

PROCEEDINGS ARTICLE

Study on the Evaluation of Linpan Buildings in the Western Sichuan Plain Based on the Analytic Network Process

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ABSTRACT

Based on the description of the composition of Linpan buildings in Western Sichuan, this article establishes the evaluation index system of Linpan buildings in Western Sichuan by using the Analytic Network Process. It constructs a comparison matrix composed of three dimensions and nine elements of architectural structure, architectural style and architectural layout, calculates the index weight, and sorts the secondary index. The results show that among the evaluation elements of Linpan buildings protection in Western Sichuan, architectural layout (0.637) is greater than architectural style (0.258) is greater than architectural structure (0.105). Specifically, Siheyuan (0.3591), Sanheyuan (0.1678) and the overall style of the building (0.1645) play an important role. It is an important factor in the protection of Linpan buildings in Western Sichuan and provides some guidance for the protection and utilization of Linpan buildings in Western Sichuan.

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1. INTRODUCTION

Today, with rapid development of the urbanization process, the shortage of resources faced by urban development is prominent. The Linpan in Western Sichuan resources are gradually swallowed up. In addition, the backward Linpan infrastructure seriously affects the living conditions of farmers, and Linpan buildings have been damaged to a great extent.

In 2008, Chengdu Construction Committee of Sichuan province put forward "Opinions on promoting the implementation of Linpan protection in Western Sichuan in Chengdu" [1], which is the first programmatic document on Linpan protection in Western Sichuan, at the same time, as a key project for Chengdu to implement the Rural Revitalization Strategy, the protection and restoration project of Western Sichuan Linpan puts forward higher requirements for the protection and utilization of Western Sichuan Linpan buildings. The Western Sichuan Linpan is rich in the ecological value, aesthetic value, humanistic value, economic value, life value and social value, it carries the agricultural

civilization of Chengdu Plain and the architectural style of folk houses in Western Sichuan. Facing a series of problems such as how to protect and scientifically utilize the Western Sichuan Linpan resources, and how to show the unique architectural style of folk houses in Western Sichuan, and how to improve the living conditions and living environment of rural houses and farmers, it is an important research on the protection and utilization of Linpan in Western Sichuan at this stage to scientifically build the evaluation index system of Linpan buildings in Western Sichuan and clarify the impact of different dimensions such as architectural structure, architectural style and architectural layout on Linpan buildings in Western Sichuan.

In this article, the Analytic Network Process is used to establish the evaluation index system of Linpan buildings in Western Sichuan, construct the comparison matrix composed of three dimensions and nine elements of architectural structure, architectural style and architectural layout, calculate the index weight, and sort the secondary index, in order to summarize experience for the protection and

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utilization of Linpan buildings and provide some ideas for the construction of new countryside, promote the coordinated development of urban and rural areas.

Analytic Network Process can accurately describe the relationship between objective things. It is a particularly effective decision-making form that is particularly close to objective things. This article selects the Analytic Network Process to analyze the Linpan buildings in Western Sichuan.

2. EVALUATION INDEX SYSTEM OF LINPAN BUILDINGS IN WESTERN SICHUAN

2.1. Overview of Linpan Buildings in Western Sichuan

Linpan in Western Sichuan consists of houses, water, forests and fields. At the same time, there are some construction facilities and infrastructure, referred to as "Linpan" and "Lin", and some are directly named after their surnames. Among them, "house" includes house and courtyard, which refers to building and courtyard refers to courtyard dam.

Most of the Western Sichuan Linpan buildings are traditional residential building style in Western Sichuan. The architectural color is mostly white walls and green tiles. The facade decoration is rich in Western Sichuan residential elements, elegant and concise, and its internal decoration depends on the financial resources of residents [2].

Most of the architectural structures are through bucket wooden structure and mixed structure. The through bucket wooden structure is a common structural system in traditional folk houses. The through brace is used to connect the columns in series to form a room frame. The purlin is directly placed on the column head, and the bucket brace is used to connect the columns in series along the purlin direction. With the transformation of rural houses, it has gradually evolved into mixed structures such as civil engineering, brick and wood. Solid walls such as masonry earth brick wall and plate wall are used as load-bearing walls. Purlins are placed on the load-bearing wall to support the roof, and purlins are stretched out to support the eaves [3].

