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Pre-Planning and Post-Evaluation Approaches to Sustainable Vernacular Architectural Practice: A Research-by-Design Study to Building Renovation in Shangri-La's *Shanpian* House, China

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Abstract: The renovation and revitalization of vernacular architecture are pivotal in sustainable rural development. In regions like Shangri-La, traditional structures not only safeguard cultural heritage but also provide a foundation for enhancing local communities' living conditions. However, these villages face growing challenges, including infrastructure decay, cultural erosion, and inadequate adaptation to modern living standards. Addressing these issues requires innovative research approaches that combine heritage preservation with the integration of contemporary functionality. This study employs a research-by-design approach, focusing on the *Shanpian* House as a case study, to explore how pre-planning and post-evaluation methods can revitalize traditional vernacular architecture. The pre-planning phase utilizes field surveys and archival research to assess spatial, cultural, and environmental conditions, framing a design strategy informed by field theory. In doing so, it evaluates how traditional architectural elements can be preserved while introducing modern construction techniques that meet current living standards. The post-evaluation phase, conducted through questionnaires and semi-structured interviews, assesses user satisfaction, focusing on the impact of architectural esthetics, structural stability, and material choices. Key findings from an OLS regression highlight the strong positive correlation between architectural style, structural choices, and cultural relevance with resident satisfaction. The research emphasizes that design elements such as structural details, materials, and infrastructure upgrades are critical in shaping perceptions of both functionality and cultural identity. Interestingly, the model reveals that improving architectural esthetics, alongside modern indoor features such as network connectivity, has a significant impact on enhancing overall resident satisfaction (significance level: 0.181). This study contributes to the broader discourse on sustainable building renovation by demonstrating how traditional architecture can be thoughtfully adapted for contemporary use and also proposes a paradigm shift in the renovation of historic buildings, advocating for a balance between preservation and modernization. The application of sustainable materials, digital modeling, and innovative construction techniques further ensures that these traditional structures meet the demands of modern civilization while maintaining their cultural integrity.

Keywords: field theory; rural revitalization; vernacular architecture; pre-planning and post-evaluation; cultural heritage preservation; research by design

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1. Introduction

Amid rapid globalization, traditional settlements worldwide face unprecedented challenges [1]. Urbanization drives rural populations to cities, leaving many villages hollow [2–4]. Simultaneously, modernization often neglects cultural heritage, leading to the demolition or alteration of historic buildings and the erosion of local cultural identities. The erosion of cultural identity and vernacular heritage is evident across rural landscapes in both developed and developing regions. In Europe, rural areas have experienced a gradual decline in traditional building practices as modern materials and techniques replace locally sourced and culturally resonant structures [3–5]. Similarly, in parts of Africa and Southeast Asia, the influx of global architectural trends has disrupted long-established practices, undermining local craftsmanship and knowledge systems [6]. In China, particularly in culturally rich areas like Shangri-La, vernacular architecture faces dual pressures, resisting globalization while aligning with national development strategies [7,8]. These trends contribute to the homogenization of rural environments, diminishing their distinct cultural landscapes and weakening community ties. Urbanization further accelerates this process as rural populations migrate to cities, leaving villages depopulated and diluting the cultural fabric [9–11].

The importance of cultural and environmental sustainability in vernacular architecture design has gained global attention [12]. International initiatives, such as UNESCO's heritage preservation programs, emphasize cultural transmission and sustainable development [13]. In China, the government's *Rural Revitalization Strategy* highlights the need to "enhance rural landscapes, preserve local flavors, and reflect regional culture" (*Rural Revitalization Strategy Plan 2018–2022*) [14]. More recently, the *Opinions on Advancing Comprehensive Rural Revitalization* further stress livability and the integration of rural culture with tourism [15,16]. However, issues of over-commercialization and superficial mimicry persist, weakening local cultural identity and sometimes harming the environment and social fabric [17,18].

Despite the increased awareness of sustainability and cultural diversity, clear research-by-design pathways for empowering traditional settlements remain elusive. Current studies focus primarily on spatial planning, offering limited insight into spatial perception [19,20]. Field theory, which examines the dynamic relationship between social activities and spatial attributes, offers a robust framework for understanding the complexities of vernacular design and aligns with rural revitalization strategies [21,22]. Additionally, spatial perception assessments can enhance evaluations of spatial quality and identify areas for improvement, increasing the reliability of proposals rooted in field theory [23,24].

This study aims to define a research-by-design paradigm that integrates cultural and environmental sustainability with spatial perception within the framework of vernacular architecture. Using the *Shanpian* House in Shangri-La as a case study, the research proposes a field theory-based design solution for vernacular architecture, employing a pre-planning and post-evaluation method. Through field surveys and questionnaires, the study explores design strategies for *Shanpian* House, offering insights for the planning and development of similar settlements. The research seeks to address the following three key questions:

1. How can vernacular design frameworks rooted in field theory be applied to traditional villages while ensuring cultural and environmental sustainability?
2. To what extent can vernacular design improve spatial perception and contribute to sustainability in existing rural contexts?
3. How can field theory inform strategies for spatial optimization and promote sustainable development in rural architecture?

The paper is structured as follows: first, we review the relevant literature and quantitative spatial analysis methods within the framework of field theory. Second, we introduce the case study of *Shanpian* House and its proposed design solution. Third, we assess the design framework based on survey data and propose strategies for spatial optimization. Finally, we conclude by outlining effective models for shaping spatial perception in the context of new urbanization and provide insights for both practitioners and scholars.

2. Literature Review

2.1. Research-by-Design Paradigm via Pre-Planning and Post-Evaluation

Research by design serves as a reflective tool for previous projects and an evidence-based framework for guiding future development [25,26]. In the context of rural design, research by design is an emerging methodology in rural vernacular architecture that blends design practice with academic inquiry and plays a pivotal role in decision-making processes [26,27]. By integrating interdisciplinary insights, this approach fosters a comprehensive understanding of rural architecture and spatial dynamics, ultimately establishing a robust theoretical foundation for future iterations [28,29]. It immerses researchers in real-world settings, enabling them to engage directly with the unique spatial characteristics and cultural narratives of rural environments [30,31]. This hands-on approach facilitates a deeper appreciation of local identity and the spirit of place, particularly in traditional villages like those in Shangri-La. Consequently, it supports a balanced preservation of cultural heritage while encouraging functional renewal and enhancing spatial vitality [32,33].

The pre-planning and post-evaluation (PPPE) framework (Figure 1) is central to implementing research by design effectively [34] (Figure 1). Currently, the PPPE framework emphasizes a closed-loop cycle of planning, design, and evaluation, urging practitioners to focus on enhancing overall design effectiveness [28,30,34]. Scholars differentiate between evaluation and critique, asserting that evaluation must rely on quantifiable data such as subjective assessment metrics suitable for semantic analysis, while critique often reflects subjective viewpoints, introducing greater uncertainty [35,36]. Thus, the PPPE approach ensures comprehensive project management from inception to completion, fostering sustainable and effective design solutions in rural contexts.

