

# Genetic Inheritance and Activation Utilization Strategies of Traditional Village Landscape from the Perspective of Urban and Rural Planning

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**Abstract** With the ongoing advancement of urban-rural integration, traditional villages are encountering challenges such as fragmented spatial patterns, the erosion of cultural landscapes, and the diminishing of distinctive features. Current landscape protection and utilization methods often exhibit limitations, including a narrow identification dimension, fragmented activation strategies, and a disconnect from modern development. To address these issues, this paper introduced the “landscape gene” theory from the perspective of urban and rural planning. It integrated artificial intelligence and Internet of Things technologies to construct a pathway for the inheritance and activation of landscape genes, centered around the concepts of Specifically, through remote sensing image recognition, village texture deconstruction, cultural element extraction, and a dynamic monitoring system, the core genes of traditional village spatial texture, historical sites, cultural symbols, and more were accurately identified and dynamically tracked. In terms of activation strategy, an AI-driven participatory planning platform guided the community in co-building and co-managing, thereby achieving adaptive regeneration and sustainable use of landscape genes in contemporary contexts. Empirical results indicated that this method could increase the retention rate of core landscape elements by 22%, enhance villager participation by 35%, and achieve an 87% satisfaction rate with landscape activation, effectively promote the cultural continuity and morphological renewal of traditional villages.

**Keywords** Traditional villages, Landscape construction knowledge, Villager participation, Artificial Intelligence and the Internet of Things, Cultural heritage

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In recent years, there has been an increasing amount of research on the landscape genes, cultural heritage, and sustainable tourism development of traditional villages. Scholars have conducted in-depth discussions from different angles<sup>[1]</sup>. The following is a review of some representative research results. As a vital carrier of cultural diversity, intangible cultural heritage (ICH) embodied the profound values of local memory, national skills, and collective identity<sup>[2]</sup>. In recent years, the growth of the cultural industry and the deepening of the concept of cultural confidence, the digital transformation and the intellectual property (IP) development of ICH were essential for promoting its living inheritance and contemporary expression<sup>[3]</sup>. However, at the practical level, the development of ICH IP still encounters significant challenges, including a lack of creative resources, limited means of expression, and weak audience engagement. Particularly in the process of integrating traditional and modern contexts, there was often a tendency toward “de-culturalization” or the risk of over-commercialization, which complicated the balance between innovation and cultural depth<sup>[4]</sup>. Therefore, this paper examined the role of generative AI in the development

of intangible cultural heritage IP, focusing on its creative structure, prompt control, cultural consistency, and user acceptance within the “co-creation mechanism” and “deduction mechanism”. Experimental models and empirical researches were designed to explore the feasibility and boundaries of AI participation in the creation of intangible cultural heritage at the mechanistic level, providing theoretical support and practical guidance for establishing a culturally sensitive AI content generation system. Previous researches focused on the identification of traditional village landscape genes, analysis of tourist perceptions, and exploration of sustainable development paths, but overall, they were mainly case studies, lacking in systematic comparison and multi-dimensional integration.

This paper first analyzed the loss of traditional village landscape characteristics during urban-rural transformation. It addressed the challenges of ambiguous identification and fragmented protection in current urban and rural planning practices, proposing a path for identification, encoding, and activation centered around landscape characteristics. By integrating artificial intelligence and Internet of Things technologies, a landscape characteristic iden-

tification model and a dynamic monitoring system were developed to enhance the ability to extract and track village cultural elements in real time accurately. The paper then explored activation strategies based on digital technology and community co-construction mechanisms to promote the continuity and regeneration of traditional landscapes in a contemporary context. Finally, this approach’s effectiveness was validated by examining typical case studies, evaluating its application value, and potential for promotion in actual planning scenarios. Existing researches focused on the identification of traditional village landscape genes, analysis of tourist perceptions, and exploration of sustainable development paths<sup>[5]</sup>. However, these case studies lacked in systematic comparison and multi-dimensional integration.

