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Design Methods for the Renovation of Public Spaces in Rural Idle Buildings Based on Digital Technology

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Abstract This study focuses on the application of digital technology in the renovation of public spaces in rural idle buildings, exploring its design methods and practical pathways. Taking Village X as the study village, the study analyzed its geographical scope, ecological environment, and public space composition. Through field survey methods, the current status of public space utilization in Village X was investigated on-site. Using various digital technologies, the renovation of public spaces such as recreational spaces and service facilities in Village X was achieved. Using methods such as the entropy weight method, the study analyzed the quality of life in different renovated areas of X Village and combined the geographic detector model to identify the core factors influencing quality of life. The survey of the current state of public spaces in X Village revealed that satisfaction ratings for recreational spaces, service facilities, landscape design, road conditions, and neighborhood connectivity were relatively low, indicating the need for further renovation. Under the renovation methods proposed in this paper, the comprehensive multifunctional evaluation values of public spaces in the main renovation areas of X Village ranged from 0.1068 to 0.1825, indicating a clustering effect in the degree of digital renovation. After digital renovation, the average quality of life in X Village was 0.446, with a Moran's index of 0.515 and $P < 0.05$, indicating that the quality of life in X Village exhibits a significant spatial autocorrelation relationship. The impact of digital renovation of public spaces on living standards in X Village is the strongest, at 0.4419.

Index Terms digital technology, public space renovation, entropy weight method, geographic detector, rural idle buildings

I. Introduction

China is an agricultural powerhouse, and rural areas have historically been the primary production bases and living spaces [1]. The environment, production and living patterns, and social structure of rural areas remained relatively stable and developed slowly for a long time [2], [3]. However, with China's rapid urbanization, rural areas are undergoing significant changes in economy, culture, and lifestyle. The mass outflow of rural labor has led to abandoned land, idle buildings, low economic efficiency in rural production, and depopulation, which, over time, has resulted in the loss of traditional rural architecture and local culture [4]-[7]. Although idle public building resources do not possess the same high historical and cultural value as the cultural relic buildings in traditional villages, they still hold their own unique significance [8], [9]. In the face of the current situation of extensive rural construction and the practical needs of rural development, relevant policies have been continuously introduced to activate the problem of idle resources led by idle rural buildings [10], [11]. Additionally, during the renovation process, due to the lack of integration with the local region, environment, and humanities, diverse regional architectural characteristics are being destroyed, leading to a "one-size-fits-all" pattern [12]-[14]. Therefore, how to develop appropriate renovation and reuse methods for idle public building resources in villages based on village development has become an urgent issue in rural spatial construction and village development.

Currently, the academic community has proposed numerous targeted renovation methods for idle rural building spaces. Xia, J., and Mo, M. F. introduced a shared-use model into the spatial renovation of idle rural buildings, employing lightweight intervention design to integrate public space resources, thereby transforming idle rural public spaces into optimal venues for preserving rural culture and organizing community activities [15]. Ma, L., et al. constructed a rural idle residential identification matrix to classify and renovate rural idle residential areas in the study region, providing important decision-making basis for the rational utilization of rural idle spaces and land spatial planning [16]. Li, Z., and Hou, X. focused on the phenomenon of idle rural primary schools, proposing a transformation strategy aimed at achieving the sustainable transformation of rural idle primary schools through a design approach based on minimal intervention [17]. Zhang, J., and Wang, Y. outlined the current issues of scarce

school-age population and excessive elderly population in rural areas, proposing the reasonable renovation of idle Hope Project schools into Sunset Project facilities to alleviate and improve the current rural elderly care situation [18]. Lou, S., et al. emphasized that local culture is the fundamental driving force behind the renovation of rural cultural public spaces. They highlighted various spatial design strategies based on a “socio-spatial” perspective, which have played an important role in promoting rural living environment construction and establishing rural cultural spaces [19]. Shiyu, M. explored the revitalization pathways and sustainable operational models for idle spaces in old communities, indicating that measures such as cultural integration, resource consolidation, and self-governance can enhance community cohesion and space utilization rates, thereby promoting the rejuvenation value of idle spaces through cultural heritage preservation and functional regeneration [20]. The aforementioned studies not only enhance the public use functions of existing idle houses and improve their utilization efficiency but also meet the internal needs of rural development. However, it should be noted that these studies are generally qualitative research based on experiential interviews or field investigations, which have certain limitations in developing general renovation methods applicable to villages with idle buildings.