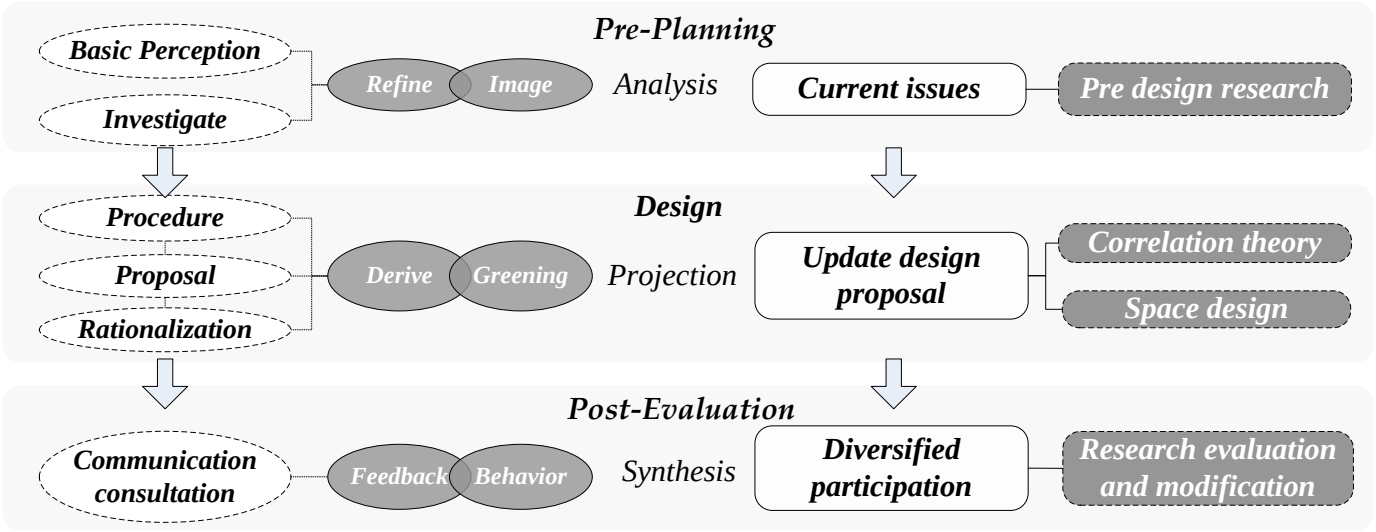


Figure 1. Pre-planning and post-evaluation (PPPE) design framework.

2.2. Vernacular Architecture Design and Assessment Through Field Theory

Field theory, a crucial framework in sociology, has increasingly influenced urban and rural planning and architectural design, revealing its unique value in assessing and designing vernacular architecture [37,38]. This theory emphasizes power relations, forms of capital, and interactions among actors within social spaces, focusing on how specific socio-cultural contexts shape residents' lifestyles and social structures [39]. In terms of spatial morphology and layout, field theory examines how vernacular architecture reflects and reinforces local cultural identity and the adaptability of structures to their natural environments [40]. Research indicates that spatial configurations are pivotal in evaluating vernacular spaces, as they often mirror Indigenous family structures and social customs [41]. Analyzing these configurations can uncover the profound social relationships and cultural transmission systems that inform individuals' perceptions of their environment.

Regarding functionality and usage, field theory highlights the actual utility of buildings and their impact on residents' lives [42]. Numerous studies have noted that the multifunctionality of vernacular architecture contributes significantly to its vitality [43]. Functions such as habitation, religious practices, and commercial activities enrich the architectural landscape, fostering economic vibrancy and social cohesion within communities [44]. Moreover, the dimensions of spatial perception and experience, alongside the cultural expressions embedded in architecture, are critical components of the assessment framework. These aspects delve into residents' and visitors' psychological responses to spaces and the conveyance of cultural identity [45]. Evidence shows that vernacular buildings enhance users' spatial experiences through unique esthetic qualities, scale, and accessibility [46]. Retaining and restoring traditional decorative elements, materials, and techniques not only preserve historical memory but also bolster cultural pride.

Additionally, the integration of sustainability into the design and assessment of vernacular architecture has become increasingly important [47]. With the rise of sustainable development ideals, research increasingly explores integrating green technologies and materials into vernacular architecture, aiming to mitigate environmental impacts [48]. For example, passive design strategies such as natural ventilation, solar orientation, and the use of local materials are now being incorporated into vernacular building practices to reduce energy consumption and enhance environmental protection. This holistic approach to assessment ensures that the design and evaluation of vernacular architecture honor cultural heritage while promoting sustainability. Thus, field theory not only frames the socio-cultural importance of vernacular architecture but also provides a pathway to align these structures with contemporary sustainability goals.

2.3. Research Framework

This study aims to develop a research framework for assessing spatial perception in vernacular architecture grounded in field theory and a spatial perception evaluation matrix (Figure 2). The framework comprises two main components. The first component distills the spatial guiding factors from field theory, encompassing five dimensions, namely spatial morphology and layout, functional use, sensory perception and experience, cultural expression, and environmental protection. These elements collectively shape how inhabitants engage with their built environment, emphasizing the relationship between spatial design and sustainability. The second component focuses on the assessment of architectural spatial perception, which includes six dimensions, which are site location, exterior appearance, structural integrity, facilities, internal space, and performance. This dual-layered framework enables a comprehensive evaluation of vernacular architecture, ensuring that both spatial characteristics and functional attributes are considered.

In terms of methodology, sustainability considerations are embedded throughout both the pre-planning and post-evaluation phases of this study. These activities provide a foundation for understanding the unique attributes of the vernacular environment. The post-evaluation phase involves constructing a structured questionnaire to capture user feedback and perceptions, coupled with an ordinary least squares (OLS) regression model with correlation analysis to discern relationships among various dimensions of spatial perception. By integrating sustainability into both field theory and the assessment framework, this study seeks to advance the evaluation of vernacular architecture, providing insight into how these structures can support cultural identity and sustainable development.

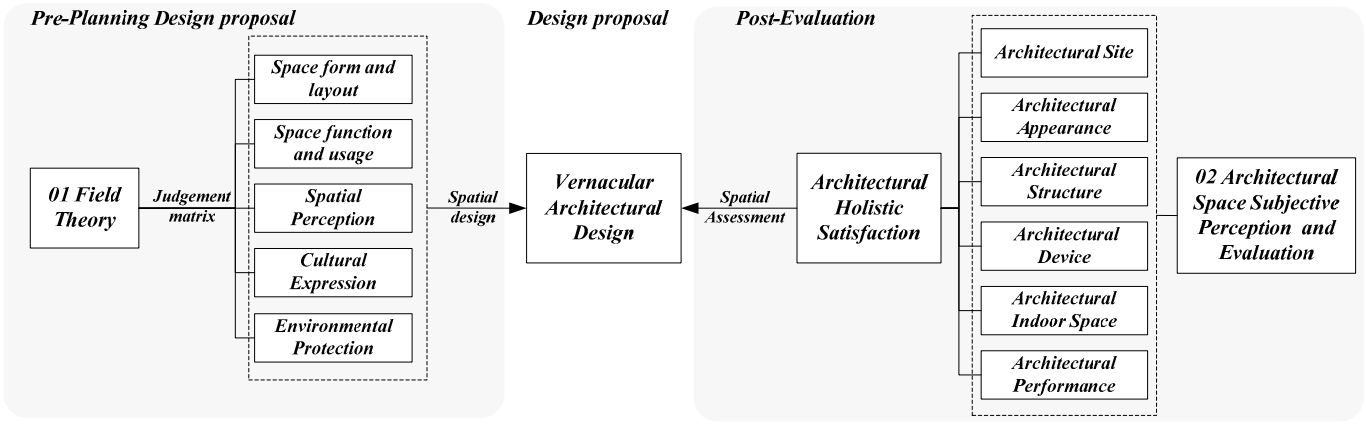


Figure 2. Creating and evaluating a spatial perception framework for rural architecture based on field theory.

3. Methods and Data

3.1. Study Area

Nestled in northwestern Yunnan, Shangri-La marks the confluence of the Yunnan, Tibet, and Sichuan provinces, China (Figure 3). This region, a multi-ethnic Tibetan autonomous prefecture, is home to the *Shanpian* House, a unique vernacular architecture that blends Tibetan and Bai architectural styles [49]. *Shanpian* House stands out among various Tibetan structures, characterized by its distinctive wooden-tiled loft space. Unlike traditional Tibetan homes that typically feature stone or rammed earth exteriors, *Shanpian* houses incorporate elements from Bai dwellings brought through the ancient Tea Horse Road from Dali. Some scholars refer to this architectural variant as "tile houses" or "wood-tile houses [50]".



Figure 3. Research object.

This singular building type not only preserves traditional cultural elements but also reflects a local approach to thermal design. Given the rapid pace of urbanization and cultural homogenization in the region, studying the *Shanpian* House becomes increasingly urgent. Understanding its architectural nuances contributes to broader discussions on heritage preservation, cultural identity, and sustainable design practices in rural settings.

By focusing on this unique vernacular form, we can better appreciate its role in embodying local traditions while addressing contemporary challenges in architectural conservation.

