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Article

Key Planning Elements for Sustainable Revitalization in Traditional Villages: An Integrated Planning Perspective from Shandong, China

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Abstract: Traditional village revitalization is not only a planning challenge but also a social-psychological one, because policy and spatial interventions ultimately depend on residents' support, cooperation, and maintenance behaviors. This study develops an integrated planning framework across environmental, cultural, economic, and social domains and examines how perceived planning elements relate to perceived sustainable revitalization in traditional villages in Shandong, China. Questionnaire data were analyzed using reliability/validity testing, factor analysis, correlation analysis, and multiple linear regression. Fourteen planning elements were positively associated with perceived revitalization outcomes, with spatial layout and landscape harmony, cultural continuity and cultural expression, economic diversification, and governance-related equity and participation emerging as consistent predictors. By linking policy-relevant planning elements to established mechanisms in environmental and social psychology, these associations indicate behavior-relevant pathways in which culturally grounded interventions may strengthen place-based attachment and identity, equity and participatory arrangements may foster trust and cooperative norms, and improvements in shared spaces may enhance collective efficacy and the perceived feasibility of collective action. The study provides an operational indicator set and psychologically informed implications for designing revitalization strategies that support sustained resident engagement and pro-community / pro-environmental intentions in rural sustainability transitions.

Keywords: Integrated planning; Sustainable planning; Traditional villages; Sustainable revitalization; Planning elements; China; Place attachment; Collective action

1. Introduction

China has placed 8,155 villages on the National List of Traditional Villages under state protection. Beyond the national list, 16 provinces have established provincial protection lists covering 5,028 villages, alongside protection actions involving approximately 556,000 traditional buildings and the safeguarding and transmission of 5,965 items of provincial-level (or above) intangible cultural heritage. In Shandong Province, the protection base is also substantial, with 168 national-level traditional villages and 384 provincial-level traditional villages currently recorded. Despite expanding designation and protection coverage, governance practice continues to face risks such as inappropriate demolition/reconstruction and "fake heritage" replacement, reinforcing the urgency of evidence-based revitalization approaches that align conservation with sustainable development goals. Rural settlements face barriers of population decline and environmental change. The spontaneous, decentralized management model of villagers has led to severe industrial homogenization [1]. The "distinctive value" of rural areas has been lost. This generalized development strategy accelerates the decline of traditional villages [2]. Sustainable development has become an urgent priority. Yet sustainability in traditional villages is not secured by physical interventions alone. Whether revitalization measures are accepted,

maintained, and translated into day-to-day stewardship depends on how residents interpret changes and on their willingness to cooperate around shared rules and common spaces.

The sustainable development of rural settlements primarily explores the relationship between rural architecture and the environment. Effective planning and architectural design, encompassing spatial planning [3], architectural aesthetics [4], and landscape design [5], play a crucial role in achieving sustainability. However, the construction of rural settlements lacks systematic planning, resulting in disorderly layouts, small scale, and dispersion [6]. Some local governments disregard traditional villages" environmental carrying capacity and develop industrial plans solely to meet economic demands [7].

Scholars and planners have proposed various development strategies owing to the persistent decline and environmental pressures in rural areas, such as community-based planning approaches, ecological design, adaptive reuse of traditional architecture, and local knowledge integration into planning. Wijaya, I. (2021) employed a research and development methodology to develop the masterplan for Pakse Bali Tourism Village based on supporting infrastructure fostering local potential while ensuring its sustainability [8]. Razzaq et al. (2020) proposed a prototypical tourism village model that can be replicated in other marshland areas by drawing on the marshlands of Almanar City as a case study [9]. Practically, Li et al. (2025) proposed a three-tier governance framework which can be coordinated with regional spatial planning to integrate cultural heritage conservation, ecological restoration, and disaster prevention [10]. Gu et al. (2025) proposed a sustainable planning framework, "Intrinsic Conservation-Spatial Optimization-Cultural Tourism Innovation," to provide theoretical and practical guidance for cultural landscape preservation and rural revitalization in Yao villages [11]. However, much of this literature remains focused on proposing planning models or design toolkits, while residents are often treated as passive beneficiaries or captured only through broad "satisfaction/support" measures. Empirical evidence is still limited on which policy-relevant planning elements are most salient from residents' perspectives and how these elements translate into perceived sustainability outcomes in traditional-village settings. In particular, the micro-psychological processes that connect planning interventions to residents' willingness to support, participate, and sustain everyday stewardship are often asserted rather than specified in a testable way.

In recent years, the Chinese government has remarkably emphasized rural development and the preservation of traditional Chinese culture. Through various policies, such as the Rural Revitalization Strategy and Traditional Village Protection policies, rural governance and spatial optimization have been systematically advanced. Although the national policy framework is relatively comprehensive, the effectiveness of rural planning depends on local implementation mechanisms and evidence data support, both of which are underdeveloped at present. Planning elements have concentrated solely on immediate construction tasks, infrastructure improvements, and environmental restoration, neglecting historical environmental features and traditional characteristics [12]. Therefore, planning elements for traditional villages require precise, explicit positioning that balances modern development needs with the preservation of the historical and cultural distinctiveness of the settlement. Second, integrating sustainability into planning processes face numerous challenges, remaining largely unchanged from those expected at the turn of the century [13,14]. However, the effectiveness of integrated planning is ultimately behavioral and social: it relies on residents' support, participation, and sustained everyday practices. In traditional-village revitalization, this study emphasizes three mechanisms that are repeatedly linked to cooperation and long-term stewardship. Place attachment and place identity shape how residents evaluate landscape change and heritage interventions and can motivate protective and maintenance-oriented behaviors [16]. Procedural justice in decision-making is associated withs legitimacy judgments and trust in local authorities, which affects residents' willingness to cooperate with collective rules and projects [17]. At the collective level, collective efficacy captures shared expectations of social cohesion and willingness to act for the common good, supporting sustained collective maintenance beyond one-off investments [18]. Intention- and value-oriented accounts of action also highlight how perceived feasibility and moral commitment can sustain pro-community and pro-environmental practices in policy contexts [15,19]. Building on these mechanisms, this study specifies how policy-derived planning elements function as resident-perceived implementation cues and examines their associations with perceived sustainable revitalization in traditional villages. The planning and design of traditional villages must inherently incorporate sustainability, implying that economic development, cultural heritage preservation, and social welfare must be integrated holistically throughout planning.

Against this background, two gaps are particularly evident. First, existing integrated-planning studies for traditional villages commonly emphasize macro-level frameworks (policy alignment, spatial optimization, industry introduction, or heritage conservation), but they less frequently operationalize planning into a parsimonious, measurable set of elements that can be assessed as resident-perceived

implementation signals (e.g., perceived equity, participation opportunities, cultural continuity, and shared-space quality). Second, although environmental and social psychology offers strong theoretical accounts for support and cooperation, these mechanisms are rarely connected explicitly to specific planning elements within a single analytical framework, leaving it unclear which elements matter most, for whom, and under what perceived social conditions. Clarifying these associations is important for translating "integration" from a planning ideal into behavior-relevant interventions that can be sustained after projects are completed.

Therefore, an integrated planning model for traditional villages in China is specified and examined using evidence from three traditional villages in Shandong Province. National policy requirements are translated into a resident-perceived indicator system covering environmental, cultural, economic, and social domains. The measurement structure of this indicator system is assessed through reliability and validity testing and factor analysis, and the associations between perceived planning elements and perceived sustainable revitalization are estimated using correlation analysis and multiple linear regression. The conceptual model specifies three mechanism-linked pathways: cultural continuity and cultural expression are linked to place attachment and place identity; governance-related equity and participation are linked to procedural fairness and trust perceptions; and spatial layout and public-space quality are linked to collective efficacy and the perceived feasibility of collective action. Measures of ecological worldview (NEP), social norms, and perceived behavioral control are included as additional covariates for robustness analyses. As the data are cross-sectional and self-reported, the empirical results describe statistical associations rather than causal effects; causal ordering, mediation, and behavioral outcomes require longitudinal or multi-source evidence. Further tests across provinces and revitalization contexts, together with behavioral and administrative indicators of participation and maintenance, can strengthen external validity and mechanism verification.

2. Literature Review

Although integrated planning is commonly discussed as a technical and institutional arrangement, rural revitalization ultimately depends on residents' everyday decisions-whether they accept, support, participate in, and maintain planning interventions. In this study, planning elements are conceptualized as resident-perceived implementation conditions that relate to three proximal social-psychological processes: place attachment/place identity, perceived procedural fairness and trust, and collective efficacy. These processes are closely associated with cooperation, acceptance of change, and sustained maintenance in community governance and place-based stewardship. This review therefore organizes the literature around these three processes to support the conceptual framework and hypotheses.

2.1. Integrated Planning

Integrated planning was initially advanced as a response to fragmented decision-making, emphasizing vertical consistency across planning tiers and horizontal coordination across sectors and agencies [20-22]. In the context of rural settlements, "integration" typically entails aligning land use, infrastructure, ecological protection, heritage conservation, and livelihood development within a coherent policy and implementation package, so that interventions in one domain do not undermine others.

From a social-psychological perspective, integration is not only a structural arrangement but also a governance signal perceived by residents. Coordinated plans can reduce uncertainty and perceived risk, clarify roles and responsibilities, and improve perceived feasibility of collective action. When integration is achieved through participatory and transparent processes, it is more likely to enhance perceived procedural fairness and trust in local institutions, strengthen shared place-based identity, and build collective efficacy-conditions repeatedly linked to cooperation, compliance, and sustained stewardship in community environmental contexts.