This paper takes X Village as the research subject for the digital transformation of public spaces, providing a brief overview of its public space composition. It also conducted on-site surveys to understand local villagers' perceptions and needs regarding the current idle building public spaces, and conducted a satisfaction evaluation. Digital technology is utilized to redesign the idle spaces in X Village, including the establishment of an intelligent management platform and the upgrading of online and offline service facilities. The redesign targets multiple aspects such as recreational spaces, service facilities, landscape integration, road conditions, and neighborhood connectivity. The Entropy Weight Method, Global Spatial Autocorrelation Analysis, and Geographic Detector Model are employed to analyze the impact of the redesign on the quality of life in X Village and the extent to which digital technology influences it.

II. Survey on the current state of public spaces in rural areas

II. A. Basic Overview of Villages

II. A. 1) Regional Scope

X Village is located approximately 50 kilometers southeast of Y City, nestled in the heart of the Qinling Mountains. The elevation of X Village ranges from 800 meters to 1 kilometer above sea level. The surrounding landscape is picturesque, with a pristine natural environment and a pleasant climate. The township to which the village belongs was historically a key route connecting the Qin and Chu regions. Currently, the village covers an area of 9,134 mu, with the village itself occupying 882 mu. The average elevation is approximately 913 meters. In terms of transportation infrastructure, the village is traversed by highways, county roads, and township roads to the south, with the main road being approximately 3.5 meters wide. Through research and analysis of the geographical environment of X Village, it was found that the northern mountain range serves as the main backbone, extending along two north-south axes. The area in front of the main mountain is where the village is located, with relatively flat terrain.

II. A. 2) Ecological Environment

X Village is located deep within the Qinling Mountains, surrounded by lush vegetation and natural barriers. The three mountains adjacent to the village are rich in vegetation. The village and its surroundings have a well-developed water system with abundant water resources and convenient transportation. A small stream flows through the village, serving as the primary source of water for the villagers. Surrounded by green mountains, the terrain is undulating, with clear streams crisscrossing the landscape, seamlessly integrating the overall layout of X Village with its natural surroundings.

The region has a subtropical humid climate, with distinct seasonal temperature differences between winter and summer. The average summer temperature is approximately 25°C, while the average winter temperature is 6°C. Precipitation is abundant but unevenly distributed. Summers are relatively dry with prolonged periods of high temperatures, resulting in significant evaporation. The mountain slopes are densely covered with lush vegetation, presenting a diverse array of plant forms. The mountainous terrain on either side of the village forms valleys, and the springs fed by streams flowing down from the north are crystal clear. The overall layout of the village follows the natural contours of the terrain, extending along the north-south axis of the mountain valleys in a “belt-like” pattern. As a result, the northern part of the village has fewer settlements, preserving the best natural conditions and offering beautiful scenery and tourist resources.

II. B. Composition of Village Public Spaces

The village is nestled amidst mountains and water, embracing natural development, and its spatial elements enrich the landscape of X Village, located in the heart of the Qinling Mountains. With its advantageous geographical

location and convenient transportation, X Village boasts a wealth of spatial elements in its public spaces, including material elements (ancient buildings, ancestral halls, temples, etc.), natural elements (ancient trees, ponds, farmland), and cultural attributes (religion, traditional customs, historical features). These elements collectively form the entire village. To conduct research and renovation in an orderly, comprehensive, and focused manner, the spatial composition was divided based on control attributes and functional roles, categorized into cultural public spaces, productive public spaces, and living public spaces.

(1) Cultural public spaces. For example, village committee offices, Buddhist halls, temples, city god temples, ancestral halls, and other public buildings in the village, along with their surrounding public spaces, are typically located at the center of the village or in other prominent and important locations to reflect the village's political authority and the religious beliefs of its clan-based social structure.

(2) Productive Public Spaces. For example, village drying yards, water systems, and gathering places provide residents with areas for daily productive activities. These spaces are primarily used for traditional agriculture and animal husbandry, and can also serve as productive public spaces for handicraft production and product exchange.

(3) Lifestyle-oriented public spaces. Examples include ancient wells, ancient trees, opera stages, and village entrances. These public spaces are primarily used by villagers for leisurely social interaction and cultural and recreational activities.

II. C.Field Research and Analysis in Village X

Through the literature review and field research conducted earlier, a general understanding of the overall site area has been gained. To gain a clearer understanding of the structure of X Village, the village conditions, and the villagers' willingness to participate in community activities, the author conducted a two-week field research stay in the village. During this period, questionnaires were distributed to different groups, including villagers, grid workers, homestay operators, restaurant owners, and tourists, to understand their perspectives and needs regarding the idle building site, providing data to support the development of a reasonable design plan.

Following an initial survey and analysis of the site's current status, a questionnaire survey method was tailored based on the results. To investigate different groups' perceptions of X Village, this survey employed a 5-point scale to assess satisfaction levels across five aspects: current recreational spaces, service facilities, landscape design, road conditions, and neighborhood connectivity. Through the questionnaire survey, the current issues with X Village's public spaces were identified, along with the participation intentions of different groups toward various elements of X Village, thereby clarifying the specific issues with the current design status of certain plots in X Village.