## 1 Related work

Ruirui et al. used Zhangguying Village as a case study and employed structural equation modeling to investigate the role of landscape genes in shaping tourist images. The study found that the landscape genes of traditional villages significantly influence the construction of tourist images, with the “丰”-shaped architectural gene

playing a dominant role in forming tourists' cognitive perceptions<sup>[6-7]</sup>. Based on the structural equation model (SEM), Zhang et al. utilized exploratory factor analysis (EFA) and SEM to enhance the Importance-Performance Analysis (IPA) method, identifying 4 dimensions of sustainable development and proposing relevant strategies. The findings indicated that integrating IPA with structural equation modeling effectively addressed inconsistencies and uncertainties in the sustainable planning of cultural landscapes<sup>[8]</sup>. Shen et al. collected over 13,000 tourist comments from domestic tourism websites, utilized the Likert scale to assess tourists' perceptions of the landscapes in 5 traditional villages, and developed an importance-satisfaction analysis model for landscape indicators. The results indicated that tourists' perceptions of visual elements were critical, yet satisfaction with certain indicators was low<sup>[9]</sup>. Runze et al. quantitatively evaluated the landscape characteristics of traditional villages in the Minjiang River Basin by introducing the concept of landscape gene similarity. Their findings revealed regional differences in the landscape genes of these villages. Based on these differences, the villages were categorized into nine landscape areas and four sub-areas, highlighting the influence of natural, cultural, and socio-economic factors on village landscapes<sup>[10]</sup>. Hearn and Fagerholm employed an interdisciplinary approach, integrating "bottom-up" ethnography and participatory research with "top-down" historical landscape characterization to analyze land use and land cover changes, as well as their future sustainability in the rural cultural landscape of northwestern Spain. Through participatory mapping and landscape perception research, they identified a decline in biodiversity, agricultural forestry, and pastoral systems<sup>[11]</sup>. Azyyati examined the language landscape of the Indonesian village of Cisaat, analyzing how the top-down tourism development model was reflected in the village's language landscape. By collecting and categorizing signs along the main roads, the study found that the language landscape was predominantly characterized by monolingual signs in Indonesian<sup>[12]</sup>. Norazlan and Said investigated how village landscapes influence children's ecological literacy and mental health through their play behaviors and perceptual expressions. The results indicated that children's proximity to the natural environment, relationships with animals and plants, physical labor, recreational activities, social interactions,

and rural landscapes contributed to the development of their ecological literacy<sup>[13]</sup>. Fisu et al. noted that at the end of 2021, Kambo Village was recognized as one of the top 100 tourist villages in Indonesia, demonstrating its significant tourism potential. However, Kambo's tourism potential has not been effectively managed; there is a lack of management and planning documents for tourism activities, and local planning does not encompass these aspects<sup>[14]</sup>. Silalahi et al. evaluated the tourism potential of significant mangrove ecosystems in Sumatra, Indonesia, and explored effective methods to promote ecotourism. The study revealed that the area possesses 38 hectares of ecotourism potential, and the mangrove ecosystem is abundant in a diverse array of animal and plant species<sup>[15]</sup>. Li et al. utilized ArcGIS spatial analysis software to apply a linear model based on 62 ancient villages in the Mentougou District. They defined the spatial influence of each village's culture and constructed a corridor model for the ancient villages in the region. By integrating natural, social, and transportation resources, a coherent spatial layout was developed, aimed at promoting the growth of ancient village tourism in Mentougou District, particularly in the overall planning of tourism routes and heritage utilization<sup>[16]</sup>. Ekici et al. investigated social sustainability and participatory methods in rural settlements, using Kemer Village in Turkey as a case study. They proposed strategies for protection, management, and sustainable development based on the priorities and perspectives of various stakeholders. The study indicated that the preservation of cultural heritage in historical villages must achieve sustainable development through the active participation of local communities. Kemer Village successfully exemplified the collaboration between the community and local government in safeguarding the integrity of the village<sup>[17]</sup>.

