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Decision-Making Analysis for Sustainable Tourism Development: A DEMATEL and SEM Approach to Infrastructure and Policy Optimization in Ethnic Village Tourism

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ABSTRACT

Achieving sustainable tourism development necessitates the utilisation of structured decision-making frameworks that effectively reconcile economic advancement, cultural heritage conservation, and infrastructural limitations. This research adopts the Decision-Making Trial and Evaluation Laboratory (DEMATEL) approach in conjunction with structural equation modelling (SEM) to pinpoint and assess the principal determinants influencing sustainable tourism within the context of strategic planning for ethnic village tourism. Focusing on the Xijiang Miao Village in China, the study incorporates semi-structured interviews and expert assessments to evaluate variables such as economic investment, infrastructure limitations, governance and managerial practices, cultural preservation efforts, and ecological sustainability. The analysis underscores the significance of multiple sub-elements associated with these core dimensions. Furthermore, through the application of SEM, the findings reveal that governance and policy ($\beta = 0.222$), alongside economic and resource management ($\beta = 0.176$), exert a favourable influence on sustainable development via enhanced strategic decision-making processes. Conversely, environmental and risk management ($\beta = -0.804$), infrastructure planning ($\beta = -0.085$), and the extent of stakeholder engagement in decision-making ($\beta = -0.074$) demonstrate adverse effects. This study enriches both qualitative and quantitative decision-support models by showcasing the integration of DEMATEL and SEM methodologies to refine strategic planning mechanisms in the realm of sustainable tourism. The insights derived are expected to guide key stakeholders, including governmental bodies, tourism authorities, and infrastructure developers, in formulating more effective policies and initiatives.

1. Introduction

Strategic decision-making is increasingly acknowledged as a pivotal concept across various disciplines [1-3], including the domain of tourism development and management [4; 5]. Its

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importance is particularly pronounced in contexts such as ethnic villages, where the interdependence between culture, community, and the environment necessitates well-considered planning. At its core, strategic decision-making involves a long-term perspective coupled with prudent utilisation of available resources. It ensures that tourism strategies are not solely driven by economic imperatives but are also aligned with social and environmental sustainability [6]. When decisions are taken with foresight and precision, the tourism sector is better positioned to benefit local populations without inflicting detrimental consequences. As highlighted by [7], stakeholder engagement in the planning process significantly enhances outcomes by fostering trust, promoting collaboration, and advancing sustainable objectives. Similarly, [8] argues that strategic foresight is instrumental in transitioning sustainable tourism from a conceptual framework to an actionable agenda. In the specific case of ethnic village tourism, where cultural traditions and natural landscapes are fundamental assets, the necessity for deliberate and systematic decision-making becomes even more pronounced.

Tourism not only satisfies fundamental human desires for exploration, education, and leisure, but it also represents a vibrant and expanding sector with global relevance. As one of the most resilient engines of economic progress, tourism has considerably shaped the socio-economic configurations of numerous countries. Current data indicate that tourism contributes approximately 11 per cent to the global gross domestic product (GDP) and supports over 225 million jobs worldwide [9]. Due to its extensive interlinkages, the tourism industry catalyses infrastructure development, fosters intercultural dialogue, and stimulates rapid growth across related sectors, such as transport, hospitality, gastronomy, culture, and entertainment. Consequently, tourism has been widely acknowledged as a strategic vehicle for enhancing national reputations, attracting foreign investment, and pursuing sustainable advancement. It also accounts for nearly 10 per cent of total global employment [10]. In the Chinese context, authorities at various administrative levels have consistently prioritised tourism as a strategic driver of economic development in ethnically diverse regions [11]. However, while ethnic tourism yields substantial economic and social benefits, it may concurrently exert adverse effects on indigenous cultures, traditional lifestyles, and communal identities.

Xijiang Miao Village, the world's largest Miao settlement, is in a quintessential river valley. The local population has reclaimed substantial terraced farmland in upstream areas, optimising scarce arable resources and utilising the terrain to construct their iconic hanging footstools. The village's rich ethnic heritage provides a robust foundation for tourism development. Initiated in 1995 with government financial backing, tourism in Xijiang Miao Village has steadily progressed. Nonetheless, limitations in local governmental experience regarding administration and infrastructure have presented considerable obstacles [12]. Conflicts frequently emerge among stakeholders in the Xijiang Hmong community over multiple concerns [13], and such tensions have significantly undermined the area's sustainable development efforts [14]. Accordingly, there is a pressing need to identify and prioritise the key variables that influence ethnic tourism development in Xijiang Miao Village, with a particular emphasis on strategic decision-making. Among these determinants, some serve as foundational causes, while others are consequential factors in the local context. To elucidate these interrelationships, this investigation applies the DEMATEL methodology, which is particularly useful for discerning the relative influence of various factors [15], thereby enabling decision-makers to target the most impactful challenges.

One prevailing perspective is that effective decision-making is fundamental to the planning of tourism infrastructure and governance. In delicate settings such as ethnic villages, where the equilibrium between modernisation and tradition is fragile, the decision-making process holds substantial weight. Poorly conceived developments such as roads, public amenities, or services that disregard long-term sustainability or neglect community voices—can produce counterproductive outcomes. As emphasised by [16], tourism-related infrastructure must be underpinned by sound planning and clearly defined responsibilities to support sustainable expansion. Furthermore, as [17] contend, connecting policy intentions with actionable strategies is critical; enhanced stakeholder collaboration fosters improved information dissemination, which in turn strengthens destination management and adaptability.

This study makes a valuable contribution to the ongoing discourse surrounding sustainable tourism by examining how structured decision-making processes influence developmental trajectories in ethnic village settings. It underscores the central role of infrastructure planning and governance frameworks in determining the success or failure of sustainability objectives. These two domains were found to exert the most consistent influence on strategic decisions. In contrast, when infrastructural initiatives lack long-term vision or when governance considerations are excluded from the strategic discourse, effective implementation becomes increasingly difficult. In addition, economic and resource management demonstrated a positive impact, signifying that appropriate fiscal planning and resource distribution can lead to more grounded and proactive decision-making. Conversely, environmental and risk management exhibited a notable yet negative influence, suggesting that current environmental strategies may be misaligned with overarching sustainability goals or executed in a manner that constrains planning efforts. Furthermore, the relatively weak impact of stakeholder engagement suggests a significant participation gap that warrants immediate intervention.