A total of 289 questionnaires were distributed, with 275 returned. Among these, 268 were valid, resulting in a return rate of 92.73%. The satisfaction survey results for X Village's public spaces are shown in Figure 1. From this, it can be seen that villagers have relatively low satisfaction ratings for X Village's current recreational spaces, service facilities, landscape design, road conditions, and neighborhood connectivity, with average questionnaire scores ranging from 1.7 to 2.8 points.

The vast majority of villagers expressed dissatisfaction or even extreme dissatisfaction with the current recreational spaces. The primary reasons include an imbalance in the types of recreational spaces available in X Village, with a lack of facilities such as streetlights and resting pavilions. Additionally, recreational spaces have limited functionality, primarily serving as venues for casual conversations among villagers, and fail to meet the diverse needs of elderly activities, children's play, and other such requirements. Public service facilities are crucial venues for villagers to access daily services, obtain external information, and participate in public decision-making. However, with the outflow of young and middle-aged labor from the village, the elderly, children, and women have become the main residents of X Village. The construction of public service facilities such as elderly care, early childhood education, and cultural and sports facilities for the remaining population in the village is significantly lagging behind, failing to meet villagers' aspirations for a better life and, to some extent, hindering the revitalization of the village. In terms of landscape design, there is a lack of professional planning and overall coordination, and the surrounding areas lack facilities such as resting benches that meet villagers' needs, resulting in a disorganized and chaotic layout. Regarding the village's road conditions, most respondents reported that roads are congested and there is a high incidence of random parking. Additionally, the absence of designated parking areas severely impacts villagers' daily commuting activities. Furthermore, the lack of public facilities has reduced interpersonal communication among neighbors, and the lag in information technology has further widened the communication gap between them.

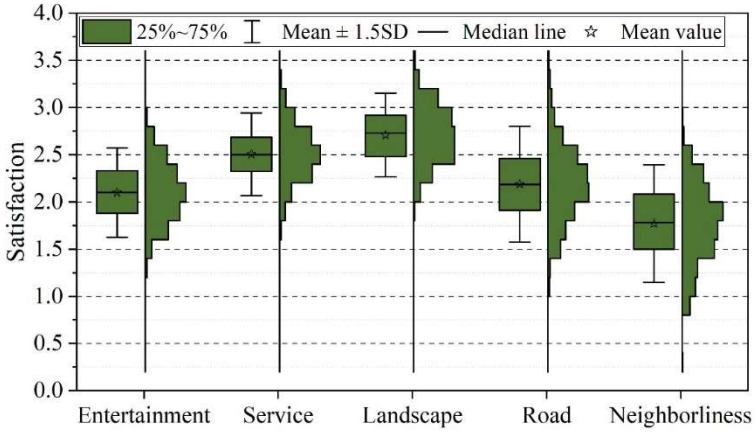

Figure 1: The results of the survey on the status of public space

III. Renovation of public spaces based on digital technology and multifunctional evaluation

The above section provides a survey and analysis of the current state of public spaces in X Village, Y City, which serves as the research foundation for the use of digital technology to renovate idle buildings in rural areas into public spaces.

III. A. Digital Transformation Strategy for Idle Public Spaces in X Village

III. A. 1) Interoperability and sharing

(1) Smart road posts and smart traffic guidance devices to alleviate the surrounding traffic environment

Relying on smart traffic guidance technology, some roads within X Village can be opened to vehicles, transformed into pedestrian streets and alleys and limited-time access roads, to ease traffic on county and rural roads. For example, the main entrance branch road to the west is opened from 7 a.m. to 8 p.m. and becomes a limited-time one-way road open to the public. Together with two one-way roads, this forms a traffic micro-circulation system, improving the regional traffic environment and alleviating traffic pressure.

(2) Establishing a digital management platform

A digital management platform is established, integrating property management, government affairs, security, and village self-governance functions. A community service center is set up at the core location of an idle building to serve X Village residents. This completes X Village's integrated online and offline management system.

III. A. 2) New Business Construction

(1) Offline centralized service facilities

In line with the “community living circle” concept, upgrade the public service facility system. Relocate existing service buildings with poor accessibility (including residents' committees, community service centers, kindergartens, etc.) and address shortcomings in public services (culture, hospitals, sports facilities). Utilize existing internet and digital technologies to keep pace with the times, collaborate with relevant software development companies, and introduce online services such as telemedicine, remote elderly care, and online education to establish an integrated online and offline public service facility system.

(2) Introduction of established new retail commercial brands

X Village is integrated into the community new retail commercial system of the surrounding four neighborhoods. In the context of consumption upgrades in the internet era, new retail commercial brands are introduced. These brands combine functions such as parcel pickup and unmanned supermarkets, with a service radius of 300 meters. By integrating traditional offline commerce with online consumption, the last mile of community retail is bridged.

