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Construction and Application of a System for Assessing the Value of Non-World Heritage Tulou in Pinghe County, Fujian Province, Based on the Analytic-hierarchy Process

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Abstract

China's Fujian tulou represent a valuable source of human heritage. With the exception of 46 tulou designated as World Heritage sites by the United Nations Educational, Scientific and Cultural Organisation (UNESCO), the tulou in Pinghe county, Zhangzhou city, which are classified among more than 3,600 non-World Heritage tulou, are the most representative of southern Fujian culture. However, as the Pinghe tulou have not been classified as World Heritage Sites by the World Heritage Committee, they lack financial support, receive minimal attention and have undergone little effective reconstruction. As a result, they are subject to structural deterioration. The goal of this article is to provide grounds for the functional repositioning of tulou by constructing an appropriate system for evaluating tulou in Pinghe county, based on the analysis of relevant factors such as value, location and material conditions. First, the general conditions and architectural characteristics of the Pinghe tulou are analysed, and their value composition is summarised. Next, a system for assessing the value of the tulou is developed, with rigorous use of the analytic-hierarchy process, the expert-scoring method and matrix calculation. Next, case studies of tulou in the town of Jiufeng, Pinghe county are outlined to illustrate opportunities to repurpose tulou through renovation. The aim of this article is to report on the construction of a system for assessing the value of tulou, thereby facilitating efforts to conserve and repurpose the Pinghe tulou and contributing to related research on the conservation and reconstruction of the Fujian tulou.

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Keywords: Analytic-Hierarchy Process (AHP); Pinghe Tulou; Evaluation system; Conservation and reconstruction

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1. Research background

There are 476 tulou in Pinghe county, Zhangzhou city, Fujian province. Of numerous tulou not classified as World Heritage Sites, the Pinghe tulou are the most representative of Fujian tulou. To date, 3,733 tulou in Fujian province have been officially recognised; they are distributed mainly in Nanjing county and Pinghe county, Zhangzhou city; Yongding county, Longyan city; and Huaan county, Quanzhou city. Forty-six Hakka tulou in Nanjing county, Yongding county and Huaan county were listed as World Cultural Heritage Sites by the United Nations Educational, Scientific and Cultural Organisation (UNESCO) in 2008, and are thus referred to here as ‘World Heritage tulou’. Pinghe county has the highest concentration of non-World Heritage tulou in Fujian province.

Unlike World Heritage tulou, the tulou in Pinghe county are numerous and widely distributed, reflecting a range of geographical relationships between the tulou and surrounding villages. Due to their variation in value, strategies for reconstruction are relatively flexible.

However, due to the sheer number of Pinghe tulou, their lack of World Heritage status and a weak local economy, efforts to conserve and reconstruct these buildings have long remained stagnant. Many valuable tulou have been neglected or even abandoned. Against this backdrop, the aim of this article is to construct a reasonable system for assessing the value of Pinghe tulou, and thereby to supplement and refine existing research on the protection and repurposing of non-World Heritage tulou.

2. Related research

2.1. Value and spatial characteristics of Fujian tulou

Previous studies of tulou in Fujian province mainly cover habitation patterns, construction features and spatial and architectural characteristics. Tulou construction strategies and types of spatial layout are summarised, providing historical insights into climate-adaptive architecture and the design of amalgamated dwellings (Hu Yang, 2012; Li Huasheng, 2013; He Xuanqiang, 2013; Zhou Hui, 2015). Researchers have also discussed the history of the development of tulou and assessed the buildings’ conservation value in terms of history, culture and construction technologies (Liu Meiqin, 2014).