The architectural layout mainly includes type I, type L, Sanheyuan and Siheyuan. Type I is mostly a plane layout of one row and three rooms. It is the simplest and most basic form of Linpan buildings and is used by small families. With the change of family economic situation, it can be expanded to five rooms, seven rooms and other forms. Type L is mostly a semi-open

space composed of two building belts, one horizontal and one along. On the one along the direction, the horizontal type I two to three houses are added through "mo angle". Sanheyuan is a house with one side added on the basis of type L. The left and right sides are connected by "mo angle". The houses on both sides are symmetrical or asymmetric, depending on the needs of residents. Siheyuan is built around the courtyard on four sides, which is connected by four "mo angle". Usually, an entrance and exit are set on one side, commonly known as "Longmen", and an independent internal environment is formed when the door is closed. At present, the bucket type wooden structure Sanheyuan and Siheyuan preserved in the Linpan are rare and valuable architectural heritage, including the Lijia courtyard in Huaqiu Village, Pingle Town, Qionglai City [4].

2.2. Construction of Evaluation Index System of Linpan Buildings in Western Sichuan

Due to the influence of many factors on the Western Sichuan Linpan buildings, the relationship between factors is also varied. According to the positioning of Western Sichuan Linpan buildings and relationship between various factors, the Western Sichuan Linpan buildings evaluation index system is set into three categories, including primary and secondary index respectively. Three categories of primary index are: architectural structure, architectural style and architectural layout. Considering the main influencing factors in the first type of primary index architectural structure, bucket wooden structure and mixed structure are selected as secondary indexes. The second type of primary index architectural style selects overall architectural style, architectural color and architectural decoration as secondary indexes. The third type of primary index building layout is related to the form of Linpan buildings in Western Sichuan and plays an important role in the protection of traditional buildings. Therefore, type I, type L, Sanheyuan and Siheyuan are selected as secondary indexes. Specific indexes are shown in Table 1.

3. CONSTRUCTION OF INDEX RELATIONSHIP BASED ON ANALYTIC NETWORK PROCESS

Through analysis of the evaluation index system of Linpan buildings in Western Sichuan, the model of network hierarchy is constructed, as shown in Fig. 1. Protection of Linpan buildings in Western Sichuan and its primary index are taken as the control layer, and the secondary index under it as the network layer.

Primary Index	Secondary Index	Explanation
Architectural Structure B1	Mixed Structure C1	Common structural system of traditional folk houses
	Bucket Wooden Structure C2	Civil engineering, brick wood, brick concrete
Architectural Style B2	Overall Architectural Style C3	Traditional residential building style in Western Sichuan
	Architectural Color C4	Theme tone and color matching
	Architectural Decoration C5	Decorative style of folk houses
Architectural Layout B3	Type I C6	Plane layout of one row and three rooms
	Type L C7	Semi open space composed of two building belts
	Sanheyuan C8	Semi enclosed space with strong enclosure
	Siheyuan C9	Surrounded by houses on four sides

Table 1. Evaluation index system of Linpan buildings in Western Sichuan.