III. A. 3) Efficient parking

Relying on mature intelligent time-shifted and peak-shifted parking technology, two efficient parking garages will be added to the north and south areas of X Village's idle land to reduce random parking. A smart parking guidance system will be set up to display real-time parking capacity for the convenience of residents. The parking garages will use efficient unmanned parking technology and mechanical parking to increase parking capacity. The village entrance road will be widened, and a ride-hailing pickup point will be set up to facilitate villagers' travel.

III. A. 4) Spatial Improvement

Demolish the low-rise garages, shantytowns, and surrounding residential buildings of poor quality in X Village, and reconstruct the public space system. Make use of available space to increase green areas and strip-shaped public spaces, providing conditions for residents to engage in offline interactions. This area utilizes the reduced ground-level parking space and shantytown space to create multiple small-scale block-shaped public spaces and several strip-shaped front-yard public spaces, laying the foundation for residents to enrich their offline social activities. Emphasize detailed design of public spaces and plant selection to create vibrant, lively, culturally rich, and charming public spaces. At the same time, attention should be given to the elderly population, with public spaces undergoing aging-friendly renovations to include fitness areas, resting walkways, tea houses, card rooms, and accessible facilities.

III. A. 5) Event Organization

Establish a virtual communication platform for residents of X Village to reshape a community that integrates the virtual and real worlds and break down barriers between neighbors. In addition to using existing social media platforms such as WeChat, QQ, and Weibo to establish resident communication groups, we can also collaborate with mature software development companies to build a community virtual online communication platform that integrates information dissemination and online communication. Establish multiple virtual communities based on interests and needs, providing residents with opportunities to continue communicating beyond the physical space.

X Village should leverage the virtual communication platform and physical public spaces to organize diverse activities and educational lectures, including sports and fitness, parent-child activities, cultural and artistic events, calligraphy, painting, chess, card games, local cultural forums, and health seminars. This would foster a diverse virtual community encompassing sports, entertainment, parent-child activities, learning, interaction, and social gatherings, thereby creating conditions for community cultural development, resident interest stimulation, and the revitalization of neighborhood relationships.

III. B. Evaluation Results of Multifunctional Development in Village X

The study was conducted by reviewing a large body of literature, distributing expert questionnaires, and incorporating the opinions of relevant experts such as rural grassroots managers and university professors. This process further established the evaluation indicators for the public space of idle buildings in X Village, forming a five-functional indicator system comprising agricultural production functions, ecological landscape functions, living support functions, recreational and entertainment functions, and transportation functions.

Based on the constructed rural multifunctional evaluation indicator system, data from the 10 main areas of X Village were input into the system. After standardization, the sum of the product of the indicators and their comprehensive weights was calculated to obtain the comprehensive score for the village revitalization index. The comparison results revealed the varying degrees of multifunctional development across different regions of X Village. Figure 2 shows the distribution of multifunctional development evaluation indicator scores across different regions of X Village. Figure 3 presents the comprehensive levels and rankings of multifunctional development across different regions.

The multifunctional evaluation index scores for the 10 regions of X Village range from 0.1068 to 0.1825, with an average of 0.1514. The region with the highest multifunctional level is Region 8 (0.1825), and the region with the lowest multifunctional level is Region 1 (0.1068). The multifunctional levels align with the actual situation. Under the impetus of digital technology, idle rural buildings and public spaces in X Village have been renovated and reused, driving the rapid development of multifunctionalization. Overall, except for a few regions, the overall multifunctional level is relatively good. There are five regions with a comprehensive multifunctional evaluation index greater than 0.16, accounting for 50% of the total, namely Regions 8, 6, 5, 10, and 3. There are four regions with a comprehensive multifunctional evaluation index between 0.12 and 0.16, accounting for 40% of the total, namely Regions 7, 2, 9, and 4. Only Region 1 has a comprehensive multifunctional evaluation index of 0.12. Except for Region 1, the differences in multifunctional development scores among the remaining regions are relatively small. However, 40% of the regions still have comprehensive multifunctional development scores below the average, indicating that the coverage of digital public space renovations discussed in this paper still needs to be improved.

Based on the rankings of the main functional evaluation measures for each region, the top five regions in terms of comprehensive evaluation measure scores are Region 8, Region 6, Region 5, Region 10, and Region 3, which also rank first in each of the five functional evaluation measures. Among these, Region 8 ranks first in living security, leisure and entertainment, and transportation evaluation measures, with measure values of 0.206, 0.142, and 0.099, respectively. Region 3 ranks first in agricultural production evaluation measures, with a measure value of 0.294. Region 10 ranks first in ecological landscape evaluation measures, with a measure value of 0.242. From the perspective of the main functional evaluation measures for each region, this paper shows a trend toward

concentrated development in public space renovations, which is not conducive to the overall development of X Village.

