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Research article

# Decision Support System for Tourist Destination Selection in Buleleng Using the Analytical Hierarchy Process (AHP)

*Anak Agung Surya Pradhana* [a*], *I Nyoman Darma Kotama* [b]

[a,b] *Department of Computer Systems, Institut Bisnis dan Teknologi Indonesia, Denpasar, Indonesia*
*email:* [a,*] surya.pradhana@instiki.ac.id, [b] darma.kotama@instiki.ac.id
** Correspondence*

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**ABSTRACT**

Tourism is a key driver of regional economic development and cultural sustainability, particularly in destinations with diverse natural and cultural assets such as Buleleng, Bali. Yet, selecting the most suitable tourist location is often difficult because it involves various decision factors, including accessibility, attractiveness, available facilities, safety, cost, cleanliness, popularity, and visitor density, which can lead to decisions based on personal bias rather than objective evaluation. To address this challenge, this study develops a Decision Support System (DSS) using the Analytical Hierarchy Process (AHP) to systematically assess and rank tourist destinations in Buleleng based on eight priority criteria. The proposed approach provides a structured weighting mechanism and ensures logical consistency in comparisons, indicated by a Consistency Ratio (CR) of 0.000. The analysis results reveal that Pura Ulun Danu Beratan is the most recommended destination, followed by Lovina Beach and Sekumpul Waterfall, supported by their strong appeal and adequate supporting infrastructure. Future development of this system may involve incorporating real-time visitor data, sentiment analysis from online travel reviews, and GIS-based visualization, as well as deployment in web or mobile platforms to increase usability for travelers and local tourism planners.



## 1. Introduction

Tourism is an essential sector that contributes significantly to regional economic development, cultural heritage preservation, and local community empowerment. Regions with diverse natural resources and cultural richness, such as Buleleng in Bali, benefit greatly from tourism activities that promote both local identity and regional economic circulation [1]. The role of tourism in encouraging local business growth, enhancing employment opportunities, and driving public infrastructure development is widely recognized in academic discourse [2]. Buleleng Regency possesses a variety of tourism attractions including beaches, waterfalls, mountain lakes, hot springs, cultural heritage temples, and traditional villages. These tourism assets offer broad experiential diversity ranging from nature-based tourism to cultural and wellness tourism [3]. However, while the abundance of tourism destinations in Buleleng provides travelers with many appealing choices, it also introduces complexity in selecting destinations that best align with visitor preferences, trip goals, time availability, and budget. Moreover, the tourism experience is influenced not only by the attractiveness of the destination but also by supporting factors such as accessibility, facilities, cleanliness, safety, and visitor density [4]. As tourist behavior becomes more dynamic and personalized, relying solely on promotional media, word-of-mouth, or past experiences is insufficient for making accurate and objective decisions. Consequently, there is a growing demand for decision-support mechanisms that

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can accommodate diverse evaluation criteria and assist travelers and tourism stakeholders in determining the most suitable tourism destinations efficiently.

Despite the positive economic contributions of tourism, the decision-making process involved in selecting tourism destinations often faces challenges due to conflicting evaluation factors and subjective considerations [5]. Tourists frequently encounter uncertainty when determining which destination offers the best experience relative to their personal priorities, such as convenience, cost, or popularity. Meanwhile, tourism planners and local authorities require structured data to identify which destinations should be prioritized for development and which require improvements in infrastructure, safety, or cleanliness [6]. Traditional approaches to tourism destination assessment typically rely on descriptive evaluations, anecdotal traveler reviews, or aggregated rankings that often overlook the multi-criteria nature of tourism decision-making. This may lead to inconsistent outcomes and potential misalignment between visitor expectations and actual tourism experiences. Additionally, social media-based perception trends can fluctuate, causing biases in destination popularity that do not always reflect sustainable tourism principles [7]. The absence of a systematic evaluation framework also complicates tourism planning, as stakeholders may struggle to allocate resources optimally. Given these issues, a robust model capable of integrating diverse criteria and offering transparent priority ranking is required. Multi-criteria decision-making (MCDM) approaches, when integrated into tourism planning, have shown substantial potential to provide reliable decision support in situations involving multiple qualitative and quantitative variables [8]. Therefore, an analytical approach is necessary to enhance decision-making consistency and accuracy in selecting tourism destinations.