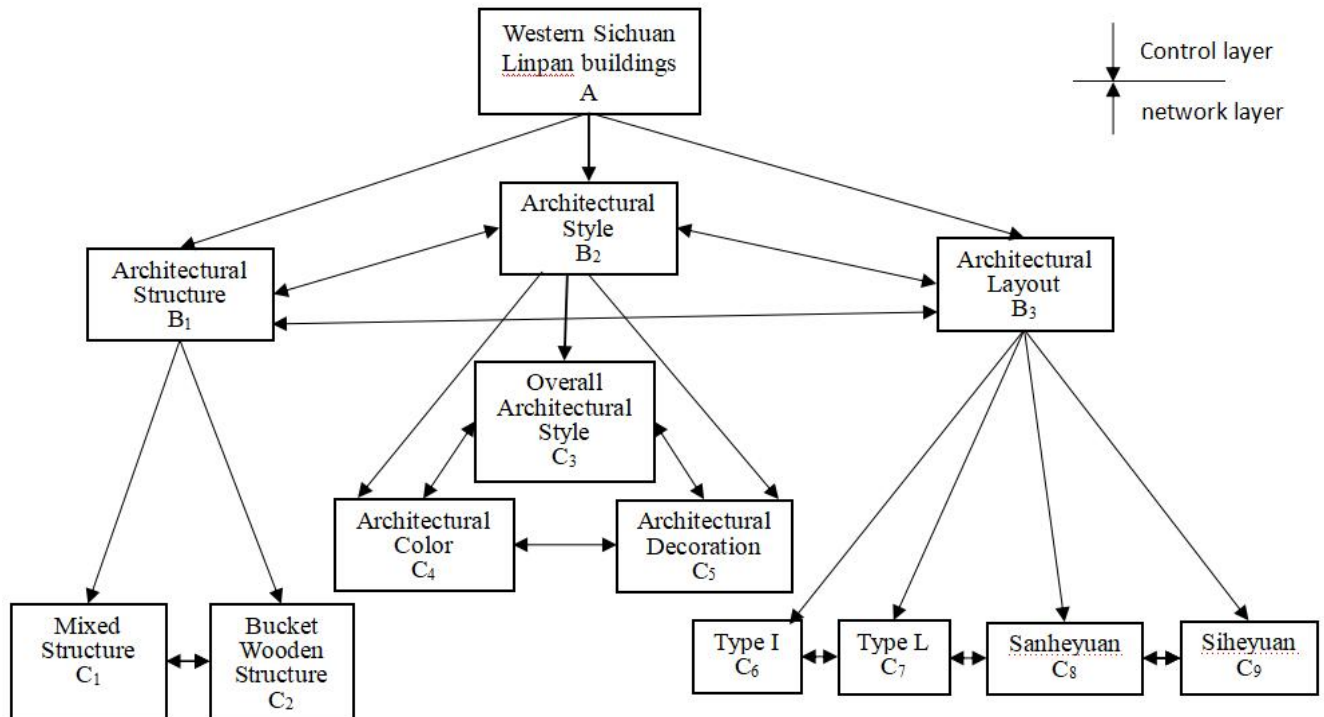


Figure 1. Network hierarchy model (source: drawn by the authors).

4. CONSTRUCTION OF COMPARISON MATRIX AND WEIGHT ANALYSIS

4.1. Constructing Comparison Matrix

The primary index and each secondary index are compared respectively, and the 1–9 scale method in Table 2 is used to scale the two factors and make a quantitative evaluation [5].

The expert survey scoring method is used to determine the evaluation indexes of Linpan buildings in Western Sichuan, and the comparison matrix is listed, as shown in Table 3, Table 4, Table 5 & Table 6.

Scale	Definition and Description
1	Both factors are equally important
3	One element is slightly more important than another
5	One element is obviously more important than another
7	One element is strongly more important than another
9	One element is extremely more important than another
2, 4, 6, 8	Scale in the middle of the above standards

Table 2. Scale table.

Western Sichuan Linpan buildings A	Architectural Structure B1	Architectural Style B2	Architectural Layout B3
Architectural Structure B1	1	1/3	1/5
Architectural Style B2	3	1	1/3
Architectural Layout B3	5	3	1

Table 3. Western Sichuan Linpan buildings A: primary index comparison matrix.

Architectural Structure B1	Mixed Structure C1	Bucket Wooden Structure C2
Mixed Structure C1	1	1/3
Bucket Wooden Structure C2	3	1

Table 4. Architectural Structure B1: secondary index comparison matrix.

Architectural Style B2	Overall Architectural Style C3	Architectural Color C4	Architectural Decoration C5
Overall Architectural Style C3	1	3	5
Architectural Color C4	1/3	1	3
Architectural Decoration C5	1/5	1/3	1

Table 5. Architectural Style B2: secondary index comparison matrix.

Architectural Layout B3	Type I C6	Type L C7	Sanheyuan C8	Siheyuan C9
Type I C6	1	1/3	1/5	1/7
Type L C7	3	1	1/3	1/5
Sanheyuan C8	5	3	1	1/3
Siheyuan C9	7	5	3	1

Table 6. Architectural Layout B3: secondary index comparison matrix.

4.2. Calculating the Index Weight

The weight calculation of the index comparison matrix of Western Sichuan Linpan buildings A in Table 3 is as follows:

1. Solving the vector of judgment matrix W:

$$W = \begin{bmatrix} 1 & \frac{1}{3} & \frac{1}{5} \\ 3 & 1 & \frac{1}{3} \\ 5 & 3 & 1 \end{bmatrix} = \begin{bmatrix} \frac{1}{15} \\ 1 \\ 15 \end{bmatrix}$$

2. Solving eigenvector:

$$\bar{W}_1 = \sqrt[3]{\frac{1}{15}} = 0.405, \quad \bar{W}_2 = \sqrt[3]{1} = 1, \quad \bar{W}_3 = \sqrt[3]{15} = 2.466$$

Normalize the vector \bar{W} : $\sum_{j=1}^3 \bar{W}_j = 3.871$

Get the weight coefficient: $W_1 = \frac{\bar{W}_1}{\sum_{j=1}^n \bar{W}_j} = 0.105$

$$W_2 = \frac{\bar{W}_2}{\sum_{j=1}^n \bar{W}_j} = 0.258 \quad W_3 = \frac{\bar{W}_3}{\sum_{j=1}^n \bar{W}_j} = 0.637$$

The eigenvector is: $\omega = \begin{bmatrix} 0.105 \\ 0.258 \\ 0.637 \end{bmatrix}$