## 2 Research methods

### 2.1 Ideas for constructing a knowledge system for traditional village landscape construction

The formation of a traditional village landscape is not achieved overnight; rather, it is the result of the accumulation and evolution of villagers' long-term interactions with nature and society. At its core lies an endogenous, self-organizing landscape knowledge system. This system is deeply rooted in the village's natural environment and cultural background, and it is

gradually refined through a continuous process of cognition, practice, and feedback<sup>[18]</sup>. It is highly adaptable and coordinated. Its characteristics are as follows: on one hand, it integrates the material spatial structure with intangible cultural connotations; on the other hand, it exhibits structural features such as networking, hierarchy, and the coordination of multiple elements. To fully understand and inherit this knowledge system, the cognitive framework for constructing traditional village landscapes can be developed at 4 levels:

- The foundational layer consists of the natural geographical and cultural-historical environment in which the village is situated. This layer serves as the ecological basis for the survival and development of landscape knowledge.

- The technical layer encompasses technical knowledge, including traditional building technology, material application, and spatial layout, which reflects the villagers' experience and wisdom regarding their environment.

- The landscape layer is evident in the physical structure and visible forms of the village, including the street pattern, architectural style, and landscape nodes. It serves as the external manifestation of traditional knowledge.

- The dynamic layer refers to the internal mechanism that guides the generation and evolution of knowledge. This includes the coordinated interaction of villagers' lifestyles, policy orientations, market forces, and cultural heritage.

This multi-level construction method not only aids in understanding the internal logic of traditional village landscapes, but also offers theoretical support for their preservation and reuse.

### 2.2 Ecological pattern protection and human settlement environment optimization

In urban and rural planning, it is essential to emphasize the interdependent overall pattern of "mountain-village-terraced fields-water system" in traditional villages. This pattern results from the symbiotic relationship between villages and their natural surroundings. It holds significant ecological value and serves as a vital representation of landscape characteristics. In contemporary planning practices, we should prioritize ecological considerations while balancing land use efficiency and aesthetic appeal. For instance, the slopes adjacent to the village can be utilized for planting fruit trees and flowers, thereby creating an ecological beautification

belt. Meanwhile, the more distant slopes can be developed for economic forests and seedlings, ensuring a harmonious blend of ecological restoration and economic benefits.

In response to the issue of ecological degradation, a zoning and classification restoration strategy should be implemented. For instance, in areas where mountains, rivers, and vegetation have been damaged, the ecological stability of the region can be restored by introducing native plant species and establishing ecological corridors. During this process, it is essential to actively engage local villagers, leveraging their familiarity with the land and environment to achieve a collaborative approach to ecological restoration characterized by “co-construction and co-management”. Plans should be made to enhance riverbank vegetation systems, while simultaneously reducing the extent of shoreline hardening by planting indigenous grasses and trees. This will not only improve the ecological resilience of the riverbank, but also enhance its visual appeal.

### **2.3 Improvement of public facilities and creation of cultural landscape**

The spatial renewal of traditional villages should adhere to the principles of “repairing the old as it is” and “revitalizing and utilizing it”. Public service functions and the cultural value of spaces should be enhanced, taking into account the actual living needs of the villagers. In terms of infrastructure, it is essential to introduce appropriate tourism service facilities, such as folk museums, community service centers, and local cultural exhibition halls. These facilities will promote positive interactions between village tourism development and cultural communication.

In the context of landscape protection, it is essential to consider the integration of historical relics with contemporary needs. For instance, culturally significant objects such as ancient wells, stone mills, and old trees should be marked with distinctive signage and harmoniously incorporated into the surrounding environment to enhance their visibility and recognition, thereby transforming them into cultural focal points of the village. Additionally, construction standards and behavioral norms should be established through village rules, regulations, and community deliberations to foster a sense of participation and identity among villagers, ensuring the preservation of traditional cultural landscapes through social consensus<sup>[19]</sup>.