2.2. Conservation and reconstruction strategies for Fujian tulou

Previous studies of the Fujian tulou provide an introduction to the process of applying for World Heritage status; some analysis of preliminary protection strategies; discussion of the current status, grades, targets, principles and scope of protection management; and proposals for methods of protection (Zhang Zucheng, 2010). In short, most researchers have addressed the current status of and problems with the protection of World Heritage tulou in Fujian, and proposed solutions to particular problems (Chen Danmei, 2013; He Xiaoxian, 2013). Some have analysed the positioning, resource development, products and infrastructure of cultural tourism in relation to World Heritage tulou in Fujian. Others have identified problems with the cultural tourism surrounding World Heritage tulou and recommended strengthening regional cooperation, integrating other natural and cultural resources and exploring Hakka culture in greater depth (Liang Haiyan, 2011; Xu Guifeng, 2013). In addition, some researchers have analysed the material, social and cultural features of tulou and considered the application of effective strategies for the protection and sustainable development of the buildings (Shao Wang, Su Yu, Li Shi, 2012). A model for the development of a cultural and creative tourism industry centred on tulou in Nanjing county has been proposed (Jiang, Zhenna, Jiangxia, 2011).

3. Analysis of current condition of Pinghe tulou and summary of problems

According to their shape, the tulou in Pinghe county can be categorised as square, round or multi-courtyard tulou; according to their population composition, they can be categorised as Hoklo tulou, Hakka tulou, etc.; and according to their planar layout, they can be categorised as unit-type tulou or corridor-type tulou.

3.1. Building type and planar layout

Inside a unit-type tulou, a longitudinal rammed earth wall acts as the load-bearing wall, and each room unit is completely separate from the others. Each building has its own entrance and stairs. The unit-type layout effectively resolves the conflict between the need to house a whole clan to resist enemies and the need to ensure the privacy of each household. Longxian Lou, in the village of Huangtian, Jiufeng, is the most representative unit-type tulou in Pinghe county.

Inside a corridor-type tulou, load-bearing is undertaken by a wooden framework. Several public staircases connect the floors, and the rooms are connected with each other via an overhanging corridor. Gongxiu Lou in the town of Luxi is the most representative corridor-type tulou in Pinghe county.

3.2. Characteristics of spatial layout

First, Fujian province boasts developed water systems, characterised by a large flood peak flow, interlinked river-valley basins and river-bend valleys, high-density river networks and a beaded distribution. The total length of all of the province's rivers is nearly 13 kilometres, with a river-network density of 0.1 km/km². Generally, the density of river networks in the upper or middle reaches is higher than that in the lower reaches.

Second, tulou originated from an agricultural civilization. As water is the most important resource for agriculture, and waterfront lands are often relatively flat, fertile and arable, it is natural for people making a living from farming in Fujian, which has many mountains, to build their houses near water. As a result, villages and thus tulou have developed along rivers.

3.3. Flexible features of reconstruction

As World Heritage tulou are subject to strict protection, technologies for the restoration of historic buildings that preserve architectural authenticity with minimal intervention have become the focus of research and practice. The use of a simple and crude ticketing system has significantly reduced the native population. In addition, only a few tulou are listed as World Heritage Sites; these buildings are highly localised and cannot easily be integrated with other resources. As a result, it is very difficult to develop diversified cultural tourism projects for World Heritage tulou, and restoration efforts are limited to superficial protection. This has caused serious problems such as 'hollowing', a loss of consistency with the surrounding landscape, homogeneous competition and incomplete tourism industry chains.

The tulou of Pinghe county have not been listed as World Heritage Sites, as they were built later than World Heritage tulou and/or are considered less valuable. Therefore, restoration efforts are subject to fewer limitations. Numerous non-World Heritage tulou can be flexibly reconstructed to meet the functional requirements of different areas and accommodate a range of facilities and users.

For example, tulou in close proximity to outstanding natural resources can be reconstructed as scenic spots or tourist service points; culturally significant tulou can be reconstructed as museums or themed cultural centres for demonstration and exhibition; and tulou with outstanding rural resources can be reconstructed for commercial purposes such as accommodation, catering and themed shopping.

In short, the reconstruction of non-World Heritage tulou, of which Pinghe county's tulou are the most representative, is in every respect more flexible than that of World Heritage tulou. Therefore, the Pinghe tulou are open to comprehensive and systematic development.

