



APPLICATION OF THE ANALYTIC HIERARCHY PROCESS FOR DETERMINING DEVELOPMENT PRIORITIES IN COMMUNITY-BASED TOURISM: A CASE STUDY OF GOA-7 IN UMA-ANA-ICO VILLAGE, TIMOR-LESTE

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Abstract

The tourism sector plays a strategic role in regional development, particularly in rural areas with significant natural and cultural resources. However, community-based tourism development often faces challenges such as limited accessibility, inadequate infrastructure, and the lack of systematic planning, as observed at the Goa-7 tourism site in Uma-Ana-Ico Village, Timor-Leste. This study aimed to determine tourism development priorities using the Analytic Hierarchy Process (AHP). Five experts participated in pairwise comparisons to calculate priority weights and assess consistency. The findings identified accessibility (0.49) as the highest priority, followed by infrastructure (0.24), community participation (0.14), economic potential (0.10), and environmental sustainability (0.05). The consistency ratio (CR = 0.046) confirmed the reliability of the evaluation. The results indicate that improving accessibility and infrastructure should be prioritized to support sustainable community-based tourism development. The study demonstrates that AHP provides an objective and systematic framework for establishing tourism development priorities and supporting evidence-based decision-making.

Keywords

Community-based tourism, Analytic Hierarchy Process, tourism development, decision-making, priority analysis

1. Introduction

The tourism sector has become a key driver of global economic growth, contributing approximately USD 10.9 trillion to the global economy and supporting around 357 million jobs in 2024, equivalent to nearly 10% of global GDP (World Travel & Tourism Council, 2024; World Bank, 2024). This indicates that tourism functions not only as a leisure activity but also as a strategic sector with significant multiplier effects, particularly in developing countries. Global tourism recovery after

the pandemic has further strengthened this role, although development remains uneven, especially in rural areas constrained by limited infrastructure, weak institutional capacity, and inadequate planning (World Economic Forum, 2024; OECD, 2024).

Community-based tourism (CBT) has been widely promoted as a sustainable approach that emphasizes local participation, empowerment, and equitable benefit distribution. Empirical evidence suggests that CBT can enhance local economic resilience and cultural preservation when effectively managed (World Bank, 2024). However, its success largely depends on structured planning and the ability to prioritize development strategies based on measurable criteria.

Tourism development involves complex and multi-dimensional factors, requiring systematic and quantitative decision-making approaches. In this context, multiple criteria such as accessibility, infrastructure, community participation, and economic potential must be evaluated simultaneously to ensure optimal outcomes. Nevertheless, recent studies indicate that tourism research remains dominated by qualitative approaches. Studies by Giampiccoli and Saayman (2021), Su et al. (2020), and Stone and Nyaupane (2020) show that most CBT analyses focus on participatory and socio-cultural dimensions, often lacking quantitative rigor and structured decision-making tools.

The need for quantitative approaches is increasingly emphasized in recent literature. Research by Kumar and Dhir (2020) and Mardani et al. (2021) highlights the importance of integrating multi-criteria decision-making models to improve objectivity and analytical precision in tourism planning. Despite this development, the application of such models in community-based tourism remains limited, particularly in developing regions (Rasoolimanesh et al., 2021). In Timor-Leste, tourism studies are still largely descriptive, with minimal use of mathematical models for prioritizing development strategies.

Uma-Ana-Ico Village in Venilale Administrative Post, Baucau Municipality, represents an area with considerable tourism potential, particularly through the Goa-7 site. Despite its natural and cultural attractiveness, tourism development in this area remains unstructured, with limited prioritization of key factors and weak integration of community-based approaches into formal planning.

This study addresses these limitations by applying the Analytic Hierarchy Process to develop a quantitative decision-making model for determining development priorities in community-based tourism at Goa-7. This approach enables systematic evaluation, weighting of criteria, and generation of priority rankings. The findings are expected to contribute to the advancement of quantitative tourism planning models while providing practical, data-driven recommendations for policymakers and local stakeholders.

2. Methods

This study employs a quantitative approach using a multi-criteria decision-making framework to determine development priorities in community-based tourism. The research design is structured to transform complex tourism development factors into measurable criteria, enabling systematic evaluation and objective decision-making.