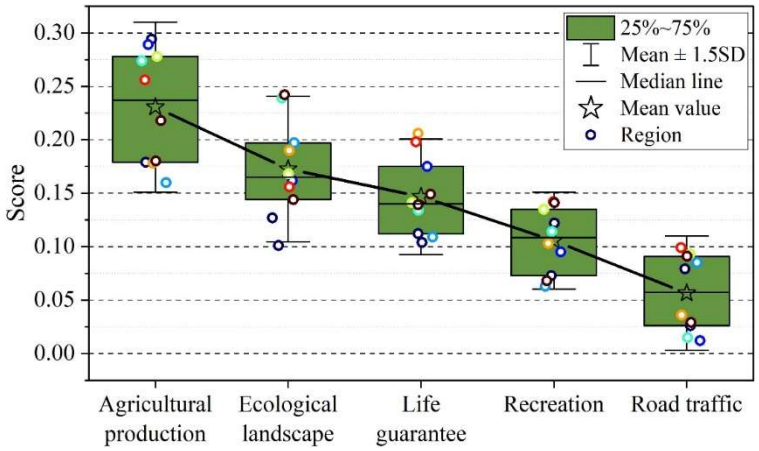

Figure 2: Multi-function development evaluation index score distribution result

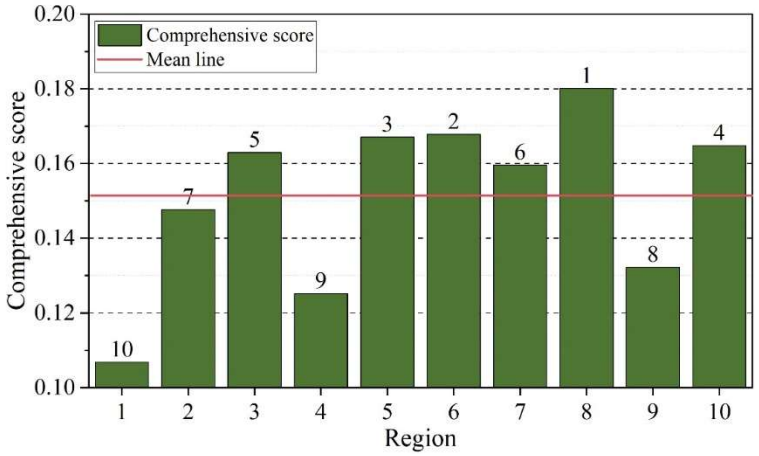

Figure 3: Multi-functional development comprehensive level and ranking results

IV. Research on the impact of digital transformation of public spaces on quality of life

IV. A. Research Methods

IV. A. 1) Entropy Weighting Method

The entropy weight method aims to determine the weights of indicators for each subsystem and constituent element using the concept of entropy values, and is an objective method for determining the weights of evaluation indicators [21]. This paper uses the entropy weight method to calculate the quality of life in Village X. The calculation formula is as follows:

$$S_{ij} = \sum_{j-1}^{m} W_j \times Z_{ij} (i = 1, 2, 3 \cdots n) \tag{1}$$

In the formula: Z_i is the dimensionless data value, W_j is the weight of indicator j, m is the number of indicators, and n is the total number of research subjects. S_{ij} is the comprehensive quality of life score for each rural area, and it is distributed within the [0, 1], with higher values indicating a higher quality of life.

IV. A. 2) Exploratory spatial data analysis

Exploratory spatial data analysis is primarily used to reveal the spatial distribution of objects and identify their spatial correlation characteristics. It measures and tests spatial correlation patterns (convergence or heterogeneity) through global spatial autocorrelation analysis and local spatial autocorrelation analysis. This study uses global spatial autocorrelation spatial correlation analysis to explore the spatial autocorrelation of quality of life in the digital technology renovation area of Village X.

Global spatial autocorrelation reflects the degree of correlation between a particular geographic phenomenon or attribute value in a given spatial unit and the same phenomenon or attribute value in neighboring spatial units, thereby reflecting the spatial distribution of the geographic phenomenon or attribute value [22]. This study calculates the global Moran's I index to analyze whether the quality of life in the various public space renovation areas of Village X exhibits clustering characteristics. The formula for the global Moran's I index is:

$$I = \frac{n}{S_0} \cdot \frac{\sum_{i-1}^{n}\sum_{j-1}^{n} W_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\sum_{i-1}^{n}(x_i - \bar{x})^2} \tag{2}$$

In the equation: n denotes the number of study spatial units, x_i and x_j are the observed values at the i th and j th spatial locations, respectively, the rural quality of life coefficients for regions i and j, $\bar{x}$ is the mean rural quality of life in the study area of Village X, W_{ij} is an element of the spatial weight matrix W, and S_0 is the sum of all elements in W.