3.4. Existing problems

- Underdeveloped social economy

Although Pinghe county has recently experienced economic growth as a result of increased cultural tourism and agricultural industrialisation, the economy of Fujian province as a whole is growing at a far greater rate. A region's economic background substantially determines its capacity for resource development, as well as the ability to attract talent and construct relevant infrastructure. Pinghe county's long-term economic underdevelopment will inevitably

impede the development of cultural tourism in the area, resulting in a small, weak and incomplete cultural tourism industry.

- Lack of tourism infrastructure

An efficient traffic system is crucial to the development of cultural tourism, especially in hinterland areas such as Pinghe county. Currently, however, only provincial and county roads run through Pinghe, as the construction of national highways and the Fuzhou-Guangzhou Expressway is not yet complete. In terms of external traffic, there are no national highways, railways, expressways, harbours or airports; and in terms of internal traffic, low-grade roads suitable only for low-density travel prevent the diversification of traffic modes. In addition, with small travel agencies and fewer than 10 starred hotels, Pinghe county lacks accommodation facilities. Even the town of Jiufeng, which is listed as one of China’s major sites protected for their national historical and cultural value, has no hotels or homestay facilities, and is thus unable to meet the accommodation requirements of cultural tourists. Finally, Pinghe county receives no support from commercial ventures; due to the lack of recreation and entertainment facilities, no industry chains have been established in the region.

- Receptiveness to new functions

The tulou of Pinghe county face not only the problems shared by all old buildings under reconstruction in China, but also problems of their own. First, it is very difficult to import new, tailor-made functions into hundreds of tulou; second, due to the lack of upper-level designs, their functions are limited to the ground floor. Therefore, it is necessary to systematically evaluate strategies for repurposing tulou to obtain insights into appropriate functional positioning.

4. Construction of an evaluation system

In this article, the analytic-hierarchy process (AHP) is introduced as the basis of a system for assessing the value of Fujian tulou. The process of constructing this system is equivalent to the process of determining the importance of the tulou. In this article, four stages of the construction of the evaluation system are described: building a framework for the system; creating judgement matrices and performing consistency tests; calculating the weights of indicators at each level; and determining the scoring factors at each indicator level and allocating related scores.

4.1. Framework for evaluation system

The value distribution of non-World Heritage Tulou in Pinghe county, which represent southern Fujian culture, offers preliminary insights into the relationships between indicators at various levels of the evaluation system. This facilitates the construction of an evaluation framework consisting of a target layer (A), a criterion layer (B) and an indicator layer (C) (Table 1). The indicator layer provides a detailed description of the criterion layer, enabling the information in the criterion layer to be quantitatively analysed.

Table 1. Framework of system for evaluating Pinghe tulou

A. Target layer	B. Criterion layer	C. Indicator layer
System for evaluating Fujian tulou	B ₁ . Historical value	C ₁₁ . Year of construction
		C ₁₂ . Popularity
	B ₂ . Artistic value	C ₂₁ . Aesthetic value of structural spaces
		C ₂₂ . Aesthetic value of details and decorations
		C ₂₃ . Aesthetic value of surrounding environment
	B ₃ . Social value	C ₃₁ . Historical status of clan
C ₃₂ . Current influence of clan		

4.2. Judgement matrices and consistency tests

Comparing indicators at a given level with those on the upper level in Table 1 yields a judgement matrix. Therefore, four judgement matrices are constructed: one matrix for the criterion layer against the target layer and three matrices for the indicator layer against the criterion layer. The general forms of the judgement matrices are presented in Table 2. Each matrix can be expressed as $A = (b_{ij}) m * n$, where b_{ij} represents the weighting given to criterion B_i and criterion B_j for target A .

Table 2 General forms of judgement matrices

A	B_1	.....	B_j	.....	B_n
B_1	b_{11}	.....	b_{1j}	.....
.....		
B_i	B_{i1}	.....	B_{ij}	.....	B_{in}
.....		
B_m	b_{m1}	.....	b_{mj}	.....	b_{mn}

Next, the expert-scoring method is used to assign values to the judgement matrices, creating a matrix for the criterion layer against the target layer and a matrix for the indicator layer against the criterion layer. The results are shown in Tables 3 to 6.

