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Research on the Vitality of Public Spaces in Tourist Villages through Social Network Analysis: A Case Study of Mochou Village in Hubei, China

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Abstract: The construction of tourist villages is an important implementation path for promoting the new urbanization strategy in China. The optimization of their spatial pattern and functional adjustment is a key way to achieve high-quality urban development. The purpose of this study is to determine the influencing factors of public space vitality in tourist villages from the perspective of human behavior activities and to provide design support strategies for enhancing the vitality of public spaces in tourist villages. Using Mochou Village as an example, physical and behavioral network models were used to conduct a quantitative study of the vitality characteristics, and Quantitative Analysis of Precedence (QAP) regression was used to investigate the influence factors. The results demonstrate that spatial characteristics, such as “small block size, high street density”, and grid-like street structure and squares, as well as factors such as store concentration, sight lines, street length, spatial openness, and street width, significantly impact the vitality of public spaces in tourist villages. The analysis of the characteristics of the vitality of public space networks in tourist villages and the discussion of the influencing factors of public space vitality in this study can provide guidance for evaluating the vitality of public spaces and designing public spaces with high vitality in tourist villages.

Keywords: tourist villages; social network analysis; public spaces vitality; influencing factors of public space vitality; QAP regression



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1. Introduction

As China’s economic level continues to develop, the urbanization process is rapidly advancing, and as of 2023, the urbanization rate in China has reached 66.16% [1]. In the context of urbanization, the development of urban and rural spaces shows a clear imbalance [2,3]. The core issues facing rural development in the new era are prominently manifesting as significant urban–rural disparities, insufficient rural development, and a gradual decline in rural areas [4,5]. To address the prominent issues in rural areas, the Chinese government has proposed a strategy to promote the development of new urbanization [6]. Within this framework, tourist villages, as a bridge between urban and rural areas, have rapidly become a key approach to promoting the coordinated development between urban and rural areas [7].

Tourist villages are rural settlements that have the traditional values of national customs and a long history of folk customs, with abundant natural resources and local culture [8]. They are a new type of development space that combines characteristic industries with regional culture, production with life, and tourism functions [9]. The core of tourist villages lies in the cultivation and development of leading industries, commercializing the region’s natural resources, cultural heritage, rural traditions, and agricultural products’ market [10,11], attracting visitors and providing catering, entertainment and other services, with the goal of achieving sustainable rural economic development [12].

With the large-scale creation of tourist villages, there have been phenomena of a lack of regional characteristics and low-level repetition in construction, causing problems such as low vitality and insufficient attractiveness [13]. Avoiding the homogenization and singleness of tourist village spaces and demonstrating the vitality of tourist villages has become an issue that needs urgent consideration at the present stage. In order to address the abovementioned issues, research has introduced the concept of “spatial vitality” to measure the public space formed by the human behavior and the physical environment [14]. Currently, research on spatial vitality is mainly focused on urban spaces [15,16], with some studies targeting general rural areas [17,18], and there is relatively less attention given to the vitality of public spaces in tourist villages. The traditional village public space is an integral part of the village, serving as a crucial hub for people’s communication and interaction. It is a dynamic living space shaped by the intersection of individuals, activities, and living areas [19]. High-quality public space environments include vitality and diversity [20]. The vitality of public spaces is the comprehensive ability of the physical environment space to attract and support human behavioral activities and the perception and identity activities of people towards the spatial place [14,21].

Various factors influence the vitality of public spaces in tourist villages, and they are closely interrelated. Different disciplines have studied this subject from distinct perspectives. Research from the cultural perspective focuses on the inheritance and display of material and non-material cultural heritage for the cultural value of revitalizing the space in tourist villages [22], and related festival activities play a positive role in reinvigorating the vitality of the village [23]. From the perspective of public physical environments, studies have found that physical attributes such as land use, accessibility, building density, spatial scale, and spatial quality are all related to the spatial vitality of tourist villages [18,24]. However, little research has focused on how environmental factors in the public space of tourist villages affect human behavioral activities and village vitality. This study takes the case of Mochou Village, a tourist village in Hubei Province, and constructs a model of the physical space network and the behavior space network of the village’s public space using a social network analysis method through field investigations, video data, and drawing materials. This study quantitatively analyzes the vitality characteristics of the public space network related to the “behavior-space” linkage. Furthermore, six key factors influencing the public spaces vitality are identified. The QAP regression analysis method is utilized to confirm the level of influence and correlation of each element on the public space vitality in tourist villages. The main goal of this study is to assess the impact of physical environmental factors in tourist villages on public space vitality, in order to recognize and incorporate rational and high-quality factors that influence public space vitality in tourist villages and to identify the key design elements for public space vitality in tourist villages. This represents the contribution of this study.

