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Evaluation of Sustainable Cultural Heritage Management in Rural Areas: A Case Study of Rural Tourism in Bosnia and Herzegovina

Abstract

Each local community has distinct traditions and customs that define its cultural heritage and make it recognizable. This paper examines how cultural heritage can strengthen and develop rural tourism. To do so, a model was developed to assess the extent to which cultural heritage is integrated into tourism activities in rural areas. The model includes seven rural households in Bosnia and Herzegovina (BiH) engaged in rural tourism, along with ten criteria for evaluating them. Using multi-criteria decision-making (MCDM), the importance of the criteria and the selected rural households were first assessed through expert evaluation. The results of fuzzy LMAW (Logarithmic Methodology of Additive Weights) indicate that attractiveness (C9) and economic potential (C7) are the most important criteria for evaluating rural households. Ranking the rural households using the fuzzy RAWEC (Ranking of Alternatives with Weights of Criterion) method shows that the Ibrišimović household is the most successful example of integrating cultural heritage into rural tourism offerings. This research offers a new approach to valuing cultural heritage in tourism and aims to support the continued development of rural tourism in BiH through sustainable practices.

Keywords: cultural heritage, rural households, rural tourism, multicriteria methods

1. Introduction

Rural areas are gaining attention as valuable tourism destinations, offering an escape from city life and a chance to connect with the countryside's calm, authenticity, and cultural richness (Seidualin et al., 2025). However, as rural tourism grows, it brings many sustainability challenges. Balancing economic development with environmental protection and local community well-being is not simple (An & Alarcón, 2020). Considering these challenges, multi-criteria decision-making (MCDM) and multi-criteria decision analysis (MCDA) have emerged as valuable tools for navigating the complexities of sustainable tourism management.

A key aspect of rural tourism is its diversity — both in what it offers and in the wide range of people it involves. From residents and tourists to policymakers and business owners, each stakeholder helps shape the direction and outcomes of rural tourism (Tang et al., 2022). Rural areas face challenges such as population decline, stagnant economic growth, and limited access to basic services. These challenges threaten the viability of rural

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communities, and sustainable economic diversification is necessary (Puška et al., 2022). In response, investments in rural tourism are expected to positively impact rural development by generating income, preserving cultural heritage, and fostering local entrepreneurship (Ortega-Rodríguez et al., 2024; Barreal et al., 2024). To reflect this complexity, our research adopts an interdisciplinary approach, drawing on insights from geography, sociology, economics, and the environmental sciences. This allows us to better understand how social, cultural, economic, and environmental factors interact within rural tourism systems (Medić et al., 2025). The paper investigates cultural heritage - an essential pillar of rural tourism that gives destinations a sense of identity, authenticity, and historical significance. Whether it is ancient landmarks, traditional customs, folklore, or local cuisine, cultural heritage attracts tourists and strengthens community pride. However, preserving and promoting cultural heritage requires thoughtful strategies that account for tourism's impact, engage local communities, and prioritize preservation. This calls for a holistic and inclusive approach to managing rural tourism.

Cultural sustainability should be closely aligned with ecological responsibility. Rural regions are home to diverse landscapes—forests, wetlands, mountains, coastlines—that support ecosystems and biodiversity and contribute to local economies (Baloch et al., 2023). As tourism grows, it is essential to manage its environmental footprint and avoid negative consequences such as habitat destruction, pollution, and resource depletion.

Alongside cultural and environmental concerns, the economic dimension matters. Rural tourism can create jobs, generate income, and help diversify local economies. Still, it is important to ensure these financial benefits are shared fairly, especially with marginalized groups. Sustainable growth also depends on adequate infrastructure—transportation, accommodations, and visitor services— to support tourists and host communities.

Social partnership is a guiding principle for addressing these interconnected challenges. Collaborative efforts among residents, businesses, governments, and NGOs can help build inclusive, adaptive, and resilient tourism systems (Ma et al., 2021). Rural tourism can prosper despite uncertainty through shared decision-making and community-led planning.

In this paper, we examine the complex dynamics of sustainable rural tourism through multi-criteria analysis (MCA), focusing on cultural heritage, environmental sustainability, economic resilience, and social inclusion. This research aims to synthesize existing literature and empirical evidence on sustainable rural tourism, identify the mechanisms that influence rural destination sustainability, and explore how cultural heritage can enhance rural tourism resilience. Building on this, the research aims to develop a model for assessing cultural heritage in rural tourism by analyzing the current situation and providing guidelines for using cultural heritage to improve tourism offerings in rural communities, all using an MCDM-based methodology. To accomplish this, the following research questions are proposed in this study:

- How is cultural heritage incorporated into rural tourism in Bosnia and Herzegovina?
- What criteria for assessing cultural heritage influence the sustainability and growth of rural communities through tourism-related offers in rural households?
- How can fuzzy MCDM methods be applied in decision-making for managing the development of rural tourism?

Based on these questions, the central hypothesis is formulated. Using MCDM, we aim to determine the extent to which rural households' cultural heritage is incorporated into tourism products.

This paper contributes by evaluating sustainable cultural heritage applications in tourism, developing a model for such assessments, improving rural tourism in BiH, and applying the fuzzy RAWEC (Ranking of Alternatives with Weights of Criterion) method to this evaluation.

This paper aims to contribute to a future of sustainable, inclusive, and equitable rural tourism. To contribute to research on sustainable rural tourism management, Sections 2-7 include the Theoretical foundations and

literature review, Methods and Methodology, Results, Discussion, Research implications and Conclusion. The "Theoretical foundations and literature review" section provides the theoretical basis for the criteria used to evaluate rural households. The "Methods and Methodology" section explains the research methodology and the MCDM methods used. The "Results" section evaluates selected rural households in the context of rural tourism using expert assessment and selected MCDM methods. The "Discussion" section explains why these results were obtained. The "Research implications" explains the implications of this research. Finally, the "Conclusion" section presents the most significant findings, along with limitations and recommendations for future research.