3.2. Methods

3.2.1. Pre-Planning via Desk Research

This research-by-design study adopts a practice-based approach, establishing criteria essential for selecting representative cases. The first criterion emphasizes data availability, necessitating that each case possesses accessible design documentation. Specifically, this includes a minimum of ten architectural photographs, primary floor plans, and cross-section drawings, complemented by supplementary diagrams that illustrate design strategies [51]. The second criterion focuses on academic recognition. Selected projects must have received notable national or international architectural awards, with related design research published in reputable academic journals. This ensures that the cases not only demonstrate design excellence but are also grounded in scholarly discourse. Information sufficiency serves as the third criterion, requiring the published literature to cover at least three distinct stages of the project lifecycle. This ensures that there is adequate information for comprehensive textual analysis, facilitating a deeper understanding of each case.

To implement these criteria, we initiated a selection process for both domestic and international vernacular architecture cases. The search commenced with the keyword "vernacular architecture" in two architectural databases, namely Gudao, which contains 252 cases, and ArchDaily, with 776 cases. We concentrated on projects published between 2008 and 2019 and retrieved the relevant literature spanning from 2008 to 2021. This process resulted in the identification of 121 cases meeting our initial screening criteria. Subsequently, we sought the literature related to these 121 cases and their architects. For Chinese projects, the CNKI database was employed, while the international literature was sourced from the Architecture Journals Complete List at the University of Illinois Library. A thorough review of all the project-related literature followed, during which we categorized the cases based on their functional attributes (Table 1).

Table 1. Selected representative projects for element collection and organization.

Time	**Educational Building Reviewed Projects**	**Time**	**Rural Settlement Reviewed Projects**
2012	Library Muyinga, Bc architects	2014	Jintai Village Reconstruction, Ru-Urban Frame
2017	Preschool of Ouled Merzoug, BC architects	2017	Wen Village from Fuyang, Wang shu
Time	**Building System Reviewed Projects**	**Time**	**Regeneration Reviewed Projects**
2013	Haiti prototype house, Econnect	2015	Ruralation Library in Tonglu, AZL Architects,
2016	Rebirth Brick Proposal and Able-to-grow House, Liu jiakun	2017	QiMen Black Tea House in Taoyuan village-Ar
2018	Lightweight prefab steel system for ru-house, Hsieh Ying-Chun	2018	Chenjiapu Civilian Bookstore, AZL Architects,
Time	**Productive Building Reviewed Projects**	**Time**	**Public Building Reviewed Projects**
2013	Wuyishan Bamboo Raft Factory, TAO	2008	Wind and Water Bar, Vo Trong Nghia
2016	Huateng hog house hall, Leeko Studio	2010	Museum of handcraft paper, TAO
Time	**Dwelling Reviewed Projects**	**2013**	**Jianamani Visitor Center, TeamMinus**
2012	Naked Gallery, Xiaohui Design studio	2013	Macha village community center, onearth-Ar
2016	Social Production of Housing, Comunal Taller de Arquitectura,	2017	Mulan Weichang, HDD
2016	Cave house on loess plateau, hyperSity Architects	2017	In Bamboo, Archi-Union Architects
2016	Guangming Village Reconstruction Project	2018	Solidaridad Village Market, Tjep Vaastuka-Ar
2018	House in Rubielos de Mora, Ramon Esteve Estudio	2018	Gui'an Innovation building, SUP Atelier Thupd

3.2.2. Post-Evaluation via OLS Regression

(1) OLS regression Model

OLS regression implies that each observation of the dependent variable y_i enhances the success rate of model construction by quantifying the relationship between independent variables and the dependent variable. The basic formula is as follows:

$$y_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_i x_i + \varepsilon \quad (1)$$

where y_i represents the spatial quality index, β_0 represents the intercept, $x_1, x_2, \ldots, x_i$ represents the independent variables, and $\beta_0, \beta_1, \ldots, \beta_i$ represent the regression coefficients. ε represents the error term, accounting for the random variation that the model cannot fully explain. The R-squared value measures the proportion of variance in the dependent variable that is explained by the independent variable. It ranges from 0 to 1, where 1 indicates a perfect fit. The formula for calculating the R^2 value, RMSE, and MAE is

$$R^2 = 1 - \frac{\sum_{i=1}^{n}(y_i - \hat{y}_i)^2}{\sum_{i=1}^{n}(y_i - \overline{y})^2} \quad (2)$$

$$RMSE = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(y_i - \hat{y}_i)^2}\,;\ MAE = \frac{1}{n}\sum_{i=1}^{n}|y_i - \hat{y}_i| \quad (3)$$

where n is the sample size, y_i is the actual value of the dependent variable, $\hat{y}_i$ is the predicted value, and $\overline{y}$ is the mean of the actual values.

(2) Robust Test: Random Sample Consensus Test (RANSAC)

RANSAC mainly verifies the insensitivity of the amount of calculation generated in the calculation process to the model error. The study uses RANSAC to verify the robustness of the results in the OLS regression model. The specific formula is as follows:

$$y_i = \sum_{j=1}^{p} x_{ij}\beta_j + e_i \quad (4)$$

Among them, β1, β2,. . ., βp are unknown regression coefficients, e1, e2,. . ., en are independent and identically distributed, and i = 1, 2. . ., n.

(3) Breusch–Pagan Check

The Breusch–Pagan test checks whether the residuals from the OLS model exhibit systematic patterns related to the independent variables, indicating potential model inefficiency. The specific formula is as follows:

$$\varepsilon^2 = \gamma_0 + \gamma_1 z_1 + \gamma_2 z_2 + \cdots + \gamma_m z_m + u \quad (5)$$

ε^2 represents the squared residuals from the original OLS model, $z_1 \ldots z_m$ are the independent variables from the OLS regression, and $\gamma_0, \gamma_1 \ldots \gamma_m$ are the parameters to be estimated. The term u is the random error. The test examines whether these residuals correlate with the independent variables, indicating the presence of heteroskedasticity.

3.3. Evaluation Indicators

The study adopts a case-based approach, applying qualitative methods to thoroughly investigate 27 selected cases. Building on the principles of the analytic hierarchy process (AHP), we categorized the content of these cases across different project phases (Table 1). Specifically, as a practice-based design study, this research employed the following three criteria when selecting representative cases: first, the cases must provide sufficient accessible design documentation, including at least ten photographs of the building, along with primary floor plans, sections, and relevant diagrams to explain their design strategies. Second, the academic merit of the projects was considered, following the design research evaluation criteria established by the University of Hong Kong in 2012 [28]. This means the projects should have received specific international or national architectural awards, and related design research must have been published in academic journals. Finally, to ensure ample information for a textual analysis of the selected projects, the published literature should cover data from at least three stages of the project lifecycle.

Through this analysis, we identified eight key clusters and 41 design elements that form the theoretical framework for contemporary vernacular architectural design (Table 2). Utilizing a case study approach, we conducted an in-depth qualitative analysis of 27 selected cases. By applying the principles of hierarchical analysis, we categorized the content from the literature concerning different stages of the projects. Subsequently, we performed textual analysis based on descriptions of design strategies at each stage, including interviews with architects and discussions in project-related journals. This allowed us to summarize the eight element clusters and 41 design elements that constitute the theoretical framework for contemporary vernacular architectural design (Table 2). As shown in Table 2, where √ represents the inclusion of the indicator in the article

Table 2. Correlation between material design elements and other local architecture works.