The study was conducted at the Goa-7 tourism site located in Uma-Ana-Ico Village, Venilale Administrative Post, Baucau Municipality, Timor-Leste. This location was selected due to its significant tourism potential and the absence of structured development planning. The research population consists of key stakeholders involved in tourism development, including local community representatives, tourism managers, and village authorities. A purposive sampling technique was applied to select respondents who possess relevant knowledge and experience related to tourism planning.

Data were collected using a structured questionnaire based on pairwise comparison, designed in accordance with the principles of the Analytic Hierarchy Process. The instrument measures the relative importance of criteria and sub-criteria influencing tourism development. The main criteria were identified through literature review and contextual relevance, including accessibility, infrastructure, community participation, economic potential, and environmental sustainability.

The data analysis follows the standard procedures of AHP. First, a pairwise comparison matrix was constructed to evaluate the relative importance of each criterion. Second, the matrix was normalized to obtain priority weights representing the relative significance of each factor. Third, the consistency of judgments was tested using the Consistency Ratio (CR), where a value of $CR \leq 0.1$ indicates acceptable consistency. Finally, the weighted scores were calculated to generate a ranking of development priorities.

The results of the analysis provide a quantitative basis for identifying the most critical factors in community-based tourism development at Goa-7. This methodological approach ensures that decision-making is based on systematic evaluation rather than subjective judgment, thereby enhancing the reliability and validity of the findings.

3. Results

Criteria Identification for Tourism Development

The identification of criteria constitutes a critical stage in the Analytic Hierarchy Process, as it establishes the hierarchical structure and determines the variables used in the decision-making process. In community-based tourism development, criteria must reflect multidimensional aspects, including physical infrastructure, socio-economic conditions, and environmental sustainability.

Recent studies emphasize that tourism development requires an integrated evaluation of accessibility, infrastructure, community involvement, economic contribution, and environmental preservation (Mardani et al., 2021; Rasoolimanesh et al., 2021; Giampiccoli & Saayman, 2021). These dimensions are particularly relevant in rural tourism contexts, where development challenges are often complex and interrelated.

Based on literature review and contextual analysis of the Goa-7 tourism site, five main criteria were identified and operationalized as presented in Table 1.

Table 1. Criteria and Operational Definitions for Tourism Development

No	Criteria	Code	Operational Definition	Key Indicators
1	Accessibility	A	The ease of reaching the tourism site from main transportation routes	Road condition, distance, transportation availability
2	Infrastructure	I	Availability and quality of supporting tourism facilities	Accommodation, sanitation, signage, public facilities
3	Community Participation	C	The involvement of local communities in tourism development and management	Local involvement, decision-making participation, benefit-sharing
4	Economic Potential	E	The ability of tourism to generate income and economic opportunities	Job creation, local income, business opportunities
5	Environmental Sustainability	S	The preservation of environmental quality and natural resources	Environmental protection, waste management, ecosystem conservation

The selected criteria represent a comprehensive framework that captures the essential dimensions of community-based tourism development. Each criterion is measurable and suitable for pairwise comparison analysis, ensuring compatibility with the quantitative requirements of the AHP method. The use of clearly defined indicators also enhances the reliability of expert judgments and supports consistency in the evaluation process.

Pairwise Comparison Matrix from Expert Judgments

The pairwise comparison matrix was developed based on expert judgments collected from five selected respondents representing key stakeholders in tourism development. Each expert assessed the relative importance of the criteria using the fundamental scale of the Analytic Hierarchy Process. To obtain a unified and representative matrix, all individual judgments were aggregated using the geometric mean method, which is widely applied in AHP to reduce bias and maintain proportional consistency among responses.

Table 2. Aggregated Pairwise Comparison Matrix (Geometric Mean)

Criteria	A	I	C	E	S
A	1.000	3.55	5.74	3.55	6.20
I	0.28	1.000	3.00	3.00	5.00
C	0.17	0.33	1.000	3.00	3.00
E	0.28	0.33	0.33	1.000	3.00
S	0.16	0.20	0.33	0.33	1.000

Source: Processed data using geometric mean from five expert respondents (2026)

The aggregated matrix demonstrates a clear pattern of expert preference in determining tourism development priorities. Accessibility (A) exhibits the highest relative importance compared to other criteria, particularly in relation to environmental sustainability (S) and community participation (C), indicating that ease of access is perceived as the primary driver in the development of the Goa-7 tourism site. Infrastructure (I) also shows a relatively strong position, especially when compared to economic potential (E) and environmental sustainability, reflecting the importance of supporting facilities in enhancing tourism attractiveness.