By utilising the DEMATEL approach alongside SEM estimation techniques, this research investigates the complex interrelations among the principal drivers of sustainable tourism development in Xijiang Miao Village. The analysis places particular emphasis on the dynamics of infrastructure, policymaking, and risk management. Through the identification of the most influential factors within this ecosystem, the study aspires to inform more strategic decisions and generate practical insights aimed at improving the governance and development of ethnic tourism destinations.

2. Literature Review

With the swift expansion of rural tourism, a significant shortage of skilled personnel has become increasingly evident. Local inhabitants typically possess limited professional training and managerial expertise, coupled with inadequate comprehension of tourism product innovation, marketing strategies, and cultural resource utilisation. Consequently, rural tourism initiatives often lack the dynamism and innovation required for sustained growth. Moreover, the advancement of rural infrastructure encounters numerous obstacles, particularly concerning transportation and parking facilities. In various rural tourist destinations, road conditions remain substandard, and essential facilities are underdeveloped, thus failing to sufficiently accommodate the needs of incoming visitors [18].

In the context of Xijiang Miao Village, tourism development is primarily spearheaded by governmental bodies, resulting in a centralised governance structure. However, a pervasive inequality in the distribution of rights among local residents has emerged as a principal source of ongoing disputes in the administration of ethnic tourism [19]. While the admission fee for the Miao Village scenic area is regulated reasonably by the state, the management of commercial entities—ranging from retail shops to hotels—is monopolised by a single tourism enterprise. This restricts the negotiation capacity of smaller businesses and undermines the development of a healthy, competitive market environment [20]. Furthermore, the influx of outsiders and the proliferation of nightlife establishments, such as bars, have precipitated an increase in criminal activity, posing a further challenge to the sustainable progression of ethnic village tourism [21].

At present, traditional craftsmanship is under considerable threat due to the mass production of imitations through mechanised processes. To appeal to consumer preferences for affordability and portability, many souvenirs have undergone changes in size, materials, and craftsmanship [22]. These modifications have progressively alienated the products from their original cultural essence and diminished their spiritual and symbolic significance [23]. Although scholars acknowledge the importance of branding in enhancing tourism destinations, specific research into branding for ethnic villages remains relatively underexplored [20]. Rapid tourism development has also affected architectural heritage; traditional ethnic styles are increasingly being replaced or obscured by modern architectural influences. Furthermore, most villages have failed to fully excavate and showcase their distinctive cultural traits, often relying on replicated tourism models devoid of contextual uniqueness [18].

When tourists from diverse cultural backgrounds visit ethnic tourism regions, they inevitably interact with local customs and traditions. In the effort to align with tourists' preferences, host communities frequently adapt their own cultural expressions, gradually leading to cultural homogenization [24]. Prolonged exposure to tourism may catalyse adverse cultural transformations. Such transformations often manifest as the erosion of longstanding traditions and values, as communities increasingly commercialise their cultural identities to meet tourist expectations—thus compromising authenticity and diminishing the intrinsic uniqueness of their heritage [23]. An overly superficial portrayal of ethnic cultures may further erode their substance, authenticity, and individuality [25].

The ecological consequences of tourism development—particularly when guided by concepts of diversity—pose another formidable barrier to the growth of ethnic villages. Alterations in local ecosystems, including the introduction of non-native flora and fauna, often yield detrimental environmental impacts [21]. Additionally, the surge in tourist numbers has led to excessive household waste and inadequately treated sewage from hospitality venues, which collectively degrade the environmental quality of these regions [18]. In many rapidly developing ethnic tourism villages, the influx of visitors has exceeded the ecological carrying capacity, and in the pursuit of economic gains, environmental stewardship is often neglected. This neglect has resulted in substantial ecological degradation [26].

Current literature primarily examines the determinants influencing rural tourism development [27-30], with relatively few studies focusing explicitly on ethnic village tourism through the lens of strategic decision making. Ethnic village tourism extends the framework of rural tourism by incorporating enriched ethnic cultural dimensions [31]. Although prior research on the sustainable development and management of tourism destinations in Xijiang Miao Village is available [20; 32; 33], there exists a noticeable gap in studies that investigate the fundamental causes hindering ethnic tourism development from a decision-making standpoint. This research applies the DEMATEL methodology to examine the multifaceted factors influencing ethnic tourism in Xijiang Miao Village, with the aim of identifying those elements exerting the most substantial impact. The goal is to formulate more effective strategies to address and rectify the complex developmental challenges currently confronting the village.

3. Methodology

3.1 DEMATEL Approach

Through a comprehensive literature review and semi-structured interviews, this study identified key determinants influencing the sustainable development of tourism in Xijiang Miao Village. Employing the snowball sampling method, subject-matter experts were purposefully selected to evaluate and analyse the various elements impacting the evolution of ethnic tourism in this context. The DEMATEL methodology was adopted to ascertain the causal relationships among the principal variables. This analytical tool is particularly adept at unveiling the directionality of interactions among complex variables [34]. By applying this technique, experts can articulate their perspectives regarding both the intensity and direction of inter-variable influences with heightened clarity and assurance. The strength of DEMATEL lies in its capacity to enable experts to systematically assess the interdependencies and degrees of influence among variables within a defined structural model. This methodological framework not only aids in organising expert insights but also reinforces the foundations upon which their evaluative judgements are based, thereby enhancing the reliability of the causal inferences drawn [35]. The procedure for implementing the DEMATEL technique comprises the following specific steps:

Step 1: Direct Relation Matrix

Based on insights gained from the literature review and semi-structured interviews, the key variables influencing the development of ethnic tourism in Xijiang Miao Village were identified. To determine the interrelationships among these variables, the Delphi method was employed, facilitating consensus among experts through iterative rounds of evaluation. This approach ensured a robust and systematic refinement of expert opinions regarding the direction and magnitude of influence between factors. Subsequently, the direct influence matrix was constructed to quantify these interrelationships. This matrix captures the extent to which one factor exerts a direct effect on another. The relationships were established using the following formula:

$$f_{ij} = \begin{cases} 5, & \text{more than 80\% of experts believe that } f_i \text{ affects } f_j \\ 4, & \text{(60-79) \% of experts believe that } f_i \text{ affects } f_j \\ 3, & \text{(40-59) \% of experts believe that } f_i \text{ affects } f_j \\ 2, & \text{(20-39) \% of experts believe that } f_i \text{ affects } f_j \\ 1, & \text{(0-19) \% of experts believe that } f_i \text{ affects } f_j \\ 0, & \text{no experts believe that } f_i \text{ affects } f_j \end{cases}$$

Formula (1)

The initial stage involved constructing a direct relationship matrix. During this process, the research team evaluated and recorded the direct influences between each pair of variables within the sample aggregate. Specifically, participating experts were tasked with scoring the interrelationships between the various variables, providing insights on the extent of direct influence each pair of elements exerted on one another. This expert feedback was systematically organised into a matrix, with each row and column representing a distinct variable. Each element of the matrix indicates the degree of direct influence between the corresponding variables. The initial direct relation matrix *F* is an *n × n* matrix, where f_{ij} denotes the degree of influence of the element *i* on the element *j* in the following format:

$$F = \begin{bmatrix} f_{11} & \cdots & f_{1n} \\ \vdots & \ddots & \vdots \\ f_{n1} & \cdots & f_{nn} \end{bmatrix}$$

Step 2: Normalised Direct Relation Matrix

This step involves the normalisation of the initial direct relationship matrix. The normalised direct relationship matrix, denoted as Y, is derived by scaling the values in the original direct relationship matrix. This normalisation ensures that the influence between the variables can be compared on a consistent scale. Specifically, the normalisation process is executed using Formulas 2 and 3. Formula 2 is used to compute the sum of each variable's influence on the other variables, which helps to identify the maximum influence of each variable, thereby providing the foundation for normalisation. Formula 3, in contrast, is applied to transform the raw influence values into normalised values, ensuring that all values fall within the range of 0 to 1. Following this procedure, the normalised direct relationship matrix Y facilitates a clearer analysis of the relative influence relationships between the variables.

$$Y=\frac{1}{S}F$$ **Formula (2)**

$$S=\max\left[\max_{1\le i\le n}\sum_{j=1}^{n} f_{ij},\ \max_{1\le j\le n}\sum_{i=1}^{n} f_{ij}\right]$$ **Formula (3)**

Step 3: Construct the Total Relation Matrix H

After step 2, numerical calculations generate the total relationship matrix H. Here, ρ represents the power role, indicating that the Y matrix undergoes multiple multiplications to reflect deeper relationships. As ρ approaches infinity, matrix Y converges, stabilising the influence relationships and providing a clearer, more reliable pattern. Additionally, I denotes the unit matrix, a square matrix with ones on the diagonal and zeros elsewhere. It plays a crucial role in adjusting and normalising the variable relationships during the total relationship matrix H calculation, ensuring accurate reflection of interactions after multiple iterations.

$$H: Y^1 + Y^2 + \cdots + Y^h = Y \times (I - Y)^{-1} = \left[y_{ij}\right]_{n\times n}\rho \to \infty$$ **Formula (4)**

Step 4: Calculate the Sum of Rows and Columns

According to the integrated impact matrix h_{ij} values in H, the degree of influence, degree of being influenced, centrality and degree of causality of each factor are further calculated. The following formula is used to calculate the level of influence. The influence level is a set consisting of the sum of each row in the matrix *H*. Specifically, for each factor *i*, all of its columns in the combined impact matrix *H* are summed to obtain the overall level of impact of that factor on all other factors. This process can be expressed as follow:

$D= (R_1, R_2, R_3, \dots, R_n), R_i = \sum_{j=1}^{n} h_{ij}, (i=1,2, 3, \dots, n)$

The degree of influence is represented by the sum of each column in matrix H, forming a set labelled C. This set reflects the total extent to which each factor is influenced by the others. By summing the rows for each factor j in the composite influence matrix H, we can determine how each factor is affected within the system, revealing its position and importance in the overall network. This process can be expressed as follows:

$C= (C_1, C_2, C_3, \dots, C_n), C_i = \sum_{j=1}^{n} h_{ji}, (i=1,2, 3, \dots, n)$

The centrality of factor *i* is derived by adding the degree of its influence to the degree of the influenced, usually expressed as M_i. Centrality reflects the position and role of a factor within the evaluation system. The magnitude of the centrality value indicates both the importance of the factor and the extent of its interaction with other factors. The formula for calculating centrality is as follows:

$$M_i = D_i + C_i$$ **Formula (5)**

The causality of a factor *i* is derived by subtracting the degree of influence of the factor from the degree to which it is influenced, with R_i. Causality measures the extent to which a factor influences other factors in the system, indicating whether it plays a causal or an outcome role. The formula for calculating the causal degree is as follows:

$$R_i = D_i - C_i$$ **Formula (6)**

If the value of R_i is greater than 0, it means that the factor has a strong influence on the other factors and is therefore called a 'cause factor' or 'driver'. In other words, this type of factor plays a positive driving role in the system and is the main source of influence on the changes of other factors. As such, causal factors are usually relatively independent key points in the system that actively influence other factors and can trigger large changes within the system. In contrast, if $R_i$is less than 0, then the factor is primarily influenced by other factors and is referred to as an 'outcome factor' or 'passive factor'. Outcome factors reflect the interaction of other factors, with their changes resulting from the influence of drivers in the system. These factors are responsive and dependent, representing the result of system changes.

Step 5: Constructing Causal Map

Plot the calculated centrality and causality and provide an explanation. Further analysis is conducted based on the actual situation, such as removing non-core elements, and integrating the interpretive structural model approach.