IV. A. 3) Geodetic detector

Due to spatial differences in the quality of life in Village X, this paper uses the geographic detector method and introduces the rural quality of life differentiation determinant index q to reveal the main factors influencing regional differences in rural quality of life [23]. The degree of influence of a certain factor on rural quality of life is:

$$q = 1 - \frac{1}{N\delta^2}\sum_{h=1}^{L} N_h \delta_h^2 \tag{3}$$

In the formula: q is the detection power value of detection factor A, and L is the type of each factor. N and N_h represent the total number of samples in the study area and the number of samples within factor A type h, respectively. δ^2 denotes the total sample variance across the entire study area, while δ_h^2 denotes the sample variance within factor A type h. The range of the q value is 0 to 1. The larger the q value, the higher the influence of factor A on rural quality of life.

IV. B. Comprehensive evaluation of quality of life and regional classification

Using GIS software to conduct a comprehensive evaluation of the quality of life in Village X, the results of the comprehensive evaluation of the quality of life in Village X are shown in Table 1. Using the natural breakpoint method, the quality of life in Village X was divided into five levels from low to high: high-level zone, relatively high-level zone, medium-level zone, relatively low-level zone, and low-level zone. The results of the quality of life level classification for each area of Village X are shown in Figure 4. Further analysis was conducted using spatial autocorrelation and the Dagum model.

After renovating idle buildings in rural areas into public spaces using digital technology, the quality of life in X Village has significantly improved. However, as mentioned earlier, due to the uneven intensity of the renovations, there are certain differences in the spatial distribution of the quality of life in X Village, with areas with higher levels of multifunctional development exhibiting higher quality of life, while areas with lower levels of multifunctional development exhibit lower quality of life. The average quality of life in X Village is 0.446. The high-quality-of-life area includes Region 8, where digital technology intervention indices are strong across agricultural production and transportation, significantly enhancing the quality of life in this region. The moderately high-quality-of-life areas include Regions 6 and 5, which feature well-developed digital infrastructure and higher development levels. Regions with moderate quality of life include Region 3, Region 7, and Region 10. These regions have moderate levels of digital technology investment, and residents' quality of life is lower than in the previous two regions. Regions with lower quality of life include Region 2, Region 9, and Region 4. Region 1 is classified as a region with low quality of life, where quality of life further declines, with lagging infrastructure and public service facilities acting as limiting factors.

In terms of improving rural residents' living conditions, rural education, healthcare, cultural and recreational facilities, and village appearance, there is typically strong financial support. Utilizing digital technology to enhance rural urbanization levels can effectively facilitate the local transfer of surplus rural labor, promote the mutual circulation of various production factors, and help drive rural economic development while improving the quality of life in rural areas.

Table 1: Evaluation of life quality of X village

	Quality of life	Agricultural production	Ecological landscape	Life guarantee	Recreation	Road traffic
Lower level	0.357	0.241	0.351	0.385	0.314	0.288
Low level	0.411	0.379	0.381	0.414	0.339	0.310
Medium level	0.437	0.453	0.426	0.466	0.368	0.331
Higher level	0.482	0.529	0.470	0.497	0.394	0.375
High level	0.545	0.663	0.508	0.531	0.441	0.412
Average	0.446	0.453	0.427	0.459	0.371	0.343

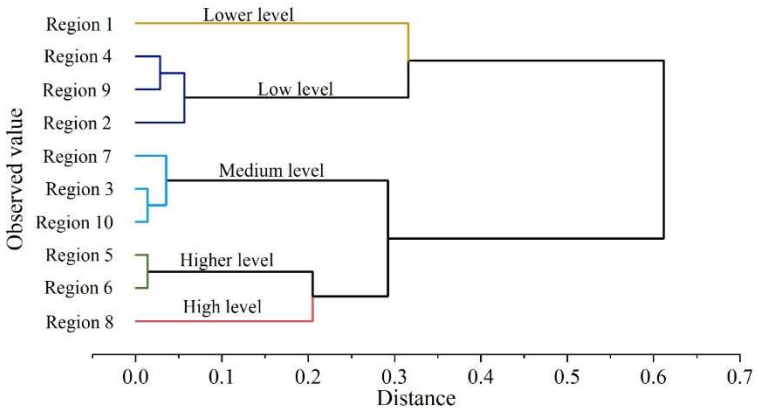

Figure 4: The results of the quality of life in the area of X village

A global spatial autocorrelation analysis was conducted using GeoDa software to test for spatial clustering in the results of the quality of life evaluation for Village X. Figure 5 shows the Moran's index for the quality of life in Village X. As shown in the figure, the Moran's I for the quality of life in Village X is 0.515, Z is 7.248, and P $\leqslant$ 0.001, passing the significance test. This indicates that the quality of life in X Village exhibits a significant spatial autocorrelation relationship, with adjacent areas influencing one another.