In response to the challenges identified, this study proposes the development of a Decision Support System (DSS) for selecting tourism destinations in Buleleng using the Analytical Hierarchy Process (AHP) technique [9]. The primary goal of this research is to construct a structured evaluation mechanism capable of ranking multiple tourism alternatives based on well-defined weighted criteria. AHP is well-suited to this objective because it enables decision-makers to break down complex decisions into hierarchical components and perform pairwise comparisons that produce priority weightings reflecting the relative importance of each criterion [10]. In this research, eight evaluation criteria are considered: accessibility, attractiveness, supporting facilities, cleanliness, cost, popularity, safety, and visitor density. These criteria were selected based on their relevance to both visitor experience and tourism management priorities [11]. The motivation for applying AHP lies in its ability to ensure logical consistency through the calculation of the Consistency Ratio (CR), which provides a reliability indicator for judgment accuracy. A low CR value signifies that the prioritization is reasonable and aligned with consistent decision logic. The AHP-based DSS developed in this study is expected to assist travelers in selecting tourism destinations more systematically and to support tourism managers in identifying which destinations hold the highest competitive advantage. Additionally, this system aligns with current trends in tourism digitalization, where intelligent decision support applications increasingly complement physical tourism infrastructure development [12].

This study contributes to the growing field of data-driven tourism planning by offering a transparent and structured evaluation model for tourism destination selection. First, it provides an analytical approach for identifying the most influential decision criteria, thereby enabling stakeholders to understand which aspects of tourism development should be prioritized. Second, the system offers a ranked list of tourism destinations in Buleleng, with Pura Ulun Danu Beratan emerging as the top recommended destination, followed by Lovina Beach and Sekumpul Waterfall, reflecting their strong natural appeal, accessibility, and facility support, as shown by evaluation outcomes. Third, the consistency of the pairwise comparison results was validated through the Consistency Ratio (CR), which yielded a value of 0.000, confirming the high reliability of the decision-making judgments. The evaluation outcomes demonstrate that the proposed AHP-based DSS offers a dependable evaluation process capable of supporting both tourists and policymakers in making informed destination choices. Looking forward, this study can be expanded by integrating real-time visitor data, online sentiment analytics, and GIS-based visualization for more dynamic recommendation outputs. Furthermore, the decision-support model can be developed into a web-

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based or mobile platform to make tourism destination recommendations more widely accessible. In conclusion, this research provides a strong foundation for enhancing tourism planning strategies and improving travel decision-making processes within the Buleleng tourism landscape.

## 2. Related Work

Research on decision-making processes in tourism destination selection has grown significantly in recent years, especially in regions where tourism functions as a primary economic sector and cultural asset. Prior studies highlight that tourism plays a vital role in promoting regional growth, economic circulation, and the empowerment of local communities [1]. In the context of Bali, particularly in the Buleleng region, tourism contributes not only to financial income but also to cultural preservation and social identity formation. However, the abundance of available tourist destinations simultaneously presents a choice complexity that requires travelers and tourism authorities to evaluate multiple considerations before determining preferred destinations [2]. Without analytical support, destination selection tends to rely heavily on subjective experiences, recommendations, or promotional narratives, which do not always reflect objective destination quality and visitor expectations. This creates a need for structured evaluation models capable of balancing qualitative and quantitative judgment factors.

Previous research on tourist preference formation and decision behavior indicates that the process of choosing a travel destination is influenced by numerous interconnected factors, such as attractiveness, accessibility, affordability, personal interest, and perceived experience value [3]. Nugroho and Widodo identified that tourists often weigh attributes differently based on personal motivations, meaning that what may be ideal for one traveler may not align with the priorities of another. Such findings illustrate the multi-dimensional nature of tourism decision-making and reinforce the argument that intuitive or promotional-based decision-making is insufficient to support accurate selection. To address these decision uncertainties, researchers have incorporated Multi-Criteria Decision-Making (MCDM) methods to ensure structured evaluation across multiple attributes [4]. Srinivas and Rao compared various MCDM approaches in tourism ranking and found that the Analytical Hierarchy Process (AHP) offers higher clarity in weight assignment for criteria and sub-criteria, making it particularly suitable for tourism planning that involves subjective judgment.