2. Theoretical foundations and literature review

This section reviews key studies on sustainable rural tourism and defines criteria for evaluating rural households. Based on this, it positions research on rural tourism, focusing on the connections among cultural heritage, economic development, and sustainability.

Sustainable management of rural tourism has become an increasingly important focus in academic research and policymaking (An & Alarcón, 2020), as destinations seek to balance economic growth, environmental protection, and social well-being (Cheng & Xu, 2021). In recent years, MCDM and MCDA methods have gained recognition as a structured approach for evaluating sustainability dimensions and informing planning decisions in rural tourism (Akbulut, 2024). Rural tourism research has covered various topics (Table 1), including cultural heritage values (Murgado Armenteros et al., 2025).

Table 1
Key contributions to sustainable rural tourism

Author(s)	Main focus	Key findings	Relevance to this study
An & Alarcón (2020)	Rural tourism sustainability	Defines the multidimensional nature of rural tourism	Conceptual foundation
Murgado Armenteros et al. (2025)	Olive oil tourism satisfaction	Highlights cultural identity and visitor experience	Cultural heritage value
Almeida-García et al. (2020)	Destination image	Examines motivation and image transformation	Marketing and branding relevance
Ortega-Rodríguez et al. (2024)	Sustainable tourism financing	Analyses green tax attitudes	Policy relevance
Barreal et al. (2024)	Regional tourism policy	Tools for sustainable management	Practical policy framework

Here, we explore key research on the sustainable management of rural tourism through the lens of MCDM and MCDA, focusing on several core criteria: cultural-historical significance, educational potential, social connection, tourist attractiveness, conservation and ecological sustainability, agricultural potential, economic potential, accessibility and infrastructure, attractiveness, and possibilities of social partnership.

2.1. Cultural-historical significance

The cultural and historical significance of rural areas shapes the tourism experience and influences visitor perceptions (Csurgó & Smith, 2022). Numerous studies underscore the importance of safeguarding cultural heritage, including historical landmarks, traditional skills, and Indigenous knowledge, as a cornerstone of sustainable tourism (Ma et al., 2021; Mu & Aimar, 2022). When integrated into tourism planning, heritage preservation enhances destination appeal and strengthens visitors' sense of place (Csurgó & Smith, 2022). Community-based approaches have proven effective in empowering local communities, sustaining cultural practices, and strengthening social bonds.

2.2. Educational potential

Rural tourism also offers meaningful opportunities for learning and cultural exchange (Petkovski & Vranić, 2025). Visitors gain firsthand insight into local traditions, customs, and ways of life (Wu et al., 2023).

Research indicates that these educational experiences enhance visitor satisfaction, foster cultural respect, and promote responsible behaviour (Fan et al., 2021). Partnerships between tourism stakeholders and educational institutions have produced creative initiatives, such as farm stays, eco-tours, and workshops, that benefit both tourists and host communities (Pavlović, 2024).

2.3. Social connection

Tourism can be a powerful bridge between visitors and host communities, fostering mutual understanding and stronger social ties (Wu et al., 2023). Studies highlight how meaningful interactions and cultural exchange shape tourist experiences and behaviors. Initiatives rooted in local participation and authenticity and guided by a strong sense of social responsibility (Gabor et al., 2024), often improve community cohesion and economic outcomes.

2.4. Tourist attractiveness

The charm of rural destinations is key to attracting visitors and standing out in an increasingly competitive tourism market. Natural beauty, recreational offerings, and cultural uniqueness all shape destination choice and visitor satisfaction (Mondal & Palit, 2022). By highlighting their unique assets, rural areas can attract niche travellers seeking authentic, meaningful experiences. Marketing elements that highlight farm-to-table dining, nature trails, and hands-on cultural experiences can enhance visibility and attract diverse tourist segments (Subakti et al., 2024).

2.5. Conservation and ecological sustainability

Protecting natural resources is essential to the long-term sustainability of rural destinations (Abdinematabad et al., 2024). Research underscores the need for low-impact tourism practices that safeguard biodiversity and promote sustainable land use (Mondal & Palit, 2022). Eco-certifications and sustainability frameworks help operators minimize their environmental footprint. Local conservation initiatives, such as habitat restoration, wildlife monitoring, and eco-farming, further strengthen environmental resilience and community involvement (Tia, 2024).

2.6. Agricultural potential

Farming remains central to the identity and economy of many rural areas (Novakivskyi et al., 2024). Agritourism allows visitors to engage with this heritage while supporting local livelihoods through activities such as fruit picking, wine tasting, and animal husbandry (Nedeljković et al., 2025). This provides additional sources of income for residents while showcasing traditional farming practices and local food products. Research suggests that combining agricultural development with tourism strategies can improve destination competitiveness, support rural livelihoods, and preserve cultural landscapes (Shen & Chou, 2022). Moreover, sustainable agricultural tourism, through organic practices, permaculture, or agroforestry, responds to the growing demand for eco-friendly and ethical travel (Wu et al., 2023).

2.7. Economic potential

Tourism can drive rural economic development by creating jobs, attracting investment, and stimulating local entrepreneurship. Studies have shown that tourism helps diversify local economies and reduce dependence on traditional sectors such as agriculture or manufacturing (Almeida & Machado, 2021). Investing tourism revenue into infrastructure, education, and business development strengthens local resilience and improves residents' quality of life (Musavengane & Kloppers, 2020). Indirect benefits also arise through increased demand for local products and services, such as food and beverages, handicrafts, and transportation (Wang & Zhao, 2025).