Community participation (C) and economic potential (E) occupy intermediate positions, suggesting that while social and economic aspects are relevant, they are not considered as immediate priorities compared to physical accessibility and infrastructure. Environmental sustainability (S) tends to have the lowest relative dominance among the criteria, indicating that long-term ecological considerations are still secondary to short-term development needs in the perception of experts.

The matrix satisfies the reciprocal property required in AHP, where each element is the inverse of its counterpart. This confirms that the aggregated judgments are logically consistent and can be further processed in the subsequent stages, including normalization and priority weight calculation.

Normalization of the Comparison Matrix

The normalization process is conducted to transform the aggregated pairwise comparison matrix into a comparable scale, allowing the relative importance of each criterion to be evaluated proportionally. In the Analytic Hierarchy Process, normalization is performed by dividing each element in a column by the total sum of that column. This procedure ensures that the values in each column sum to one, thereby enabling the calculation of priority weights.

Table 3. Normalized Pairwise Comparison Matrix

Criteria	A	I	C	E	S
A	0.53	0.66	0.57	0.33	0.34
I	0.15	0.19	0.30	0.28	0.27
C	0.09	0.06	0.10	0.28	0.16
E	0.15	0.06	0.03	0.09	0.16
S	0.08	0.04	0.03	0.03	0.05

Source: Processed data from the aggregated pairwise comparison matrix (2026)

The normalized matrix illustrates the proportional contribution of each criterion across all comparisons. Accessibility (A) consistently shows the highest normalized values across most columns, indicating its dominant influence in the decision-making structure. This suggests that experts strongly prioritize accessibility when evaluating tourism development strategies.

Infrastructure (I) demonstrates moderate values across all columns, reflecting its supporting but still significant role in tourism development. Community participation (C) and economic potential (E) display relatively balanced contributions, indicating that both criteria are considered relevant but not dominant factors.

Environmental sustainability (S) shows the lowest normalized values across the matrix, suggesting that it is perceived as less critical compared to other criteria

in the current development context. This pattern reflects a tendency among experts to prioritize immediate and tangible development factors over long-term environmental considerations.

The normalized matrix serves as the basis for calculating priority weights, which will determine the final ranking of criteria in the subsequent analysis.

Priority Weights Calculation

The priority weights represent the relative importance of each criterion in the decision-making process. In the Analytic Hierarchy Process, the priority weights are obtained by calculating the average value of each row in the normalized matrix. This step produces a priority vector (eigenvector approximation) that reflects the contribution of each criterion to the overall decision.

Table 4. Priority Weights of Criteria

Criteria	Code	Priority Weight	Rank
Accessibility	A	0.49	1
Infrastructure	I	0.24	2
Community Participation	C	0.14	3
Economic Potential	E	0.10	4
Environmental Sustainability	S	0.05	5

Source: Processed data from normalized matrix (2026)

The results indicate that accessibility (A) has the highest priority weight (0.49), making it the most influential factor in determining tourism development strategies at the Goa-7 site. This finding suggests that improving access, transportation, and connectivity is perceived as the primary requirement for enhancing tourism attractiveness.

Infrastructure (I) ranks second with a weight of 0.24, highlighting the importance of supporting facilities such as accommodation, sanitation, and public amenities. The relatively high weight of infrastructure indicates that physical readiness remains a key determinant of tourism development success.

Community participation (C) occupies the third position with a weight of 0.14, reflecting its role as a supporting factor in ensuring sustainability and local engagement. Economic potential (E) follows with a weight of 0.10, indicating that while economic benefits are important, they are not the primary driver in the initial stage of development.

Environmental sustainability (S) has the lowest priority weight (0.05), suggesting that ecological considerations are currently perceived as secondary compared to more immediate development needs. This pattern reflects a development orientation that prioritizes accessibility and infrastructure as foundational elements before addressing long-term sustainability concerns.

