.12	2.00
C2	4.70	5.00	C12	4.61	5.00	C22	3.12	3.00
C3	4.64	5.00	C13	2.61	3.00	C23	4.91	5.00
C4	2.61	3.00	C14	2.45	2.00	C24	2.82	3.00
C5	3.61	3.00	C15	3.48	3.00	C25	2.24	3.00
C6	1.64	1.00	C16	1.73	1.00	C26	1.79	1.00
C7	1.15	1.00	C17	3.85	4.00	C27	1.36	1.00
C8	5.00	5.00	C18	1.42	1.00	C28	1.39	1.00
C9	3.06	3.00	C19	2.58	3.00	C29	1.85	2.00
C10	4.45	5.00	C20	3.52	3.00	C30	1.88	2.00

3.3. The Systematic Clustering Analysis

According to mathematical statistics of people of different ages, the collective opinions on the style and features of Qiang architecture can be well realized within each age group, but the disadvantage is that the collective opinions of the three groups

of people can't be obtained as a whole. If the collective opinion of the total number of the three groups of age groups is adopted, there will be a certain degree of deviation due to the disadvantage of the age difference and the disunity of the number of the investigated population. For the Qiang people can form a unified cognitive view in their architectural style, this paper uses SPSS21.0 software to carry on the systematic clustering analysis to the data of the three groups of age people who have obtained the grade standard, and finally obtains the cluster genealogical table of the Qiang architectural style factor (see Figure 5).
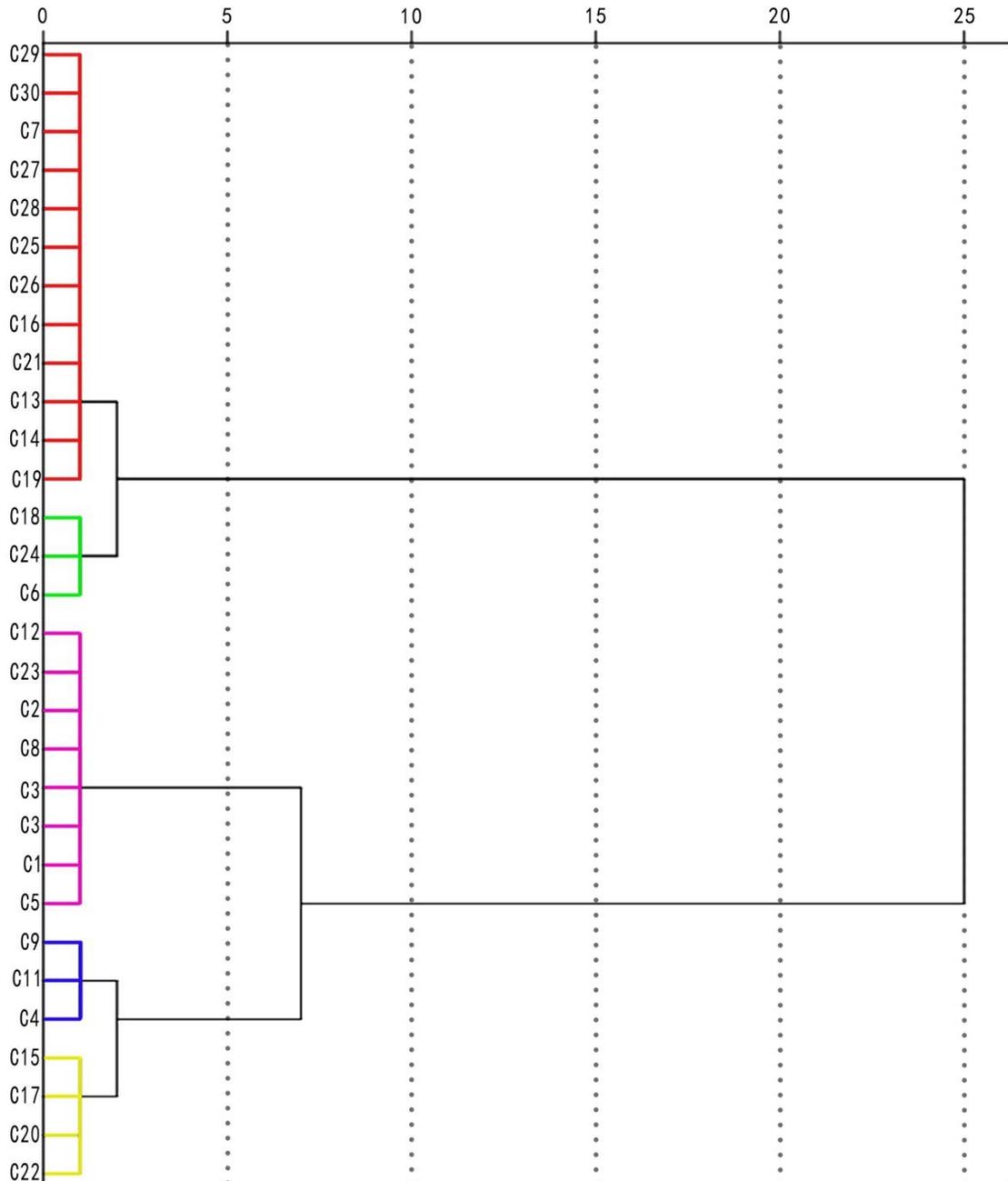