Studies conducted in North Bali further show that environmental appeal, cultural distinctiveness, and authentic natural scenery are among the main factors influencing tourist satisfaction and destination image [5]. Mahendra and Pradnyana, for instance, discovered that although natural beauty is an important pull factor, travelers also evaluate supporting elements such as cleanliness, convenience of access routes, and available visitor facilities to determine whether a destination is worth revisiting. Meanwhile, decision-support literature has shifted toward digital platforms, recognizing that modern tourists increasingly depend on online information systems for planning and evaluating travel options [6]. Saeed and Alkhodair emphasized that Decision Support Systems (DSS) in tourism have become more relevant with the growth of digital tourism and mobile-based search behavior, suggesting that integrated models capable of synthesizing multiple criteria are essential for practical real-world adoption.

The use of AHP-based decision support models in tourism recommendation has been explored in several prior studies. Lestari and Gunawan implemented an AHP-driven recommendation system for hotel and destination ranking and demonstrated that model-based prioritization leads to recommendations that match user expectations more consistently compared to preference-based search alone [7]. Their research underscores the capability of AHP to translate subjective perceptions into structured hierarchical evaluations that allow travelers to understand trade-offs more clearly. Similarly, Rahman and Susanto performed a comparison of different MCDM techniques for tourism development planning and determined that AHP offers the advantage of interpretability, making it easier for stakeholders to justify decision outcomes [8]. Their evaluation confirmed that while some methods can produce fast computational scores, AHP remains more transparent in showing how criteria weight differences influence the final ranking.

Further developments in tourism evaluation models include combining AHP with empirical performance analysis. Permana et al. assessed tourism attractions using structured weighting and concluded that priority-based evaluation can help regional managers identify which destinations

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require infrastructure improvements and which deserve strategic promotion [9]. This is particularly important in regions like Buleleng, where tourism resources are abundant but vary in terms of accessibility, facility quality, and popularity. Complementary research integrating spatial analysis presents another methodological expansion. Wahyudi and Nurhidayah used Geographic Information Systems (GIS) to visualize the spatial relationships among destinations and their accessibility patterns, demonstrating that geospatial representation enhances tourism planning decisions by enabling planners to view tourism development within a spatially contextualized framework [10].

Recent tourism studies also indicate the increasing importance of digital popularity indicators, such as social media engagement and location check-in patterns. Sudarma and Marlina showed that visitor density trends and digital footprint metrics can act as proxies for destination popularity while also providing insights into how tourism flows change over time [11]. This suggests that tourism recommendation systems can be improved by integrating behavior-driven dynamic data instead of relying solely on static evaluation values. In addition, tourism statistics reported annually by the Ministry of Tourism and Creative Economy continue to emphasize the variability of visitor patterns influenced by trends, accessibility conditions, travel restrictions, and regional promotional strategies [12]. These observations highlight the ongoing need for adaptive decision-support tools that remain responsive to evolving travel behaviors and tourism demand.

From the reviewed literature, it is evident that the development of tourism decision-support systems is shaped by three primary research directions. The first concerns the analysis of tourist perceptions and destination attractiveness, emphasizing how experiential and environmental qualities influence travelers' destination choices. The second focuses on the adoption of structured multi-criteria evaluation methods, particularly the Analytical Hierarchy Process (AHP), which provides a systematic approach for weighting and comparing tourism attributes. The third involves the integration of digital and data-driven analytics, including Geographic Information Systems (GIS) and social media-derived insights, which enable real-time and spatially contextual evaluations of tourism patterns.

Despite these advancements, existing research still leaves identifiable gaps. Many studies assess only a narrow set of criteria or emphasize single destination types, rather than developing comprehensive models that evaluate diverse destination categories simultaneously. Additionally, several decision-support approaches lack consistency validation, even though ensuring the logical reliability of pairwise comparisons is a crucial step in multi-criteria analysis. The present study addresses these shortcomings by implementing AHP with eight evaluation criteria and confirming comparison consistency through the Consistency Ratio (CR). Furthermore, this research is tailored specifically to the tourism context of Buleleng, thereby providing a decision-support model that is both methodologically rigorous and regionally relevant. The findings contribute not only to theoretical discussions regarding tourism decision frameworks but also to the practical application of DSS tools that can support strategic tourism planning and traveler decision-making in real-world settings.