Dimension	Main Factors	[52]	[53]	[54]	[55]	[56]	[57]	[58]	[59]	[60]
Architectural site	Location					√		√	√	√
	Landscape	√	√	√	√	√	√	√	√	
	Climate	√	√	√	√	√	√	√	√	
	Accessibility				√					
	Pubic space				√	√	√		√	
Architectural appearance	Form	√	√	√	√	√	√	√	√	√
	Cladding Texture						√	√	√	
	Color	√	√	√	√	√	√	√	√	√
	Opening				√	√			√	
	Materiality	√	√	√	√	√	√	√	√	√
Architectural structure	Facade				√	√			√	
	Structure	√	√	√	√	√	√	√	√	√
	Connection Joints			√	√	√			√	
	Construction Methods	√	√	√	√	√		√	√	√
	Material Treatment	√	√	√	√	√	√	√	√	√
Architectural device		√	√	√	√	√	√	√	√	√
Architectural space	Orientation	√	√	√	√	√	√	√	√	√
	Functions	√	√	√	√	√	√	√	√	√
	Layout	√	√	√	√	√	√	√	√	√
	Height			√		√				
	Stairs and Storage					√				
	Hue/Color	√		√						√
	Furniture					√				
Architectural performance			√	√	√	√	√	√	√	

3.4. Data Acquisition

3.4.1. Pre-Investigation via Field Survey

A field survey conducted in Shangri-La from 3 to 6 October 2019 revealed that local residents often construct new buildings adjacent to the original *Shanpian* houses rather than renovating or rebuilding them. This practice stems from evolving residential needs and changes in building service systems. Key observations include the following:

First, during the pre-investigation phase, the research team conducted extensive archival studies and oral history interviews with elderly residents and local experts. These interviews yielded invaluable insights into the historical uses of *Shanpian* houses, particularly their communal roles in weddings, religious ceremonies, and other community events. By gathering first-hand accounts from local elders, the study aimed to capture aspects of intangible cultural heritage that may not be immediately apparent from the physical structures alone. This approach enhances our understanding of the traditional functions and social significance of various spatial layouts.

Second, a spatial analysis of the original layouts and designs of *Shanpian* houses were undertaken to reconstruct the architectural intentions behind specific spatial divisions. Detailed building surveys, coupled with comparisons to historical documents, enabled the identification and mapping of areas originally designated for public or ceremonial purposes. These findings were cross-referenced with oral histories to ensure both accuracy and cultural relevance. Additionally, a comparative analysis of current and historical uses of space was conducted. By observing how contemporary residents have adapted *Shanpian* houses to meet modern needs, such as constructing adjacent kitchens and bathrooms, the research identified which aspects of the original spatial definitions have been lost or altered. This analysis informs more thoughtful strategies for restoring and transforming these spaces in a manner that honors their historical significance while accommodating contemporary lifestyles.

Furthermore, the pre-investigation phase explored the potential for reintegrating public functions into modern usage patterns, drawing on the historical role of *Shanpian* houses as community activity centers. While new community centers now fulfill some of these roles, the study considers how to revive certain traditional public spaces to enhance cultural continuity, establishing meaningful connections between the past and present uses of vernacular architecture.

Overall, through a combination of oral histories, spatial analysis, and comparative studies, the pre-investigation phase seeks to restore the historical uses and spatial definitions of *Shanpian* houses. This not only preserves their cultural significance but also ensures that any renovation or transformation respects the integrity of their original functions within the broader community context.

3.4.2. Post-Evaluation Data Collection via Questionnaire

The study developed a subjective questionnaire focusing on six dimensions of post-design building spaces, namely location, appearance, structure, facilities, interior space, and performance. The questionnaire design draws on a thorough analysis of the relevant literature and aligns with the specific objectives of this study, ensuring the selected categories accurately address the design challenges and strategies tied to stakeholder needs. The six dimensions examined were derived from Table 1, reflecting trends identified across two decades of the architectural literature and iconic projects. This review reveals that contemporary design priorities consistently center around these six dimensions. Using a structured literature synthesis, the study distilled key evaluation criteria into measurable indicators (Table 2), forming a robust assessment framework.

For sample selection, the study adopted a snowball sampling method. Initial participants were identified through recommendations from residents, with the sample gradually expanding to capture a broader and more diverse range of feedback. This iterative approach ensured that the collected responses reflected a wide spectrum of perspectives, enhancing the representativeness and relevance of the findings.

These categories aim to identify design challenges and strategies related to stakeholder needs. Additionally, a "general information" section was included to gather demographic data such as gender, education, income, age, and work experience, factors that could influence respondents' perceptions of building requirements. The second section assessed satisfaction with design factors tied to participants' needs. Responses were measured using a five-point Likert scale, evaluating satisfaction with both design elements and the application of case-specific strategies. Data collection took place between 20 and 28 February 2024, with 149 local residents completing the survey (Table 3). Additionally, given the questionnaire's focus on specific technical aspects of architectural planning, the data collection process required careful communication. Collectors conveyed specialized questions to respondents, providing necessary explanations to ensure clarity and relevance. Rather than relying solely on participants to complete the forms independently, collectors documented the responses based on participants' answers, minimizing the risk of misinterpretation.

This approach enhanced the accuracy of the data, ensuring that complex architectural concepts were correctly understood and reflected in the survey results.

Table 3. Statistical information of the survey sample (N = 149).

Included Variables	Content	Number	Percent
Gender	Man	74	49.7%
	Woman	75	50.3%
Age	18–20	30	20.1%
	21~35	54	36.2%
	36~50	40	26.8%
	51~75	20	13.4%
	76–100	5	3.4%
Annual income	RMB $\leq$ 50,000	30	20.1%
	RMB 50,000–250,000	35	23.5%
	RMB 250,001–450,000	54	28.7%
	RMB 450,001–650,000	25	36.2%
	RMB $\geq$ 650,000	5	3.4%
Household registration	Urban local hukou	11	7.4%
	Rural local hukou	37	24.8%
	Urban migrant	33	22.1%
	Rural migrant	15	10.1%
	Collective hukou	53	35.6%

4. Pre-Planning and Post-Evaluation Results

4.1. Shangri-La's Shanpian Vernacular Architecture Design Based on Field Theory

Grounded in field theory, this design for the traditional *Shanpian* House in Shangri-La addresses the complex intersection of regional and cultural conditions with modern building practices. The site, located in a historic district surrounded by vernacular structures, presents both climatic and logistical challenges. The cold winters of the region necessitate design solutions focusing on insulation and airtightness (Figure 4). Additionally, access constraints due to the pedestrianized zone and restrictions on large vehicles required the use of smaller cost-efficient pickup trucks for construction. In response to these conditions, the design adopts a public space strategy inspired by Ganden Tower, integrating a corridor that serves both as a hotel lounge and a public gathering area for local residents during construction.

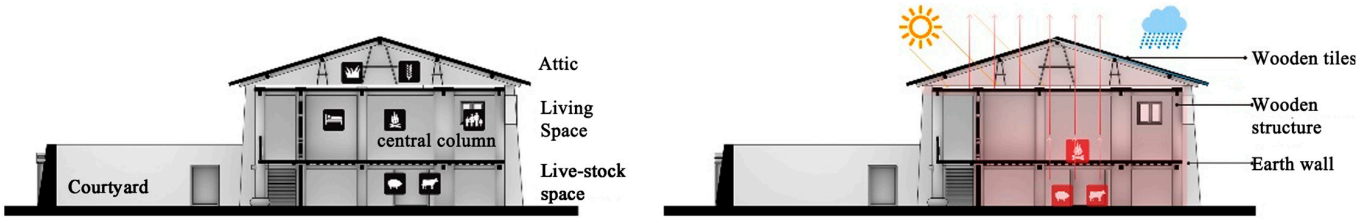


Figure 4. Analysis of building lighting and thermal insulation under climate influence.

(1) Exterior and Structural Design: Harmonizing with Vernacular Esthetics

In terms of exterior design, the structure mirrors the traditional massing of local vernacular buildings, with a slightly steeper roof pitch and unified material choices (Figure 5). It is worth mentioning that, as shown in Figure 5, the existing building only has the entrance gate section left, and the rest has been damaged and demolished (a). Therefore, the facade maintains a consistent palette, with earth-toned walls and wooden shingles for the roofing, ensuring continuity with the regional esthetic (b). Larger window openings, strategically placed along the gable walls, enhance natural lighting while maintaining the integrity of the brick boundary wall (c). Insulation materials have been used to reduce wall

thickness, improving thermal efficiency without compromising the visual connection to the *Shanpian* House tradition. Among them, a, b, and c represent different angles of the venue respectively.