2.2. Sustainable Planning

Since the advent of sustainable development, the planning community has regarded it as a "belief system" or ideology, providing fundamental value principles and action guidelines for planning practice and decision-making [23,24]. From a behavioral perspective, sustainability-oriented planning is consequential because it shapes residents' support, participation, and long-term maintenance in place. Broad intention- and value-oriented perspectives highlight how planning signals can relate to willingness to act and persist over time in policy contexts. In traditional villages, these responses are most consistently discussed through place-based attachment/identity, fairness-related trust in governance, and collective efficacy for collective action [25]. These theories offer explicit mechanisms linking planning signals and narratives to residents' acceptance, participation, and long-term

maintenance behaviors. In traditional villages, place-based motives are particularly salient. Place attachment and place identity can increase residents' willingness to protect heritage landscapes, invest in collective upkeep, and resist short-term, extractive development. Accordingly, sustainable planning that reinforces continuity of meaning (heritage, memory, identity) while improving everyday functionality (services, safety, accessibility) is more likely to generate durable stewardship than plans framed solely as infrastructure delivery.

Sustainable planning emphasizes the integration of socioecological knowledge, driving societal change through community-based, public-interest-oriented collective action [26-29], and systematically implementing sustainability principles within planning practice [24]. These approaches exhibit considerable diversity, encompassing urban planning and design movements, participatory and community-driven planning models, environmental and ecological planning methodologies, and more recent pathways emphasizing the provision of multiple socioecological services and integrated benefits through urban and rural natural systems and ecosystems [14,30-31]. Conversely, revitalization planning should focus on economic growth in rural areas and systematically address cultural heritage conservation, local distinctiveness preservation, and community participation mechanisms [33]. Consequently, sustainable planning for traditional villages requires coordinated integration and a comprehensive balance across multiple dimensions, including environmental, cultural, economic, and social aspects.

2.3. Sustainable Revitalization

Regarding rural revitalization studies, Turner [32] and Liu et al. [33] emphasized that such efforts should be conducted within a sustainable development framework, ensuring equilibrium among ecological, economic, and social progress in rural areas. Nocca [34] contends that promoting rural settlements" character, distinctiveness, and cultural heritage is essential to their enduring prosperity. Rural revitalization signifies the renewal and innovation of rural spatial, economic, and social life as an increasingly prominent topic. Sustainable revitalization fosters a positive image. It shapes the vision of a robust and balanced community that is economically competitive, socially cohesive, and environmentally sustainable [35].

The sustainable revitalization of historic districts addresses the rapid transformations by globalization and urbanization. Sustainable revitalization essentially safeguards historic areas facing environmental degradation, encompassing physical, economic, and sociocultural dimensions [36]. Furthermore, a balance between preservation and development remains a central concern for scholars within heritage conservation, with the harmonization of these two imperatives being crucial for sustainable regeneration [37]. As traditional villages possess the attributes of "cultural conservation units that require protection and function as rural communities that require development, their preservation must be combined with development to form a mutually reinforcing relationship [38]. Consequently, the sustainable revitalization of traditional villages must achieve coordinated advancement across environmental, economic, cultural, and social dimensions, balancing developmental pursuits with historical character and conservation requirements.

Importantly, sustainable revitalization is not only a material transformation of space but also a social outcome manifested in residents' perceived well-being, willingness to cooperate, and everyday stewardship. In many village contexts, the same physical intervention may be interpreted either as empowerment or as imposed disruption, depending on residents' trust in local authorities, perceived fairness of decision-making, and the extent to which interventions resonate with local identity and attachment [39]. Conceptualizing revitalization outcomes in terms of support, participation, and maintenance behaviors therefore provides a psychologically meaningful bridge between planning elements and long-term sustainability.

2.4. Planning Interventions and Micro-Psychological Mechanisms: Gaps in Existing Evidence

A growing body of research proposes integrated and sustainability-oriented planning frameworks for traditional villages, emphasizing policy alignment, spatial optimization, infrastructure upgrading, heritage conservation, and livelihood development [10,11,20-24]. Although these studies provide valuable planning rationales and design toolkits, the resident-side mechanism is frequently simplified. In many cases, residents are treated as beneficiaries of delivered projects, and evaluation relies on broad outcome descriptors such as overall satisfaction, perceived improvement, or generalized support for revitalization, rather than specifying how particular planning actions translate into stable cooperation and long-term maintenance in everyday village life [35-39].

Environmental and social psychology offers well-established accounts of why residents support or resist change and when cooperation becomes sustainable. Place attachment and place identity capture affective and identity-based bonds that condition how landscape change and heritage interventions are evaluated [16]. Procedural justice research highlights that respectful, transparent, and voice-inclusive decision processes shape legitimacy judgments and trust, which are closely tied to voluntary cooperation with collective rules and governance arrangements [17,43]. Collective efficacy emphasizes shared expectations of cohesion and a community's capacity to act for common goals, which is critical for sustained joint maintenance beyond one-off investments [18]. Despite their relevance, these mechanisms are often introduced in planning studies as general background explanations rather than being connected to specific, actionable planning elements.

Three limitations are particularly salient in the current evidence base. One limitation is the weak operational linkage between "integrated planning" and micro-psychological processes: planning is frequently represented at the level of broad domains (e.g., environment, culture, economy, governance), while psychological mechanisms are measured-if at all-using generic constructs that are not tied to identifiable implementation cues. A second limitation concerns construct parsimony and comparability: studies may draw on multiple psychological variables without clarifying which pathway is central, which pathways are auxiliary, and how overlap among constructs is addressed, thereby reducing interpretability and cumulative comparability across cases. A third limitation is design-related: cross-sectional, single-source perceptions dominate, making it difficult to distinguish whether observed associations reflect planning implementation, pre-existing community differences, or short-term project salience rather than durable stewardship-oriented processes.

In response, the present study treats policy-derived planning elements as resident-perceived implementation cues and examines their statistical associations with perceived sustainable revitalization. The framework specifies three focal pathways linking perceived planning elements to residents' support and stewardship-oriented outcomes: place attachment/place identity, procedural fairness and trust, and collective efficacy [16-18]. This logic provides the basis for the conceptual framework and hypotheses developed in the following section.

2.5. Traditional Villages Related Planning Policies in China

China's traditional-village conservation and revitalization are guided by national regulations and ministerial requirements that specify planning objects and implementation tasks [40]. In this study, these policy documents are used as the textual basis for extracting planning themes and operational elements, and Table 1 summarizes the key documents that informed the construction of the policy-derived indicator system.

Table 1. Planning policies related to traditional Chinese villages.

Planning Title	Time	Ministry	Planning Type	Planning Purpose	Planning Object
Requirements for planning and protecting historical and cultural cities, towns, and villages	2012	The Ministry of Housing and Urban-Rural Development (MOHURD) and National Cultural Heritage Administration (NCHA)	Conservation	Preservation and continuity of the history and culture	Historic and cultural cities, historic and cultural neighborhoods, and towns and villages
Basic requirements for planning, protecting, and developing traditional villages	2013	MOHURD	Conservation and development	Balancing conservation and development efforts	Traditional villages
Strategic planning for village revitalization 2018-2022	2018	State Council	Revitalization	Integrating conservation, utilization, and development	Villages and traditional villages

In recent policy evolution, traditional-village planning has shifted from conservation-oriented requirements toward integrated revitalization objectives that combine heritage protection, infrastructure improvement, and livelihood development under the broader rural revitalization agenda. Revitalization

planning research has primarily focused on two dimensions: developmental factors, such as economic, demographic, and social conditions [41], and cultural heritage preservation [42]. Thus, China's planning policies for traditional villages have evolved from a focus on conservation by emphasizing development to the integration of sustainability principles and finally toward revitalization practices.

Policy completeness does not automatically translate into implementation effectiveness. Heritage conservation and vernacular-built environment interventions often require implementation routines that are not directly observable to residents, especially when they are guided by heritage governance guidelines and technical standards [79,81,83]. In village settings, perceived procedural fairness in planning processes and trust in local authorities are associated with residents' cooperation and sustained participation [43]. When policies are implemented through fair and respectful procedures, they can build trust and voluntary compliance, reducing resistance and encouraging long-term collective maintenance. This mechanism is especially relevant for traditional-village revitalization, where interventions inevitably touch identity-laden spaces and livelihood-sensitive resources.

2.6. Conceptual Framework and Study Hypothesis

The integrated planning theme development process employs a structured approach to refine themes into a more systematic framework (Figure 1).

Figure 2 summarizes the policy-derived planning indicator architecture used in this study. The policy coding and sustainability-character mapping [44] generated an initial pool of 21 candidate planning elements grouped into four sustainability domains (environmental, cultural, economic, and social/governance). Given the proximity in meaning among several elements, construct definitions were specified at the theme level and subsequently evaluated for distinctness using expert judgement (relevance, clarity, and uniqueness) and measurement diagnostics. For hypothesis testing and construct-level interpretation, the analysis reports a parsimonious set of 14 theme-level planning factors supported by the latent-structure results, while the full candidate pool is retained for descriptive profiling and robustness checks.

The relatively limited social dimension variables in constructing the indicator system for integrated planning herein stems from the content structure of China's traditional village planning policies. Planning policies primarily emphasize environmental remediation, infrastructure enhancement, cultural heritage preservation, and industrial introduction. Social sustainability is largely confined to service facilities and governance structures, with scant consideration given to "soft social elements," such as community identity, equitable mechanisms, and social integration. Consequently, the social dimension exhibits a relatively constrained scope when extracting planning themes based on policy orientation.