## 3. Methodology

### 3.1. Data Collection

This study utilizes 10 tourism destination alternatives located in Buleleng Regency: Lovina Beach (A1), Gitgit Waterfall (A2), Buyan Lake (A3), Tamblingan Lake (A4), Sekumpul Waterfall (A5), Ulun Danu Beratan Temple (A6), Munduk Village (A7), Banjar Hot Spring (A8), Krisna Funtastic Land (A9), and Buleleng Museum (A10). The evaluation is based on eight criteria, namely C1 Accessibility, C2 Tourist Attraction, C3 Supporting Facilities, C4 Cleanliness, C5 Cost (cost-type), C6 Popularity, C7 Safety, and C8 Visitor Density (cost-type). Criteria C1, C2, C3, C4, C6, and C7 are classified as benefit criteria, while C5 and C8 are cost criteria. The priority weights used for each criterion are: C2=0.28, C6=0.22, C1=0.14, C3=0.12, C7=0.10, C4=0.07, C5=0.04, and C8=0.03 (total = 1.00). The destination list, criteria definitions, and weight assignments are adopted directly from the original research document. The structure of this dataset aligns with DSS and MCDM literature in tourism, where diverse experiential, infrastructural, and perceptual attributes must be represented [1], [3], [6], [8].

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### 3.2. Data Preprocessing

Data preprocessing was conducted to ensure evaluation consistency and scale comparability. First, criteria were confirmed under their respective benefit or cost classifications to maintain correct decision direction. Second, alternative scoring used a 1–9 rating scale, where higher values indicate more favorable outcomes for benefit criteria and less favorable outcomes for cost criteria. Third, scoring was normalized during AHP local priority calculation, ensuring equal comparability across criteria. Since criteria weights and hierarchical structure were already well-defined, no additional rescaling or imputation was necessary. These preprocessing procedures are aligned with standard AHP implementation practices in tourism-based multi-criteria decision-making [4], [7], [8].

### 3.3. Decision Hierarchy Design

The decision model is structured into three hierarchical levels: (1) Goal: Selecting the most recommended tourism destination; (2) Criteria: C1–C8; and (3) Alternatives: A1–A10. The hierarchical structure ensures that each decision element reflects a distinct and non-overlapping dimension of tourism experience, preventing redundancy and improving clarity during pairwise comparison. Hierarchy-based structuring is critical to yield interpretable prioritization consistent with established decision-support methodologies in tourism analytics [4], [8], [9].

### 3.4. Pairwise Comparison and Weight Derivation

Pairwise comparisons among criteria were performed based on the provided priority weights, forming a comparison matrix where each entry represents the importance ratio ($a_{ij} = w_i / w_j$). The principal eigenvector of the matrix provides the criteria priority weights used in decision aggregation. For alternatives, each destination was scored 1–9 on each criterion, then normalized to derive local priorities. This follows the standard AHP computational framework, widely used in tourism recommendation and facility selection research [7]–[9].

### 3.5. Consistency Checking

Consistency of the comparison matrix was evaluated using $\lambda$_max, Consistency Index (CI), and Consistency Ratio (CR), with a maximum threshold of $CR \leq 0.10$. Based on the document results, the matrix achieved $\lambda$_max = 8.000, CI = 0.000, and CR = 0.000, confirming perfect consistency. Ensuring consistency is one of the key methodological advantages of AHP, providing strong reliability in justification of judgment-based weighting [4], [8].

### 3.6. Alternative Scoring and Global Priority Aggregation

After obtaining local priorities, global priorities were calculated by multiplying each local priority vector by its corresponding criterion weight, followed by summation across criteria. This aggregation generated the final ranking, where Ulun Danu Beratan Temple (A6) achieved the highest global priority (≈0.1136), followed by Lovina Beach (A1) and Sekumpul Waterfall (A5). The weighted aggregation process is standard in AHP-based ranking systems for tourism planning [4], [7]–[9].

### 3.7. Sensitivity Analysis and Result Robustness

To evaluate robustness, sensitivity testing was conceptually performed by adjusting weights for dominant criteria (e.g., C2 Tourist Attraction and C6 Popularity) to observe shifts in final rankings. Sensitivity analysis helps stakeholders understand how changing preferences may alter recommendation outcomes. This approach aligns with the DSS recommendation literature where scenario testing is used for planning stability [8], [9].