2.8. Accessibility and infrastructure

A destination's success often depends on its adequate transportation networks, accommodation facilities, and visitor amenities. Research has highlighted that well-developed roads, accommodations, and visitor services enhance travel experiences and increase tourism potential (Almeida & Machado, 2021). From cozy farm stays to boutique bed-and-breakfasts, reliable transport links, and quality infrastructure support longer stays, higher spending, and return visits. That said, destinations must manage infrastructure growth to avoid environmental damage and preserve their rural character (Prus & Sikora, 2021).

2.9. Attractiveness

Research suggests that destination branding, marketing, and visual identity shape tourists' initial impressions and influence their destination choices (Tang et al., 2022). Highlighting a rural area's distinctive features, such as breathtaking scenery, rich cultural heritage, and immersive experiences, can enhance its appeal and help it stand out in a crowded market (Mondal & Palit, 2022).

2.10. Possibilities of social partnership

Collaboration is crucial for the sustainability of rural tourism. Partnerships among local governments, communities, NGOs, and the private sector help align diverse interests and encourage inclusive decision-making toward shared sustainability goals (Prus & Sikora, 2021). When communities are directly involved in planning and benefit-sharing, outcomes tend to be founded in social equity, cultural integrity, and ecological sustainability (Tan et al., 2024).

2.11. Notes on theoretical foundations and literature review

This review highlights the multidimensional nature of sustainable rural tourism management and the value of MCA for evaluating and balancing diverse sustainability criteria. By applying MCA, practitioners and policymakers can make more informed decisions that support ecological preservation, cultural heritage, and socioeconomic development. In doing so, they can help strengthen the long-term sustainability and resilience of rural tourism destinations. However, further research is needed to incorporate more stakeholder perspectives and to evaluate the long-term impacts of sustainable tourism efforts in rural areas.

2.12. Research gaps

Recent research on rural tourism highlights that sustainability requires integrating cultural, social, environmental, and economic factors into the planning and management of rural community development (Barreal et al., 2024; Murgado Armenteros et al., 2025). However, earlier studies have not extensively used MCDM methods to evaluate cultural heritage, especially in transition countries such as Bosnia and Herzegovina. This study helps address this gap by combining fuzzy MCDM techniques with rural tourism assessment, using rural households as an example.

3. Methods and methodology

During research on cultural heritage with ecological dimensions, tourist offerings from rural households in BiH were evaluated. These households were selected because this type of tourism has been gaining popularity. Following the COVID-19 pandemic, tourists sought unique experiences, moving away from the crowded and rushed nature of urban tourism. In contrast, rural households offer a traditional ambiance and local cuisine that characterize their specific regions, presenting cultural heritage and regional traditions through their tourist offerings.

To examine the extent to which rural households use cultural heritage in the context of rural tourism, a combination of expert opinion and fuzzy MCDM techniques was used to evaluate them. This research process involved identifying rural households engaged in tourism, selecting a representative sample, and evaluating the sample against 10 sustainability criteria.

However, because no comprehensive register of these households exists in BiH, this research used only a sample. The unique constitutional structure of BiH, comprising two entities and the Brčko District, means there are no unified registers for these households in the region. The households were identified through specialized web portals focused on rural tourism. The portals used to form the basic set of rural households were: tourismbih.com, turizamrs.org, snagalokalnog.ba, alterural.ba, agroklub.ba, putovaobih.blog, and agroturizam.ba. These portals identified 56 rural households offering tourism services. To create the sample, every eighth household was selected for the study.

First, a base set of 56 households was created and arranged alphabetically. Using a random number generator, the first household in the sample was selected, and the remaining households were included by adding 8 to the initial number. This method determined a sample of 7 rural households:

- A1 – Rural household "Banjac"
- A2 – Rural household "Tuka"
- A3 – Rural household "Household at the end of the world"
- A4 – Rural household "Ibrišimović"
- A5 – Rural household "Kovačević"
- A6 – Rural household "Ibreljić"
- A7 – Rural household "NaturaAS"

The aim was not to evaluate all households but to assess, using a sample, how these households incorporate cultural heritage into their tourism offerings and whether they do so in line with sustainability principles. The results will reveal how individual households implement their tourism offerings using cultural heritage and how they apply sustainability principles in doing so. Based on these results, guidelines will be provided to all households on how to incorporate cultural heritage into their tourism offerings to improve and add value to the development of these local areas. To achieve this, rural tourism experts working in BiH were selected to evaluate these households. A total of eight experts participated in the research. First, the aim was to determine the importance of the criteria presented in the previous section. The second was to assess how the selected households perform based on the established criteria. Choosing the right experts was an important step, as their insights were key to understanding how effectively these households incorporate cultural heritage into their tourism offerings. Their evaluations highlight areas for improvement and serve as a valuable reference for others involved in rural tourism.

To evaluate these households, a fuzzy-number MCDM tool was used. Fuzzy numbers were appropriate because the experts' ratings were provided in linguistic terms (Maiti et al., 2025; Mohammad Kamari et al., 2025). To use these linguistic terms, a transformation into fuzzy numbers was required. To simplify the calculation of research results for determining the criteria weights and the importance of the alternatives, a unique linguistic value scale with seven levels was used (Table 2). This transformation used a membership function, mapping each linguistic value to a specific fuzzy number (Table 2). For example, the value "Very bad" (VB) is transformed into the corresponding fuzzy number (1, 1, 2), and the value "Good" (G) into the fuzzy number (7, 9, 10). In this way, all linguistic terms are converted to their corresponding fuzzy numbers.