3.2 SEM Approach

This research employed SEM via Smart PLS 4.0 to investigate the connections between critical factors affecting sustainable tourism development, with sustainable development for strategic decision-making as the dependent variable. The independent variables comprised infrastructure planning, governance and policy, environmental and risk management, economic and resource management, and stakeholder engagement in decision-making. A structured questionnaire was designed based on validated items from extant literature, employing a five-point Likert scale (1 = strongly disagree to 5 = strongly agree). The survey targeted local tourism officials, village leaders, tourism operators, and planners engaged in ethnic village tourism. Of the 400 questionnaires distributed, 341 were returned, of which 318 were deemed valid for SEM analysis. Reliability and validity were assessed using Cronbach's alpha, composite reliability, Average Variance Extracted (AVE), and the Heterotrait-Monotrait Ratio (HTMT). Furthermore, path analysis was utilised to assess the strength and significance of the relationships among the variables. SEM facilitated a deeper insight into the interrelationships between the variables, while weaker or negative paths revealed areas where current strategies may not be adequately supporting sustainable development in the context of strategic decision-making.

4. Analysis and Discussion

4.1 DEMATEL's Findings

There exists substantial academic debate regarding the optimal number of experts needed for a multi-criteria decision analysis (MCDM) study. The selection of an appropriate expert panel size is pivotal for ensuring the reliability and validity of MCDM study results. Hogarth suggests that the ideal size for an expert panel in MCDM studies should range between 6 and 25 individuals. This range effectively balances the diversity of perspectives within the panel with the sufficiency of information provided.

Table 1
Experts' Profile

Category	Classification	Number of Experts
Identity	Heads of Government Departments	4
	Local Residents	6
	Tour Operators	6
	Researchers	2
Working Years	＞1 Year	3
	1-10 Years	6
	11-20 Years	4
	＞20 Years	5
Education Level	Bachelor	3
	Graduate	1
	Doctor	2
	Others	12

A panel of too few experts may result in underrepresentation and unreliable findings, while a panel that is too large may lead to increased coordination costs and a higher likelihood of divergent opinions. Thus, selecting between 6 and 25 experts ensures a comprehensive and accurate set of results, while maintaining the efficiency and manageability of the analysis process. Additionally, this range allows for effective control over time and resources when gathering expert opinions and coordinating group discussions, thereby enhancing the practicality of the research [36]. In this study, 30 tourism-related government officials, residents, tour operators, and academic experts were invited to participate in research focused on ethnic village tourism. Ultimately, 18 experts consented to take part in the study. The sample size is considered adequate for an MCDM study and meets the necessary criteria [37]. Through semi-structured interviews with these 18 experts, the factors influencing the sustainable development of tourism in Xijiang Miao ethnic village were identified. Details of the experts interviewed are provided in Table 1.

Based on the results of the semi-structured interviews, 17 factors were identified as affecting sustainable tourism development in Xijiang Miao Village. These factors were subsequently re-assigned to the experts to assess their relative importance, with results revealing that 15 factors had an average score greater than 3.0 on the 5-point Likert scale. This process was carried out between March 1 and April 15, 2024. Table 2 below presents the mean and standard deviation values for these 17 influencing factors, as well as their corresponding main categories. As indicated by the findings in Table 2, the first two factors were categorised under economic investment, while the subsequent three—namely inadequate infrastructure (F3), poor security (F4), and overcrowding due to unregulated tourism (F5)—fall under the infrastructure constraints category. These results highlight that underdeveloped infrastructure poses a significant challenge to the promotion of sustainable tourism.

Furthermore, governance and management in the context of sustainable tourism development within ethnic villages face several key challenges. A prominent issue identified is the conflict between residents and the government (F6), which hampers effective policy implementation. Another critical challenge is the lack of professional managers (F7), resulting in poorly planned and inefficient tourism initiatives. The absence of structured cultural protection plans (F8) exacerbates the situation, leaving heritage conservation efforts without clear direction and increasing the risk of losing important traditions over time. This challenge is further compounded by the level of commercialization of ethnic culture (F9), which undermines cultural authenticity. Finally, the lack of effective tourism marketing and promotional strategies (F10) prevents ethnic villages from effectively attracting potential visitors, thereby limiting the development of a sustainable tourism environment.

Table 2

Main Category and Sub-Factors Influencing Sustainable Tourism Development

Main Category	Sub-Factor	Codes
Economic Investment Factors	Lack of Investment	F1
	There is no Brand Hotel in Ethnic Village	F2
Infrastructure Constraints	The infrastructure is Inadequate	F3
	Poor Security	F4
	Overcrowding due to Unregulated Tourism	F5
Governance and Management	Residents often have Conflicting Interests with the Government	F6
	Ethnic Villages Lack Professional Managers	F7
	The Protection of Ethnic Culture Lacks Planning	F8
	Commercialisation of Ethnic Culture	F9
	Lack of Tourism Marketing and Promotional Strategies	F10
Cultural Preservation	Residents Lack Education	F11
	Homogenisation of Ethnic Villages	F12
Environmental Sustainability	Rivers in Ethnic Villages are Polluted	F13
	Neglect of Environmental Protection by Ethnic Village managers	F14
	Lack of Environmental Awareness among Local Residents	F15
	Lack of Publicity about Environmental Protection	F16
	Lack of Environmental Protection Regulation	F17

In addition, two sub-factors related to cultural preservation were identified: residents' lack of education and the homogenisation of ethnic villages. The final category, environmental sustainability, includes river pollution (F13), neglect of environmental protection by village managers (F14), and low environmental awareness among local residents (F15). Furthermore, insufficient publicity about environmental protection (F16) and the lack of regulatory frameworks for environmental conservation (F17) were also included under this category, as shown in Table 2.

As shown in Table 3, 15 impact factors had a mean value greater than 3.0. These factors were reassigned to a panel of experts for scoring using Formula 1. The experts assessed these factors in detail, reflecting their perceptions and professional judgement regarding the direct relationships between them. This scoring process resulted in the final direct relationship matrix F, presented in Table 3. The matrix outlines the direct interactions between the factors, enabling the researcher to gain a deeper understanding of the influence paths and identify the most influential factors in the system. Constructing matrix F is a crucial step in subsequent analyses, providing the foundation for determining the causality and strength of influence of each factor.