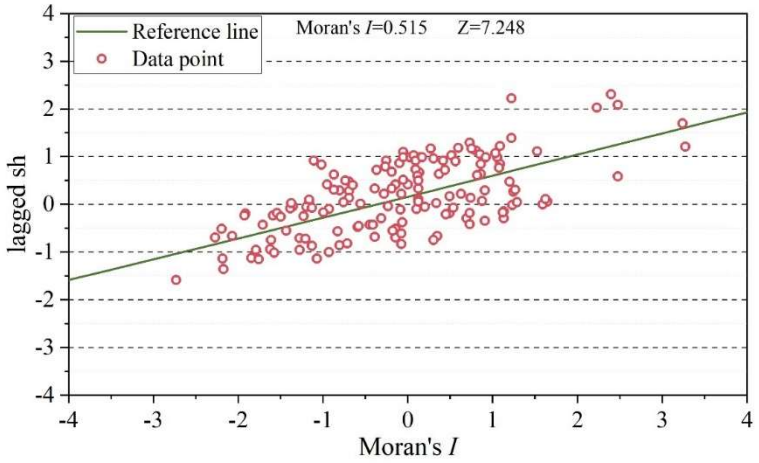

Figure 5: The Moran's index of the quality of life in X village

Using the geographic detector model, we calculated the q-values for the ability of various factors to influence the differences in quality of life in Village X. The results of the quality of life factor detection for Village X are shown in Table 2. As can be seen from the table, the impact of agricultural production, ecological landscape, livelihood security, leisure and entertainment, and transportation on the quality of life in Village X ranges from 0.2066 to 0.4419,

and the p-values for all factors are less than 0.05, indicating that all factors significantly influence the quality of life in Village X.

Table 2: Detection results of rural life quality factors in X village

Index	q	p
Agricultural production	0.2163	0.0274
Ecological landscape	0.2066	0.0195
Life guarantee	0.4419	0.000
Recreation	0.3812	0.0254
Road traffic	0.3697	0.014

V. Conclusion

This study conducted a survey on the current state of design for public space plots in idle buildings in X Village, Y City, and analyzed villagers' needs for public space functions using a satisfaction evaluation questionnaire. Based on this, a targeted digital renovation design was carried out for the public space in idle buildings in X Village, focusing on aspects such as recreational spaces, service facilities, and landscape integration. Subsequently, a multi-functional evaluation index system for public spaces was established to analyze the extent to which digital technology has transformed the functional utilization of public spaces. Combining various data analysis methods, further research was conducted on the quality of life in X Village after the renovation and its influencing factors. Villagers' satisfaction with the current state of public spaces in X Village was relatively low, with questionnaire scores ranging from 1.7 to 2.8 across all indicators, failing to meet villagers' daily needs. After the digital renovation of public spaces, the comprehensive multifunctional evaluation index for the main renovated areas in X Village ranged from 0.1068 to 0.1825, with minor differences. The area with the highest multifunctional development level (Area 8) had the highest quality of life (0.545), while the average quality of life in X Village was only 0.446. The quality of life evaluation results for X Village passed the global spatial autocorrelation test, indicating that adjacent areas influence each other's quality of life. Factors such as agricultural production and ecological landscapes significantly influence X Village's quality of life, with impact levels ranging from 0.2066 to 0.4419. The digital transformation of idle building public spaces in X Village has achieved certain results, but the study identified issues of uneven layout in implementing digital transformation strategies, leading to imbalances in the distribution of digital resources across different areas. Future research could establish a demand assessment model to analyze the actual needs of different rural areas through big data analysis.

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References

[1] Yawson, D. O., Adu, M. O., Asare, P. A., & Armah, F. A. (2019). Transforming urban idle spaces into green, productive and aesthetic landscapes. AgriFoSe2030 Report, (19).

[2] Li, B., Yang, F., Long, X., Liu, X., Cheng, B., & Dou, Y. (2024). The organic renewal of traditional villages from the perspective of logical space restoration and physical space adaptation: A case study of Laoche village, China. Habitat International, 144, 102988.

[3] Bodnar, J. (2015). Reclaiming public space. Urban studies, 52(12), 2090-2104.

[4] Yeon, G., & Na, I. (2022). A study on the characteristics of urban idle spaces in declined area for urban regeneration in the dongincheon station area. International Journal of Sustainable Building Technology and Urban Development, 13(3), 266-283.