Table 2
Linguistic terms and membership function

Linguistic terms	Fuzzy numbers
Very bad (VB)	(1, 1, 2)
Bad (B)	(1, 2, 4)
Medium bad (MB)	(2, 4, 6)
Medium (M)	(3, 5, 7)
Medium good (MG)	(5, 7, 9)
Good (G)	(7, 9, 10)
Very good (VG)	(9, 10, 10)

To apply these fuzzy numbers in this research, the fuzzy LMAW (Logarithm Methodology of Additive Weights) and fuzzy RAWEC methods are used. The reasons for choosing these methods are as follows. The LMAW method, unlike other subjective methods for calculating weight coefficients, enables the decision maker (DM) to easily evaluate the weights using a linguistic scale (Table 2). It does not require mutual comparison of criteria, ranking of criteria, or comparison with the first or last criterion, simplifying the DM's task. The RAWEC method was selected because it is a new MCDA approach that deserves promotion in MCDM. Additionally, as demonstrated by Puška et al. (2024), this method correlates well with other methods. It is also user-friendly, combining two common steps in other methods into a single step, simplifying the calculation process and reducing the number of steps (Trung et al., 2025). The following subsections will explain the steps of these two methods.

3.1. Fuzzy LMAW (Logarithm methodology of additive weights)

The LMAW method was introduced by Pamučar et al. (2021) and was later fuzzified in Božanić et al. (2022), following specific steps.

Step 1. Prioritizing criteria using linguistic evaluations.

Step 2. Defining the absolute fuzzy anti-ideal point ($\tilde{\gamma}_{AIP}$). This point is a value smaller than the smallest value of the defined fuzzy numbers.

Step 3. Defining the fuzzy relationship vector. Here, the fuzzy numbers are divided by the fuzzy anti-ideal point.

$$\tilde{\mu}_{Cn}^{e} = \left(\frac{\tilde{\gamma}_{Cn}^{e}}{\tilde{\gamma}_{AIP}}\right) = \left(\frac{\gamma_{Cn}^{(l)e}}{\gamma_{AIP}^{(r)}}, \frac{\gamma_{Cn}^{(m)e}}{\gamma_{AIP}^{(m)}}, \frac{\gamma_{Cn}^{(r)e}}{\gamma_{AIP}^{(l)}}\right) \tag{1}$$

Step 4. Determining the vector of weight coefficients using the natural logarithm (ln)

$$\widetilde{\omega}_{j}^{e} = \left(\frac{\ln(\tilde{\mu}_{Cn}^{e})}{\ln(\prod_{j=1}^{n} \tilde{\mu}_{Cn}^{e})}\right) = \left(\frac{\ln(\tilde{\mu}_{Cn}^{(l)e})}{\ln(\prod_{j=1}^{n} \tilde{\mu}_{Cn}^{(r)e})}, \frac{\ln(\tilde{\mu}_{Cn}^{(m)e})}{\ln(\prod_{j=1}^{n} \tilde{\mu}_{Cn}^{(m)e})}, \frac{\ln(\tilde{\mu}_{Cn}^{(r)e})}{\ln(\prod_{j=1}^{n} \tilde{\mu}_{Cn}^{(l)e})}\right) \tag{2}$$

Step 5. Calculating the final values of the weighting coefficients.

3.2. Fuzzy RAWEC (Ranking of alternatives with weights of criterion)

The RAWEC method was developed by Puška et al. (2024), while additional practical applications of this method were demonstrated by Durmuş (2025) and Katrancı et al. (2026). The fuzzy RAWEC method involves the following steps:

Step 1. Forming the decision matrix. The matrix is formed by evaluating the linguistic values of the alternatives based on the observed criteria, and these values must be transformed into fuzzy numbers (l, m, u).

Step 2. Normalizing the decision matrix.

$$n_{ij} = \frac{x_{ij}^{l}}{\max x_j^u}, \frac{x_{ij}^{m}}{\max x_j^u}, \frac{x_{ij}^{u}}{\max x_j^u}; \; n'_{ij} = \frac{\min x_j^l}{x_{ij}^u}, \frac{\min x_j^l}{x_{ij}^m}, \frac{\min x_j^l}{x_{ij}^l}; \text{ for benefit criteria;} \quad (3)$$

$$n_{ij} = \frac{\min x_j^l}{x_{ij}^u}, \frac{\min x_j^l}{x_{ij}^m}, \frac{\min x_j^l}{x_{ij}^l}; \; n'_{ij} = \frac{x_{ij}^{l}}{\max x_j^u}, \frac{x_{ij}^{m}}{\max x_j^u}, \frac{x_{ij}^{u}}{\max x_j^u} \; ; \text{ for cost criteria} \quad (4)$$

Where $x_{j\,min}$ – is the minimum value, and $x_{j\,max}$ – is the maximum value of a specific criterion.

Step 3. Calculation of the deviation from the criterion weight.

$$\tilde{v}_{ij} = \sum_{i=1}^{n} \tilde{w}_j \cdot \left(1 - \tilde{n}_{ij}\right); \tilde{v}'_{ij} = \sum_{i=1}^{n} \tilde{w}_j \cdot \left(1 - \tilde{n}'_{ij}\right) \quad (5)$$

where $\tilde{w}_j$ is the weight of the criteria.

Step 4. Defuzzification.

$$v_{ij\,def} = \frac{v_i^l + 4v_i^m + v_i^u}{6}; \; v'_{ij\,def} = \frac{v'_i{}^l + 4v'_i{}^m + v'_i{}^u}{6} \quad (6)$$

Step 5. Calculating the RAWEC method value.

$$Q_i = \frac{v'_{ij} - v_{ij}}{v'_{ii} + v_{ii}} \quad (7)$$

After the household rankings are calculated, a sensitivity analysis is performed to assess how the rankings change when the criteria weights are adjusted. This allows for an examination of how individual households respond to changes in the weights.