Table 3
Mean and SD of Sub-Factors

Sub-Factor	Codes	Mean	SD
Lack of Investment	F1	3.67	0.94
There is no Brand Hotel in Ethnic Village	F2	3.94	0.70
The Infrastructure is Inadequate	F3	4.06	0.78
Poor Security	F4	3.89	0.74
Overcrowding Due to Unregulated Tourism	F5	4.33	0.58
Residents often have Conflicting Interests with the Government	F6	4.17	0.60
Ethnic Villages Lack Professional Managers	F7	4.11	0.66
The Protection of Ethnic Culture Lacks Planning	F8	4.22	0.63
Commercialisation of Ethnic Culture	F9	3.72	0.80
Lack of Tourism Marketing and Promotional Strategies	F10	3.56	0.96
Residents Lack Education	F11	3.61	0.68
Homogenisation of Ethnic Villages	F12	3.78	0.71
Rivers in Ethnic Villages are Polluted	F13	3.11	0.87
Neglect of Environmental Protection by Ethnic Village Managers	F14	3.50	0.76
Lack of Environmental Awareness Among Residents	F15	3.61	0.76
Lack of Publicity About Environmental Protection	F16	2.94	0.52
Lack of Environmental Protection Regulation	F17	2.50	0.83

The scoring step resulted in the final direct relationship matrix F, as shown in Table 4. This matrix outlines the direct interactions between the influencing factors. By analysing the matrix, the researcher gains a deeper understanding of the influence paths, allowing for clearer identification of the most influential factors in the system.

Table 4
Direct Influence Matrix F

Factors	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	3	5	3	0	0	3	2	0	0	0	0	2	0
3	2	0	0	0	0	0	0	0	0	0	0	0	3	0	0
4	0	5	3	0	0	0	0	0	0	0	0	0	0	0	0
5	3	4	2	3	0	5	4	2	1	4	0	5	0	5	3
6	0	0	0	0	0	0	4	0	3	2	0	0	0	0	0
7	0	4	0	0	0	0	0	0	0	1	0	0	0	0	0
8	0	2	0	0	0	4	2	0	4	1	0	0	0	0	0
9	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
12	1	0	0	0	0	0	0	0	0	0	4	0	0	5	4
13	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	2	0	3	0	0
15	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0

Constructing matrix F is a key step in the analysis, laying the foundation for determining causality and the strength of influence of each factor. The direct relationship matrix in Table 4 was then normalised using Formula 2 and Formula 3, resulting in the normalised direct relationship matrix presented in Table 5. The normalisation process standardises the scoring criteria for the influencing factors, enabling a comparison of the degree of influence between the factors on a consistent scale.

Formula 2 is used to calculate the normalised coefficients, ensuring that the values in the matrix of the direct relationship for each factor are adjusted within a reasonable range. Formula 3 applies these normalised coefficients to the items in matrix F, resulting in a new normalised matrix. Table 5 demonstrates the relative influence and strength of action between the factors, providing the researcher with an intuitive understanding of their weights and interactions. Table 4 offers a precise data framework that clearly quantifies the interactions among factors, supporting further causal analysis. Using Formula 4, the normalised matrix Y is converted into the total relationship matrix H, as shown in Table 5. The Total Relationship Matrix H reflects the overall interrelationships among the factors, encompassing both direct and indirect influences, thus presenting a comprehensive network of influences. Specifically, Equation 4 applies multiple power operations to the normalised matrix Y to progressively calculate the indirect influences of each factor until they converge to stable values. Each entry in matrix H captures both direct and indirect impacts, offering a holistic view of the system's underlying mechanisms.

Table 5

Normalized Direct Relation Matrix Y

	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Y15
Y1	0.000	0.122	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Y2	0.000	0.000	0.073	0.122	0.073	0.000	0.000	0.073	0.049	0.000	0.000	0.000	0.000	0.049	0.000
Y3	0.049	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.073	0.000	0.000
Y4	0.000	0.122	0.073	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Y5	0.073	0.098	0.049	0.073	0.000	0.122	0.098	0.049	0.024	0.098	0.000	0.122	0.000	0.122	0.073
Y6	0.000	0.000	0.000	0.000	0.000	0.000	0.098	0.000	0.073	0.049	0.000	0.000	0.000	0.000	0.000
Y7	0.000	0.098	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.024	0.000	0.000	0.000	0.000	0.000
Y8	0.000	0.049	0.000	0.000	0.000	0.098	0.049	0.000	0.098	0.024	0.000	0.000	0.000	0.000	0.000
Y9	0.000	0.049	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Y10	0.000	0.122	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Y11	0.000	0.098	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Y12	0.024	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.098	0.000	0.000	0.122	0.098
Y13	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.098	0.000	0.000	0.000	0.000
Y14	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.049	0.000	0.073	0.000	0.000
Y15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.122	0.000	0.000	0.000	0.000

In the Total Relationship Matrix H, presented in Table 6, the researcher can examine the combined influence of each factor on others, including the specific causal chain manifestations within the system. This matrix provides valuable insights into the driving roles and dependencies of the factors, helping to identify the core drivers and critical paths of influence more effectively. The overall relationship matrix H offers essential data for subsequent causal analysis and weighting assessments, enabling a systematic presentation of the dynamic interactions of influencing factors within the complex system.