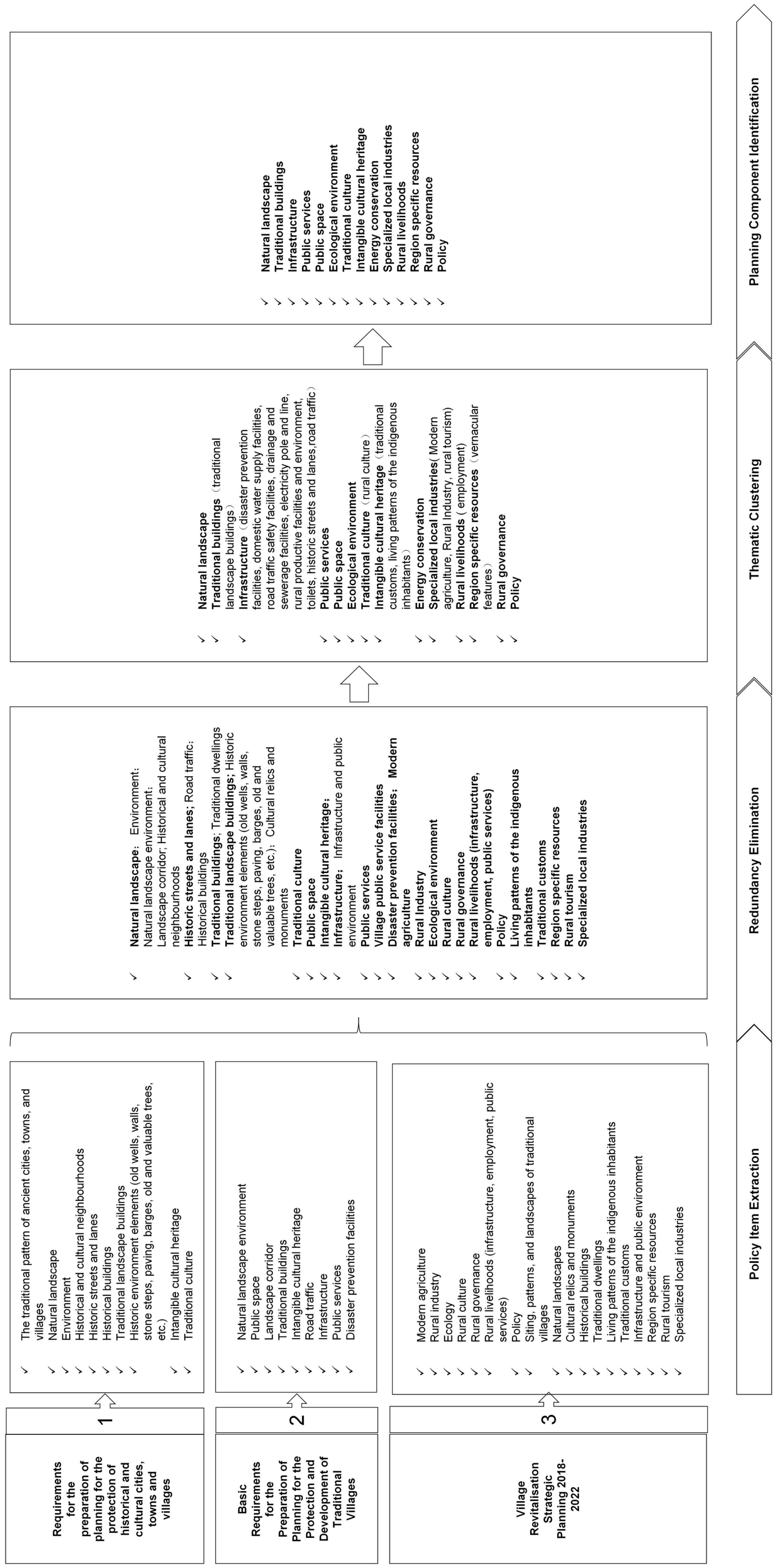

Figure 1. Integrated Planning Theme Beveling Process (Source: Author).

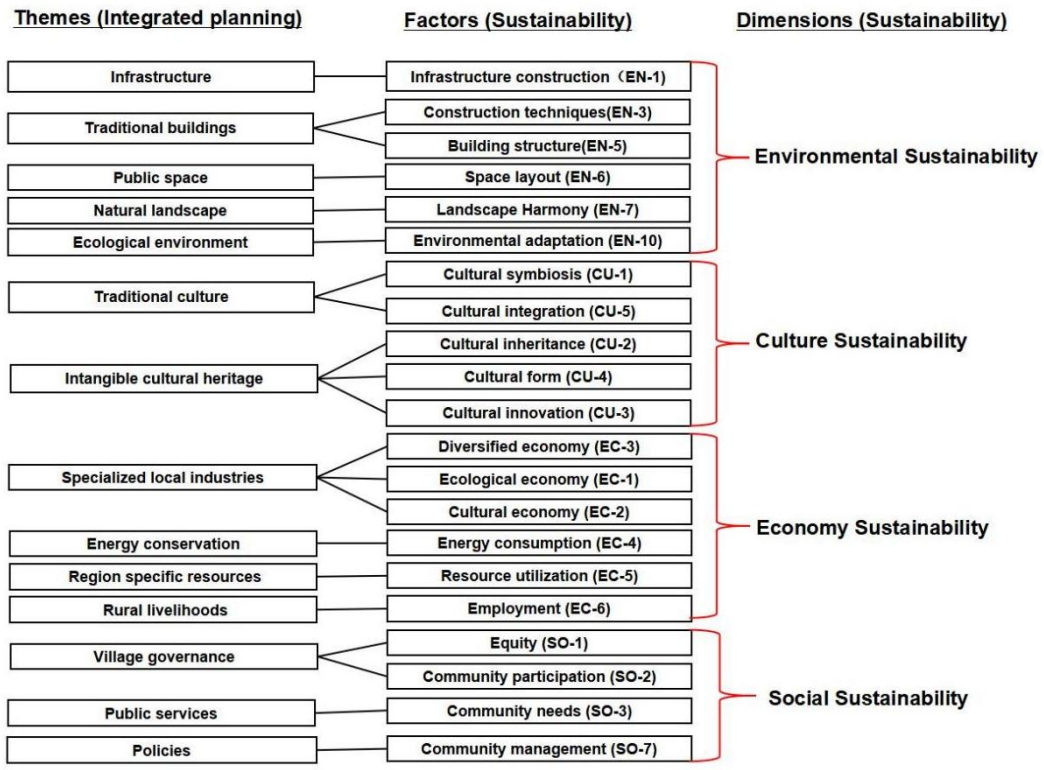

Figure 2. Relationship Between Integrated Planning Themes and Sustainable Character Factors (Source: Author).

To make the framework behaviorally explicit while keeping the mechanism structure focused, the four planning themes are treated not only as technical levers but also as resident-perceived cues linked to three processes. Cultural conservation and landscape continuity are expected to relate to place attachment and place identity, shaping acceptance of heritage-oriented interventions and motivation for stewardship. Equity and participation in governance are expected to relate to perceived procedural fairness and trust, which supports cooperation with collective rules and projects. Infrastructure, spatial layout, and public-space quality are expected to relate to collective efficacy, strengthening the perceived capacity for sustained collective maintenance and joint action. The following paragraphs elaborate how each planning theme and its associated elements correspond to these processes.

Infrastructure development advances rural environmental conditions and enhances residents' quality of life [45]. A well-developed rural road network facilitates connections between villages and external markets, optimizes agricultural product distribution efficiency, and creates additional employment opportunities for villagers [46]. The installation of speed bumps, pavements, and traffic signs reduces road traffic accidents and safeguards villagers' safety [47].

The traditional villages" construction techniques and building structure constitute the core elements in the formation and heritage of traditional architecture. Construction techniques embody craftsmanship, wisdom, and regional adaptability accumulated through prolonged practice, thereby reflecting a profound understanding of the natural environment and material properties [48]. Building structures bear the organic integration of mechanics and spatial organization, further illustrating how local resources, craftsmanship, and cultural logic deeply shape vernacular forms [49]. The evolution of traditional architecture is intrinsically linked to local craftsmanship, climatic conditions, and cultural perspectives, emphasizing sustainability and community continuity [50].

Public spaces facilitate villagers" social interactions, ceremonial activities, and cultural transmission, whereas spatial layouts determine settlements" structural organization and interaction logic. A close structural and functional coupling exists between the spatial layout and public spaces in traditional villages, where villagers" behavioral patterns are shaped by accessibility and spatial hierarchy [51]. Layout patterns determine the distribution and accessibility of public spaces, influencing social cohesion and cultural activity continuity within the village [52]. Moreover, spatial functions predominantly shape the structural order and adaptive transformation of traditional settlements, supporting sustainable community interactions [53].

Village landscape planning leverages topography, water systems, and vegetation to establish harmonious spatial structures and habitable ecological environments. Landscape harmony reflects ecological adaptation and embodies cultural symbolism and local identity [54]. To balance ecological and cultural functions, natural landscape planning should prioritize ecological pattern continuity and cultural spatial integrity. By preserving topographical texture and optimizing green space systems, the ecological aesthetics and cultural harmony of traditional villages can be achieved [55].

The "environmental adaptability" of traditional villages embodies the wise response of humanity to natural ecosystems. Village siting and spatial layout typically align with natural elements, such as topography, watercourses, and climate, forming an ecological pattern [56]. In planning, ecological environments should reinforce the principle of environmental adaptability, ensuring that settlement structures evolve harmoniously with their surroundings. Sustainable ecosystems can be fostered by optimizing terrain use and safeguarding natural water systems and vegetation, achieving a dynamic equilibrium and symbiosis between humanity and nature [57].