4. Results

To determine how many households incorporate cultural heritage into their tourism offers and whether they apply sustainability principles, this paper proposes using the fuzzy versions of the LMAW and RAWEC methods. Since household ranking requires criteria weights, they will first be calculated using the fuzzy LMAW. The procedure has been detailed in many papers; here, a brief explanation of how the criteria weights are obtained is provided.

With this method, experts primarily evaluate the criteria weights using linguistic evaluations (Table 3). The next step in implementing this method is to transform linguistic values or grades into fuzzy numbers. This transformation is accomplished by applying the membership function (Table 2). Next, the smallest value of these fuzzy numbers is determined, which is the number one (1). This value is necessary to establish the absolute fuzzy anti-ideal point, representing a value smaller than this minimum. Here, it was decided that this value would be 0.9. All fuzzy numbers were then divided by this value.

Table 3
Initial decision matrix for calculating criteria weights

Criteria	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
Expert 1	M	MB	MG	G	MG	M	G	G	G	MG
Expert 2	MG	MB	M	VG	G	MB	VG	G	VG	MG
Expert 3	M	B	MG	VG	MG	M	VG	VG	VG	M
Expert 4	MB	MG	M	G	G	MB	VG	G	VG	MG
Expert 5	M	G	MG	VG	G	B	VG	VG	VG	G
Expert 6	MG	M	M	MG	MG	MB	MG	MG	G	MG
Expert 7	G	G	MG	MG	MG	MB	MG	M	G	MG
Expert 8	M	MG	M	MG	MG	MB	VG	MG	VG	MG

Legends: C1 – Cultural-Historical Significance; C2 – Educational Potential; C3 – Social Connection; C4 – Tourist Attractiveness; C5 – Conservation and Ecological Sustainability; C6 – Agricultural Potential; C7 – Economic Potential; C8 – Accessibility and Infrastructure; C9 – Attractiveness; C10 – Possibilities of Social Partnership.

After completing these steps, the weight coefficients vector is calculated. First, each value is log-transformed using the natural logarithm, then divided by the logarithm of the product of these values. This process creates the individual criteria weights for all experts. To calculate the final weights, the last step is to aggregate the individual weights. Table 4 shows that C9 (Attractiveness) received the highest weight, indicating that attractiveness is the most important criterion in this case. Following this, criterion C7 (Economic Potential) ranks next, then criterion C4 (Tourist Attractiveness), with criterion C6 (Agricultural Potential) receiving the least weight. However, across all criteria, the weights show no significant deviations. All criteria have relatively equal influence on the final decision, with no single criterion weighing twice as much as any other.

Table 4
Criteria weight values

Id	Weight	Id	Weight
C1	(0.06, 0.09, 0.13)	C6	(0.03, 0.07, 0.11)
C2	(0.04, 0.08, 0.13)	C7	(0.09, 0.11, 0.14)
C3	(0.06, 0.09, 0.13)	C8	(0.08, 0.11, 0.14)
C4	(0.09, 0.11, 0.14)	C9	(0.10, 0.12, 0.15)
C5	(0.08, 0.11, 0.14)	C10	(0.07, 0.10, 0.14)

After calculating the weight values, the household values are determined based on the fuzzy RAWEC method. The first two steps are identical to those of the fuzzy LMAW method, except that experts evaluate alternatives using the same linguistic values (Table 1A) and specific criteria.

The linguistic values are then transformed into fuzzy numbers. Next, we construct a summary decision matrix in which each expert's input is weighted equally, and we calculate the average fuzzy-number values for all alternatives based on the selected criteria (Table 5).

Table 5
Summary decision matrix

	C1	C2	C3	…	C10
A1	(3.75, 5.75, 7.63)	(4.25, 6.25, 8.13)	(3.75, 5.75, 7.75)	…	(5.25, 7.25, 9.13)
A2	(2.38, 4.25, 6.25)	(3.75, 5.75, 7.75)	(3.25, 5.25, 7.25)	…	(3.13, 5.13, 7.13)
A3	(6.25, 8.13, 9.50)	(5.25, 7.25, 8.63)	(6.00, 7.88, 9.38)	…	(4.25, 6.25, 8.25)
A4	(5.75, 7.63, 9.13)	(7.00, 9.00, 10.00)	(5.00, 7.00, 8.63)	…	(3.75, 5.75, 7.63)
A5	(5.25, 7.25, 9.00)	(6.25, 8.13, 9.25)	(3.88, 5.88, 7.88)	…	(3.50, 5.50, 7.50)
A6	(4.75, 6.75, 8.63)	(4.50, 6.50, 8.25)	(5.00, 7.00, 9.00)	…	(4.00, 6.00, 7.75)
A7	(5.50, 7.50, 8.88)	(6.25, 8.25, 9.63)	(3.75, 5.75, 7.75)	…	(5.75, 7.75, 9.38)

After this, normalization is performed. A unique aspect of this method is the use of two normalizations. The first is the standard one, in which each element of the decision matrix is divided by the maximum value for its respective criterion. In the second normalization, the minimum value for each criterion is divided by all the values in the summary decision matrix. It is crucial during this process to maintain the integrity of the fuzzy number values, ensuring that the first fuzzy number remains smaller than the second, and the second remains smaller than the third. For example, for criterion C1 and household A1, the normalization is calculated as follows:

$$n_{11} = \frac{3.8}{9.5} = 0.39, \frac{5.8}{9.5} = 0.61, \frac{7.6}{9.5} = 0.80;\ n'_{11} = \frac{2.4}{7.6} = 0.31, \frac{2.4}{5.8} = 0.41, \frac{2.4}{3.8} = 0.63$$

After this step, the weight deviation is calculated. Using the same example, this step is computed as follows:

$$\tilde{v}_{11} = 0.06 \cdot (1.00 - 0.80) = 0.01, 0.09 \cdot (1.00 - 0.61) = 0.05, 0.13 \cdot (1.00 - 0.39) = 0.08$$

$$\tilde{v}'_{11} = 0.06 \cdot (1.00 - 0.63) = 0.02, 0.09 \cdot (1.00 - 0.41) = 0.05, 0.13 \cdot (1.00 - 0.31) = 0.09$$

Next, these values are summed for each alternative, and the resulting sums are defuzzified. Then, the final ranking of the alternatives is determined. Using the example of households A1 and A4, the calculation proceeds as follows:

$$Q_1 = \frac{0.499 - 0.510}{0.499 + 0.510} = -0.012;$$

According to the obtained results (Table 6), the best performance was achieved by household A4 (Rural household "Ibrišimović"), followed by household A3 (Rural household "Household at the End of the World"), while the worst performance was seen in household A2 (Rural household "Tuka").