2. Literature Review

2.1. Research on the Vitality Theory of Public Space

Research related to the theory of public space vitality can be classified into three main areas: recognition, stimulation, and evaluation.

First is the recognition of public space vitality. From the perspective of urban and social research, public space is defined as a location for social interaction [25]. Carr describes it as an open public place that can facilitate group and individual activities [26]. In a tourist village, public space serves as a site for daily interactions and transactions between residents and tourists, forming a spatial network of key nodes and streets [27,28]. The functionality of public space has been a focus for many scholars [29]. Theories such as K. Lynch’s “urban image theory”, Jane Jacobs’ “urban vitality analysis” and Jan Gehl’s “life between buildings” have all positively discussed the importance of creating vibrant public spaces [30–32]. In summary, the definition of public space vitality mainly focuses on two core elements: crowd activities and the physical environment in which activities take place [33]. From the perspective of space users, public space vitality has three basic

characteristics: multicentricity, aggregation, and stability [34]. Multicentricity refers to the multiple central points of attraction and vitality in the public space network, which could be squares, streets, natural landscape nodes, etc. Aggregation refers to the density of spatial connections, with higher densities leading to increased gatherings and communication. Stability pertains to the relative stability and coherence of the physical environment of public space, ensuring the continuity of crowd activities over a prolonged period.

Second is the stimulation of public space vitality. Lynch believes that optimal spatial forms encompass both vitality and diversity [20], and that spatial vitality can be improved through high-quality spatial design. Furthermore, Peter Calthorpe's theory of new urbanism suggests that mixed spaces and functions can promote urban vitality [35]. Likewise, Wayne Otto's urban catalyst theory leverages urban elements to stimulate the vitality of the catalyst point and its surroundings [36].

Third is the evaluation of public space vitality. The evaluation factors includes various factors, such as the street network, functional density, diversity, and accessibility [37,38]. Some studies evaluate public space vitality based on spatial environmental amenities, including sanitation facilities, fitness and entertainment facilities, and facilities for different age groups [39,40]. Additionally, some studies have also analyzed the vitality of urban green spaces and found that factors such as green space area and external and internal spatial characteristics are key elements influencing the vitality of public spaces [41].

2.2. Research on the Characteristics and Influencing Factors of Public Space Vitality

Previous methods of assessing public space vitality primarily relied on on-site observations and questionnaires [42]. However, these methods require a significant amount of time and manpower, and questionnaire data may be biased due to the subjectivity of the respondents. In this traditional data environment, there is a lack of data and quantitative methods to support the measurement and assessment of the built environment in public spaces [43]. In recent years, the development of geographic spatial tools has enhanced the accessibility of spatial data. Information is extracted from historical remote sensing imagery and street view imagery using computer algorithms to analyze the morphological characteristics of building spaces [44,45]. Additionally, location-based spatio-temporal behavioral data (LBS), cellular-telephone-collected GPS data, points of interest (POI), and social media data provide technical support for quantitatively analyzing public space vitality [46–48]. Public spaces consist of human behavior and the physical environment [14], and previous studies have explored the close relationship between these two components and public space vitality through quantitative analysis [49,50]. In terms of human behavioral characteristics, researchers use basic human behavioral data such as the space visitation rate [51], the spatial tour path [52], user diversity [53], etc., to reflect the diversity of spatial functions. As for physical environmental factors, spatial function, spatial scale, accessibility, the number of adjacent roads and road intersections, catering service reception facilities, and regional culture have been found to be associated with spatial vitality [50,54–56]. Previous studies have directly or indirectly analyzed the impact of different factors on the quality of public spaces in tourist villages.

The definition of public space vitality is evolving, and the influencing factors have transitioned from being singular to multifaceted. Space acts as the medium for human behavior, which is influenced by the physical variations and environmental conditions of space [50]. Crowd activities play a crucial role in enlivening the public space of a tourist village. However, there is currently limited research on the factors influencing the vitality of public spaces in the physical environment of tourist villages from the perspective of human behavior. Therefore, researchers should establish a comprehensive model of the public space network to determine the level of vitality and influencing factors of public spaces in tourist villages. This study adopted Mochou Village as the research object, and the village's vitality characteristics were quantitatively analyzed. Furthermore, through QAP regression analysis, the key influencing factors of spatial vitality were explored, providing theoretical support for the high-quality development of public space in tourist villages.