### **2.4 Lifestyle evolution and restoration of landscape knowledge gap**

The essence of traditional village landscape construction revolves around the concept of villagers developed highly practical and adaptable construction methods in response to daily challenges. For instance, granaries are frequently optimized and rebuilt due to dampness and susceptibility to mold; village walls are reinforced and expanded to meet defense requirements; and stone formations are adjusted and arranged to fulfill religious purposes. This ongoing process of trial and error, along with re-creation, represents the living inheritance of traditional knowledge.

However, the accelerated pace of modern society, coupled with strong policy interventions and market orientation, has left villagers with insufficient time and space for self-reflection and experimentation. In the pursuit of rapid development, the traditional rhythms of life and construction have been disrupted, leading villagers to bypass the process of “re-practice” in favor of adopting a “modern landscape” template imposed by outsiders<sup>[5]</sup>. Although this architectural style may appear contemporary, it can easily result in a rupture of knowledge and cultural disconnection.

Therefore, in urban and rural planning, we should prioritize reserving space and rights for villagers to “recreate” and avoid substituting their traditional construction wisdom with a singular, external solution. By encouraging villagers to engage in construction practices, we restore their prominent role in landscape development and reactivate the village’s knowledge ecosystem.

### **2.5 “Revitalization and regeneration” of street space and historic buildings**

As a vital component of the character of traditional villages, streets and lanes serve as the primary venues for residents’ daily activities, economic exchanges, and cultural events. Their preservation and enhancement are crucial not only for maintaining the spatial form but also for fostering the village’s spiritual identity. In terms of protection strategies, we should focus on 3 key aspects: spatial interfaces, landscape characteristics, and infrastructure.

The spatial environment of the streets and alleys has been optimized, with careful control over the scale and design of the buildings to preserve the original street style. Discarded materials, such as ceramics, could be repurposed to repair damaged walls following local conditions, thereby maintaining a consistent

material texture and reinforcing the regional cultural identity<sup>[19]</sup>.

At the landscape level, the village’s inherent visual style should be preserved, with careful attention to details such as native plants, traditional paving, and wall decorations. This approach aims to foster a street atmosphere that reflects cultural memory.

Traditional buildings should be protected in a systematic and classified manner. A strategy of “renovating the old while updating the new” should be implemented for valuable historical structures. This approach not only preserves their form and characteristics but also enhances their functional efficiency through spatial reconstruction and functional adaptation. For instance, while maintaining the original appearance, new functions such as commercial activities and cultural displays can be introduced to meet the needs of the local community, thereby achieving the “revitalization and regeneration” of historical buildings.

In renewing the courtyard space, we should thoroughly consider the actual production and living styles of the villagers. It is essential to scientifically optimize the functional layout, revitalize traditional spaces, and achieve the sustainable utilization of traditional landscape resources.

## **3 Results and discussion**

### **3.1 Experimental subjects**

The representative traditional village, Yaotou Village, was selected as the experimental sample, which had the following characteristics:

- A typical “mountain-village-field-water” pattern;
- Retain a relatively complete street structure, historical buildings, and folk activities;
- Villagers still have emotional identification with traditional landscapes;
- A preliminary foundation for protection or planning intervention.

### **3.2 Experimental grouping**

Two control groups were established for comparative analysis. The experimental group introduced the “co-construction and co-management” mechanism, which enhanced villager participation and implemented multi-level revitalization measures, including cultural exhibitions, functional replacements, and ecological restoration. In contrast, the control group only implemented basic protection measures, such as repairing streets and lanes and installing signs, without establishing a mechanism for

villagers' participation and engagement.

### 3.3 Experimental methods

**3.3.1 Participatory planning intervention.** Workshops with villagers could be conducted to gather insights and emotional memories related to traditional landscape elements. Collaborative designs could be engaged by integrating villagers' perspectives into the transformation plans for streets, courtyards, and key nodes. Activation points could be established, such as cultural exhibition spaces and areas for experiencing traditional skills.

**3.3.2 Implementation of spatial and cultural interventions.** The villages in the experimental group received spatial restoration that emphasized historical features, including street-scale control and the restoration of building textures. Additionally, ecological restoration elements were incorporated, such as replacing non-native vegetation with local plants and restoring natural coastlines. Areas for displaying intangible cultural heritage were also established, featuring folk art spaces for activities like paper cutting and pottery.