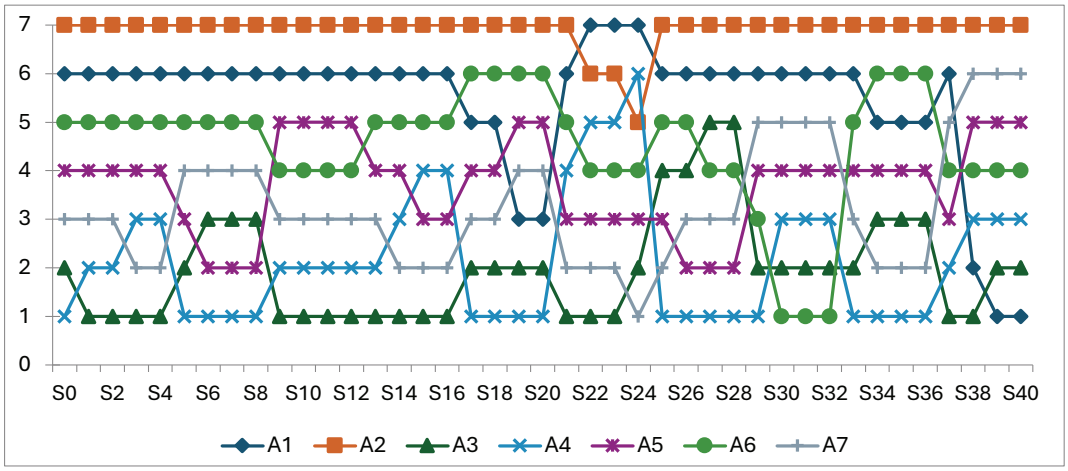
Table 6
Final values of the fuzzy RAWEC method

Id	$\tilde{v}$	def v	$\tilde{v}'$	def v'	Q_i	Rank
A1	(0.11, 0.55, 0.75)	0.51	(0.19, 0.49, 0.83)	0.50	-0.01	6
A2	(0.17, 0.65, 0.88)	0.61	(0.02, 0.41, 0.78)	0.41	-0.20	7
A3	(0.04, 0.44, 0.59)	0.40	(0.28, 0.57, 0.89)	0.57	0.18	2
A4	(0.04, 0.43, 0.59)	0.39	(0.30, 0.58, 0.89)	0.58	0.20	1
A5	(0.06, 0.47, 0.65)	0.44	(0.26, 0.55, 0.87)	0.55	0.12	4
A6	(0.08, 0.50, 0.68)	0.46	(0.23, 0.53, 0.86)	0.53	0.07	5
A7	(0.06, 0.52, 0.56)	0.45	(0.46, 0.55, 0.88)	0.59	0.14	3

After determining the final household ranking, a sensitivity analysis is conducted. Sensitivity analysis can be performed in various ways, such as adjusting individual criterion weights, creating scenarios in which criterion weights deviate from the initial values, and increasing or decreasing individual weights (Tešić & Khalilzadeh, 2024; Więckowski & Sałabun, 2025). Here, a sensitivity analysis will be conducted by increasing the specific weight of a given criterion by factors of 2, 3, 4, and 5 while simultaneously decreasing the weights of the other criteria by the same factors (Tešić, 2025). This approach adapts the method used by Ahmadi et al. (2020).

Since each of the 10 criteria is adjusted four times, the sensitivity analysis includes 40 scenarios. The results are interpreted by examining changes in households' rankings across these scenarios (Özekenci, 2025; Mishra et al., 2025). If a household drops in the rankings when the weight of a particular criterion is increased, it suggests that the household performs relatively poorly in that area compared to others (Arman et al., 2026). On the other hand, an improved ranking indicates stronger performance on that specific criterion (Petchimuthu et al., 2025). For example, Household A4 showed the strongest overall performance, ranking first in 17 of the 40 scenarios. Therefore, household A4 ranks highest, particularly in criteria C2 (Educational Potential), C5 (Conservation and Ecological Sustainability), C7 (Economic Potential), and C9 (Attractiveness). However, this household performed the worst when the weight for criterion C6 (Agricultural Potential) was increased. This indicates that household A4 has relatively low agricultural potential compared to the other observed households. To improve the management of sustainable cultural heritage, Household A4 should focus on enhancing performance in areas where it did not rank highly, while maintaining, and if possible, improving, the quality of services in areas where it excelled. For example, for criterion C2 (Educational Potential), which produced the highest ranking for household A4, efforts should be made to make use of and promote this potential to attract more tourists. Similar strategies should be applied to other criteria where household A4 performed well. Other households should similarly analyze the sensitivity analysis results to identify areas for improvement in their tourist offerings, thereby enhancing their potential and improving their business performance.