3. Methodology

3.1. Research Object and Data Processing

Mochou Village is one of the members of China's key tourism project libraries. With the goal of upgrading the rural tourism sector, Mochou Village was presented with new opportunities for development (Figure 1). During the development of tourist villages, researching the vitality characteristics of public space networks and their influencing factors becomes the fundamental work to enhance high-quality spatial development, addressing issues such as spatial commodification and spatial homogenization.



Figure 1. Guide map of Mochou village. Source: Zhongxiang Wanxi Cultural Tourism Co., Ltd.

Spatial form and human behavioral data were collected in Mochou Village to comprehensively analyze the spatial patterns and characteristics of human behavior in the region. Spatial data were collected from field survey maps and project design documents, including street networks, property boundaries, and the built public space environments. The key spaces were abstracted into 23 nodes (Figure 2). Simultaneously, video surveillance data of passenger flows were retrieved for 4 days in 2020: October 24th, 25th, 31st, and November 1st. The video images were extracted at one frame per minute for each camera point, and the number of tourists was observed and recorded. The average of the total statistical data of the four days was calculated to obtain the average daily tourist flow value of key spaces in the village (Figures 3 and 4).



Figure 2. Critical space nodes.



Figure 3. Video images.

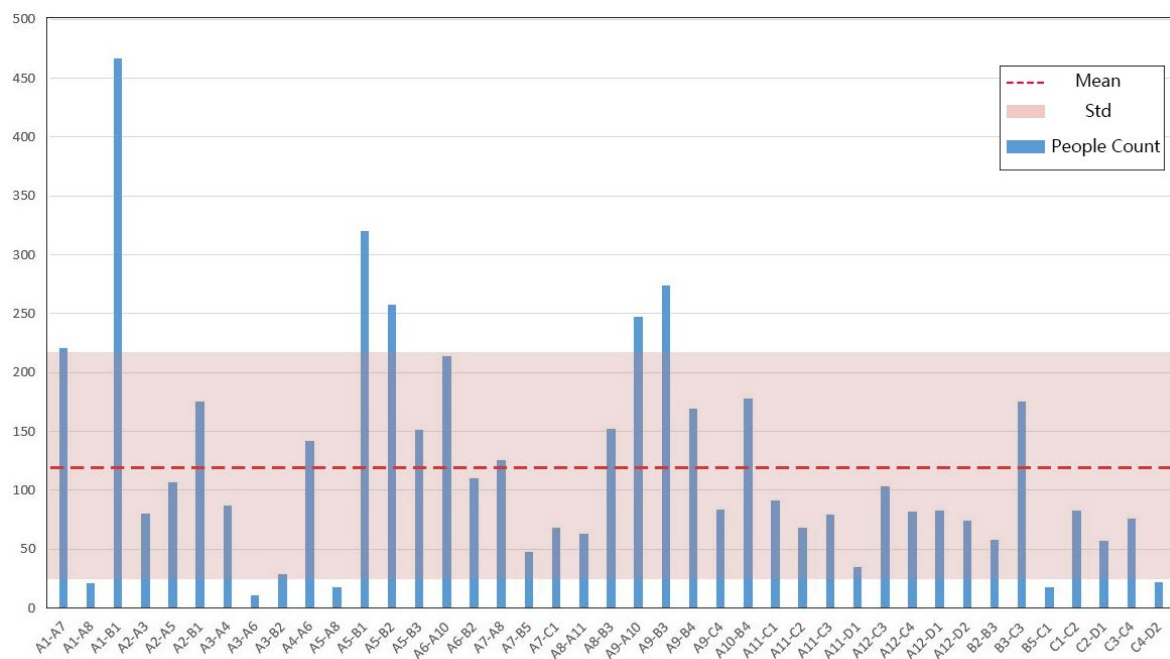


Figure 4. Video surveillance data of tourists flows.

3.2. Technical Approaches and Research Methods

The study of public space vitality and its influencing factors in tourist villages was carried out in four steps. First, the principles of social network analysis were applied to construct network models of physical space and behavioral space. Next, establishing computational indicators derived from the system of social network structure analysis were established. Then, relevant indicators of the network topology structure were calculated, and the results were analyzed. Finally, QAP regression analysis was used to validate the influencing factors that affect the vitality of public spaces before conclusions were drawn.