Figure 5. *The pedigree of systematic clustering analysis.*

3.4. Determination of the Grade Standards Under Collective Memory

Based on the cluster analysis of the above style's factors of Qiang architecture, it is found that the distance between the style's factors of Qiang architecture is

concentrated in the range of 5, forming five clustering relationships. In order to make the design of the Qiang architecture more operational, this paper determines the grade standard as three grades, so it is necessary to sum up the five clustering relationships obtained above for once again modified. In the process of 2nd induction, the principle of reference to Figure 4 is carried out, so this paper quickly obtains the clustering relationship of the factors of Qiang architectural style (see Table 6).

Table 6. Factors clustering and grade standards.

Grade standard	Number and factors name
central factors	C1: form's contraction, C2: overhang the balcony, C3: Set-back model; C5:Lese(the mascot of house roof corner), C8: Gray-stone group wall, C10: Festooned door, C12: Wooden lattice window, C23: Flat roof
Important factors	C4:Set-back roof, C9: Wooden wall, C11: Shigandang (Stone tablet at entrance), C15: Ethnic window, C17: Mullion balustrade, C20:White-stone eaves, C22:White-stone decorated roof
General factors	C6: Architectural climbing, C7: Stacking platform, C13: Cross window, C14: Bucket window, C16: Window place white stone , C18: Wooden plank balustrade, C19:Transverse-ring eaves, C21: wooden eaves, C24:Sheep Totem, C25: Fire Totem, C26: Back-type pattern, C27: Snowflake pattern, C28: Moon and star patterns , C29: Animal and plant patterns, C30: Human pattern

4. Conclusions

Under the beautiful rural construction plan, the Qiang architectural style is composed of two parts: architectural skeleton and decoration. In the design process of architectural style, designers should grasp the principle of the whole, the principle of the primary and secondary order, and the principle of the proper disposition.

According to the recognition of the important degree of 30 architectural style's factors among the Qiang people, 7 important factors and 15 general factors were determined (see Table 6). Based on the results of this study, authors put forward several suggestions for the design of Qiang-style architecture in the future.

The central factors of Qiang architectural style, they should be regarded as an indispensable architectural skeleton factors for this type of Qiang architecture, so as to realize the basic style of the architecture on the macro level.

The important factors of Qiang architectural style should be regarded as the first choice in shaping the style of Qiang architecture, so as to achieve the purpose of national decoration in Qiang architectural features.

The general factors of Qiang architectural style, because these factors appear less frequently in Qiang architectural style than other factors. But, it can form local differences between architecture and architecture, so as to improve the regional characteristics of Qiang architectural style.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

Acknowledgments

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