### 3.4 Evaluation index design

This study conducted a multi-dimensional and systematic evaluation of the inheritance and revitalization of traditional village landscape characteristics by designing indicators such as villagers' participation, awareness of traditional landscapes, recognition and retention of landscape elements, and the synergistic effects of key influencing factors<sup>[20]</sup>.

After comparing the 5 indicators of the experimental group with those of the control group, it was evident that the experimental group scores were significantly higher in "understanding the project", "willingness to participate", "actual participation", and "sense of identity". Average scores for the experimental group were 4.65, 4.625, 4.35, 4.425, and 4.85, respectively, while the control group's scores were 3.15, 3.025, 2.9, 3.025, and 3.05. This data indicated that the experimental group demonstrated higher overall participation and a more positive attitude

toward the village landscape project. Notably, in the "sense of identity" category, the difference between the 2 groups was as high as 1.8 points, suggesting that the experimental group developed a stronger emotional connection to the goal of village landscape inheritance during the participation. The results presented in Fig.1 illustrated that, through specific guidance mechanisms, participation platforms, or feedback systems, the villagers in the experimental group were more likely to establish trust and a sense of belonging to the project, leading to more active participation and the expression of suggestions. Overall, the data indicated that enhancing participation mechanisms and ensuring information transparency were crucial strategies for improving residents' engagement and sense of identity in the process of village construction and knowledge activation.

As illustrated in Fig.2, the experimental group scored significantly higher than the control group across 5 dimensions: "Traditional Architecture Awareness", "Intangible Cultural Heritage Skills Awareness", "Folk Customs Awareness", "Village Pattern Awareness", and "Style Awareness". Specifically, the average score for the 5 indicators in the experimental group was 4.54, compared to 3.0 for the control group, resulting in an overall difference of 1.54 points. Notably, the score for "Intangible Cultural Heritage Skills Awareness" in the experimental group was 4.6, while the control group only achieved a score of 2.8, indicating that the experimental group has shown the most significant improvement in their awareness of intangible culture. This suggested that through guided communication, cultural explanations, situational immersion, and other methods, the experimental group has developed a deeper and more comprehensive understanding of the traditional village landscape. Furthermore, the disparities in better equipped to grasp the overall characteristics of the village from both spatial and visual perspectives<sup>[21]</sup>. Overall, the data reflected that enhancing cultural communication

methods and fostering interaction between villagers and landscapes could significantly deepen their understanding of traditional landscape elements, thereby establishing a solid foundation for future protection, inheritance, and revitalization.

From the data on the retention rates of landscape elements and the recognition by villagers, it was evident that key landscape features in traditional villages have been well-preserved during the renewal and were generally highly regarded by the local population. Notably, the retention rate of the "village entrance archway" reached 95%, with a recognition score as high as 4.9, ranking it first among all items. This indicated that, as a symbolic gateway to the village, it embodied a strong sense of cultural belonging and spiritual identity. "Ancient wells", "stone mills", "traditional lanes", and other elements closely associated with daily life and historical memory have maintained a retention level of over 85%. These elements have received a recognition score exceeding 4.6 from villagers, indicating that a successful dual retention of cultural heritage and landscape beauty has been achieved through revitalization and utilization efforts. In contrast, the retention rates for "Adobe old houses" and "land use patterns relatively lower", at 80% and 82%, respectively; however, their recognition scores remain above 4.4. This suggested that effective protection measures have been implemented despite limited resources. The overall data presented in Fig.3 demonstrated that the systematic retention of traditional landscape elements aligned closely with the villagers' cultural memory, which was a crucial pathway for enhancing the recognition of protection projects and fostering the sense of cultural connection.