The cultural symbiosis and integration within traditional villages reflect the long-term interaction and harmonious coexistence of diverse ethnic groups, beliefs, and lifestyles within shared geographical spaces. Local clan cultures, folk beliefs, and external cultural elements have continually merged during the formation and evolution of these settlements, forging a culturally inclusive and pluralistic system [58]. Preservation and planning of traditional culture should prioritize cultural symbiosis and integration. By safeguarding regional cultural DNA and strengthening cultural exchange spaces, a sustainable cultural framework can be established preserving local distinctiveness while embracing multicultural diversity [59].

Cultural inheritance embodies the continuity of traditional crafts, rituals, languages, and beliefs, serving as a vital repository of a village's memory. Cultural forms manifest regional and ethnic characteristics through architectural layouts, festive ceremonies, and lifestyles. Cultural innovation drives the revitalization and regeneration of traditional culture within contemporary society [60]. The safeguarding of intangible cultural heritage must balance transmission and innovation, fostering cultural vitality through diverse expressions to construct a dynamically evolving traditional cultural system [61].

The specialized local industries of traditional villages are supported by their "diversified," "ecological," and "cultural" economies. The diversified economy emphasizes an agriculture-based foundation, integrating handicrafts, rural tourism, and local product development for a composite economic structure [2]. The ecological economy prioritizes the sustainable use of natural resources, balancing economic development and ecological conservation through ecoagriculture, green industries, and the circular economy [62]. The cultural economy leverages intangible cultural heritage, traditional crafts, and local cultural brands to facilitate villages" industrial transformation [63]. Therefore, the integration of specialized local industries into planning should embody ecofriendly practices, cultural heritage preservation, and multifaceted integration, thereby establishing a sustainable and innovative rural economic system.

Traditional villages have developed low-energy consumption models based on natural lighting and ventilation design and the utilization of local materials through long-term adaptation to their natural environments, balancing daily living and energy use [64]. Energy conservation planning should prioritize waste reduction, building energy efficiency design optimization, and renewable energy promotion [65]. This approach facilitates a green transition in village energy structures by integrating traditional energy-saving principles with modern technologies.

Traditional villages rely on local natural and cultural resources to form region-specific resource systems. This regional resource use reduces environmental burdens and establishes region-specific resource structures with dual economic and cultural value. In contemporary planning, the integration of agriculture, forestry, water resources, and traditional craftsmanship constructs multifunctional, low-consumption resource use systems. This approach integrates traditional wisdom with contemporary sustainable development.

Traditional villages" employment is primarily centered on agriculture, handicrafts, forestry, and local trade, reflecting the characteristics of a self-sufficient, geographically dependent economy [66]. With socioeconomic transformation, traditional livelihoods have gradually expanded into tourism, rural cultural creativity, and ecoindustries, offering villagers diversified employment opportunities [67]. Therefore, planning for traditional villages should integrate emerging employment models with cultural industries while safeguarding traditional industries.

Equity refers to the just distribution of village resources, opportunities, and benefits, which serves as the foundation for maintaining social stability and villagers" trust. Meanwhile, community participation reflects the villagers" agency in decision-making, planning, and management, fostering democratic consultation and collective action in public affairs [68]. Village governance should focus on

self-governance, achieving social sustainability by stimulating villagers" willingness to participate [69]. During planning, strengthening village governance must consider fairness principles and mechanisms for community participation to foster the sustainable revitalization of traditional villages [70].

The public service system in traditional villages should be oriented toward community demand, strengthening villagers" participation in planning and decision-making to ensure targeted and equitable service. Research indicates that public services meeting community needs enhance villagers" sense of wellbeing and foster social cohesion and cultural continuity [71]. Villages plan efforts to improve public services centering on villagers" needs and establishing inclusive, equitable service systems with distinctive local characteristics.

Community management emphasizes villager self-governance and social collaboration, which are dependent on policy support and institutional safeguards. Scientific policies should completely account for the grassroots characteristics of community management by refining organizational structures and empowering villagers to participate in decision-making to promote the equitable distribution of public resources and social cogovernance [72]. Policy formulation for traditional village planning should prioritize a bottom-up community governance logic, ensuring a positive interaction between policy direction and local autonomy.

Based on the sustainable development theory, this study proposed 21 integrated planning elements across four dimensions as key indicators. These elements are expected to relate to perceived sustainable revitalization through three focal processes (place attachment/place identity; procedural fairness and trust; collective efficacy). Because perceptions of revitalization can also reflect general predispositions and feasibility-related cognitions, ecological worldview (NEP), perceived social norms, and perceived behavioral control are treated as competing explanations and included as covariates. In addition, heterogeneity is expected across resident embeddedness and village development contexts, given the distinct development orientations and sustainability tensions of the sampled villages (cultural tourism with commercialization pressure; ecological fishery; ecological agriculture) (Table 2).

H1a: Integrated planning elements are positively associated with perceived sustainable revitalization outcomes in traditional villages.

H1b: The positive association between integrated planning elements and perceived sustainable revitalization remains after adjusting for ecological worldview (NEP), perceived social norms, perceived behavioral control, and key demographic characteristics.

H2: The association between culturally oriented planning elements (e.g., cultural continuity and cultural forms) and perceived sustainable revitalization is mediated by place attachment and place identity.

H3: The association between governance-oriented planning elements (e.g., equity and community participation) and perceived sustainable revitalization is mediated by perceived procedural fairness and trust in local authorities.

H4: Collective efficacy moderates the association between perceived planning elements and stewardship-oriented outcomes, such that the association is stronger when collective efficacy is higher.

H5: Resident embeddedness moderates the cultural pathway, such that the association between culturally oriented planning elements and perceived sustainable revitalization is stronger among residents with longer residence duration.

H6: Village development context moderates governance-related effects, such that the association between governance-oriented planning elements and perceived sustainable revitalization differs across villages with distinct development orientations and sustainability tensions.

These mechanisms are operationalized using validated scales for place attachment/place identity, procedural justice and trust, collective efficacy, and NEP, enabling regression-based or SEM path tests of the specified mediation and moderation relationships.

3. Materials and Methods

3.1. Questionnaire Design

Seven experts in rural planning, heritage conservation, and village development were invited to evaluate the policy-extracted planning components. Using a 4-point scale (1-4), experts assessed each component's relevance, clarity, and uniqueness (conceptual distinctness from other components). Item-level content validity (I-CVI) was calculated as the proportion of experts rating 3-4. Components with I-CVI $\geq$ 0.86 ($\geq$6/7) were retained; those with I-CVI = 0.71 (5/7) were revised and re-evaluated; and those with I-CVI $\leq$ 0.57 ($\leq$4/7) were removed or re-specified. Where uniqueness concerns were raised, component definitions and item wordings were refined to strengthen domain boundaries before operationalization into questionnaire indicators and subsequent latent-structure assessment.

The questionnaire comprised four sections: Section A recorded respondents' basic demographic and residential information. Section B employed a 5-point Likert response scale (1=Strongly Disagree, 5=Strongly Agree) to measure residents' perceptions of integrated planning elements based on a 21-element policy-derived candidate pool; for hypothesis testing and construct-level interpretation, results are reported primarily for a parsimonious set of theme-level planning factors supported by the latent-structure assessment. Section C evaluates three focal sociopsychological processes associated with support, cooperation, and sustained stewardship in place-based communities: place attachment/place identity [16], perceived procedural/distributive fairness [43] and trust in local authorities (wording adapted to the village governance context) [73], and collective efficacy (shared expectations of cohesion and willingness to act for common benefit) [18]. In addition, brief measures of ecological worldview (New Ecological Paradigm; NEP) [25] and perceived social norms/perceived behavioral control were included as supplementary variables for robustness checks rather than as focal pathways. Section D measured perceived sustainable revitalization outcomes, including residents' perceived improvements and self-reported willingness to support, participate in, and contribute to long-term maintenance. These measures are treated as perception- and intention-based proxies rather than observed participation, governance actions, or maintenance behaviors.

To mitigate methodological biases and response artifacts common in single-source self-report designs, the questionnaire employs standard procedural safeguards: explicit assurance of anonymity, neutral wording, separation of program element items (Section B) from psychological mechanism measures (Section C), and inclusion of at least one attention check item. The study plans statistical diagnostics for common methodological differences, to be reported in the results section [74].

The questionnaire pretest served as a preliminary assessment of the survey instrument [76]. This test evaluated the comprehensibility of the survey questions, appropriateness of wording, and logical sequencing of items. Jankowicz (2005) recommended that questionnaires undergo pretesting with a diverse sample [75]. For this questionnaire, 10 residents of traditional villages were selected as respondents. The pretest was conducted using an online questionnaire, which was subsequently adjusted based on the test results.

3.2. Study Site

This study was conducted in Shandong Province, China. Shandong currently has 168 national-level traditional villages and 384 provincial-level traditional villages, which are mainly concentrated in the central Shandong mountainous area, the Jiaodong Peninsula, and along the Qi Great Wall heritage corridor. Spatial analyses further indicate pronounced clustering of traditional villages at the municipal scale, with higher concentrations in cities such as Jinan, Weihai, and Yantai. Village selection followed a purposive maximum-variation logic rather than probability sampling. Three villages were selected to represent distinct revitalization orientations and sustainability tensions that are salient in Shandong's traditional-village governance while remaining under comparable provincial policy conditions: Zhujiayu (Jinan; cultural tourism with commercialization pressure), Yandunjiao (Weihai; ecological fishery with ecological-balance constraints), and Suizhuang (Jining; ecological agriculture with agricultural transformation challenges) (Table 2). This design supports typological comparison across contrasting development contexts within the province and does not aim to estimate province-wide population parameters.