The social network analysis (SNA) method is employed to investigate the interrelationships among different behavioral subjects in social activities. In the theory and practice of public space, social network analysis has been increasingly applied to the complex rural system to intuitively and quantitatively reveal the relevant characteristics of the rural spatial network system [57,58]. Compared with other analysis methods such as GIS, social network analysis pays more attention to the behavioral needs of people in small and medium-scale spaces and is therefore more suitable for analyzing the public space of tourist villages [59]. Social network analysis views actors as nodes and the relationships between actors as connections, thus constructing a social space network [60]. In public spaces, the areas with regulatory spatial functions are designated as network nodes, and

the trajectory relations of people's activities in these spaces form a comprehensive system. This study focused on identifying the most representative behavior-space interaction areas in Mochou Village. In total, 4 types of spaces were chosen, including street intersections, squares, natural landscapes, and widened street sections, resulting in a total of 23 network nodes. The spatial connections that exist between nodes, without passing through others, are considered as edges, leading to the formation of a physical space network diagram (Figure 5). However, the physical space network represents only the topological structure of the physical environment, failing to capture the interactive relationship between tourists and space. Thus, using the physical space network diagram, the volume of tourist travel between nodes was utilized as an edge weight to construct a 23×23 multivariate matrix. The mean value subtracted from the standard deviation of tourist traffic volume between each node was set as the threshold value, which was calculated to be 26. If the tourist traffic volume between two nodes exceeded 26, it was considered to indicate an existing relationship, with a matrix value of 1; if it was less than 26, there was no relationship, and the matrix value was 0. The multivariate matrix underwent a binary process using UCINET to filter out low-traffic connections among people, forming a behavioral space network diagram that can effectively illustrate the interactive relationship between humans and space. The thickness of the edges represents the strength of the relationship between nodes (Figure 6).

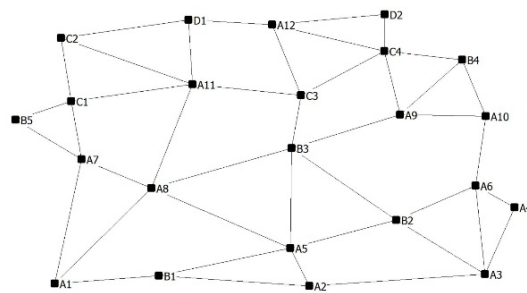


Figure 5. Space network.

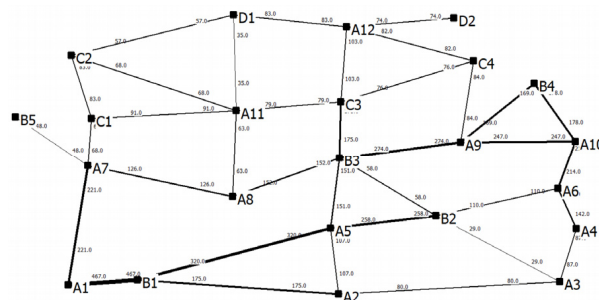


Figure 6. Behavioral space network.

3.3. Indicator System

The purpose of social network analysis is to examine the relationships between entities through network connections, with a focus on network relationships and structures. Social networks consist of nodes and connecting lines, where the nodes represent the elements under study, and the lines represent the objective relationships between them [61]. The vitality characteristics of public spaces in this tourist village were explored through integration of the research content and social network analysis indicators. Block models were utilized to identify the spatial distribution characteristics of nodes, while spatial connectivity characteristics were analyzed using network density and average path length. Additionally, spatial structural characteristics were assessed using lambda sets. Finally, QAP regression analysis was conducted to investigate the factors influencing public spaces and vitality in Mochou Village.

(1) Block Models

Block model analysis is a method used to analyze the spatial characteristics of network nodes, characterizing the internal structure and state of the correlation network through spatial clustering, and the role and status of each member within the network. Members with similar roles form subgroups [62]. The CONCERT algorithm of UCINET, which is also known as the iterative correlation convergence method, was used to conduct the block model analysis of this research subject. This approach enables the identification of the overall structural features of the network as well as the assessment of interaction strength within internal groups [63].

(2) Network Density

Network density is defined as the ratio of the actual number of connections between nodes in a network and the theoretical maximum number of connections. A higher density value indicates closer connections between nodes in the network, resulting in a more compact network structure and more complete network function [64]. The formula is expressed as follows:

$$D = y/[x(x-1)/2]$$

(3) Average Path Length

The average path length is the average of the shortest paths between any two points in the network. It is a global indicator that measures the transmission efficiency of the network. A smaller average path length indicates closer connectivity between network nodes. Its formula is as follows:

$$L = \frac{\sum_{i=j} d_{ij}}{n(n-1)/2}$$

In the formula, L is the average path length, n is the number of nodes in the network, i and j are the nodes, and d_{ij} is the shortest path length between i and j .