This dataset examined 6 major influencing factors, analyzing their independent roles in the construction and revitalization of traditional village landscapes, as well as their synergistic relationships with other key dimensions, including villagers' participation, local culture,

**Table 1 Influencing factors of traditional village landscape construction knowledge and their synergistic effect scoring table (Expert scoring method, 1–5 points, 5 points represent a significant and positive impact)**

Influence Factor	Independent Effect Score	Synergy with "Villager Participation"	Synergy with "Local Culture"	Synergy with "Policy Introduction"
Traditional Construction Knowledge	4.8	4.7	4.9	3.5
Villager Practice & Trial-Error Mechanism	4.6	5.0	4.5	3.7
Vernacular Natural Environment	4.5	4.2	4.6	3.8
Local Spiritual Culture	4.9	4.8	5.0	4.0
Government Intervention (Positive)	4.0	3.9	4.1	5.0
Market Trends and Preferences	3.5	3.2	3.0	4.4



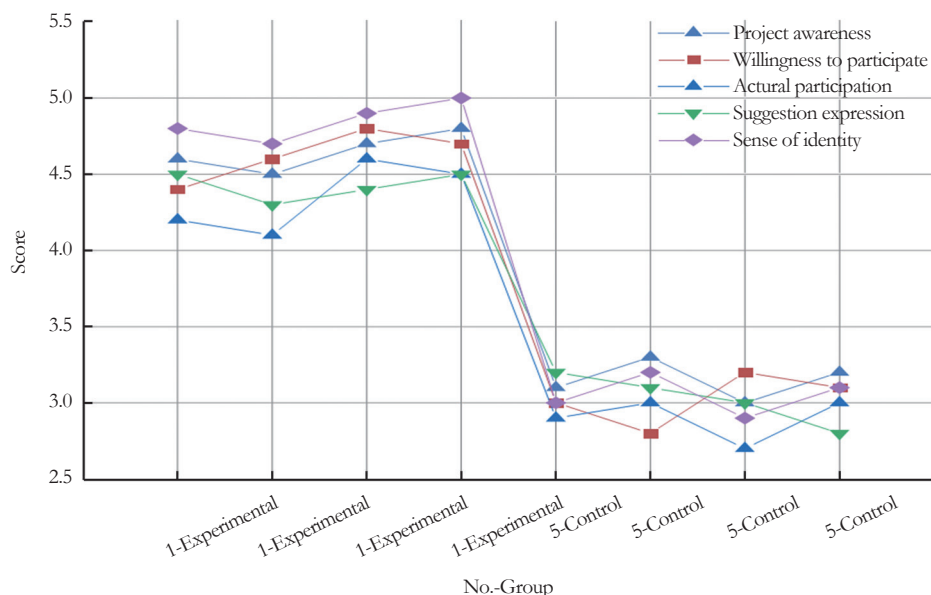


Fig. 1 Villager participation in the experimental group and the control group

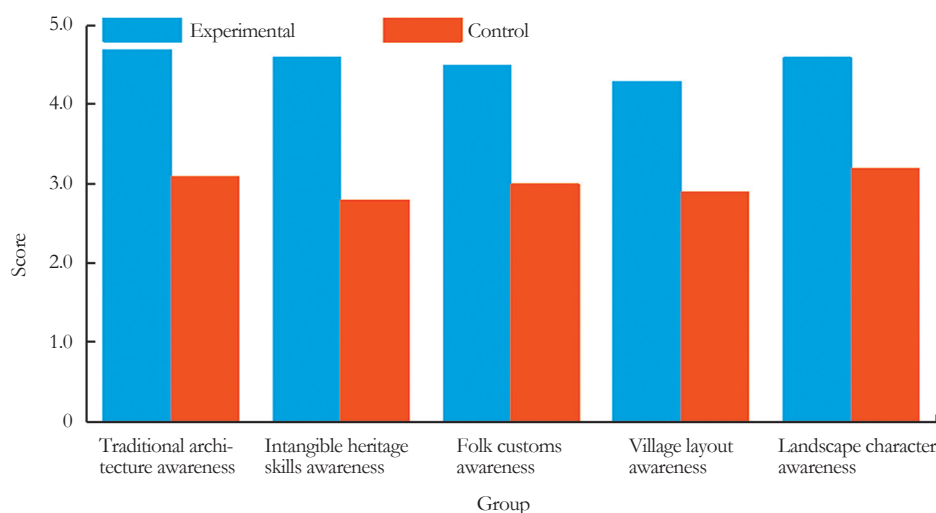


Fig.2 Comparison of traditional landscape awareness (group scoring system, full score is 5 points)