Table 2. Sample villages and sustainability context.

Villages	Location	Development Model	Sustainability Challenges
Zhujiayu Village	Jinan	Cultural tourism	Tourism commercialization
Yandunjiao Village	Weihai	Ecological fishery	Ecological balance
Suizhuang Village	Jining	Ecological agricultural	Agricultural transformation

3.3. Sample Selection

Eligible participants were adult residents (≥18 years) with the capacity to make independent decisions and provide reliable responses. To ensure that respondents had sufficient exposure to village life and local revitalization practices, participation was restricted to residents who had lived in the sampled village for at least one year; visitors and short-term migrants were excluded. The survey was administered primarily via the QuestionStar online platform to facilitate standardized delivery and data collection. To reduce digital-access undercoverage, especially among middle-aged and older permanent residents, the second-stage field promotion included on-site assistance for questionnaire completion (e.g., device operation support while responses remained self-reported). To improve data quality, responses were screened using completeness criteria and basic validity checks (e.g., removal of

duplicate submissions when identifiable, exclusion of responses with implausibly short completion times, and exclusion of straight-line answering patterns when evident).

The achieved sample size was evaluated against common guidance for multiple regression models. For a model with multiple predictors, a sample size of 50 + 8m (where m is the number of predictors) has been suggested as a practical minimum for stable estimation [77]. Given m=21 planning elements, the recommended minimum is 218; the final valid sample (n=347) therefore provides adequate statistical power for the planned analyses.

3.4. Questionnaire Survey Procedure

The survey was conducted in two stages to maximize the response rates. Initially, 300 questionnaires were distributed, yielding 231 valid responses. Next, promotion and follow-up visits were conducted to fill the data gaps from stage one, with 150 questionnaires distributed and 116 valid responses collected. During follow-up visits, assisted completion was offered to residents with limited digital literacy, with particular attention to middle-aged and older permanent residents. Consequently, 347 valid questionnaires were obtained during the survey, achieving a sample rate of 77.1%, which is slightly below the anticipated target. This study employed an anonymous, low-risk questionnaire survey method involving no intervention or deception, with participation entirely voluntary. Prior to accessing questionnaire items, respondents received an online information sheet detailing the research objectives, nature of questions asked, anonymity of responses, and the right to withdraw at any time without penalty; proceeding with the survey constituted informed consent. No directly identifiable personal information was collected. Data was securely stored with access restricted to research team members, and results were reported solely in aggregated form.

3.5. Data Analysis

Data were screened for completeness, duplicates, and inattentive responses. Descriptive statistics and bivariate correlations were calculated prior to model testing. Internal consistency was assessed using Cronbach's α and McDonald's ω. The measurement model was specified a priori based on the policy-derived planning themes and their construct definitions, and was evaluated using confirmatory factor analysis (CFA), reporting CFI/TLI, RMSEA, and SRMR. Convergent validity was examined using standardized loadings, composite reliability (CR), and average variance extracted (AVE), while discriminant validity was evaluated using Fornell–Larcker criteria and HTMT ratios. Redundancy concerns were handled at the construct-definition stage (expert uniqueness review) and verified empirically using discriminant-validity diagnostics. Common method variance was addressed through procedural remedies and statistically assessed using Harman's one-factor test and CFA one-factor comparison. Hypotheses were tested using regression-based or SEM path models, controlling for key demographic and village characteristics. Mediating effects were examined using bootstrap confidence intervals, and moderation effects were tested via mean-centered interaction terms using resident embeddedness (residence duration) and village development context (dummy-coded village membership) as moderators. Multicollinearity and influential cases were checked using VIF and diagnostic residual analysis.

4. Results

The final analytic sample comprised N = 347 valid questionnaires. Results are reported in four parts: descriptive patterns of the planning constructs, measurement quality (reliability/validity), the retained theme-level planning factors, and their bivariate and multivariate associations with perceived sustainable revitalization.

4.1. Descriptive Analysis (DA)

Across environmental constructs, mean scores ranged from 2.836 to 3.389 (Table 3). Construction techniques (EN-3) received the highest mean, whereas spatial layout (EN-6) showed the lowest mean and the largest dispersion (highest CV), indicating more divergent evaluations of public-space and layout arrangements than of building-related practices.

Table 3. Descriptive statistics (n=347).

Dimension	Construct	Mean	SD	Min	Max	CV
Environmental Sustainability	EN-1	3.137	0.834	1.00	5.00	0.266
	EN-3	3.389	0.989	1.00	5.00	0.292
	EN-5	3.155	0.848	1.00	5.00	0.269
	EN-6	2.836	0.968	1.00	5.00	0.341
	EN-7	3.258	0.922	1.00	5.00	0.283
	EN-10	2.979	0.979	1.00	5.00	0.329
Cultural Sustainability	CU-1	3.071	0.776	1.00	5.00	0.253
	CU-2	3.291	0.880	1.00	5.00	0.267
	CU-3	2.856	0.990	1.00	5.00	0.347
	CU-4	3.390	0.752	1.00	5.00	0.222
	CU-5	3.061	0.810	1.00	5.00	0.265
Economic Sustainability	EC-1	3.283	0.826	1.00	5.00	0.252
	EC-2	3.368	0.706	1.00	5.00	0.210
	EC-3	3.314	0.830	1.00	5.00	0.250
	EC-4	3.092	0.890	1.00	5.00	0.288
	EC-5	3.064	0.847	1.00	5.00	0.276
	EC-6	3.019	0.831	1.00	5.00	0.275
Social Sustainability	SO-1	3.214	0.713	1.00	5.00	0.222
	SO-2	3.239	0.783	1.00	5.00	0.242
	SO-3	3.436	0.976	1.00	5.00	0.284
	SO-7	3.091	0.825	1.00	5.00	0.267

Cultural constructs generally received higher evaluations, with cultural forms (CU-4) and cultural continuity (CU-2) ranking highest, while cultural innovation (CU-3) showed a comparatively lower mean and greater dispersion. In the economic domain, cultural economy (EC-2) and economic diversification (EC-3) were rated relatively high, whereas employment (EC-6) was rated lower. In the social domain, community needs responsiveness (SO-3) and community participation (SO-2) showed the highest means, and equity (SO-1) exhibited relatively stable ratings, suggesting that basic service responsiveness and perceived fairness are salient components in residents' evaluations.

In the social sustainability (SO) dimension, the highest mean scores were achieved for community needs (SO-3; mean=3.438) and community participation (SO-2; mean=3.239), indicating that respondents recognize both as crucial to the sustainable revitalization of villages. Community management (SO-7; mean=3.091) presented the lowest score in this dimension, which can be attributed to the limited involvement of villagers in community management. The lowest coefficient of variation (SO-1; CV=0.222) suggests a high degree of consensus, indicating that equity is a widely acknowledged and relevant component of village society. In contrast, the highest coefficient of variation (SO-3; CV=0.284) revealed substantial variability in responses, suggesting significant differences in respondents" perceptions and recognition of community needs.

4.2. Questionnaire Validity and Reliability

To assess the internal consistency of the questionnaire scales, reliability analysis was conducted using Cronbach's alpha coefficients [78,79]. The reliability of all independent variables was evaluated; all measurement scales demonstrated good internal consistency (Table 4).

Table 4. Reliability statistics.

Construct	k (items)	Cronbach's α	McDonald's ω	CR	AVE
EN-1 Infrastructure construction	4	0.785	0.801	0.80	0.52
EN-3 Construction techniques	3	0.903	0.914	0.91	0.71
EN-5 Building structure	4	0.881	0.892	0.88	0.64
EN-6 Spatial layout	5	0.932	0.939	0.94	0.70
EN-7 Landscape coordination	3	0.766	0.756	0.77	0.53
EN-10 Environmental adaptability	3	0.898	0.906	0.90	0.69
CU-1 Cultural symbiosis	3	0.806	0.812	0.81	0.59
CU-2 Cultural continuity	3	0.866	0.873	0.87	0.69
CU-3 Cultural innovation	4	0.921	0.928	0.92	0.68
CU-4 Cultural forms	4	0.851	0.859	0.86	0.60
CU-5 Cultural integration	3	0.848	0.853	0.85	0.66
EC-1 Ecological economy	3	0.841	0.847	0.84	0.64
EC-2 Cultural economy	3	0.751	0.762	0.77	0.52
EC-3 Economic diversification	3	0.851	0.858	0.85	0.66
EC-4 Energy consumption	3	0.877	0.885	0.88	0.71
EC-5 Resource utilization	3	0.840	0.845	0.84	0.64
EC-6 Employment	3	0.849	0.854	0.85	0.66
SO-1 Equity	3	0.740	0.756	0.77	0.53
SO-2 Community participation	5	0.890	0.901	0.89	0.62
SO-3 Community needs	3	0.893	0.900	0.90	0.69
SO-7 Community management	3	0.845	0.852	0.85	0.66
YY Sustainable revitalization	4	0.912	0.919	0.92	0.70

All constructs demonstrated acceptable internal consistency (Cronbach's α = 0.740–0.932; McDonald's ω = 0.756–0.939) and convergent validity (CR = 0.77-0.94; AVE = 0.52-0.71) (Table 4) [78]. Sampling adequacy supported factor analysis (KMO = 0.912; Bartlett's test $p < 0.001$) (Table 5). The construct-level CFA showed acceptable fit (χ^2/df = 2.41, CFI = 0.928, TLI = 0.919, RMSEA = 0.064, SRMR = 0.052), and standardized loadings were significant and within an acceptable range. Discriminant validity met Fornell–Larcker and HTMT criteria (HTMT = 0.21–0.84), and common method variance checks did not indicate a dominant single-factor pattern.