Figure 1
Sensitivity analysis results



5. Discussion

The research illustrates how households that provide rural tourism services can be evaluated for their use of rich cultural heritage to develop sustainable tourism. The aim was not to evaluate all rural households but to develop a model for assessing how they apply cultural heritage in tourism. A model used 10 criteria. These criteria assess not only cultural heritage but also agricultural potential. Households must capitalize on this agricultural potential to enhance their tourism offerings. However, agricultural potential is not separate from cultural heritage, as it can demonstrate to tourists how agriculture was traditionally practiced before the advent of modern mechanization. This approach helps preserve and present the region's agricultural traditions. Therefore, the model includes this criterion. Additionally, households can prepare traditional dishes using locally grown agricultural products.

Using these criteria, seven households were evaluated based on the sample taken in this research. The assessment was carried out using linguistic values, which are more suitable for experts than numerical ratings. However, using linguistic values calls for the application of fuzzy logic (Akbulut, 2024). This approach assigns a fuzzy number to a linguistic value using a membership function. Fuzzy numbers are used because linguistic values do not have exact numerical equivalents; for instance, the value "bad" could correspond to a fuzzy number ranging between 1 and 4. This involves three values within a triangular fuzzy number (Yalçın, 2025).

To apply fuzzy numbers in practice, the fuzzy versions of LMAW and RAWEC were used. Using the LMAW, expert subjective evaluations were used to determine the importance of specific criteria for assessing the application of sustainable cultural heritage in households. The results indicated no significant differences in the criteria weights, as the differences among them did not exceed 30%. Therefore, the final assessment of the households considered all criteria. According to the experts' evaluations, criteria C9 (Attractiveness), C7 (Economic Potential), and C4 (Tourist Attractiveness) are slightly more important. The experts emphasized that the most crucial aspect is attractiveness, both in organizing various events, excursions, and workshops, and in the household's overall appeal to tourists. Additionally, the economic potential of these households is also significant. The experts believe that these households do not need to invest heavily in agricultural potential but can instead use local products to enhance their offerings.

When these households were ranked using experts' evaluations and the fuzzy RAWEC method, household A4 (Rural household "Ibrišimović") achieved the best results. This household stood out for strong indicators

in C2 (Educational Potential), C5 (Conservation and Ecological Sustainability), C7 (Economic Potential), and C9 (Attractiveness). Notably, two of these criteria had the highest weights. Household A4 must leverage these strengths to remain competitive in the market. Apart from this household, household A3 (Rural household "Household at the End of the World") also performed well, achieving the top ranking in the sensitivity analysis across an equal number of scenarios. These two households were the leaders in the sensitivity analysis. Therefore, they should serve as models for other households in implementing sustainable management of cultural heritage in rural tourism. It should also be noted that household A6 (Rural household "Ibreljić") exhibited strong indicators for criterion C8 (Accessibility and Infrastructure). This household should be seen as an example of how to develop infrastructure as part of the tourist offering.

However, for an adequate tourist offer in rural areas, enhancing infrastructure, especially road infrastructure, is crucial (Prus & Sikora, 2021). Therefore, local communities must focus on improving conditions beyond households' control, as this will help attract more tourists and, in turn, support community development (Medić et al., 2025). This research can help households enhance their offerings, but local communities and entities must also contribute. BiH's cultural heritage is rich and should be used to develop rural tourism. Tourists seek unique experiences and are more likely to be satisfied with distinctive offerings. A satisfied tourist is the best promoter, as they will share their positive experiences with others, thereby increasing visitor numbers. As tourism grows, it is crucial to avoid ecological traps, as increased tourism will lead to greater demand and higher population density in a given area, which can negatively impact the environment. This is why this paper emphasizes sustainability, ensuring that these cultural and natural treasures are preserved for future generations.

6. Research implications

The implications of this research extend beyond applying the MCDM decision-making model to its conceptual basis for integrating sustainability and cultural heritage management. In this way, cultural heritage can be examined through economic, social, and ecological dimensions that contribute to rural tourism development and the implementation of sustainable tourism in BiH. This research shows that cultural resources can drive rural tourism development. It shows that cultural heritage can actively drive tourism development and influence the development of certain local communities. This contributes not only to a community's economic development but also to understanding sustainable rural tourism as a system in which culture helps protect a people's identity. In addition, developing rural tourism through cultural heritage supports demographic recovery in rural areas. This is reflected in job growth in these areas, which helps retain the population. Furthermore, the research advances understanding of sustainable management of rural destinations by incorporating measurable criteria into the decision-making model. This bridges the gap between the concept of sustainability and its practical application by evaluating rural destinations through a decision-making model.

The results also have broader implications for managing rural destinations, especially in transition countries facing depopulation and limited investment capacity. This research shows that tourism development must use the cultural heritage specific to each area. Infrastructure projects should not be the priority; instead, rural destinations should use the cultural heritage that gives them a distinctive character to deliver a unique tourist product. In this way, tourists will be satisfied with the tourist offer and will become ambassadors, promoting these rural areas. As a result, more people will engage in tourism activities, which will also boost local entrepreneurship by improving employment in the community. As a result, more people will be involved in tourism activities, and the population's quality of life will improve. Cultural heritage thus becomes a tool for territorial cohesion and economic diversification. In addition, this research shows that sustainable rural tourism can transform rural areas and advance their development.

7. Conclusion

This research aimed to examine how rural households incorporate sustainable cultural heritage into their tourism offerings. To achieve this, a unique model was developed that included ten criteria for evaluating the use of cultural heritage. To implement this model in practice, a methodology that uses fuzzy versions of the LMAW and RAWEC methods was developed. Using these methods, the criteria weights were first determined, followed by ranking the observed rural households selected as the sample for this research. This approach enabled an expert assessment of the current state of sustainable cultural heritage applications in the selected households. A sensitivity analysis was then conducted to examine how well households met each criterion. Based on the results, guidelines were provided for each observed household to improve their tourism product by effectively applying cultural heritage. This was exemplified by Household A4 (Rural household "Ibrišimović"), which demonstrated the best results.