Figure 5. Comparison of architectural outdoor performance before and after reconstruction.

As illustrated in Figure 6, the attic space was repurposed into modern suites, transforming the original 2.5-story vernacular structure into a full three-story building. The roof was constructed in three layers, which comprised internal wooden insulation, steel corrugated roofing for structural integrity, and outer decorative wooden shingles. This layering effectively balances modern functional requirements with the preservation of the traditional form.

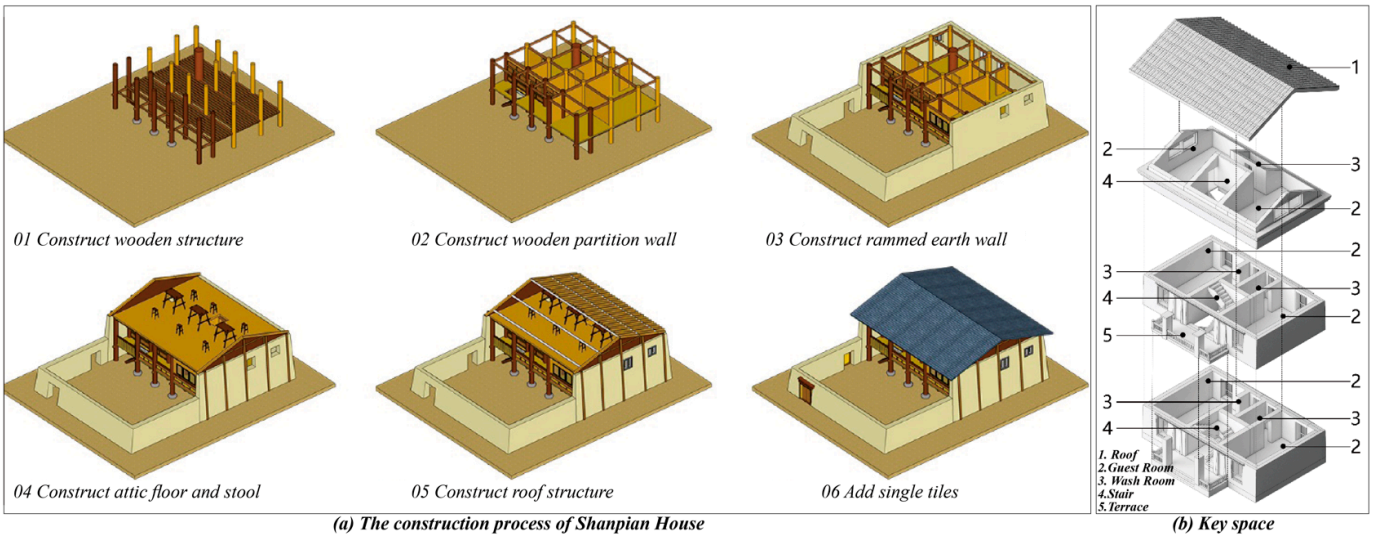


Figure 6. Analysis of the design structure and major space of *Shanpian* House.

(2) Interior and Facilities: Blending Tradition with Modern Comfort

The interior design (Figure 7) aligns with the vernacular ethos but introduces modern amenities. The lower two floors house symmetrical guest rooms, while the third-floor attic has been transformed into suites complete with living and sleeping areas. Centralized

staircases and bathrooms ensure efficient circulation and drainage while maximizing sunlight exposure for south-facing rooms. Public functions are concentrated on the ground floor, enhancing the space's flexibility as a communal area or hotel lobby. The use of warm wooden furnishings and vibrant interior accents recreates the familiar ambiance of a traditional Tibetan household, offering comfort and cultural immersion. Among them, a, b, and c represent different angles of the venue.

Given the region's fluctuating climate, airtightness presented a technical challenge. Wooden frames, prone to expansion and contraction, could not provide sufficient sealing. Industrial-grade windows were, therefore, installed to mitigate noise and maintain insulation. These design decisions ensure that the building is not only culturally resonant but also functionally resilient, meeting contemporary standards of comfort and energy efficiency. This design exemplifies a careful balance between heritage preservation and modern functionality, ensuring that traditional forms are respected while integrating necessary updates to meet current living standards.

Overall, this study delves into the significant differences between the pre- and post-design phases of vernacular architecture. The preservation of traditional building forms and construction techniques is not only a continuation of cultural heritage but also a reaffirmation of local identity. Given the limited status quo retained in this research, the design process emphasizes the revival of culture and functionality, aiming to meet contemporary diverse needs while respecting tradition. Furthermore, to ensure cultural resonance in architecture, the study prioritizes dialog between the built environment and the community, striving to integrate the perceptions and usage habits of local residents into the design. These design decisions focus not only on preserving traditional forms but also on ensuring the functional resilience of the buildings, meeting modern standards of comfort and energy efficiency.



Figure 7. Comparison of indoor space design before and after construction.

4.2. Post-Evaluation Results Via Regression Model Assessment

The post-evaluation phase, grounded in field theory, examined how various factors impact overall satisfaction with vernacular buildings like the *Shanpian* House. Using the OLS regression model, we analyzed six dimensions, namely architectural appearance, structure, facilities, interior space, performance, and site, each consisting of 35 independent variables. Control variables included location, landscape, climate, accessibility, and public

space. The results, detailed in Table 4, provide insights into the relative importance of these factors to overall user satisfaction.

Table 4. Regression results of various factors' impact on overall satisfaction.

	VARIABLES	OLS Regression Result				RANSAC Regression Result			
		(1) Overall Satisfaction		(2) Overall Satisfaction'		(3) Overall Satisfaction		(4) Overall Satisfaction'	
		Coff.	*p*	Coff.	*p*	Coff.	*p*	Coff.	*p*
Architectural Appearance	Styling satisfaction	3.731	0.000 ***	3.976	0.000 ***	4.382	0.000 ***	6.373	0.000 ***
	Texture of overlay satisfaction	−2.136	0.036 **	−2.855	0.006 ***	−1.852	0.064 *	−3.193	0.001 ***
	Color satisfaction	0.28	0.781	0.914	0.364	0.69	0.49	1.966	0.049 **
	Open the window satisfaction	1.388	0.169	1.402	0.165	0.715	0.474	−0.06	0.952
	Material characteristics	−1.6	0.114	−0.664	0.509	−2.111	0.035 **	−0.108	0.914
Architectural Structure	Building skin satisfaction	−1.037	0.303	−0.853	0.396	−1.215	0.224	−0.611	0.541
	Building Structure satisfaction	3.05	0.003 ***	3.309	0.001 ***	4.166	0.000 ***	5.792	0.000 ***
	Detail nodes satisfaction	−0.086	0.932	−0.942	0.349	−0.208	0.835	−2.902	0.004 ***
	Construction method	0.793	0.43	1.214	0.229	1.26	0.208	2.981	0.003 ***
	Material processing satisfaction	−3.134	0.002 ***	−3.907	0.000 ***	−4.01	0.000 ***	−6.569	0.000 ***
Architectural Device	Energy supply satisfaction	3.617	0.001 ***	3.702	0.000 ***	4.941	0.000 ***	6.008	0.000 ***
	Infrastructure upgrade	−0.583	0.562	−1.33	0.188	−1.385	0.166	−2.632	0.008 ***
	Internet or television	2.976	0.004 ***	3.936	0.000 ***	3.305	0.001 ***	5.441	0.000 ***
Architectural Space	Orientation satisfaction	0.439	0.662	−0.237	0.814	0.041	0.968	−0.678	0.498
	Building function satisfaction	−0.601	0.55	−0.568	0.572	−0.275	0.784	−0.699	0.484
	Architectural layout satisfaction	−0.658	0.513	−0.891	0.376	−1.161	0.246	−1.709	0.087 *
	Height and layer height	3.232	0.002 ***	2.781	0.007 ***	3.608	0.000 ***	4.051	0.000 ***
	Staircase storage satisfaction	−0.024	0.981	−0.299	0.766	0.122	0.903	0.015	0.988
	Tone and Color satisfaction	−0.166	0.869	−0.44	0.661	−0.25	0.803	−1.288	0.198
	Furniture satisfaction	2.761	0.007 ***	2.358	0.021 **	2.886	0.004 ***	3.227	0.001 ***
Architectural Performance	Airtightness satisfaction	0.694	0.49	1.678	0.098 *	1.302	0.193	2.658	0.008 ***
	Waterproof satisfaction	−1.768	0.081 *	−2.688	0.009 ***	−2.732	0.006 ***	−4.716	0.000 ***
	Sound insulation satisfaction	1.427	0.158	2.072	0.042 **	0.835	0.404	1.955	0.051 *
Architectural Site	Location			1.578	0.119			2.34	0.019 **
	Landscape terrain			0.94	0.351			1.434	0.152
	Climate			−1.201	0.234			−1.443	0.149
	Accessibility			1.249	0.216			2.003	0.045 **
	Public spaces			−2.314	0.024 **			−3.734	0.000 ***
Time FE		Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2		0.822		0.840		0.806		0.810	
Adjusted-R^2		0.767		0.776		0.746		0.733	

*** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

In terms of architectural appearance, styling satisfaction showed a significant positive influence on overall satisfaction, with coefficients of 3.731 and 3.976 across two models. This underscores the importance of architectural esthetics in vernacular design, particularly in maintaining traditional forms while addressing modern user expectations. In contrast, dissatisfaction with material texture negatively affected overall impressions, with coefficients of −2.136 and −2.855, indicating that material choices must meet both functional and esthetic standards to enhance satisfaction.

In terms of structural design, satisfaction with the building structure had a notable positive effect, with coefficients ranging from 3.05 to 6.37, illustrating the crucial role that structural integrity and attention to construction details play in shaping user perceptions. However, satisfaction with material processing showed a significant negative impact, with coefficients as low as −3.134, suggesting that poor material treatment undermines otherwise positive structural features.

In terms of facilities and performance, satisfaction with energy supply and infrastructure upgrades also significantly influenced overall satisfaction, particularly in RANSAC regression results. For instance, energy supply had a robust positive effect, with coefficients as high as 6.008 in some models. Conversely, dissatisfaction with waterproofing and sound insulation posed significant negative effects, reinforcing the need for functional building improvements.

In terms of cultural and regional factors, the study also explored how vernacular architecture aligns with cultural identity. Satisfaction with traditional architectural features, particularly stylistic elements such as roof design and the use of local materials, showed a strong correlation with cultural resonance. The results highlight the need for architects to consider not only the functional but also the symbolic value of design elements that connect inhabitants to their heritage. For instance, traditional color schemes and the integration of local materials such as wood and stone played a crucial role in enhancing both esthetic appeal and cultural authenticity.

The findings underscore the delicate balance required in vernacular architecture between maintaining cultural authenticity and meeting modern performance standards. Traditional esthetics, when combined with structural integrity and well-functioning facilities, contribute significantly to overall satisfaction. However, failure in material quality or functional performance can detract from this positive perception. These insights offer a path forward for architects and planners seeking to revitalize vernacular spaces while ensuring they meet contemporary needs.

To ensure the robustness of the satisfaction model, the RANSAC method was employed to minimize sensitivity to outliers. This technique enhances model stability by focusing on reliable data points, reducing the influence of outliers that could skew results. As shown in Table 4, the assumption of abnormal regression between samples was not validated, with the F-test yielding a highly significant *p*-value of 0.000 ***. This result confirms the statistical significance of the relationship between the dependent variable (overall satisfaction) and the predictor variables, suggesting that the model effectively captures the key factors impacting satisfaction.

Further validation was conducted using the Breusch–Pagan test, which assesses heteroskedasticity in linear models. Table 5 presents the Breusch–Pagan results, with four models corresponding to the six dimensions of satisfaction identified in the OLS regression. The LM values (indicating test statistics) and their t-values are reported, alongside the R^2 (pseudo R^2) value, representing the goodness of fit. Across all models, the LM values were minimal, with *p*-values well below 0.05, indicating that the hypothesis of heteroskedasticity can be rejected at a 95% confidence level. This confirms the absence of heteroskedasticity, thereby supporting the robustness of the regression results.

Table 5. Robustness check: Breusch–Pagan check.

VARIABLES	(1) Overall Satisfaction	(2) Overall Satisfaction′	(3) Overall Satisfaction	(4) Overall Satisfaction′
LM	0.000 ***	0.014 **	0.046 **	0.003 **
	(1.797)	(2.117)	(1.821)	(1.595)
R^2 (Pesudo R^2)	0.889	0.953	0.930	0.942
Controls	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes

*** $p < 0.001$, ** $p < 0.01$.

The Breusch–Pagan test further strengthens the linear regression findings, demonstrating that even after controlling for related variables, the model provides a reliable framework for understanding the factors influencing overall satisfaction with vernacular architecture. The validation framework follows a sequential logic. The study first employed OLS regression, as shown in Table 5, to check for model robustness. However, OLS estimates parameters by minimizing the sum of squared residuals, making it sensitive to outliers. When outliers are present, the model attempts to fit these anomalies, which can distort parameter estimates and reduce accuracy. To address this, a RANSAC-based robustness check was performed to mitigate the influence of outliers and enhance the reliability of the model. This dual validation through both RANSAC and Breusch–Pagan tests offers confidence in the model's ability to reveal significant predictors of architectural satisfaction, ensuring the results are both statistically sound and applicable to real-world scenarios.

Figure 8 illustrates the relationship between architectural appearance characteristics and overall satisfaction ratings. The scatter plots depict five distinct aspects of architectural appearance, namely styling satisfaction, texture of overlay satisfaction, color satisfaction, opening the window satisfaction, and material characteristics. The R-squared values, ranging from 0.006 to 0.154, suggest varying degrees of association between the architectural appearance factors and overall satisfaction. A higher R-squared value indicates a stronger linear relationship between the predictor and the response variable. In this case, styling satisfaction has the highest R-squared value of 0.154, followed by texture of overlay satisfaction with 0.104 and color satisfaction with 0.012. Opening the window satisfaction and material characteristics have relatively weaker correlations with overall satisfaction, as indicated by their R-squared values of 0.027 and 0.006, respectively. The root mean square error (RMSE) and mean absolute error (MAE) values also provide insight into the predictive power of the models. Lower values of both the RMSE and MAE indicate better agreement between the predicted and observed values.

Figure 9 provides valuable insights into the relationship between architectural structure- and device-related factors with overall satisfaction ratings. The scatter plots illustrate six distinct aspects, namely material processing satisfaction, building structure satisfaction, construction method satisfaction, energy supply satisfaction, infrastructure upgrade satisfaction, and internet or television satisfaction. The R-squared values, ranging from 0.0021 to 0.179, reveal varying degrees of association between these factors and overall satisfaction. Material processing satisfaction exhibits the strongest correlation with an R-squared value of 0.179, followed by building structure satisfaction with 0.135 and construction method satisfaction with 0.021. Energy supply satisfaction, infrastructure upgrade satisfaction, and internet or television satisfaction have relatively weaker correlations with overall satisfaction, as indicated by their R-squared values of 0.164, 0.025, and 0.181, respectively.

RMSE and MAE values offer additional information regarding the predictive power of the models. Lower values of both the RMSE and MAE indicate better agreement between the predicted and observed values. For instance, the model predicting material processing satisfaction has an RMSE of 2.47 and an MAE of 2.13, suggesting it captures the variability in overall satisfaction scores effectively. Conversely, the model predicting internet or television satisfaction has a higher RMSE of 1.21 and an MAE of 1.36, indicating less accurate predictions. The mention of values is that the points in the graph represent the predicted results under different numerical values, where the bold ones represent the values that are more prepared for the predicted results.