Table 5. KMO and Bartlett's test results.

KMO measurement		0.912
Bartlett's Test	Approximate Chi-square	12,666.448
	df	2775
	p	0.000

4.3. Factor Analysis

An item-level factor-analytic screening was conducted to examine whether the planning-item pool aligns with the policy-derived theme structure specified in the conceptual framework and to identify potential cross-loadings. An unconstrained PCA solution using the eigenvalue>1 rule produced 22 components (Table 6), which was treated as an initial diagnostic upper bound rather than the basis for substantive interpretation.

Table 6. Total variance.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	18.910	25.213	25.213	18.910	25.213	25.213	4.184	5.579	5.579
2	2.496	3.328	28.541	2.496	3.328	28.541	4.146	5.529	11.107
3	2.210	2.946	31.487	2.210	2.946	31.487	3.701	4.935	16.042
4	2.099	2.799	34.286	2.099	2.799	34.286	3.326	4.435	20.477
5	1.890	2.520	36.806	1.890	2.520	36.806	3.197	4.263	24.740
6	1.825	2.433	39.240	1.825	2.433	39.240	3.196	4.261	29.001
7	1.671	2.228	41.468	1.671	2.228	41.468	2.688	3.584	32.585
8	1.648	2.198	43.666	1.648	2.198	43.666	2.665	3.553	36.138
9	1.603	2.138	45.804	1.603	2.138	45.804	2.602	3.469	39.607
10	1.573	2.097	47.900	1.573	2.097	47.900	2.563	3.417	43.024
11	1.515	2.021	49.921	1.515	2.021	49.921	2.404	3.206	46.230
12	1.437	1.917	51.838	1.437	1.917	51.838	2.329	3.106	49.335
13	1.411	1.882	53.719	1.411	1.882	53.719	1.875	2.501	51.836
14	1.347	1.796	55.516	1.347	1.796	55.516	1.525	2.033	53.869
15	1.295	1.726	57.242	1.295	1.726	57.242	1.415	1.886	55.755
16	1.271	1.694	58.936	1.271	1.694	58.936	1.400	1.866	57.622
17	1.240	1.653	60.590	1.240	1.653	60.590	1.382	1.843	59.464
18	1.210	1.614	62.203	1.210	1.614	62.203	1.360	1.814	61.278
19	1.158	1.544	63.748	1.158	1.544	63.748	1.339	1.786	63.064
20	1.115	1.486	65.234	1.115	1.486	65.234	1.301	1.734	64.798
21	1.092	1.456	66.690	1.092	1.456	66.690	1.248	1.664	66.462
22	1.016	1.355	68.045	1.016	1.355	68.045	1.187	1.583	68.045
23	0.990	1.320	69.365						
24	0.978	1.304	70.670						
25	0.934	1.245	71.915						
26	0.913	1.218	73.133						
27	0.892	1.190	74.323						
28	0.846	1.128	75.450						
29	0.814	1.085	76.535						
30	0.811	1.081	77.616						
31	0.762	1.016	78.632						
32	0.750	0.999	79.632						
33	0.734	0.979	80.611						
34	0.676	0.901	81.511						
35	0.670	0.893	82.405						
36	0.623	0.830	83.235						
37	0.588	0.783	84.018						
38	0.573	0.764	84.783						
39	0.549	0.732	85.515						
40	0.519	0.691	86.207						
41	0.506	0.675	86.881						
42	0.485	0.647	87.528						
43	0.472	0.630	88.158						
44	0.464	0.618	88.776						
45	0.441	0.588	89.365						
46	0.416	0.555	89.919						
47	0.402	0.536	90.455						
48	0.393	0.525	90.980						
49	0.391	0.522	91.502						
50	0.384	0.512	92.013						
51	0.373	0.497	92.511						
52	0.355	0.473	92.983						
53	0.336	0.449	93.432						
54	0.328	0.437	93.869						
55	0.319	0.426	94.295						
56	0.307	0.410	94.705						
57	0.296	0.394	95.099						
58	0.294	0.393	95.492						
59	0.287	0.382	95.874						
60	0.269	0.358	96.232						
61	0.267	0.355	96.588						
62	0.249	0.332	96.920						
63	0.240	0.320	97.240						
64	0.224	0.298	97.538						
65	0.222	0.296	97.834						
66	0.212	0.283	98.117						
67	0.202	0.270	98.386						
68	0.191	0.255	98.641						
69	0.189	0.252	98.893						
70	0.164	0.219	99.112						
71	0.156	0.208	99.320						
72	0.143	0.191	99.511						
73	0.132	0.176	99.686						
74	0.124	0.166	99.852						
75	0.111	0.148	100.000						

Substantive factor labeling and subsequent construct-level analyses were restricted to factors that correspond to the pre-specified integrated planning themes and satisfy minimum loading-pattern requirements (salient loadings ≥0.50 and sufficient item coverage per factor). Under these criteria, 14 theme-consistent factors were retained and interpreted as the core planning constructs for subsequent association analyses. The rotated loading patterns are reported in Table 7, and the retained factors are summarized below.

Table 7. Factor analysis results.

Rotational Component Matrix																						
Component	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
EN1_1			0.828																			
EN1_2			0.718																			
EN1_3			0.737																			
EN1_4			0.714																			
EN3_1												0.812										
EN3_2												0.686										
EN3_3												0.684										
EN5_1				0.782																		
EN5_2				0.705																		
EN5_3				0.682																		
EN5_4				0.729																		
EN6_1		0.862																				
EN6_2		0.710																				
EN6_3		0.735																				
EN6_4		0.696																				
EN6_5		0.770																				
EN7_1														0.476								
EN7_2														0.505								
EN7_3																						
EN10_1																					0.815	
EN10_2																0.455						
EN10_3															0.668							
CU2_1										0.765												
CU2_2										0.730												
CU2_3										0.652												
CU3_1					0.849																	
CU3_2					0.648																	
CU3_3					0.709																	
CU3_4					0.682																	
CU4_1						0.767																
CU4_2						0.686																
CU4_3						0.709																
CU4_4						0.708																
CU1_1														−0.545								
CU1_2																		−0.657				
CU1_3																						
CU5_1															0.725							
CU5_2																				0.611		
CU5_3																	0.743					
EC1_1								0.838														
EC1_2								0.784														
EC1_3								0.754														
EC2_1							0.781															
EC2_2							0.729															
EC2_3							0.728															
EC3_1									0.776													
EC3_2									0.725													
EC3_3									0.664													
EC4_1																		0.516				
EC4_2																0.521						
EC4_3																		0.552				
EC5_1																						−0.712
EC5_2																0.648						
EC5_3																						
EC6_1																				0.703		
EC6_2														0.497								
EC6_3															0.419							
SO1_1											0.772											
SO1_2											0.692											
SO1_3											0.665											
SO2_1	0.806																					
SO2_2	0.667																					
SO2_3	0.713																					
SO2_4	0.681																					
SO2_5	0.664																					
SO3_1													0.717									
SO3_2													0.522									
SO3_3													0.679									
SO7_1																						
SO7_2																			−0.768			
SO7_3																	0.515					
yy-1																						
yy-2																						
yy-3																						
yy-4																						

The item-level screening yielded an unconstrained 22-component solution as a diagnostic upper bound (Table 6). Based on the pre-specified theme structure and loading-pattern criteria, 14 theme-consistent planning factors were retained as the core constructs for subsequent analyses (Table 7). Salient loadings generally met the ≥0.50 threshold with adequate item coverage. Landscape coordination (EN-7) was measured with limited item coverage and is therefore interpreted cautiously in construct-level inference.

4.4. Correlation Analysis

Figure 3 shows Heatmap of Pearson correlations among planning factors and perceived sustainable revital-ization, and Table 8 summarizes bivariate correlations between the 21 planning factors and perceived sustainable revitalization. Correlations with the outcome ranged from negligible and non-significant (e.g., environmental adaptability EN-10, cultural symbiosis CU-1, cultural integration CU-5, energy consumption EC-4, resource utilization EC-5, employment EC-6, community management SO-7) to moderate positive associations. The largest positive correlations were observed for building structure (EN-5; r = 0.661), cultural forms (CU-4; r = 0.651), cultural continuity (CU-2; r = 0.635), landscape harmony (EN-7; r = 0.629), community participation (SO-2; r = 0.629), community needs responsiveness (SO-3; r = 0.623), and economic diversification (EC-3; r = 0.608).

Across domains, stronger associations clustered around cultural continuity/visibility, spatial/public-space quality, and governance participation/fairness-related elements. This pattern is consistent with the study's mechanism structure in which identity-laden cultural interventions correspond to place attachment/identity processes, governance-related equity and participation correspond to fairness and trust evaluations, and spatial/public-space quality corresponds to collective efficacy and perceived feasibility of collective action.