### 3.8. Implementation Workflow

The implementation process follows the sequence: (1) hierarchy definition, (2) criteria weighting, (3) scoring of alternatives, (4) normalization and priority extraction, (5) consistency validation, (6) weighted aggregation to global priorities, and (7) final ranking interpretation. This workflow is compatible with both spreadsheet-based manual implementations and automated DSS platforms discussed in tourism analytics [6], [7], [10].

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### 3.9. Optional Integration with Data-Driven Signals

Although this study does not apply deep learning, the model can be extended to integrate data-driven popularity metrics (e.g., social media engagement) or GIS-based accessibility and visitor density analytics at the alternative-scoring level. Such integration maintains AHP's interpretability while incorporating real-time dynamics [10], [11], [12].

### 3.10. Ethical Considerations and Reproducibility

This method emphasizes transparency and reproducibility through complete documentation of hierarchy structures, scoring values, weighting logic, and CR results. The model can be consistently reproduced and audited, aligning with ethical and traceability standards in modern DSS frameworks [6], [8], [9].

## 4. Results and Discussion

### 4.1 Results

The Analytical Hierarchy Process (AHP) evaluation resulted in a ranked list of ten tourism destinations in Buleleng based on eight decision criteria: accessibility, tourist attraction, supporting facilities, cleanliness, cost, popularity, safety, and visitor density. The global priority score for each destination was derived by multiplying the local priority value of each alternative within a criterion by the criterion's respective weight and then summing the weighted contributions across all criteria (Table 1). This aggregation process identified Ulun Danu Beratan Temple (A6) as the highest-ranked destination with a global priority value of approximately 0.1136, followed by Lovina Beach (A1) with 0.1044, and Sekumpul Waterfall (A5) with 0.1033. These results indicate that A6 exhibits superior performance across multiple tourism attributes, particularly in attraction quality, accessibility, facility availability, and popularity.

The next cluster of destinations Gitgit Waterfall (A2) and Banjar Hot Spring (A8) show moderate priority scores (~0.1030 and ~0.0984), suggesting that these sites retain strong appeal but may require improvements in certain supporting criteria. Further down the ranking, Munduk Village (A7) and Krisna Funtastic Land (A9) demonstrate balanced yet less dominant strengths, while Buyan Lake (A3) and Buleleng Museum (A10) yield lower prioritization due to relatively narrow attractiveness scope and lower popularity. The lowest-ranked destination, Tamblingan Lake (A4), has a global priority of 0.0930, largely due to limited accessibility and higher perceived visitor effort.

The Consistency Ratio (CR) for the criteria comparison is 0.000, confirming perfect decision consistency. This is critical because it ensures the reliability and logical coherence of weight assignments [4], [8]. The prioritization outcome is therefore considered statistically reliable and decision-justifiable.

Overall, the AHP computation successfully differentiates destination performance based on structured multiple-criteria evaluation rather than subjective intuition alone. This result supports the use of AHP to guide decision-making in tourism recommendation and developmental planning [7], [9].

Table 1. Final Ranking of Tourist Destination Alternatives Based on AHP Global Priorities

| Rank | Alternative | Global Priorities |
|---|---|---|
| 1 | A6 Ulun Danu Beratan | 0.1136 |
| 2 | A1 Lovina Beach | 0.1044 |
| 3 | A5 Sekumpul Waterfall | 0.1033 |
| 4 | A2 Gitgit Waterfall | 0.1030 |
| 5 | A8 Air Panas Banjar | 0.0984 |
| 6 | A7 Desa Munduk | 0.0984 |
| 7 | A9 Krisna Funtastic Land | 0.0972 |
| 8 | A3 Danau Buyan | 0.0946 |
| 9 | A10 Museum Buleleng | 0.0942 |
| 10 | A4 Danau Tamblingan | 0.0930 |

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### 4.2 Discussion

The high ranking of Ulun Danu Beratan Temple reflects its iconic scenic profile, strong cultural identity, and high accessibility, supported by a well-developed tourism corridor around Bedugul. This reinforces findings from prior tourism perception studies stating that tourist attraction quality (especially uniqueness, scenic beauty, and cultural significance) tends to be the strongest determinant of travel decisions in nature–culture blended destinations [3], [5]. The site's infrastructure, including parking, food facilities, signage, and photography points, further strengthens its competitive advantage, aligning with literature emphasizing facility completeness as a key determinant of tourist satisfaction [5], [9].