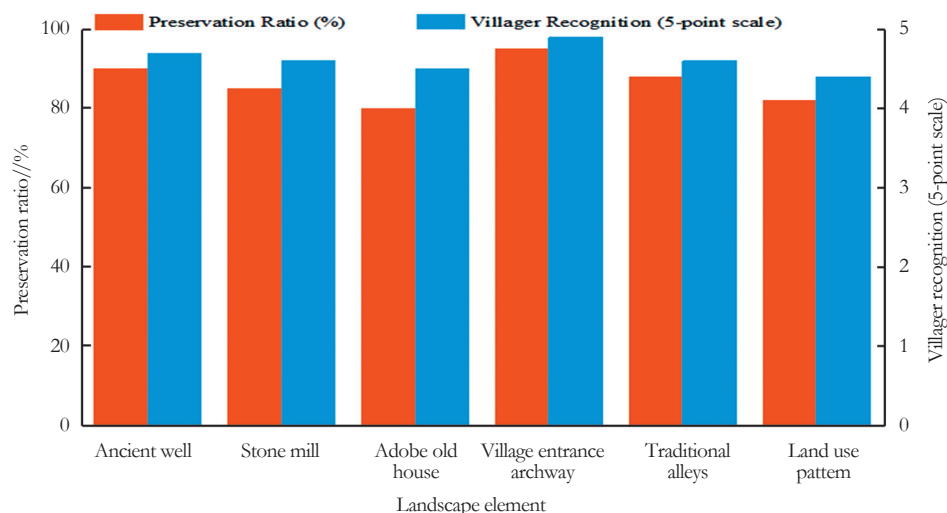


Fig.3 Cross-analysis of the retention and recognition of traditional landscape elements (experimental group)

and policy implementation. Overall, “local spiritual culture” and “traditional construction experience” received the highest independent role scores of 4.9 and 4.8, respectively, indicating that they were the primary forces driving the effective inheritance and expression of traditional landscapes. Additionally, their synergistic scores with “villagers’ participation” and “local culture” also exceeded 4.7 points, suggesting that these 2 factors not only possessed independent value but also could be intricately connected to local cultural identity and villagers’ autonomous actions, thereby forming a robust self-organizing mechanism. Although the independent score for “villager practice and trial-and-error mechanisms” was slightly lower at 4.6, its synergistic score with “villager participation” achieved a perfect score of 5, underscoring its effectiveness and adaptability in the bottom-up landscape evolution process, as illustrated in Table 1.

## 4 Conclusion

This study examined the inheritance and revitalization of traditional village landscape characteristics. It constructed a multi-dimensional knowledge model comprising a foundational layer, technical layer, landscape layer, and dynamic layer<sup>[5]</sup>. The research explored the mechanisms of generation and contemporary expressions of traditional landscape construction knowledge through the lenses of local culture, resident participation, and spatial planning. Through field research and quantitative data comparison between the experimental group and the control group, the results indicated that the strategy of promoting villagers’ participation while emphasizing the coordinated protection of intangible culture and material landscapes significantly enhanced the villagers’ sense of identity, cultural awareness, and willingness to engage with the landscape protection. The proportion of retained landscape elements was strongly correlated with the subjective assessments provided by the villagers, reflecting the intrinsic value of local construction experiences and the villagers’ involvement in landscape renewal. Although this study integrated theoretical models with empirical data, it still faced certain limitations regarding sample size, diversity of village types, and temporal scope. Future researches should expand to a broader range of geographical areas and implement long-term tracking evaluations to enhance the development of dynamic knowledge systems and explore more effective policy supports

for achieving the sustainable development of traditional village landscapes.

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