(4) Lambda Sets

Network stability is not determined by connection density. Figure 7 illustrates that in two networks with the same density, if there is increased density due to a core node, that network collapses when the core node is removed, indicating poor stability. The lambda sets can be used to evaluate the overall stability of a network structure through analysis of the line connectivity at various levels [65]. The connectivity between any two nodes in the lambda sets is greater than that between any two nodes within or outside the sets. Therefore, a higher lambda value with a larger proportion of nodes indicates greater network stability. Edge connectivity is defined as the minimum number of edges required to disconnect two nodes in a network. A higher edge connectivity value indicates a stronger relationship between the two nodes.

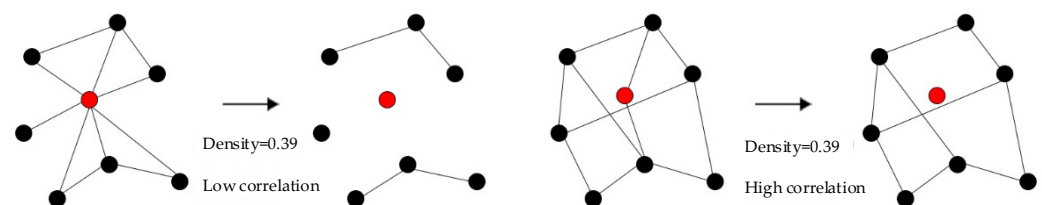


Figure 7. Comparison of correlation coefficients.

(5) QAP Regression Analysis

The QAP regression analysis involves regressing multiple independent variables against a matrix of dependent variables using a non-parametric method. This method does not assume independence among the variables, making it more effective and robust than

parametric methods [66]. The study analyzed the relationship matrix of tourist behavior in the nodal spaces of Mochou Village and its influencing factors to determine the factors influencing the spatial vitality of the village.

4. Results

4.1. Analysis of the Vitality Characteristics of the Public Space Network in Mochou Village

4.1.1. Polycentricity of Spatial Distribution

The tourism activity-based network was analyzed using the CONCERT algorithm with a maximum cut depth of 3 and a concentration standard of 0.2. As a result, the block model analysis of the Mochou Village activity-based network identified eight sub-blocks, as shown in Table 1, along with the corresponding sub-blocks density matrix in Table 2. The previous calculations indicated that the overall density of the activity-based network in Mochou Village was 0.1423. Sub-blocks densities equal to or greater than 0.1423 signify higher density than the overall level, suggesting a concentration trend within the sub-blocks [67]. Values in the sub-block's density matrix equal to or greater than 0.1423 were denoted as 1, while values less than 0.1423 were denoted as 0. This conversion results in a succinct relationship matrix (Table 3). A diagram illustrating the relationships between the eight subgroups was created based on this matrix (Figure 8), with larger nodes representing increased human flow interaction within sub-blocks, and thicker lines indicating more frequent human flow interaction between sub-blocks. Figure 8 shows frequent human flow interaction among external sub-blocks, but with uneven link strength. Internal relationships within sub-blocks reveal that IV, VI, and VIII have significantly higher density scores, indicating clear activity centers in these areas of Mochou Village, while the remaining sub-blocks exhibit relatively weaker activity. In conclusion, Mochou Village offers a diverse and uneven spatial layout for plaza nodes, demonstrating multi-centered and heterogeneous characteristics, enriching the flow rhythm and spatial experience for tourists through the analysis of the vitality characteristics of the public space network in Mochou Village.

Table 1. Block model analysis of Mochou village.

Sub-Block	Nods
I	A1, A8, B5, C1
II	A7, C2
III	A11, A12
IV	C3, C4, D1, D2
V	A2, A4, B2
VI	A3, A5, B1, B3
VII	A6
VIII	A9, A10, B4

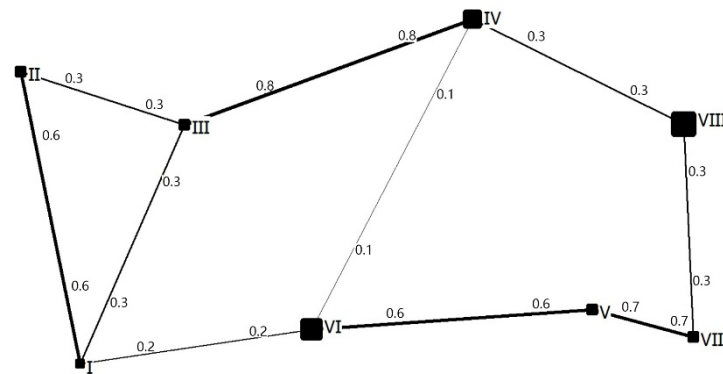
Table 2. Group density matrix of Mochou village.