The limitations, as with any research based on MCDM methods, lie primarily in the selection of criteria or alternatives. In practice, different criteria could be chosen, as it is never possible to include all relevant criteria in a single survey. Therefore, future research should further develop the presented model to better evaluate the application of cultural heritage in tourism. This model demonstrated how these criteria could be used, which was the goal of this research. Future research should explore how other criteria could be incorporated into the assessment of sustainable cultural heritage. Another limitation concerns the choice of alternatives used in this research. The goal was not to conduct a comprehensive survey of all agricultural households involved in tourism, but to illustrate how this evaluation can be applied using this sample. Based on these findings, guidelines for future research can be developed to extend this approach. This model has demonstrated its feasibility, showing ease of application and flexibility, and can be adapted for other forms of tourism. Therefore, future research should aim to further develop this model, which can be extended to other types of tourism.

This research addressed the research questions and demonstrated how cultural heritage can be effectively integrated into rural tourism offerings. This was illustrated through an example of rural households in BiH. The research showed that, when building an integrated relationship, the tourist offer should be based on attractiveness and economic potential, as these are the most important criteria for evaluating rural households for cultural heritage applications. Additionally, the research demonstrated that applying the fuzzy LMAW and RAWEC methods can support decision-making for managing rural tourism development. By applying this approach, it is possible to evaluate cultural heritage in the tourist offer not only in rural tourism but also in other areas of tourism. Policymakers and local stakeholders should use this research to enhance the tourist offering by leveraging cultural heritage as a key attraction.

Declaration of Competing Interests

The authors declare that they have no known competing interests that could have appeared to influence the work reported in this paper.

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Appendix

Initial linguistic decision matrix

E1	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
A1	MB	M	MG	MG	G	M	G	M	MG	MG
A2	M	MG	M	M	MG	M	MG	M	MB	MG
A3	MG	M	MG	G	MG	MG	MB	MG	M	M
A4	MG	G	MG	M	MG	M	MB	MG	G	G
A5	M	M	MB	MG	MG	G	G	MG	MG	MG
A6	M	MG	MG	MG	MG	M	M	G	M	M
A7	G	G	MG	MG	M	MB	G	MG	MG	G
E2	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
A1	M	G	MG	M	G	MB	MG	MG	MG	MG
A2	MB	MG	MG	M	M	M	MG	MB	MB	M
A3	G	MB	MG	MG	MG	G	M	MG	MG	M
A4	G	G	MB	M	MG	MB	M	MG	G	MG
A5	MG	G	M	MG	M	G	MG	MG	M	M
A6	G	M	MG	MG	M	M	G	G	MG	M
A7	G	G	M	MG	M	M	G	MG	M	G
E3	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
A1	MG	MG	MG	M	MG	MB	M	MG	MG	G
A2	B	MG	M	M	M	G	MG	MB	MB	MB
A3	MG	MB	G	MG	G	G	M	G	MG	M
A4	VG	G	MB	MG	MG	MB	G	MG	G	M
A5	G	G	M	MG	MG	G	MG	MG	MB	M
A6	M	M	MG	MG	M	G	G	G	M	M
A7	G	G	M	MG	MG	M	G	MG	M	G
E4	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
A1	M	MG	M	M	MG	B	MB	M	MG	MG
A2	MB	M	M	MG	M	MG	MG	M	MB	M
A3	G	G	G	MG	MG	G	MG	G	MG	MG
A4	MG	G	G	MG	G	MB	G	G	G	M
A5	MG	G	MG	MG	MG	MG	MG	MG	M	M
A6	MG	MG	MG	MG	M	G	MG	G	M	M
A7	G	G	M	MG	M	M	MG	MG	M	MG
E5	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
A1	M	MG	M	M	MG	B	MB	M	MG	MG
A2	MG	M	M	MG	M	MG	G	M	M	M
A3	VG	G	VG	MG	MG	VG	MG	G	MG	MG
A4	G	G	G	MG	G	M	G	G	M	M
A5	MG	VG	MG	MG	MG	MG	MG	MG	M	M
A6	MG	G	MG	MG	M	G	MB	G	M	M
A7	M	G	M	MG	G	M	MG	G	M	MG
E6	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
A1	MB	M	M	M	M	B	B	M	MB	MG
A2	MB	M	M	MB	M	MG	MB	M	MB	M
A3	MG	G	MG	MG	MG	M	MG	MG	MG	MG
A4	M	G	MG	MG	G	M	G	MG	M	M
A5	MG	M	MG	MG	MG	MB	MG	M	M	M
A6	MG	M	MG	MB	M	G	M	MG	M	M
A7	M	MG	M	MG	G	M	MG	M	M	MG

Table *(continued)*

E7	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
A1	MG	M	M	G	VG	M	G	M	M	MG
A2	MB	M	M	MB	M	MG	MB	M	MB	M
A3	MG	G	MG	MG	MG	M	MG	MG	MG	MG
A4	MG	G	MG	G	G	MG	G	MG	G	M
A5	MG	G	MG	MG	G	MG	MG	M	G	M
A6	MG	M	MG	G	M	MG	M	G	M	G
A7	M	MG	MG	MG	G	VG	MG	M	M	MG
E8	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
A1	G	M	M	G	VG	M	G	M	M	MG
A2	MB	M	M	MB	M	MG	MB	M	MG	M
A3	G	G	MG	VG	VG	M	MG	MG	MG	MG
A4	MG	G	G	G	VG	MG	G	MG	G	M
A5	G	G	M	VG	G	MG	G	VG	G	MG
A6	MG	G	MG	G	VG	M	G	G	M	G
A7	G	MG	MG	MG	VG	VG	MG	M	M	MG