3. Solving the maximum eigenvalue λ_{max}

$$PW = \begin{bmatrix} 1 & \frac{1}{3} & \frac{1}{5} \\ 3 & 1 & \frac{1}{3} \\ 5 & 3 & 1 \end{bmatrix} \begin{bmatrix} 0.105 \\ 0.258 \\ 0.637 \end{bmatrix} = \begin{bmatrix} 0.318 \\ 0.785 \\ 1.935 \end{bmatrix}$$

$$\lambda_{max} = \frac{1}{n} \sum_{i=1}^n \frac{(PW)_i}{W_i} = \frac{1}{3} \left[\frac{(PW)_1}{W_1} + \frac{(PW)_2}{W_2} + \frac{(PW)_3}{W_3} \right] = 3.039$$

4. Consistency test:

$$CI = \frac{\lambda_{max} - n}{n - 1} = \frac{3.039 - 3}{3 - 1} = 0.0193$$

Search average random consistency table [6],

$RI = 0.58$, so: $CR = \frac{CI}{RI} = 0.033 < 0.1$, pass the consistency test.

It shows that the comparison matrix of an index of Western Sichuan Linpan buildings A has satisfactory consistency. See Table 7 for calculation results.

Primary Index	Weight
Architectural Structure B1	0.105
Architectural Style B2	0.258
Architectural Layout B3	0.637

Table 7. Primary index weight table.

Category	Secondary Index	Weight
Architectural Structure B1	Mixed Structure C1	0.250
	Bucket Wooden Structure C2	0.750
Architectural Style B2	Overall Architectural Style C3	0.637
	Architectural Color C4	0.258
	Architectural Decoration C5	0.105
Architectural Layout B3	Type I C6	0.055
	Type L C7	0.118
	Sanheyuan C8	0.263
	Siheyuan C9	0.564

Table 8. Secondary index weight table.

It can be seen from the weight of primary indicators that the degree of protection of Linpan buildings in Western Sichuan is: architectural layout (0.637), architectural style (0.258), architectural structure (0.105). From the results, the architectural layout occupies an important position in the protection of Linpan buildings in Western Sichuan.

Through the same method, the secondary index weights of architectural structure B1, architectural style B2 and architectural layout B3 can be obtained. The calculation results are shown in Table 8.

The comprehensive weight of each secondary index is the weight of the primary index corresponding to the secondary index \times the weight of the secondary index. The comprehensive weight of each index is shown in Table 9.

Target	Primary Index	Secondary Index	Comprehensive Weight
Western Sichuan Linpan buildings A	Architectural Structure B1 (0.105)	Mixed Structure C1 (0.250)	0.0262
		Bucket Wooden Structure C2 (0.750)	0.0785
	Architectural Style B2 (0.258)	Overall Architectural Style C3 (0.637)	0.1645
		Architectural Color C4 (0.258)	0.0667
		Architectural Decoration C5 (0.105)	0.0271
	Architectural Layout B3 (0.637)	Type I C6 (0.055)	0.0350
		Type L C7 (0.118)	0.0750
		Sanheyuan C8 (0.263)	0.1678
		Siheyuan C9 (0.564)	0.3591

Table 9. Comprehensive weight table.

It can be seen from Table 9 that the total ranking is Siheyuan (0.3591), followed by Sanheyuan (0.1678), overall architectural style (0.1645), bucket wooden structure (0.0785), type L (0.0750), architectural color (0.0667), type I (0.0350), architectural decoration (0.0271) and mixed structure (0.0262). From the results, Siheyuan, Sanheyuan and overall architectural style occupies an important position in the protection of Linpan buildings in Western Sichuan, among which Siheyuan has the greatest impact. Of course, the protection of Linpan buildings in Western Sichuan needs to be tailored. Combined with the impact of various indicators on Linpan buildings in Western Sichuan, corresponding measures should be taken to protect Linpan buildings in Western Sichuan.

5. CONCLUSION

In this article, the Analytic Network Process is used to evaluate the Western Sichuan Linpan buildings protection, which can accurately present the correlation between indicators at all levels, and determine the impact of each index on the Western Sichuan Linpan buildings protection according to the comprehensive weight of each index, in order to determine the impact on the Western Sichuan Linpan buildings protection, in order to determine the factors that have a great impact on the Western Sichuan Linpan buildings protection. Provide basis for the protection of Linpan buildings in Western Sichuan.

From the perspective of the Western Sichuan Linpan buildings protection, this article selects three criteria of architectural structure, architectural style and architectural layout, quantifies the indicators of Linpan buildings protection in Western Sichuan by

using the Analytic Network Process, establishes the Western Sichuan Linpan buildings evaluation index system, analyzes in detail the 9 elements of the secondary indexes, the weight of the primary indexes, and sorts the indexes. The indexes that need to be protected are screened out. It can be seen that Siheyuan is still one of the key points of Western Sichuan Linpan buildings protection. At the same time, the qualitative and quantitative analysis of Western Sichuan Linpan building protection is also helpful to identify the value of Linpan buildings and provide guidance for the protection and utilization of Linpan buildings.

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