Research on Vitality Measurement of Village Public Space Based on Big Data and Multidimensional Module

Jing Luo
Dianchi College, Yunnan University, Kunming, China

*Corresponding author e-mail: reegine@qq.com

Abstract. The study takes village public space as the object, builds an information database based on massive data, and builds a multi-dimensional module and measurement system for public space vitality measurement. The research introduces measurement indexes such as Syntactic geometry and integration degree, and establishes three sub-modules from different dimensions. For the three sub-modules and their constituent elements, element analysis, superposition calculation and correlation matrix are established. Through GIS-spatial syntactic analysis, reveal the element system that affects the vitality of village public space, explore quantitative analysis methods based on big data and multi-dimensional modules, and put forward scientific measurement methods and optimization suggestions.

1. Introduction
In the context of China's "village revitalization", the development of traditional villages has entered an era in which "traditional protection" and "activation and utilization" are equally important. The traditional village public space is an important part of the village, which bears the important function of people's communication and exchange, and is a diverse living space formed by the interweaving of people, activities and living fields. The public space embodies the life atmosphere of the village and carries the culture, history and memory of the village. With the impact of urban civilization, these spaces have been gradually eroded, and the traditional lifestyle has gradually been lost.

Village public space, as an organic part of village revitalization and development, has attracted more and more attention from the society. Clarifying public space and its fundamental value, exploring its mechanism of action, and studying its optimization strategies are conducive to the repair and shaping of public space and promote the healthy development of traditional villages.

2. Vitality characteristics of village public space
Village public space refers to the public places in the village that promote interpersonal communication and social relations. There are many types of factors that affect the vitality of public spaces in traditional villages, and they are closely related to each other.

Zheng Xia (2009) divided the village public space into two types: physical state and ideological space [1]. Yan Xueqing (2012) divided public space into five categories: street space, square space, public green space, front house space, and cemetery space [2]. Zhang Jian (2012) pointed out that due to changes in lifestyle and ideology, traditional public spaces and functions have gradually weakened or no longer exist [3]. Ye Yun (2013) found that the public space of the village was constantly being eaten...
up and occupied, and finally became a public space with a main transportation function [4]. Chen Ran (2017) used behavioral architecture and environmental psychology to discuss the key points of creating humanized communication space in ancient villages [5]. Duan Degang et al. (2018) proposed that by reshaping the ecological ethics of public spaces, the rural traditional culture can be regained [6].

In this paper, the research on the vitality characteristics of village public space mainly starts from three aspects: physical space, social attributes of the selected people influencing the space, and the communication behavior of people in the space environment. The research on the measurement of the vitality of village public space reveals the driving mechanism that affects the vitality of traditional village public space from the perspective of multiple perspectives, based on spatial attributes and social attributes, and from the influencing factors of public space utilization.

3. Research ideas and technical framework

3.1. Research object

This article takes the traditional village of Nuohei Village, Shilin County, Kunming, Yunnan Province as a typical empirical location. As the "Yunnan Cultural Heritage Demonstration Village" and the second batch of traditional Chinese villages, the spatial activation and inheritance of Nuohei Village is the epitome of the protection and inheritance of traditional Yunnan villages. In 2019, there are about 400 households in Nuohei Village, with a population of about 1600 people.

![Fig.1 Aerial view of Nuohei Village](image)

3.2. Research ideas and technical framework

By analyzing the theory of village public space at home and abroad, this paper has formed a systematic and scientific understanding of the influencing factors, dynamic mechanism of public space utilization, and used this to establish the theoretical framework of village public space vitality.

This article establishes three sub-modules of “physical space (village public space)”, “social causes (village social structure)” and “spatial vitality (activity characteristics of public space groups)”, including: ① physical space, ② the population of space use Social attributes, ③ people's communication behavior in the spatial environment, based on GIS, spatial syntax to analyze these factors accordingly.

GIS spatial multivariate correlation analysis is performed on the raster maps of elements in the sub-modules "spatial environmental impact factors" and "social structure impact factors" and the sub-module "spatial vitality distribution" obtained by the aforementioned research, to establish a correlation matrix.
between layers. The influencing factors and influencing characteristics of public space vitality are obtained.

**Fig. 2** Research framework
4. Submodule 1: Research on "Elements of Space Environmental Impact"

Fig.3 Public space identification ideas and contents

Using scale space, place space, fuzzy space and sequence space theory, the village public space is identified and classified, and it is divided into nodal space and band space.

Tab.1 Public Space Type Census Table

| Node space       | Portal space       | Neighborhood space | Assembly space | Ribbon space |
|------------------|--------------------|--------------------|----------------|--------------|
|                  | Entrance plaza     | Solitary plant     | Node Plaza    | River bank   |
|                  | Village archway    | Well               | Village Office| River        |
|                  | Main entrance      | By the pond        | Cultural Activity Room | Roadway intersection |
|                  | Bridge end         | Small park         | Senior Activity Room | End road     |
|                  |                    | Hydrophilic dock   | Ancestral hall |              |
| Ribbon landscape |                    |                    | Temple         |              |
|                  |                    |                    | Academy         |              |

This article conducted a field survey of the buildings and public spaces in Nuohei Village, and classified the public spaces within the village area. The results are shown in the following figure.
Fig.4 Public space distribution

Fig.5 Public space classification

Fig.6 Visibility analysis based on space syntax

Fig.7 Integration analysis based on space syntax
This article uses Depthmap tools and spatial syntax analysis to analyze the integration and visibility of all public spaces in the research area, understand the accessibility and visibility of public spaces in the study area, and thus judge the characteristics of public spaces.