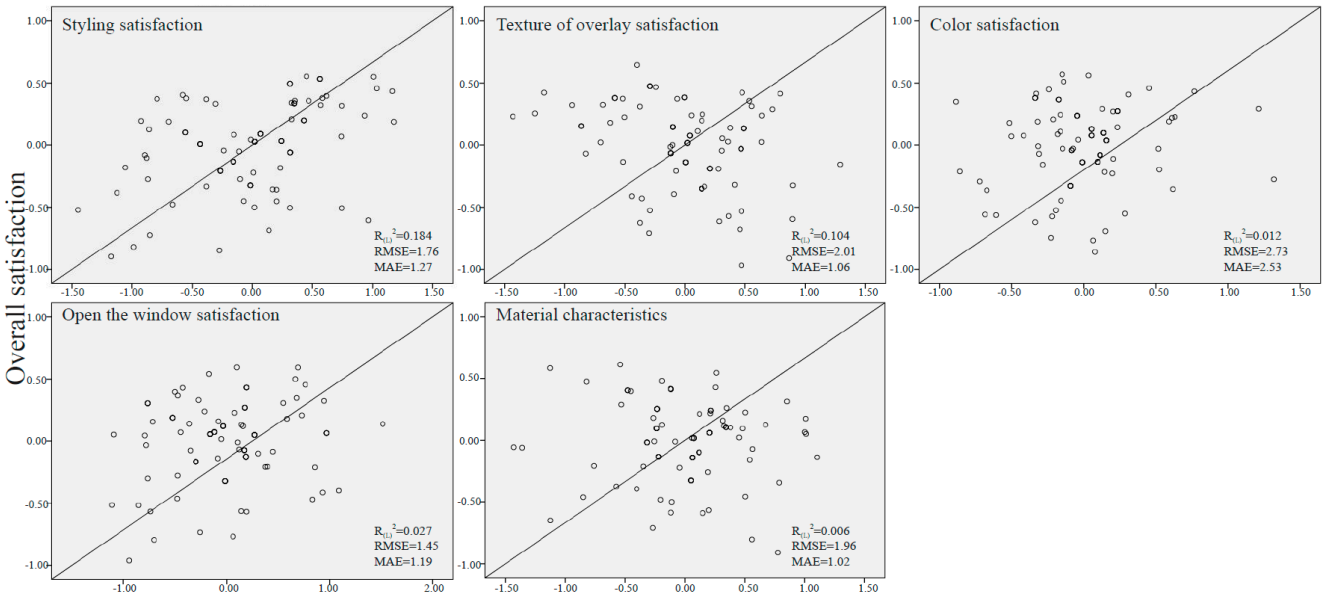


Figure 8. Prediction of architectural appearance impact on overall satisfaction.

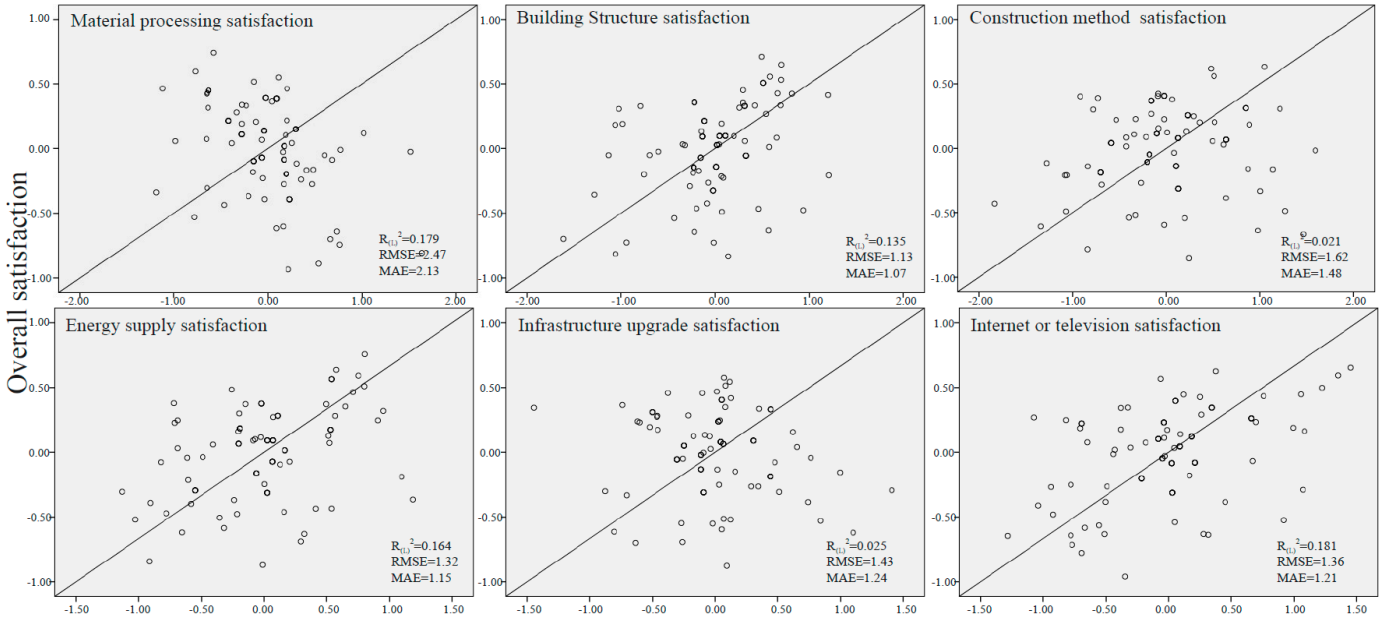


Figure 9. Prediction of architectural structure and device impact on overall satisfaction.

In Figure 10, the relationship between architectural space and performance factors with overall satisfaction is presented through six scatter plots. The graphs show the following aspects: architectural layout satisfaction, height and layer height satisfaction, furniture satisfaction, airtightness satisfaction, waterproof satisfaction, and sound insulation satisfaction. The R-squared values range from 0.0001 to 0.011, indicating varying degrees of association between these factors and overall satisfaction. Architectural layout satisfaction has the highest R-squared value of 0.011, followed by height and layer height satisfaction with 0.010 and furniture satisfaction with 0.001. Airtightness satisfaction, waterproof satisfaction, and sound insulation satisfaction exhibit relatively weaker correlations with overall satisfaction, as suggested by their R-squared values of 0.039, 0.069, and 0.058, respectively.

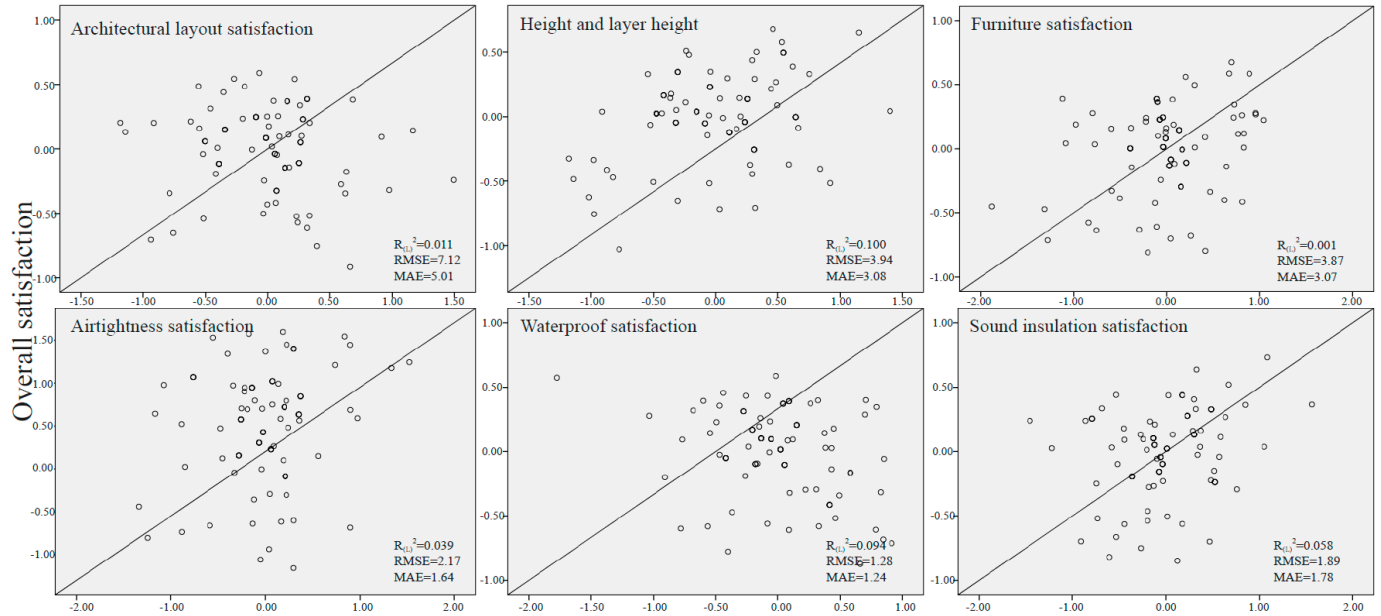


Figure 10. Prediction of architectural space and performance impact on overall satisfaction.