The priority weights obtained in this stage form the basis for consistency testing and final decision-making in the subsequent analysis.

Consistency Test

The consistency test is conducted to evaluate the reliability of expert judgments in the pairwise comparison matrix. In the Analytic Hierarchy Process, consistency is measured using the Consistency Index (CI) and Consistency Ratio

(CR). A consistent judgment is indicated when the CR value is less than or equal to 0.10, ensuring that the comparisons made by respondents are logically coherent.

The calculation process involves determining the maximum eigenvalue (λ_{max}), followed by the computation of CI and CR using the standard formulas. The Random Index (RI) value is determined based on the number of criteria ($n = 5$).

Table 5. Consistency Test Results

Parameter	Value
λ_{max}	5.21
Consistency Index (CI)	0.052
Random Index (RI)	1.12
Consistency Ratio (CR)	0.046

Source: Processed data using AHP consistency calculation (2026)

The results show that the Consistency Ratio (CR) is 0.046, which is below the acceptable threshold of 0.10. This indicates that the judgments provided by the experts are consistent and reliable. The low CI value further confirms that the level of inconsistency in the pairwise comparisons is minimal.

These findings validate the use of the aggregated comparison matrix and the derived priority weights for further analysis. The consistency of the data ensures that the resulting priority ranking reflects a logically sound decision-making process, thereby strengthening the credibility of the study.

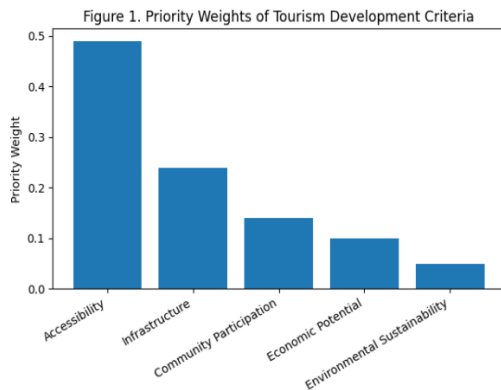
Ranking of Development Priorities

The final ranking of development priorities is derived from the calculated priority weights obtained through the Analytic Hierarchy Process. This ranking represents the relative importance of each criterion in guiding strategic decisions for community-based tourism development at the Goa-7 site.

Table 6. Final Ranking of Tourism Development Priorities

Rank	Criteria	Code	Priority Weight
1	Accessibility	A	0.49
2	Infrastructure	I	0.24
3	Community Participation	C	0.14
4	Economic Potential	E	0.10
5	Environmental Sustainability	S	0.05

Source: Processed data from AHP results (2026)



The ranking results indicate that accessibility is the most critical factor in the development of community-based tourism at Goa-7, with a significantly higher weight compared to other criteria. This suggests that improving road conditions, transportation access, and connectivity should be prioritized as the primary development strategy.

Infrastructure occupies the second position, highlighting the importance of providing adequate facilities to support tourism activities. The relatively high weight of this criterion reinforces the need for investment in basic amenities and service quality to enhance visitor experience.

Community participation ranks third, indicating that while local involvement is essential, it functions more as a supporting factor rather than a primary driver in the initial development phase. Economic potential follows in the fourth position, suggesting that economic benefits are expected to emerge as a consequence of improved accessibility and infrastructure.

Environmental sustainability is ranked last, reflecting a lower perceived priority among experts. This finding implies that environmental considerations are currently secondary to immediate development needs. However, this does not diminish its importance, as sustainability remains crucial for long-term tourism viability.

The ranking provides a clear and systematic basis for decision-making, enabling policymakers and stakeholders to allocate resources effectively and implement targeted development strategies in the Goa-7 tourism area.

4. Discussion

The results of this study show a clear hierarchy of development priorities, where accessibility (0.49) emerges as the most dominant criterion, followed by infrastructure (0.24), community participation (0.14), economic potential (0.10), and environmental sustainability (0.05). The substantial gap between accessibility and the other criteria indicates a strong consensus among experts that physical access is the primary constraint in the development of the Goa-7 tourism site.

The dominance of accessibility, with a weight nearly double that of infrastructure, suggests that improvements in road conditions, transportation availability, and connectivity are perceived as the most urgent interventions. This finding aligns with destination competitiveness theory, which emphasizes that accessibility functions as a gateway variable that determines tourist inflow and overall destination performance. In rural tourism contexts, limited accessibility often becomes a structural barrier that prevents the effective utilization of tourism potential.