Table 6

Total Relation Matrix H

	H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	H11	H12	H13	H14	H15
H1	0.001	0.126	0.011	0.016	0.009	0.002	0.002	0.010	0.007	0.001	0.001	0.001	0.001	0.007	0.001
H2	0.010	0.035	0.089	0.132	0.076	0.017	0.013	0.079	0.061	0.010	0.006	0.009	0.011	0.061	0.006
H3	0.049	0.007	0.001	0.001	0.001	0.000	0.000	0.001	0.000	0.000	0.007	0.000	0.073	0.000	0.000
H4	0.005	0.127	0.084	0.016	0.009	0.002	0.002	0.010	0.008	0.001	0.001	0.001	0.007	0.007	0.001
H5	0.080	0.152	0.067	0.093	0.011	0.129	0.114	0.060	0.047	0.109	0.031	0.123	0.016	0.146	0.086
H6	0.000	0.020	0.002	0.003	0.001	0.000	0.098	0.002	0.074	0.051	0.000	0.000	0.000	0.001	0.000
H7	0.001	0.104	0.009	0.013	0.008	0.002	0.001	0.008	0.006	0.025	0.001	0.001	0.001	0.006	0.001
H8	0.001	0.065	0.006	0.008	0.005	0.099	0.059	0.005	0.109	0.031	0.000	0.001	0.001	0.004	0.000
H9	0.000	0.050	0.004	0.006	0.004	0.001	0.001	0.004	0.003	0.001	0.000	0.000	0.001	0.003	0.000
H10	0.001	0.126	0.011	0.016	0.009	0.002	0.002	0.010	0.007	0.001	0.001	0.001	0.001	0.007	0.001
H11	0.001	0.101	0.009	0.013	0.007	0.002	0.001	0.008	0.006	0.001	0.001	0.001	0.001	0.006	0.001
H12	0.025	0.015	0.001	0.002	0.001	0.000	0.000	0.001	0.001	0.000	0.116	0.000	0.009	0.123	0.098
H13	0.000	0.010	0.001	0.001	0.001	0.000	0.000	0.001	0.001	0.000	0.098	0.000	0.000	0.001	0.000
H14	0.000	0.006	0.000	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.056	0.000	0.073	0.000	0.000
H15	0.000	0.012	0.001	0.002	0.001	0.000	0.000	0.001	0.001	0.000	0.122	0.000	0.000	0.001	0.000

In step 4 of the DEMATEL method, the centrality and causality degrees of each factor influencing the sustainable development of ethnic tourism in Xijiang Miao Village are calculated. This analysis enables the identification of factors with central influence in the system and distinguishes between driver and resultant factors. The centrality degree is derived by summing the degree of influence and the degree of being influenced for each factor, while the causality degree is obtained by subtracting the factor's causal role in the system. The centrality degree indicates the factor's overall importance and position within the system, while the causality degree helps identify whether a factor serves as a primary driver or an outcome. Table 7 presents the centrality and causality degrees of each factor, offering valuable insights into the key drivers in the sustainable development of ethnic tourism in Xijiang Miao Village. This information is crucial for developing effective management strategies, optimising resource allocation, and promoting sustainable tourism development in the region.

Table 7

Centre Degree and Cause Degree of Factors

Code	Factors	D+C	D-C
F1	Local Residents often have Conflicting Interests with the Government	0.372	0.022
F2	Lack of Investment	1.572	-0.341
F3	Local Residents Lack Education	0.436	-0.156
F4	The Infrastructure is Inadequate	0.603	-0.042
F5	Ethnic Villages Lack Professional Managers	1.409	1.123
F6	The Protection of Ethnic Culture Lacks Planning	0.509	-0.003
F7	Commercialisation of Ethnic Culture	0.479	-0.106
F8	Few Ethnic Culture Researchers	0.592	0.194
F9	Fewer Cultural and Creative Products	0.411	-0.253
F10	Homogenisation of Ethnic Villages	0.431	-0.037
F11	Rivers in Ethnic Villages are Polluted	0.598	-0.283
F12	Neglect of Environmental Protection by Ethnic Village Managers	0.532	0.253
F13	lack of Environmental Awareness among Local Residents	0.308	-0.082
F14	Lack of Publicity about Environmental Protection	0.512	-0.236
F15	Lack of Environmental Protection Regulation	0.336	-0.054

In step 5 of the DEMATEL method, a causal relationship diagram illustrating the factors affecting tourism development in Miao ethnic villages in Xijiang is presented in Figure 1. The diagram shows that factors F1, F5, F8, and F12 have positive causal relationships, categorising them as cause factors. Conversely, F2, F3, F4, F6, F7, F9, F10, F11, F13, F14, and F15 have negative values, marking them as outcome factors. Based on the centrality calculations, F5—representing the lack of professional managers in ethnic villages—emerges as the most influential cause factor. Among the outcome factors, F2, reflecting the lack of investment, is identified as the most significant.

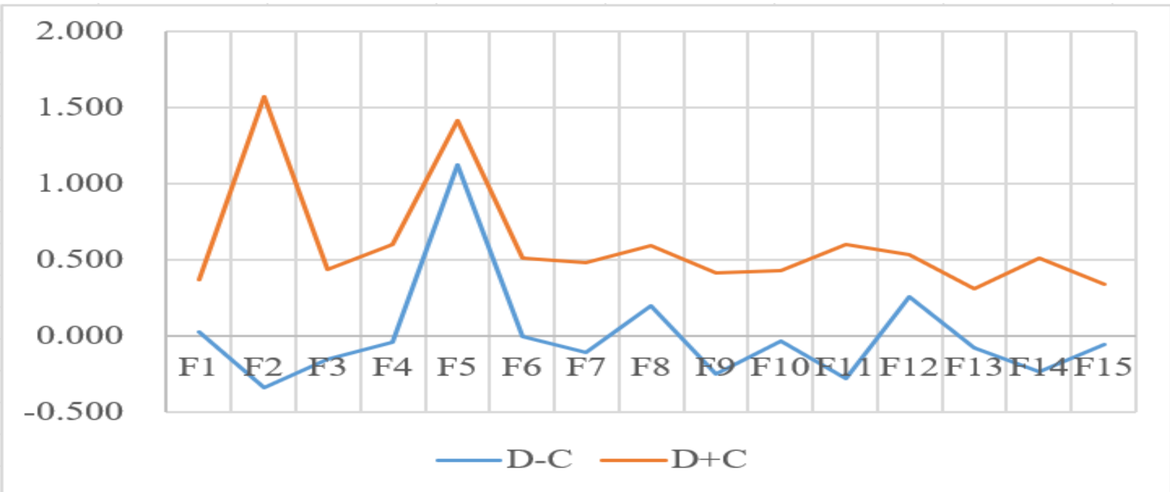

Fig.1. Causal Map

4.2 SEM's Findings

For the SEM analysis, the results captured both reliability and validity measures using Smart PLS version 4. The initial results focused on Cronbach's alpha for the variables, with both alpha values and composite reliability (rho_a and rho_c) contributing to the reliability assessment. The reliability analysis confirmed that all constructs demonstrated strong internal consistency and convergent validity. For instance, the Environmental & Risk Management construct showed a Cronbach's alpha of 0.803, rho_a of 0.808, rho_c of 0.884, and an AVE of 0.719. These values indicate that the items under this construction are both reliable and valid in measuring environmental awareness and risk management practices in ethnic village tourism. A representative item, such as "Tourism development respects natural landscapes and biodiversity," reflects the decision-making considerations assessed during the data collection.