Table 3 Results of weight-factor assignment in criterion layer

	B_1 Historical value	B_2 Artistic value	B_3 Social value
B_1 Historical value	1	2	5
B_2 Artistic value	1/2	1	3
B_3 Social value	1/5	1/3	1

Table 4 Results of weight-factor assignment in indicator layer corresponding to Criterion B_1

	C_{11} Year of construction	C_{12} Popularity
C_{11} Year of construction	1	1/3
C_{12} Popularity	3	1

Table 5 Results of weight-factor assignment in indicator layer corresponding to Criterion B_2

	C_{21} Aesthetic value of structural spaces	C_{32} Aesthetic value of details and decorations	C_{32} Aesthetic value of surrounding environment
C_{21} Aesthetic value of structural spaces	1	3	5
C_{22} Aesthetic value of details and decorations	1/3	1	2
C_{23} Aesthetic value of surrounding environment	1/5	1/2	1

Table 6 Result of weight-factor assignment in indicator layer corresponding to Criterion B_3

	C_{21} Historical status of clan	C_{22} Current influence of clan
C_{31} Historical status of clan	1	2
C_{32} Current influence of clan	1/2	1

As the importance of each weighted factor is determined mainly by comparison of tulou in southern Fujian, inconsistencies in judgement may arise, resulting in errors. Therefore, it is necessary to test the consistency of the judgement matrices created for the risk factors in the indicator layer (C) and the criterion layer (B).

4.3. Calculating weights of indicators at each level

After the judgement matrices have passed the consistency tests, a matrix-calculation formula can be used to calculate the weight of each indicator in the matrix. The general form of the matrix indicated in Table 2 is abstracted as a mathematical formula, as shown below:

$$B = (b_{ij})_{m \times n} = \begin{pmatrix} b_{11} & b_{12} & \cdots & b_{1m} \\ b_{21} & b_{22} & \cdots & b_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ b_{m1} & b_{m2} & \cdots & b_{mm} \end{pmatrix}, \tag{1}$$

where B is the judgement matrix for the relative importance of weighted factors in the indicator layer; n is the number of weighted factors in the criterion layer; and b_{ij} is the importance of criterion b_i compared with criterion b_j .

Next, the weight of each indicator at each level, U_i , is calculated. The judgement matrices are normalised and the eigenvector of each matrix – that is, the weight vector U of the weighted factor in the criterion layer against the target layer – is calculated.

$$u_i = \frac{\sum_{j=1}^m b_{ij}}{\sum_{i=1}^m \sum_{j=1}^m b_{ij}}, \tag{2}$$

$$\sum_{i=1}^m u_i = 1 \tag{3}$$

where $U = (u_1, u_2, \dots, u_m)$ denotes the weight vector of the weighted factor in the criterion layer against the target layer; n is the number of weighted factors in the criterion layer; and b_{ij} is the importance of criterion b_i relative to criterion b_j .

Similarly, the importance of each indicator layer (C_i) relative to the corresponding criterion layer (B_i) is obtained. The weight of each target relative to the criterion at the upper level is calculated, and the results determine the framework of the system, as shown in Table 7.

Table 7 Results of calculating factor weights for criterion layer and indicator layer

B. Criterion layer	Weight	C. Indicator layer	Weight
B ₁ Historical value	0.5701	C ₁₁ Year of construction	0.7500
		C ₁₂ Popularity	0.2500
B ₂ Artistic value	0.3207	C ₂₁ Aesthetic value of structural spaces	0.5701
		C ₂₂ Aesthetic value of details and decorations	0.3207
		C ₂₃ Aesthetic value of surrounding environment	0.1092
B ₃ Social value	0.1092	C ₃₁ Historical status of clan	0.6667
		C ₃₂ Current influence of clan	0.3333

4.4. Determining scoring factors at each indicator level and allocating related scores

After determining the weights of the criterion layer and the indicator layer, each indicator in the indicator layer is further described by a scoring factor, enabling the textual descriptions to be quantified by expert scoring.