Sub-Block	Density Matrix							
	I	II	III	IV	V	VI	VII	VIII
I	0.000	0.625	0.250	0.000	0.000	0.165	0.000	0.000
II	0.625	0.000	0.250	0.125	0.000	0.000	0.000	0.000
III	0.250	0.250	0.000	0.750	0.000	0.000	0.000	0.000
IV	0.000	0.125	0.750	0.167	0.000	0.063	0.000	0.283
V	0.000	0.000	0.000	0.000	0.000	0.583	0.667	0.000
VI	0.165	0.000	0.000	0.063	0.583	0.333	0.000	0.083
VII	0.000	0.000	0.000	0.000	0.667	0.000	—	0.333
VIII	0.000	0.000	0.000	0.283	0.000	0.083	0.333	1.000

Note: R-squared = 0.435.

Table 3. Group picture matrix of Mochou village.

	I	II	III	IV	V	VI	VII	VIII
I	0	1	1	0	0	1	0	0
II	1	0	1	0	0	0	0	0
III	1	1	0	1	0	0	0	0
IV	0	0	1	1	0	0	0	1
V	0	0	0	0	0	1	1	0
VI	1	0	0	0	1	1	0	0
VII	0	0	0	0	1	0	—	1
VIII	0	0	0	1	0	0	1	1

**Figure 8.** Spatial distribution map of Mochou village.

High-vitality areas are mainly concentrated in the B1, B2, and B3 squares and the connecting streets; the B4 square and the adjacent streets; and the C3 and C4 natural landscape nodes and the widened section between D1 and D2. These high-vitality spaces are predominantly located around the squares, with sub-blocks of the square being more frequently interconnected with other sub-blocks. This suggests that the holistic effect of the square space is crucial in activating the vitality of the area. This study is in line with a previous study in Polish villages; that is, the multifunctional squares are the most essential to maintaining the vitality of village public space [68].

4.1.2. Aggregation of Spatial Connectivity

The spatial network density of the streets was calculated to be 0.1423, while the spatial network density of the material was 0.1660. The difference between the two was only 0.0237, and both did not have independent nodes. Specifically, there were 23 nodes and 41 groups of node relationships in the material spatial network of Mochou Village, and 23 nodes and 36 groups of node relationships in the behavior network. This indicated the presence of 36 active paths among the nodes, accounting for 87.80% of the total paths. The average path length of the behavioral network was 3.036, indicating high spatial accessibility within Mochou Village. A high degree of nodalness of a public space means that the number of public spaces directly accessible to it by road is high [59]. In summary, the spatial connectivity of Mochou Village exhibits strong aggregation.

According to the data, the street sections in Mochou Village range from 15 m to 70 m, with approximately 76% being under 50 m, indicating a high street network density. The human visual range is 70–100 m, allowing tourists in Mochou Village to clearly see people and their activities at street intersections from anywhere on the street. The strong spatial permeability and connectivity attract pedestrian flow. Furthermore, Mochou Village's current area is relatively small compared to similar tourist villages, allowing tourists to visit different areas within their physical limits. The small block size and high street density improve the spatial connectivity and aggregation of Mochou Village.

4.1.3. Stability of the Spatial Structure

Table 4 shows that the spatial network has a minimum lambda value of two, indicating a minimum edge connectivity of two and a maximum lambda value of five, suggesting there are at least two paths between any two spatial nodes in village and at least five paths between 39.13% of the nodes. In the behavior network, the minimum lambda value is 1, with 91.30% of nodes having a lambda value of 2, indicating very few terminal nodes and at least two highly dynamic paths between the majority of nodes. The maximum lambda value is 4, indicating at least 4 highly dynamic paths between 39.13% of the nodes. Overall, both the spatial and behavioral networks show relatively high maximum lambda values, large proportions of nodes in the set, no core nodes, and strong spatial stability.

Table 4. Analysis of the lambda set of Mochou village.