Similarly, the Economic & Resource Management (ERM) constructed excellent internal consistency with a Cronbach's alpha of 0.829, rho_a of 0.923, rho_c of 0.894, and an AVE of 0.738. These values demonstrate the construct's ability to assess the management of financial and resource allocation decisions in the tourism sector. An example item, "Resources are allocated efficiently to tourism-related projects," highlights how respondents perceived economic decision-making in supporting sustainable outcomes for the region. The Governance & Policy (G&P) construct showed strong reliability, with a Cronbach's alpha of 0.813, composite reliability values of rho_a = 0.851 and rho_c = 0.880, and an AVE of 0.652. These metrics indicate that the construction is both reliable and valid. It assesses the effectiveness and clarity of policy frameworks and institutional support, as exemplified by the item, "Local governance supports sustainable tourism development," highlighting the significance of coherent policymaking in promoting sustainable tourism.

The Infrastructure Planning (INF) construct demonstrated excellent internal consistency, with a Cronbach's alpha of 0.833, rho_a = 0.857, rho_c = 0.891, and AVE = 0.675. These results affirm the reliability of measuring infrastructure-related decision-making. An example item, "Tourism infrastructure is well maintained and developed," reflects the practical aspects of infrastructure that influence sustainable tourism outcomes. The study's main dependent variable, Sustainable Development (SDM), also showed excellent reliability with a Cronbach's alpha of 0.921, rho_a = 0.924, rho_c = 0.937, and an AVE of 0.682. The item "Decision-making processes in tourism are aligned with long-term sustainability goals" exemplifies strategic, future-oriented planning. Lastly, the Stakeholder & Decision-Making (STM) construct demonstrated high reliability, with Cronbach's alpha = 0.857, rho_a = 0.881, rho_c = 0.903, and AVE = 0.699. A representative item, "Local communities are involved in tourism planning and decisions," underscores the importance of community engagement in ensuring sustainable and socially responsible tourism practices.

Table 8

Items Reliability and Validity Output

	Cronbach's Alpha	Composite Reliability (rho_a)	Composite Reliability (rho_c)	AVE
ENM	0.803	0.808	0.884	0.719
ERM	0.829	0.923	0.894	0.738
G&P	0.813	0.851	0.880	0.652
INF	0.833	0.857	0.891	0.675
SDM	0.921	0.924	0.937	0.682
STM	0.857	0.881	0.903	0.699

Note: INF: Infrastructure Planning, G&P: Governance and Policy, ENM: Environment and Risk Management, ERM: Economic and Resource Management, SDM: Sustainable Development for Strategic Decision Making, STM: Stakeholder & Decision Making

The HTMT ratio assesses discriminant validity by evaluating the correlations between constructions. As shown in Table 9, the correlation between ERM and ENM is 0.582, indicating sufficient distinction between these constructs. However, the correlation between ENM and G&P is higher at 0.821, suggesting a strong link between environmental and governance-related factors. G&P and INF also exhibit a high correlation of 0.838, reflecting a close relationship between governance frameworks and infrastructure planning. Similarly, INF and ERM are well correlated at 0.787. Sustainable Development in SDM shows notable correlations with ERM (0.637), G&P (0.794), and INF (0.601), indicating that sustainable tourism development is influenced by governance quality, infrastructure planning, and resource management. The STM construct shows strong correlations with ENM (0.767), INF (0.735), and SDM (0.743), highlighting the significant role of stakeholder involvement in environmental practices, infrastructure efforts, and sustainability decisions. However, the correlation between STM and ERM is relatively low at 0.123, suggesting that stakeholder involvement has less influence on economic or financial decision-making. Overall, the correlation results confirm an acceptable level of discriminant validity among these variables. Figure 2 illustrates the loadings of the items used to measure the constructions.

Table 9
HTMT Ratio

	ENM	ERM	G&P	INF	SDM	STM
ENM						
ERM	0.582					
G&P	0.821	0.428				
INF	0.550	0.787	0.838			
SDM	0.243	0.637	0.794	0.601		
STM	0.767	0.123	0.446	0.735	0.743	