For example, C₁₁ represents the indicator ‘year of construction’, which is a very broad concept. Consideration of the actual history of China’s tulou enables this indicator to be further divided as follows: ‘Ming Dynasty and earlier’, ‘Qing Dynasty’, ‘Republic of China’ and ‘since 1950s’. Next, scores are allocated to the sub-indicators at arithmetic intervals, with higher scores given to earlier periods, resulting in a complete system for the evaluation of tulou in southern Fujian (Table 8).

Table 8 System for evaluating Pinghe tulou

A. Target layer	B. Criterion layer	Weight (%)	C. Indicator layer	Weight (%)	Scoring factor	Score
System for evaluating Pinghe tulou	B ₁ Historical value	57.01	C ₁₁ Year of construction	75	Ming Dynasty and earlier (before 1644)	100
					Qing Dynasty (1644-1911)	75
					Republic of China (1911-1949)	50
					Since 1950s (1950 onwards)	25
			C ₁₂ Popularity	25	Popularity in city	100
					Popularity in county	75
	Popularity in town	50				
	Popularity in village	25				
	C ₂₁ Aesthetic value of structural spaces	57.01			Excellent	100
			Good	75		
			Moderate	50		
	B ₂ Artistic value	32.07	C ₂₂ Aesthetic value of details and decorations	32.07	Low	25
					Excellent	100
					Good	75
					Moderate	50
	C ₂₃ Aesthetic value of surrounding environment	10.92			Low	25
					Excellent	100
					Good	75
					Moderate	50
					B ₃ Social value	10.92	C_{31} Historical status of clan	66.67	Low	25
	Very high	100				
High	75					
Moderate	50					
C ₃₂ Current influence of clan	33.33			Low	25	
				Very high	100	
				High	75	
				Moderate	50	

5. Determination of functional positioning

The functional positioning of a tulou is determined by the results of the AHP evaluation. The most restrictive factor, namely the value of a given tulou, is considered first. Next, the architectural type and location of the tulou are considered in order. The final consensus on functional positioning is obtained through comprehensive and integrated analysis.

Useful examples are provided by 14 tulou in the town of Jiufeng in Pinghe county. Grade 1 tulou such as Yanqing Lou, Yongchun Lou and Longxian Lou are most valuable, and are listed as county-level cultural units for protection.

Therefore, they should be comprehensively repaired and conserved. However, as planar reconstruction is prohibited, Grade 1 tulou can only be remodelled as tulou museums or exhibition halls. As Grade 2 tulou such as Jingyun Lou, Fengyuan Lou, Nanyang Lou, Renmei Lou, Shengchang Lou, Xiashui Tulou and Fengxiang Lou are also relatively valuable, only limited reconstruction is permitted: the intensive creation of sanitation spaces and large changes (e.g. for dining and residential purposes) are forbidden. Therefore, Grade 2 tulou can only be reconstructed as shops, activity centres and exhibition halls. Grade 3 tulou, such as Lianhui Lou, Xinfu Lou, Yijing Lou and Changli Lou, are the least valuable, and can thus be reconstructed with various functions according to their architectural characteristics and location.

6. Conclusion

The tulou of Fujian province are the product of southern Fujian culture and Hakka culture, and represent a valuable source of heritage for humanity at large. The non-World Heritage tulou widely distributed in Pinghe county are of great historical and cultural importance, and their protection and reuse have become significant topics of research. In this article, a scientific and reliable AHP-based system for evaluating Pinghe tulou is proposed and its application discussed. The actual conditions of tulou are explored through case studies to identify appropriate strategies for the conservation and reconstruction of non-World Heritage tulou in Pinghe county and provide a point of reference for the sustainable development of tulou in other regions of China.

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