Lambda	Spatial Network		Behavior Network	
	Number of Nodes	Proportion	Number of Nodes	Number of Nodes
1	0	0%	23	100%
2	23	100%	21	91.30%
3	20	86.96%	18	78.26%
4	13	56.52%	9	39.13%
5	9	39.13%	0	0%

Mochou Village's spatial network does not contain any dead-end streets, and 82.60% of its street intersections offer three or more directional choices. The high lambda value of the material spatial network in Mochou Village is attributed to the multiple-choice intersections created by the grid-like street structure, as well as the high clustering of spatial connections. This allows the spatial network to maintain the characteristics of the street structure. Furthermore, each node is connected to multiple nodes, resulting in a stable network structure. In summary, the grid-like street structure ensures close spatial connections and provides visitors with a stable and coherent physical environment, leading to potentially enjoyable congregation and increased spatial vitality.

4.2. Analysis of Factors Affecting the Vitality of Public Spaces Network

4.2.1. Factors Affecting Selection

Tourist activities shape the spatial network, which reflects the interactive characteristics of "behavior-space" and fundamentally influences tourists' perception of spatial vitality. A well-designed pedestrian system and spatial sequence positively impact spatial network vitality [69]. Factors influencing tourists' path choice in tourist villages include path attributes and environmental attributes, which can be categorized into scale function, sight line function, and along-street function [70]. Scale function consists of the street length, street width, and street curvature; sight line function include the sight lines' relationships and spatial openness; along-street function is determined by the density of stores. Six indicators from these categories were used to analyze the factors affecting the spatial network connectivity of Mochou Village and are presented in Table 5.

4.2.2. QAP Regression Analysis

With the use of UCINET software (version 6.759), 5000 random permutations were selected for QAP regression analysis. The results show that the adjusted R^2 was 0.739, and the p value was 0.000 (Table 6). That is, at the 1% significance level, the selected influencing factors explained 73.9% of the formation of Mochou Village's spatial network, demonstrating a strong overall fit. Furthermore, excluding the street curvature factor, the street length, street width, line of sight, spatial openness, and store density all passed the regression significance test, indicating varying degrees of influence on the correlation between nodes, with the strongest influence coming from the store density, followed by line of sight, street length, spatial openness, and street width. Specifically, the regression

coefficient for the street width was 0.038, indicating that after 5000 random permutations, only 3.8% of the actual observations were higher than the fitted coefficient, while 96.3% were less than the fitted coefficient. The coefficient was statistically significant at the 5% level, and the standardized regression coefficient for street width was positive, suggesting that street width has a positive effect on the strength of connections between nodes, i.e., the number of tourists passing through street segments between nodes. The regression coefficient for street length was 0.007, and the standardized regression coefficient was negative, indicating that street length was significant at the 1% level but had a negative effect on the strength of connections between nodes; the longer the street, the lower the number of tourists passing through. The regression coefficient for line of sight was 0.003, and the standardized regression coefficient was positive, indicating that line of sight was significant at the 1% level and had a positive effect on the strength of connections between spatial nodes. The regression coefficient for spatial openness was 0.028, and the standardized regression coefficient was negative, indicating that spatial openness was significant at the 5% level; the more open the space at the nodes at both ends of a street segment, the lower the strength of connections between nodes. The regression coefficient for store density was 0.000, and the standardized regression coefficient was positive, indicating that the more stores there were between nodes, the greater the tourist traffic. The coefficient of adjustment for street curvature was 0.475, indicating that street curvature had an insignificant impact.

Table 5. QAP analysis index system.

Influence Factor		Index	Symbol	Calculation Method	Unit
path attributes	scale function	street length	length	length of centerline of section between nodes	m
		street width	width	inter-nodal roadway area divided by roadway length	m
		street curvature	curvature	inter-nodal roadway area divided by roadway length	%
environmental attributes	sight line function	sight lines relationship	sight	if the line of sight between the two nodes passes directly through each other photographs were taken at the nodes at the ends of the roadway at a height of 1.6 m towards the direction of the roadway to find the mean of the sky pixel values as a percentage of the total pixel values	-
		spatial openness	openness		%
	along-street function	store density	density	number of stores per 100 m of street	pcs

Table 6. Results of QAP matrix regression analysis.

Variant	Standardized Regression Coefficient	Fitting Factor	<i>p</i> (Large)	<i>p</i> (Small)
length	−0.2053 **	0.007	0.993	0.007
width	0.1440 *	0.038	0.038	0.963
curvature	0.0030	0.475	0.475	0.525
sight	0.3339 **	0.003	0.003	0.998
openness	−0.2317 *	0.028	0.972	0.028
density	0.7953 **	0.000	0.000	1.000
r^2		0.742		
Adj- r^2		0.739		
<i>p</i>		0.000		
observed value		650		
number of random permutations		5000		

Note: *, **, indicate significant at the 5% and 1% level, respectively.