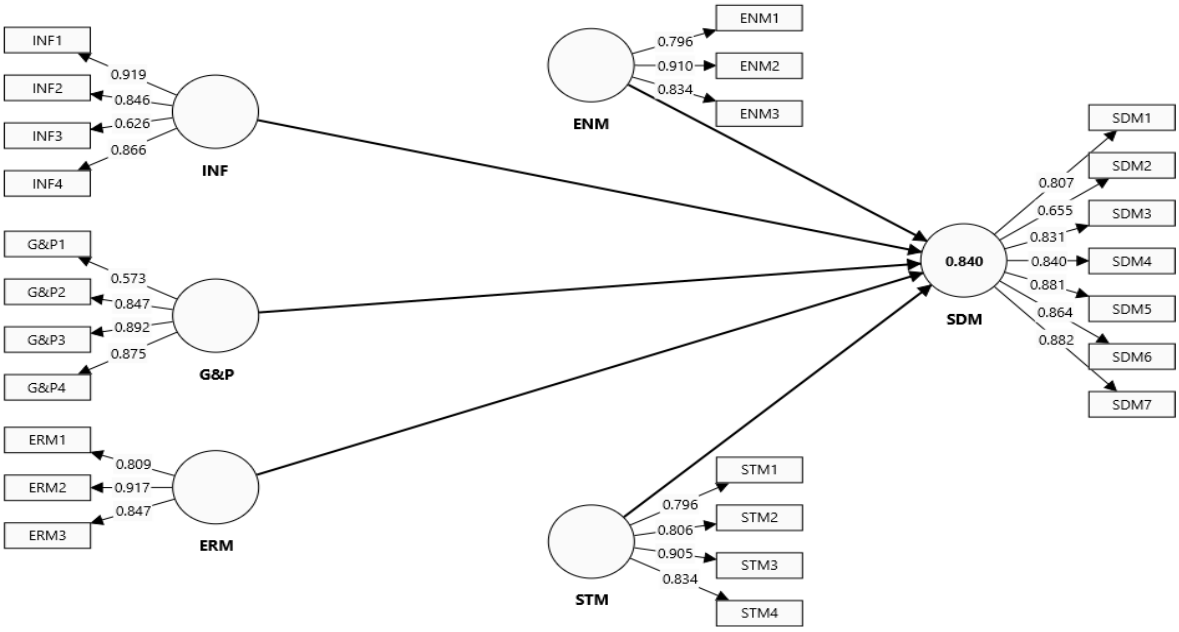

Fig.2. Loadings of the Constructs' Items

4.3 Analysing the Structural Relationships

The structural relationships were analysed using the Smart PLS bootstrapping method, and the results are summarised in Table 10. It was found that the impact of environment and risk management on sustainable development for SDM is negative and statistically significant, with a path coefficient of -0.804, a standard deviation of 0.059, a t-statistic of 13.527, and a p-value below 1%. This suggests that an increased focus on the environment and risk management is associated with a decrease in SDM within the tourism sector. This counterintuitive finding may reflect the current misalignment of these initiatives with broader strategic goals. Strict environmental regulations and risk management policies could be perceived as burdens, limiting decision-making flexibility and discouraging long-term sustainability investments. Therefore, the study suggests that policymakers need to reconsider their approach to environmental and risk management to better support sustainable tourism development.

In contrast, ERM shows a positive and statistically significant relationship with SDM, with a path coefficient of 0.176. Efficient resource management, whether financial, natural, or human, leads to better strategic decisions for sustainable tourism. Stable economic planning enables tourism organisations and policymakers to focus on long-term sustainability rather than short-term profits.

Similarly, G&P have a significant positive impact on SDM, with a path coefficient of 0.222. This suggests that strong institutional frameworks, transparent governance, and supportive policies help guide strategic decisions in a sustainable direction. Clear rules, accountability, and consistency foster trust and encourage long-term planning, while government incentives or legal frameworks promoting sustainability increase the likelihood of responsible tourism practices. On the other hand, INF shows a relatively weaker relationship with SDM, with a coefficient of -0.085, which is statistically significant at the 10% level.

Table 10

Structural Relationships

Directions	Original Sample	Standard Deviation	T Statistics	P Values
ENM -> SDM	-0.804	0.059	-13.527	0.000
ERM -> SDM	0.176	0.077	2.293	0.022
G&P -> SDM	0.222	0.040	5.55	0.000
INF -> SDM	-0.085	0.050	-1.705	0.088
STM -> SDM	-0.074	0.10	0.736	0.462

This indicates that while infrastructure is necessary for tourism development (e.g., transport, water, energy), it does not automatically lead to sustainable development unless planned with sustainability in mind. Lastly, the relationship between STM and SDM is negative and statistically insignificant, with a coefficient of -0.074. Since the relationship is not significant, further discussion of this path is not guaranteed.

5. Conclusion and Suggestions

This study investigates the key factors influencing decision-making for sustainable tourism development, particularly focusing on ethnic village tourism in Xijiang Miao Village. The research uses a combination of DEMATEL and SEM to identify the most impactful factors and areas that require improvement. The initial stage of the study applies the DEMATEL method to analyse the complex factors influencing sustainable tourism development, with a focus on infrastructure and policy optimisation. Through literature review and semi-structured interviews, 17 factors were identified, which were then refined to 15 key variables after expert evaluation. These were categorised into causal and outcome factors. Among the causal factors, key issues included frequent conflicts between residents and the government, a lack of professional managers, scarcity of cultural researchers, and poor environmental awareness among village managers. The most influential of these was the lack of professional tourism managers, which directly affects strategic planning, stakeholder coordination, and environmental and cultural preservation. The outcome factors, such as inadequate infrastructure, low environmental awareness, cultural commercialization, and insufficient investment, were viewed as consequences of ineffective management and policy shortcomings. These findings highlight the critical need to strengthen professional management, improve governance mechanisms, and invest in infrastructure and cultural preservation to support data-driven decision-making and promote long-term sustainable tourism development in ethnic villages.

In the second stage of the study, SEM was employed to explore the specific drivers of sustainable development decisions in the context of Xijiang Miao Village. The results indicate that governance and policy, along with economic and resource management, have a clear and positive impact on sustainable decision-making. The presence of strong policies and efficient resource management increases the likelihood that decision-makers will prioritise sustainability. However, the study also raised concerns regarding other factors and their relationship with strategic decision-making for sustainable development. For instance, the environmental and risk management factor showed a negative impact, suggesting that current efforts in this area may not be effectively contributing to better strategic decisions. While these efforts yield positive outcomes, they may inadvertently hinder sustainable planning and actions. Additionally, infrastructure planning was found to have weaker negative influences, indicating that current infrastructure development is not aligned with long-term sustainability goals. Furthermore, stakeholder involvement did not have a significant effect on sustainable development decision-making.

Overall, the study highlights the importance of better planning, stronger governance, and more efficient resource management to achieve sustainable development in ethnic tourism. The findings extend beyond the tourism sector to broader fields, including infrastructure planning, public policy, engineering, and environmental management. The study suggests that strategic decision-making in ethnic village tourism must move beyond short-term fixes and adopt long-term, integrated approaches that balance environmental protection with tourism growth. It also emphasises the need for infrastructure planning to be more strategically aligned with sustainability goals. Strengthening governance structures and improving economic and resource management practices will lay a stronger foundation for sustainable decision-making. Furthermore, local stakeholders must be more actively involved in the decision-making process to ensure that tourism development reflects community needs and priorities. By addressing these areas, Xijiang Miao Village, and similar ethnic villages, can better navigate the complex dynamics of sustainable tourism development, fostering a balance between tourism growth and the preservation of cultural and environmental resources.

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