5. **Submodule 2: Research on "Influencing Factors of Social Structure"**

Fig.8 Ideas and contents of social structure research

Traditional villages usually form stable social relationships based on blood relationship and historical origin. The subject investigates village blood relationship, population distribution, ethnic culture, and collective memory. Through field investigation and GIS analysis, the distribution of kinship and agglomeration of kinship within the village are obtained, as shown in the following figure.

Fig.9 Kinship distribution

Fig.10 Kinship analysis
In this paper, based on GIS, the population distribution and collective memory points of the village are analyzed, and the population aggregation and the distribution of collective memory places within the research scope are obtained. The results are shown in the following figure.

6. Submodule 3: Research on "Characteristic Distribution of Spatial Activities"

This article investigates the behavioral characteristics of different public spaces in Nuohei Village to understand the basic attributes and activity characteristics of villagers in public spaces. Collect data on public spaces in different spaces and at different times through surveys on the use of public spaces within three time periods, morning (8-10 o'clock), afternoon (13-15 o'clock), and evening (17-19 o'clock) Information, such as number of contacts, number of people, duration, etc. Based on the above data, an analysis of the comprehensive activity intensity and duration of the public space was conducted.
Fig. 14 Morning activity intensity

Fig. 15 Morning activity length index

Fig. 16 Afternoon activity intensity

Fig. 17 Afternoon activity length index
7. **Vitality measurement conclusion and discussion of village public space**

In this paper, the GIS multivariate data model is used to calculate the correlation between the three sub-modules and the establishment of the correlation matrix, so as to determine the influencing factors and the degree of correlation of public space vitality from the perspective of sociology and space. Judgment of the correlation strength between elements and public space vitality through the following data ranges: the correlation coefficient is extremely strong between 0.8-1.0; the strong correlation is between 0.6-0.8; the moderate correlation is between 0.4-0.6; the correlation between 0.2-0.4 The correlation is weak; the correlation between 0.0-0.2 is very weak or no correlation.

The analysis results show that the extremely positively correlated element groups are surname distribution and integration, spatial distribution density and integration, population density, and collective memory space points; the strongly positively correlated element groups are evening activity intensity and evening activity length, and evening activity Intensity and activity intensity in the afternoon; the element group with moderate positive correlation is the activity intensity in the afternoon and the activity time in the evening.
Fig. 20  Multi-layer data correlation analysis matrix

Note: L1-Visibility, L2-Integration, L3-Collective memory, L4-Kinship, L5-public space, L6-Space population, L7-Morning activity length, L8-Afternoon activity length, L9-Evening activity length, L10-Morning activity intensity, L11-Afternoon activity intensity, L12-Evening activity intensity, L13-Terrain

The extremely negatively correlated element groups are spatial distribution and visibility, afternoon activity length and integration, morning activity intensity and population density; the strongly negatively correlated element groups are collective memory space and evening activity length, terrain elevation and surname distribution, Afternoon activity duration and morning activity intensity; the element groups with moderate negative correlation are afternoon activity duration and collective memory space, terrain elevation and spatial distribution, afternoon activity intensity and morning activity duration.

Village public space is a space carrier that carries village vitality and inherits village traditional culture. It can be drawn from the analysis results that many elements in the three sub-modules of the distribution characteristics of public space, the social reasons that affect the formation of space, and the vitality characteristics of space are strongly related.

From the results of element analysis of sub-modules and correlation analysis of multivariate data, to improve the vitality of village public space, the following methods can be used: (1) optimize the level and integration of public space in terms of spatial distribution, Balance, (2) strengthen and re-create the collective memory space of the village, make these spaces more sense of identity and belonging, (3) increase the population density around the public space. Combined with the analysis results, the vitality of the village public space can be improved through the above methods.

Acknowledgments
Funded by the base project of Philosophy and Social Sciences of Yunnan Province, “Research on the Vitality of Public Space in Traditional Villages in Yunnan Based on GIS and Space Syntax” (JD2018YB12).

References
[1] Zheng Xia, Jin Xiaoling, Hu Xijun. On the traditional village public communication space and inheritance [J]. Economic Geography 2009; 29(5):823-826.
[2] Yan Xueqing, Liao Qiulin, Wang Weiwei, Tang Bin. Research on the public space types and components of the settlement landscape of Zhang Guying Village [J]. Chinese Agricultural Science Bulletin 2012; 28(10):289-297.
[3] Zhang Jian. Renewal and reconstruction of public spaces in traditional villages ——Taking Panling Daling Village as an example [J]. Huazhong Architecture 2012; 7:039.

[4] Ye Yun. Research on the evolution mechanism of the public space form of villages on the edge of the city ——Take F Village F of Huangshi City as an example [J]. Huazhong Architecture 2013; 31(8):167-170.

[5] Chen Ran. Investigation and redesign of public spaces in historical and cultural villages based on the needs of different subjects [D]. Suzhou University of Science and Technology. 2018.

[6] Duan Degang, Yang Ru. A Study on the Path of Regaining the Rural Traditional Culture in the Restoration of Sanyi Village Public Space [J]. Journal of Western Human Settlements Environment 2018, 33(01): 7-12.