Lovina Beach ranks second primarily due to its marine wildlife attraction (dolphin tours) and strong international visibility, particularly among backpackers and independent travelers. However, its slightly lower cleanliness and infrastructure consistency compared to A6 likely prevented it from obtaining the top position. These results are consistent with tourism service perception research showing that coastal destinations require ongoing maintenance management to retain visitor satisfaction [5].

Sekumpul Waterfall ranks third due to exceptional natural attraction value, but its accessibility challenges such as steep trails and limited transport options reduce its relative convenience. This dynamic illustrates a common trade-off in ecotourism planning: high environmental authenticity often correlates with reduced accessibility, requiring strategic infrastructure support to unlock full tourism potential [6], [9]. Lower-ranked destinations (e.g., A3, A4, A10) highlight how destinations with strong environmental authenticity but limited facilities and accessibility struggle to convert natural value into visitor mobility. These insights reinforce the importance of integrated tourism development strategies that coordinate access, facility support, environmental monitoring, and promotional ecosystems rather than relying on natural attraction alone [1], [2].

## 4. Conclusion

This study developed a Decision Support System (DSS) for selecting tourism destinations in Buleleng using the Analytical Hierarchy Process (AHP). The system evaluated ten tourism destinations based on eight criteria, namely accessibility, tourist attraction, supporting facilities, cleanliness, cost, popularity, safety, and visitor density. The AHP method allowed the criteria to be weighted through pairwise comparison, and the results demonstrated a Consistency Ratio (CR) of 0.000, indicating that the decision framework was logically consistent and reliable. The final ranking results identified Ulun Danu Beratan Temple as the most recommended tourism destination, followed by Lovina Beach and Sekumpul Waterfall, reflecting their strong attractiveness and adequate supporting infrastructure. These findings support the use of AHP as a transparent and structured approach for evaluating multi-dimensional tourism decisions [4], [7], [9].

The outcomes of this research highlight the importance of integrating multiple tourism attributes when assessing destination competitiveness. Attractions with cultural significance, high aesthetic value, good accessibility, and strong visitor visibility tend to receive higher prioritization. Meanwhile, destinations with natural appeal but limited facilities or accessibility benefit from targeted development strategies. This approach can be used not only by tourists when making travel choices but also by tourism institutions and policymakers for regional planning, resource allocation, promotional strategies, and sustainable tourism management [1], [2], [6].

For future development, this decision-support model may be enhanced by incorporating real-time data sources, such as social media engagement metrics, online reviews, and seasonal visitor volume analytics, to increase adaptive recommendation accuracy [10], [11]. The system may also be integrated with GIS-based mapping to provide spatial insights into travel accessibility and route planning [10]. Additionally, this DSS can be deployed as a web-based or mobile-friendly platform to improve accessibility for both travelers and tourism managers. Such enhancements would strengthen the system’s practicality, responsiveness, and relevance in supporting tourism development in Buleleng and beyond.

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## 5. Suggestion

Future research may consider expanding the scope of this decision-support model by incorporating dynamic and real-time tourism data, such as seasonal visitor trends, weather conditions, social media engagement, and online review sentiment. Integrating these types of data will allow the system to provide adaptive recommendations that respond to changing visitor preferences and destination conditions [10], [11]. Additionally, further studies could implement Geographic Information Systems (GIS) to visualize accessibility networks, travel routes, and spatial distribution of tourism facilities. GIS-based integration would help planners identify infrastructure gaps and support more efficient regional tourism zoning [10].

Another direction for future research is to extend the model into a multi-stakeholder decision environment, where evaluation criteria may differ among tourists, tourism operators, community representatives, and government agencies. Applying multi-perspective weighting or AHP group decision-making could increase fairness and representativeness in the decision results, particularly when balancing environmental preservation, cultural integrity, and economic benefit [6], [8]. Furthermore, the development of a mobile or web-based interactive application could enhance system usability and accessibility for travelers and tourism authorities, enabling real-time decision recommendations.

Finally, future research could explore the integration of machine learning or predictive analytics to improve automated scoring of alternatives, especially for criteria like popularity, satisfaction trends, and crowding levels. Such hybrid models would retain the interpretability of AHP while leveraging data-driven forecasting capabilities to anticipate destination demand patterns [10], [11]. These enhancements would strengthen the model's function as a comprehensive, adaptable, and intelligent tourism decision-support tool.

**Declaration of Competing Interest**

We declare that we have no conflict of interest.

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