Infrastructure, with a weight of 0.24, occupies the second position and reflects the importance of supporting facilities in enhancing visitor experience. The difference between accessibility (0.49) and infrastructure (0.24) also indicates that stakeholders perceive access as a prerequisite, while infrastructure acts as a

complementary factor. This pattern supports development planning theory, which posits that physical connectivity must precede facility enhancement to ensure optimal resource allocation.

Community participation, although central in the concept of community-based tourism, only achieves a weight of 0.14. This value indicates that its relative importance is significantly lower than that of accessibility and infrastructure. The gap suggests that stakeholders prioritize immediate and tangible development outcomes over participatory processes in the early stages of tourism development. This does not imply that participation is unimportant, but rather that it is considered a secondary priority once basic physical conditions are met.

Economic potential (0.10) and environmental sustainability (0.05) rank fourth and fifth, respectively. The relatively low weight of economic potential suggests that stakeholders view economic benefits as a derived outcome rather than a primary driver. Meanwhile, environmental sustainability, with the lowest weight, reflects a limited emphasis on long-term ecological considerations. The difference between community participation (0.14) and environmental sustainability (0.05) further indicates that social aspects are still considered more relevant than environmental concerns in the current development context.

When compared with previous studies, these findings both confirm and challenge existing perspectives. Research by Giampiccoli and Saayman (2021) and Stone and Nyaupane (2020) identifies community participation as the core element of community-based tourism. However, the present study demonstrates that in the case of Goa-7, accessibility (0.49) and infrastructure (0.24) are significantly more dominant than participation (0.14). This discrepancy suggests that the relative importance of CBT components is context-dependent and influenced by the development stage of the destination.

Furthermore, studies by Mardani et al. (2021) and Kumar and Dhir (2020) highlight the effectiveness of multi-criteria decision-making approaches in addressing complex planning problems. The current study supports these findings by showing that the application of the Analytic Hierarchy Process produces a clear and quantifiable ranking of priorities. The numerical differentiation between criteria, particularly the large gap between the highest (0.49) and lowest (0.05) weights, demonstrates the strength of AHP in capturing expert preferences with high resolution.

The relatively low ranking of environmental sustainability (0.05) is consistent with findings from Rasoolimanesh et al. (2021), which indicate that in developing regions, economic and infrastructural concerns often outweigh environmental priorities. However, this also highlights a critical issue, as the underestimation of environmental factors may pose risks to long-term sustainability if not addressed in subsequent development phases.

The novelty of this study lies in its ability to quantify the relative importance of community-based tourism components within a specific local context. While previous studies have largely relied on qualitative assessments, this study provides a measurable and structured prioritization model. The clear numerical hierarchy—particularly the dominance of accessibility (0.49)—offers new insights into how tourism development should be staged in emerging destinations such as Goa-7. Additionally, the application of AHP in the context of Timor-Leste contributes to the limited body of quantitative tourism research in the region.

The findings suggest that tourism development in Goa-7 should follow a sequential strategy, beginning with improving accessibility, followed by infrastructure development, and subsequently strengthening community participation and sustainability initiatives. This staged approach ensures that development efforts are aligned with both expert priorities and practical constraints.

5. Conclusion

This study applies the Analytic Hierarchy Process to determine development priorities in community-based tourism at the Goa-7 site. The findings indicate that accessibility (0.49) is the most dominant factor, followed by infrastructure (0.24), community participation (0.14), economic potential (0.10), and environmental sustainability (0.05). The significant gap between accessibility and other criteria highlights that physical access and connectivity are the primary constraints in tourism development. These results suggest that improving transportation networks and road conditions is a fundamental prerequisite for enhancing tourism performance in the study area.

The study further reveals that infrastructure plays a crucial supporting role, while community participation, although essential in the concept of community-based tourism, is positioned as a secondary priority in the early stages of development. Economic potential is perceived as an outcome of improved accessibility and infrastructure, rather than an initial driver. Meanwhile, the low priority assigned to environmental sustainability reflects a short-term development orientation, which may pose challenges for long-term sustainability if not properly addressed.

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