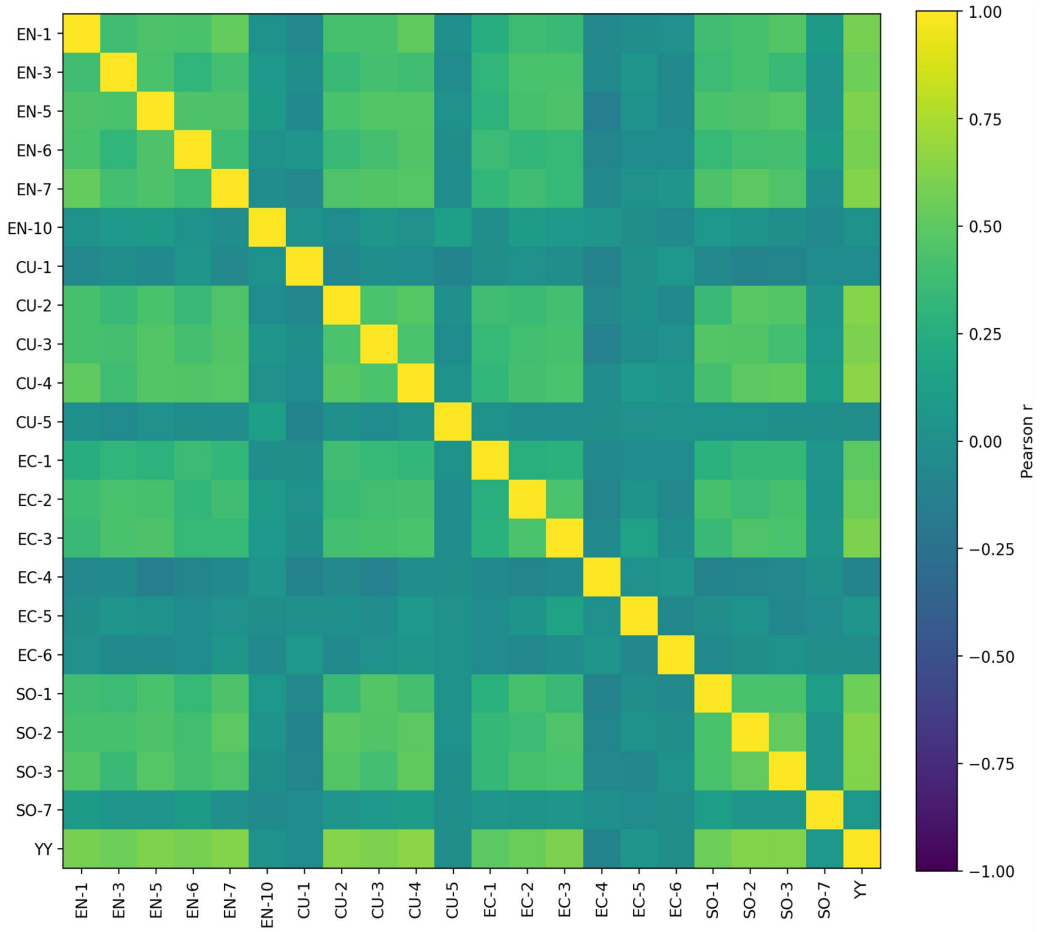

Figure 3. Heatmap of Pearson correlations among planning factors and perceived sustainable revitalization (N = 347).

Table 8. Correlations (N=347).

	EN-1	EN-3	EN-5	EN-6	EN-7	EN-10	CU-1	CU-2	CU-3	CU-4	CU-5	EC-1	EC-2	EC-3	EC-4	EC-5	EC-6	SO-1	SO-2	SO-3	SO-7	YY
EN-1	1																					
EN-3	0.385 **	1																				
EN-5	0.442 **	0.427 **	1																			
EN-6	0.423 **	0.315 **	0.443 **	1																		
EN-7	0.526 **	0.399 **	0.442 **	0.378 **	1																	
EN-10	0.030	0.084	0.088	0.025	−0.016	1																
CU-1	−0.062	−0.011	−0.046	0.046	−0.060	0.024	1															
CU-2	0.416 **	0.355 **	0.424 **	0.353 **	0.450 **	−0.028	−0.065	1														
CU-3	0.417 **	0.409 **	0.465 **	0.407 **	0.456 **	0.056	−0.006	0.434 **	1													
CU-4	0.514 **	0.384 **	0.465 **	0.458 **	0.472 **	0.008	−0.025	0.477 **	0.432 **	1												
CU-5	0.003	−0.037	0.015	−0.014	−0.023	0.127 *	−0.098	0.001	−0.024	0.031	1											
EC-1	0.247 **	0.316 **	0.291 **	0.369 **	0.326 **	−0.013	−0.010	0.389 **	0.336 **	0.321 **	0.023	1										
EC-2	0.376 **	0.428 **	0.419 **	0.324 **	0.385 **	0.102	0.010	0.365 **	0.398 **	0.409 **	−0.022	0.265 **	1									
EC-3	0.358 **	0.425 **	0.440 **	0.337 **	0.338 **	0.083	−0.012	0.399 **	0.418 **	0.433 **	−0.021	0.280 **	0.430 **	1								
EC-4	−0.058	−0.051	−0.138 *	−0.082	−0.048	0.052	−0.103	−0.057	−0.116 *	−0.021	−0.009	−0.054	−0.090	−0.054	1							
EC-5	−0.014	0.040	0.029	−0.024	0.012	−0.008	0.007	0.007	−0.016	0.082	0.013	−0.026	0.037	0.156 **	0.015	1						
EC-6	0.010	−0.040	−0.050	−0.027	0.055	−0.047	0.069	−0.049	0.013	0.055	0.021	−0.036	−0.055	−0.020	0.046	−0.064	1					
SO-1	0.385 **	0.370 **	0.429 **	0.342 **	0.441 **	0.065	−0.057	0.359 **	0.468 **	0.411 **	0.025	0.279 **	0.418 **	0.359 **	−0.107 *	−0.012	−0.047	1				
SO-2	0.419 **	0.421 **	0.438 **	0.391 **	0.498 **	0.037	−0.107 *	0.485 **	0.460 **	0.494 **	0.019	0.332 **	0.370 **	0.452 **	−0.085	0.021	−0.014	0.425 **	1			
SO-3	0.464 **	0.355 **	0.470 **	0.410 **	0.450 **	−0.007	−0.085	0.462 **	0.403 **	0.512 **	−0.007	0.330 **	0.418 **	0.433 **	−0.058	−0.065	0.024	0.428 **	0.518 **	1		
SO-7	0.086	0.054	0.047	0.089	0.002	−0.049	−0.031	0.051	0.071	0.102	−0.006	0.047	0.038	0.055	0.000	−0.038	−0.013	0.111 *	0.056	0.060	1	
YY	0.593 **	0.556 **	0.611 **	0.587 **	0.629 **	0.031	−0.028	0.635 **	0.608 **	0.651 **	−0.008	0.497 **	0.550 **	0.608 **	−0.103	0.050	−0.010	0.557 **	0.629 **	0.623 **	0.064	1

Note: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

4.5. Multiple Linear Regression Analysis

In Table 9, the overall model demonstrates a good fit ($F(21, 325)=61.627$, $p < 0.001$), indicating that the independent variables exert a statistically significant is associated with on sustainable revitalization. The coefficient of determination ($R^2=0.799$) shows that the model explains 79.9% of the total variance in sustainable revitalization, whereas the adjusted $R^2=0.786$ confirms that a high level of explanatory power (78.6%) is retained after controlling for sample size and the number of predictors; this indicates that the model has a certain explanatory effect.

Table 9. Multiple linear regression analysis results.

Model	Unstandardized Coefficients		Standardized Coefficients	*t*	*p*	Collinearity Statistics	
	B	SE	Beta			Tolerance	VIF
EN-1	0.066	0.029	0.074	2.255	0.025 *	0.570	1.755
EN-3	0.074	0.029	0.080	2.588	0.010 **	0.646	1.549
EN-5	0.061	0.030	0.067	2.016	0.045 *	0.563	1.775
EN-6	0.128	0.030	0.134	4.295	0.000 ***	0.639	1.565
EN-7	0.101	0.030	0.115	3.420	0.001 ***	0.543	1.842
EN-10	−0.014	0.033	−0.011	−0.414	0.679	0.933	1.071
CU-1	0.015	0.030	0.013	0.512	0.609	0.936	1.068
CU-2	0.128	0.028	0.146	4.515	0.000 ***	0.592	1.690
CU-3	0.074	0.031	0.079	2.410	0.017 *	0.581	1.722
CU-4	0.090	0.031	0.101	2.932	0.004 **	0.518	1.931
CU-5	−0.001	0.029	−0.001	−0.046	0.963	0.959	1.043
EC-1	0.094	0.026	0.103	3.591	0.000 ***	0.745	1.343
EC-2	0.057	0.027	0.065	2.092	0.037 *	0.640	1.563
EC-3	0.132	0.029	0.147	4.597	0.000 ***	0.605	1.652
EC-4	−0.011	0.029	−0.010	−0.380	0.705	0.945	1.058
EC-5	0.026	0.031	0.022	0.837	0.403	0.929	1.077
EC-6	0.008	0.031	0.007	0.273	0.785	0.952	1.051
SO-1	0.064	0.028	0.072	2.283	0.023 *	0.625	1.599
SO-2	0.069	0.031	0.074	2.185	0.030 *	0.538	1.860
SO-3	0.073	0.031	0.079	2.349	0.019 *	0.540	1.853
SO-7	−0.019	0.030	−0.017	−0.655	0.513	0.966	1.036
F-value					61.627 ***		
R^2					0.799		
ΔR^2					0.786		

Note: *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$.

Within the environmental dimension, several variables exert significant positive effects on sustainable revitalization. Spatial layout (EN-6) shows the strongest is associated with ($\beta=0.134$, $p < 0.001$), followed by landscape harmony (EN-7) ($\beta=0.115$, $p < 0.001$), indicating that physical and spatial environment predominantly shape sustainable revitalization. In addition, construction techniques (EN-3) ($\beta=0.080$, $p < 0.01$), infrastructure development (EN-1) ($\beta=0.074$, $p < 0.05$), and building structure (EN-5) ($\beta=0.067$, $p < 0.05$) demonstrated significant positive effects, although with relatively smaller effect sizes. In contrast, environmental adaptability (EN-10) does not exhibit a significant regression coefficient ($\beta=-0.011$, $p=0.679$), suggesting that this factor has not yet directly is associated withd revitalization outcomes at the perceptual level of residents.