RMSE and MAE values provide additional information about the predictive power of the models. Lower values of both the RMSE and MAE indicate better agreement between the predicted and observed values. For example, the model predicting architectural layout satisfaction has an RMSE of 7.12 and an MAE of 5.01, suggesting it captures the variability in overall satisfaction scores effectively. However, the model predicting sound insulation satisfaction has a higher RMSE of 1.78 and an MAE of 1.89, indicating less accurate predictions.

Overall, the results highlight the significance of architectural esthetics and material quality in driving user satisfaction. Styling satisfaction exhibited the highest correlation, with a 10% increase leading to a 15.4% rise in overall satisfaction. Among structural and equipment-related factors, material processing satisfaction recorded a coefficient of 0.179, while layout satisfaction, a spatial and functional aspect, showed a more modest coefficient of 0.011. These findings underscore the relative impact of esthetic and material attributes over spatial configuration in shaping user perceptions.

5. Discussion

5.1. Shangri-La's Shanpian House: Cultural Identity and Structural Significance

Our analysis confirms that architectural style plays a decisive role in influencing overall satisfaction, strongly supporting theories of cultural identity. Cultural recognition, as Stephenson argues through his field theory, positions architectural style as a reflection of a community's cultural capital, embedding social values and esthetic preferences into the built environment [61]. This study demonstrates that traditional architectural styles in vernacular settings, such as *Shanpian* House, significantly enhance community pride and a sense of belonging. The positive correlation between style and satisfaction (coefficients of 3.731 and 3.976) confirms that design choices resonate deeply with residents, reinforcing the idea that architecture functions as both a physical and symbolic marker of cultural identity. As Giddens further articulates, architectural style becomes a visual language that conveys collective societal values, and our findings align with this perspective [62].

Structural stability, on the other hand, is equally pivotal. Residents prioritize the safety and durability of their homes, a fact supported by FEMA's 2015 study, which highlights that well-constructed buildings contribute directly to higher satisfaction and better living conditions [63]. This study finds that satisfaction with structural design, including node details and construction methods, had a substantial positive impact, with coefficients between 3.05 and 6.37. However, we must not overlook the risk of over-complexity. As Elshater warns, intricate structural designs, while visually appealing, can increase long-term maintenance costs, thus diminishing overall satisfaction [64]. This tension between esthetic complexity and practicality demands careful consideration in future design strategies.

5.2. Strategies for Enhancing Vernacular Architecture in Shangri-La

5.2.1. Responding to Local Physical Context

The enhancement of traditional architecture must align with the specific climatic and landscape conditions of the region. Local environments dictate key architectural features such as materials, colors, and structural design. In the case of *Shanpian* House, adaptations to the original structure while preserving cultural integrity can significantly improve functionality. By optimizing the building's inherent characteristics, such as insulation, wind proofing, and moisture resistance, we can elevate the comfort and longevity of the dwellings. Historically, local climate has shaped vernacular building practices, such as the stilted houses of humid regions and the stone houses of the arid northwest [65]. Strengthening the existing structure is crucial, but enhancing the original performance with modern techniques is equally important. As we adapt traditional forms to contemporary needs, the challenge lies in balancing esthetic preservation with functional optimization.

The findings suggest that while cultural identity remains a core value in architectural satisfaction, there is a growing expectation for functional and structural improvements that do not compromise esthetic authenticity. The future of vernacular architecture lies in this delicate balance between tradition and innovation. By leveraging modern technologies and materials, we can address the practical concerns of durability, cost, and environmental sustainability without eroding the cultural essence that gives these buildings their unique character.

5.2.2. Embracing Modern Technology with Cultural Concern

Incorporating modern technology into the preservation and renovation of traditional architecture is essential for future-proofing these structures. Advanced technologies such as laser scanning and digital modeling improve precision and efficiency in restoration, while new prefabricated materials enhance durability and reduce costs. The integration of these technologies with traditional building methods offers a sustainable pathway for preserving cultural heritage while meeting modern standards. For instance, in Yunnan's Leju Village, a tourist center was constructed using 3D printing, rammed earth, and prefabricated steel structures [66]. This innovative approach improved earthquake resistance while maintaining the traditional Yi-style esthetic, showcasing how modern methods can coexist with cultural preservation [67].

Furthermore, by utilizing local resources to produce prefabricated components, construction becomes not only more efficient but also environmentally friendly [68,69]. The study of the "Main House" types along the Guijiang River demonstrates how new materials and modern techniques can preserve the original appearance of vernacular buildings while enhancing their structural integrity and livability. Similarly, research on traditional dwellings in multicultural areas highlights the role of technology in safeguarding cultural diversity, enabling the architecture to evolve while remaining true to its roots. Future studies must explore how emerging technologies can further integrate with vernacular forms, pushing the boundaries of architectural preservation while fostering sustainable development. The dual pursuit of cultural continuity and functional advancement will shape the future of rural architecture, offering a model for global architectural practices.

6. Conclusions

The safeguarding and advancement of traditional vernacular architectural and cultural features are pivotal for rural revitalization, as evidenced by the *Shanpian* House case study in Shangri-La. These structures not only encapsulate rich cultural heritage but also catalyze growth within rural communities. To capitalize on this potential, proactive measures must counteract the persistent threats of demolition, aging infrastructure, and cultural erosion facing traditional villages.

This research adopted a multifaceted approach, which is essential for leveraging the cultural significance of these buildings. Field surveys and archival research in the pre-planning phase reveal that understanding field theory can enhance design processes, facilitating cultural revival. Such insights challenge conventional design paradigms, suggesting that a synthesis of traditional architectural styles with contemporary needs can breathe new life into rural spaces. The successful integration of these elements hinges on a nuanced appreciation of the community's historical context and architectural identity. Post-evaluation findings underscore the vital role of construction details—structural elements, methods, and infrastructure upgrades—on resident satisfaction. The significant positive correlations identified through the OLS regression not only validate the importance of architectural choices but also highlight an opportunity for further exploration. Future studies could investigate how specific design interventions might enhance cultural transmission and community cohesion, potentially guiding policy and funding decisions in rural development initiatives.

Moreover, the study emphasizes the necessity of harnessing technological advancements to augment traditional design processes. By proposing strategies that integrate site-specific designs with new technological tools, we can empower rural revitalization efforts more effectively. This dual approach not only fosters cultural continuity but also stimulates economic vitality, ensuring that traditional architecture remains relevant in a rapidly evolving landscape. Additionally, incorporating traditional vernacular architecture into rural tourism initiatives holds profound significance. These structures embody rich historical and cultural narratives, offering visitors a unique cultural experience while showcasing the diverse rural traditions of China. This experiential engagement allows tourists to immerse themselves in local lifestyles, customs, and traditional craftsmanship.

Despite these promising findings, the study's limitations, particularly regarding sample size, warrant attention. Expanding the dataset could uncover deeper insights into the dynamics between vernacular architecture and community perceptions. Such exploration will provide a more comprehensive understanding, enabling researchers to formulate robust strategies for preserving cultural heritage while promoting sustainable development in rural contexts.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Ethics Committee of Xi'an Jiaotong—Liverpool University (215000 and approval data: 27 February 2019).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The original contributions presented in the study are included in the article; further inquiries can be directed to the corresponding author.

Conflicts of Interest: The authors declare no conflicts of interest.

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