In general, street function, sight line function, and along-street function each had varying degrees of influence on the strength of the spatial node connectivity. It is important to emphasize that this impact was the result of the combined effect of different factors, and simply enhancing a single positive factor would not necessarily yield positive results.

5. Discussion and Conclusions

Public space vitality is an important indicator of the high-quality development of tourist villages [50]. This study applied social network analysis to analyze the spatial network vitality characteristics of a tourist town, starting from the perspective of “behavior-space” interaction relationships. It calculated the spatial correlation by using the number of tourists passing between each node as the standard and established a visual model of the node space network. From the three aspects of spatial distribution, spatial connection, and spatial structure, it quantitatively analyzed the vitality characteristics of the public space network in the tourist village and determined the index system for evaluating the vitality of this network. Furthermore, through QAP regression analysis, it explored the influencing factors of the vitality of this network. The result of this study is helpful to improve the spatial network structure of tourism villages, which can enhance the overall spatial vitality of tourism villages. This, in turn, can increase the competitiveness of these villages in the tourism market and promote their sustainable development in tourism. The main conclusions of the research are as follows:

- (1) From the perspective of spatial distribution, there is a strong population integration effect in the spatial layout. Through a heterogeneous and polycentric spatial layout, the sense of hierarchy and interest of the space can be increased, while promoting an improvement in spatial vitality.
- (2) From the perspective of spatial distribution, “small block size, high street density” fosters the integration of spatial network connections in tourist villages from a spatial connectivity standpoint. The density of the street network and the quantity of intersections are strongly associated with the spatial vitality.
- (3) From the perspective of spatial structure, the grid road structure is more conducive to enhancing the spatial stability of a tourist town. The higher the complexity and connectivity of the road network, the more helpful it is to improve the traffic conditions, thus effectively enhancing the spatial vitality.
- (4) The impact factors of the vitality characteristics of public spaces in tourist villages are studied based on the interaction characteristics of crowds, behaviors, and spaces. It is suggested that there exists a correlation between the factors affecting tourists’ path choices and the network vitality of public spaces in small towns. These factors comprise the road length, road width, road curvature, line-of-sight relationship, spatial openness, and shop density.
- (5) Through the verification of the six aforementioned factors, it was found that their impact on the vitality of public space was in order of store density > visual relationships > road length > spatial openness > road width. However, road curvature did not have a significant effect. This may be related to the fact that the road curvature of different street segments in Mochou Village is similar. Fang’s research results indirectly support this viewpoint, that is, streets with less changes in road curvature are more conducive to walking, thus promoting the vitality of street space [71]. Among the six factors, store density, visual relationships, and road width were positively correlated with the street space vitality (correlation strength) and public space vitality, while spatial openness and road length were negatively correlated with the public space vitality.

This study explored the impact mechanism and evaluated of the vitality of the public space network in tourist villages. In comparison with prior research, this study completed the entire process from qualitative analysis to quantitative calculation, from comprehensive judgment to typical case analysis, and established a characteristic town public space network characteristic evaluation model. The model integrates public space vitality evaluation data represented by path attributes and environmental attributes in the physical environ-

ment as influencing factors, further enhancing the connection between tourist behavior and public space. The research findings not only offer a scientific foundation for the construction and planning of public spaces in tourist villages, but also hold significance for enhancing the overall quality of tourist villages and improving their competitiveness in the tourism market. However, several issues were identified during the research process that merit further discussion:

- (1) Due to the characteristics of Mochou Village itself and the limitations of the relationship matrix model, only six correlated factors affecting the vitality of public spaces were selected. However, some other important factors, such as spatial heterogeneity, distribution of rest facilities, and green view rate, were not included in the scope of this discussion. Therefore, the exploration of the factors influencing the vitality of public spaces still needs to be improved.
- (2) For different types of tourists, distinguished by age, cultural level, type of work, or by their presence at different time periods during the day and night, there may be different preferences and the formation of behavior networks with different characteristics; this also requires further research.

Meanwhile, there are several aspects that are worth further research in order to enrich the research results regarding public spaces in tourist villages:

- (1) How to balance public health and safety while ensuring the vitality of public spaces in tourist villages is a question worth further research and discussion.
- (2) Public spaces in tourist villages often attract visitors with unique holiday activities and distinctive landscape features at the beginning of construction. However, as the novelty of the tourism fades, more research is needed to ensure the sustainability of public space vitality in tourist villages.
- (3) It is worth further researching and discussing how to further explore the historical and cultural heritage of public spaces in tourist villages, enhance the public space vitality, and serve the development of new urbanization.

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