Within the cultural dimension, cultural continuity (CU-2) emerges as one of the most influential predictors among all variables (β=0.146, $p < 0.001$), underscoring the central role of intangible cultural heritage in sustainable revitalization. Cultural forms (CU-4) (β=0.101, $p < 0.01$) and innovation (CU-3) (β=0.079, $p < 0.05$) also exert significant positive effects, highlighting the relevance of cultural vitality and innovative cultural practices in revitalization. Conversely, cultural symbiosis (CU-1) (β=0.013, p=0.609) and integration (CU-5) (β=−0.001, p=0.963) could not reach statistical significance, indicating that the current forms of cultural interaction and integration have not yet translated into discernible impacts on residents" perceptions of revitalization.

Within the economic dimension, economic diversification (EC-3) shows a relatively large positive standardized coefficient (β=0.147, $p < 0.001$), indicating a strong association with perceived sustainable revitalization. Ecological economy (EC-1) (β=0.103, $p < 0.001$) and cultural economy (EC-2) (β=0.065, $p < 0.05$) also show positive coefficients, suggesting that respondents reporting higher salience of culture- and ecology-oriented economic practices also report higher perceived revitalization sustainability. In contrast, energy consumption (EC-4) (β=−0.010, p=0.705), resource utilization (EC-5) (β=0.022, p=0.403), and employment (EC-6) (β=0.007, p=0.785) do not reach statistical significance in the current models.

Within the social dimension, community needs (SO-3) (β=0.079, $p < 0.05$), community participation (SO-2) (β=0.074, $p < 0.05$), and equity (SO-1) (β=0.072, $p < 0.05$) show statistically significant positive coefficients, indicating their associations with perceived sustainable revitalization. In contrast, community management (SO-7) does not reach statistical significance (β=−0.017, p=0.513), which may reflect limited salience of management arrangements in residents' evaluations under predominantly top–down governance conditions.

Multicollinearity diagnostics indicate that all explanatory variables have tolerance values >0.40 and variance inflation factor (VIF) values of 1.036-1.931, well below the typically accepted threshold of 10, suggesting that no serious multicollinearity is present. Accordingly, each explanatory variable contributes independently to the model, and the regression coefficients are stable and reliable. Overall, the constructed regression model demonstrates high statistical validity, structural robustness, and predictive effectiveness, providing strong empirical support for understanding the multidimensional driving mechanisms underlying traditional village revitalization.

5. Discussion

5.1. Salient correlates and mechanism-consistent interpretation

The multivariate results indicate that only a subset of planning elements remain salient correlates of perceived sustainable revitalization when other elements are held constant. Cultural continuity-related elements (e.g., cultural continuity/inheritance and cultural forms), spatial/public-space elements (e.g., spatial layout and landscape harmony), livelihood feasibility elements (e.g., economic diversification and ecological economy), and governance elements (e.g., equity, community participation, and responsiveness to community needs) exhibit positive coefficients. This configuration is consistent with the mechanism structure specified in the framework: culturally salient cues align with place attachment/place identity processes; equity- and participation-related cues align with fairness-based trust evaluations; spatial/public-space cues align with collective efficacy and the perceived feasibility of sustained collective maintenance [16-18,43]. The salience of spatial/public-space elements is consistent with evidence that rural public-space quality is closely linked to perceived sustainability benefits and everyday use experience [80].

5.2. Interpreting non-significant coefficients: salience, overlap, context, and time-lag

Several elements emphasized in policy and planning discourse do not reach statistical significance under the current specification (e.g., cultural integration/symbiosis, community management, employment, energy consumption, resource utilization, and environmental adaptability). Non-significance in this context is compatible with multiple explanations. Limited perceptual salience is one plausible account: community management arrangements, resource utilization systems, and energy-saving practices often operate as technical or administrative routines, and residents may have limited direct exposure to implementation quality, weakening the correspondence between measured perceptions and underlying governance or technical performance. Conceptual adjacency and shared variance provide another account: elements such as cultural integration and cultural continuity/forms may overlap in residents' evaluations, and unique contributions can be absorbed by more central cultural cues in multivariate models; similarly, employment perceptions may overlap with broader livelihood feasibility captured by economic diversification and ecological economy. Contextual

constraints related to governance structure and local power relations may also matter: under predominantly top-down implementation, formal "community management" may not translate into resident-perceived decision influence, limiting its statistical association with perceived sustainability outcomes. Temporal lag and intervention intensity offer an additional explanation: environmental adaptability and resource/energy efficiency may reflect longer-term upgrading cycles and behavioral routines, which are less likely to be captured in a cross-sectional snapshot, particularly where interventions are early-stage or modest in intensity.

5.3. Theoretical refinement and boundary conditions

Taken together, the results suggest a salience hierarchy among policy-derived planning cues in traditional-village contexts: elements tied to identity continuity, everyday spatial experience, and livelihood feasibility tend to show stronger associations with perceived sustainable revitalization than elements that are technical, indirect, or institutionally opaque. This refinement narrows the integrated-planning argument by indicating that not all planning elements are equally behavior-relevant as resident-perceived implementation cues. Boundary conditions are also implicated by the typological variation across villages. In tourism-oriented contexts with commercialization pressure, cultural continuity cues may be more closely linked to place identity and acceptance of change; in production-oriented contexts (ecological fishery/agriculture), livelihood feasibility cues may be more closely linked to perceived sustainability; under differing governance arrangements, equity and participation cues may differ in their association with trust and cooperation. Future work can examine these boundaries using multi-group comparisons (e.g., by village context, residence duration, and age cohort), alternative specifications using reduced factor sets to address overlap, and sensitivity checks for common-method bias in single-source survey designs. This is aligned with arguments that cultural identity reconstruction and governance effectiveness jointly condition residents' evaluations and support under rural revitalization agendas [82]. Variation in development orientation and governance arrangements is consistent with studies reporting protection–development imbalances, post-productivist transitions, and heterogeneous governance effectiveness in China's traditional villages and rural revitalization practices [84-86].

5.4. Limitations

The empirical scope is confined to three villages within Shandong Province, and the village selection follows a typological logic rather than probability sampling; generalization beyond contexts with similar development orientations and governance conditions should therefore be made cautiously. The evidence is based on cross-sectional, self-reported survey data; the dependent measures reflect perceived revitalization and stewardship-oriented intentions rather than observed participation, governance actions, or long-term maintenance behaviors, and may be affected by recall and social desirability bias. Online-first administration may underrepresent middle-aged and older permanent residents despite field follow-up support, introducing potential coverage bias for key decision-making groups in revitalization practice. Measurement constraints remain, including possible overlap among adjacent planning elements and limited item coverage for certain constructs, which can attenuate discriminant validity and reduce coefficient stability in multivariate models. Longitudinal or panel data, multi-source indicators (e.g., participation records, collective maintenance logs, structured observation), and mixed-mode sampling would allow stronger tests of temporal ordering, mechanism dynamics, and external validity across village types and provinces.

6. Conclusions

This study specifies an integrated planning model encompassing environmental, cultural, economic, and social dimensions and estimates the associations between 21 planning factors and perceived sustainable revitalization using survey evidence from three traditional villages in Shandong Province. The analyses indicate statistically significant positive coefficients for spatial layout, landscape harmony, cultural continuity-related factors, economic diversification, equity, and community participation, while several elements (e.g., cultural integration, community management, employment, and environmental adaptability) are not statistically significant under the current specification. Future surveys should combine online and offline modes, apply age- and residency-based quota targets where feasible, and consider post-stratification weighting using village demographic profiles to improve coverage of key decision-making groups. These patterns are discussed in relation to place attachment/place identity, fairness-related trust, and collective efficacy as plausible behavioral mechanisms in village contexts, but the present evidence remains correlational due to the

cross-sectional, self-reported design. Practical implications should therefore be interpreted cautiously and verified in future studies using longitudinal or multi-source evidence.

Although this study develops a systematic model of sustainable revitalization for traditional villages, several limitations should be acknowledged. First, the empirical scope is confined to three villages within Shandong Province. The village selection is typological and therefore not statistically representative of all traditional villages in Shandong or China; generalization beyond contexts with similar development orientations and governance conditions should be made cautiously. Second, the study relies on cross-sectional, self-reported survey data. The dependent measures capture perceived revitalization outcomes and stewardship-oriented intentions rather than observed participation, governance actions, or long-term maintenance behaviors, and may be affected by recall and social desirability bias. Third, the survey does not incorporate behavioral or administrative indicators (e.g., meeting attendance, volunteer/service hours, collective maintenance records, participation rosters), direct observation, or qualitative interviews that could triangulate whether perceptions correspond to actual cooperative practice. Fourth, future research can strengthen inference by using longitudinal or panel designs, incorporating multi-source evidence (administrative and behavioral indicators, structured observation, and spatial/land-use data), and conducting comparative tests across provinces and village types to improve external validity and mechanism verification.

Author Contributions
Conceptualization, X.Z.; methodology, X.Z.; software, X.Z.; validation, X.Z.; formal analysis, X.Z.; investigation, X.Z.; resources, X.Z.; data curation, X.Z.; writing-original draft preparation, X.Z.; Writing-original draft, X.Z.; writing-review and editing, X.Z., and S.S.B.H.; visualization, X.Z.; supervision, S.S.B.H. and S.B.I.; project administration, S.S.B.H., and S.B.I.; funding acquisition, X.Z. All authors have read and agreed to the published version of the manuscript.

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Abbreviations
KMO: Kaiser-Meyer-Olkin Measure of Sampling Adequacy.

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