[5] Wang, J., Xie, P., & Yun, J. (2021). Research on comprehensive benefit evaluation based on development and utilization of idle house site in rural area in Yunnan province. In Journal of Physics: Conference Series (Vol. 1774, No. 1, p. 012053). IOP Publishing.

[6] Sun, Z., Li, D., & Liu, Z. (2024). Design Strategies for Rural Revitalization under the Background of Rural Revitalization: A Case Study of Baimaozhuang Village, Baodi District, Tianjin City. Journal of Landscape Research, 16(4), 44-50.

[7] Chen, L., Cheng, Y., Zhou, Z., & Wen, Y. (2025). The Impact of Differences in Renovation Models of Abandoned Boiler Rooms on Community Vitality—A Case Study of Shenyang, China. Buildings, 15(11), 1807.

[8] Li, C. (2020). Research on the public space renewal strategy of Chinese Tujia nationality heritage villages based on the healthy rural theory: A case study of Lianghekou village in enshi xuanen county, Hubei province. WIT Transactions on Ecology and the Environment, 241(11), 145-155.

[9] Yang, R., & Lin, Y. (2022). Rural spatial transformation and governance from the perspective of land development rights: A case study of Fenghe village in Guangzhou. Growth and Change, 53(3), 1102-1121.

[10] Shen, C. (2020, March). Study on the Application of Land Art in Rural Public Space Against the Background of New Urbanization. In 4th International Conference on Culture, Education and Economic Development of Modern Society (ICCESE 2020) (pp. 264-267). Atlantis Press.
[11] Liu, H., Weng, D., & Liu, H. (2021). Decoding rural space reconstruction using an actor-network methodological approach: A case study from the yangtze river delta, China. Land, 10(11), 1110.
[12] Lou, S. (2022, March). Reconstruction and invigoration of rural housing space from the perspective of sustainable renewal. In International Civil Engineering and Architecture Conference (pp. 491-499). Singapore: Springer Nature Singapore.
[13] You, X., Zhang, Y., Tu, Z., Xu, L., Li, L., Lin, R., ... & Ren, W. (2023). Research on the sustainable renewal of architectural heritage sites from the perspective of extenics—using the example of Tulou renovations in LantianVillage, Longyan city. International Journal of Environmental Research and Public Health, 20(5), 4378.
[14] Zhiqiang, C., Min, G., Kaiqi, W., & Meijian, S. (2024). Research on the Construction Strategy of Multi-level Demand Rural Living Space. Journal of Civil and Transportation Engineering (ISSN: 3005-5695), 1(2), 97.
[15] Xia, J., & Mo, M. F. (2023, March). Reutilization of Idle Space in Village Under Light Intervention Theory. In Proceedings of the 2nd International Conference on Culture, Design and Social Development (CDSD 2022) (pp. 18-33). Atlantis Press.
[16] Ma, L., Tao, T., Yao, Y., & Li, Y. (2023). Renovation Potential Evaluation and Type Identification of Rural Idle Residential Land: A Case Study of Yuzhong County, Longzhong Loess Hilly Region, China. Land, 12(1), 163.
[17] Li, Z., & Hou, X. (2024). Research on Sustainable Reconstruction of Rural Idle Primary Schools Based on Light Intervention: A Case Study of Nanqiang Primary School in Kaiping Tangkou Town. In Design Studies and Intelligence Engineering (pp. 530-539). IOS Press.
[18] Zhang, J., & Wang, Y. (2019, June). Study on the Elderly-oriented Improvement of Rural Idle Schools. In 2019 International Conference on Architecture: Heritage, Traditions and Innovations (AHTI 2019) (pp. 385-388). Atlantis Press.
[19] Lou, S., Chen, Y., Feng, J., & Zhang, L. (2025). Reconstruction of rural cultural space and planning base on the perspective of “Social-Spatial” theory: A case study in Zhuma Township, Zhejiang Province. Buildings, 15(5), 671.
[20] Shiyu, M. (2025). A Case Study on the Revitalization of Unused Community Space-Tianfu Social Innovation Center. Humanities and Social Science Research, 8(3), p101-p101.
[21] Wei Hui,Liu Yunyao,Li Jue,Dai Yinhan & Xie Cheng. (2025). Optimization and Performance Prediction of SBS-Modified Asphalt Crack Sealant Using Entropy Weight and ANFIS Methods. Journal of Materials in Civil Engineering,37(8),
[22] Yang Jie,Liu Qiliang & Deng Min. (2023). Spatial hotspot detection in the presence of global spatial autocorrelation. International Journal of Geographical Information Science,37(8),1787-1817.
[23] Xiaochi Liu,Mark Patrick Taylor,Yongze Song & C Marjorie Aelion. (2025). Identifying factors influencing trace metal concentrations in urban residential soil using an optimal parameter-based geographical detector model.. Environmental research,283,122045.