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Examining of the sustainable rural tourist potential of Semberija using multi-criteria analysis methods

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Abstract
To promote the development of rural areas, it is essential to implement collaborative initiatives, with tourism being one of them. Tourism significantly contributes to the economic growth of a country. Unfortunately, rural areas have faced a decline in recent decades. Hence, it is crucial to foster tourism as a means to develop these regions. This research study aims to evaluate the potential of rural travel industry using a fuzzy methodology. To achieve this, an approach was devised to assess the rural tourism potential specifically in the Semberija area, using expert opinions. The developed model was then applied to six rural settlements in Semberija. The findings revealed that the Dvorovi settlement exhibited the highest rural tourism potential, while the Suvo Polje settlement displayed the least favourable results. These outcomes demonstrate ways to enhance the rural tourism potential in Semberija. The efficacy of this model in evaluating tourism potential suggests its applicability, with necessary adjustments, to other tourism sectors and specific geographical regions.

Keywords Rural tourism · Tourist potential · Fuzzy methods · Expert assessment

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1 Introduction

The global recession in rural areas can be attributed to the advent of industrial civilization, necessitating the implementation of tourism and various other activities (Gao & Wu, 2017) to revitalize these regions. Rural areas widely recognize tourism as a means of rejuvenation (Rozman et al., 2009). Consequently, the agricultural industry's significance in countryside regions has diminished, with greater emphasis being directed towards travel industry (Lun et al., 2016).

Tourism serves as a catalyst for the socioeconomic advancement of specific rural communities, primarily by augmenting the income of households and the community at large. However, it is imperative to predicate the development of tourism upon principles of sustainability to ameliorate the adverse repercussions associated with its growth within these local communities (Mijajlović et al., 2020). Furthermore, the expansion of tourism may exert detrimental influences on the indigenous culture and traditions of the local community. The indigenous populace often assimilates the preferences of tourists, gradually adopting foreign customs under the pervasive influence of globalization. To mitigate these effects, there is a pressing need to champion local culture and tradition by means of innovative tourism products (Gabor et al., 2023) and to zealously safeguard the distinctive identity of the local community. The preservation of local culture and tradition exerts a positive influence on the allure of the locale for tourists (Duxbury et al., 2021). Consequently, it is incumbent upon us to foster the growth of tourism in these rural communities while concurrently upholding the preservation of their indigenous culture and tradition.

Rural tourism possesses two key characteristics: it provides employment opportunities for rural residents and harnesses existing rural infrastructure and resources to create tourist attractions (Lane & Kastenholz, 2015). The primary objective of tourism in rural areas is to entice vacationers through the rural tourism offerings, thereby enhancing income and living standards for the local population (Puška et al., 2021), while utilizing available resources. As rural tourism develops and expands, new tourist facilities and services are introduced. However, this expansion may engender adverse consequences for the rural community, as it could lead to the reduction of green spaces, agricultural lands, and negative repercussions on biodiversity in these regions (Ramaano, 2021). Given the relatively lower educational levels and income rates in rural areas, it becomes imperative to cultivate social capital in these regions, which will, in turn, bolster the foundations for sustainable tourism (Rahmawati et al., 2023). Consequently, it is essential to heighten the awareness of local residents about the imperative nature of sustainable tourism (Ikrimah et al., 2023). This proactive approach ensures that the promotion of tourism in these regions does not yield adverse effects on the natural resources and environmental integrity of these locales. Through such measures, sustainable rural tourism seamlessly transitions into an ecofriendly form of tourism.

Tourism serves as a catalyst for the development (Pavlov et al., 2023) of rural areas. However, it may not always be the optimal solution for all aspects requiring improvement in rural development, such as agriculture or industry. Rural tourism can lead to decreased incomes, business instability, low earning potential, reliance on external labour, investor conservatism, and other factors (Lun et al., 2016). Hence, it is crucial to promote a holistic approach to rural development, where tourism acts as a complementary component to existing activities engaged in by the local population.

Rural tourism showcases domestic products to tourists, thereby contributing to local and regional development. It should not replace agriculture as a means of livelihood for the

rural population but rather serve as an extension of their existing activities. In the context of rural tourism, the focus should be on fostering cross-cultural interaction and bridging the gap between tourists and the rural way of life. This approach ensures that tourists are not mere passive consumers, and the rural population is not imposed upon but rather thrives as social capital is cultivated through tourism (Steel, 2012). The development of tourism ought to be leveraged to augment agricultural production and market these products to tourists extensively.

However, the progression of tourism in rural areas invariably engenders an upsurge in waste production, necessitating the implementation of sustainable waste management practices within these communities (Han et al., 2019). The most pressing issue arising from the proliferation of waste due to increased tourism pertains to the surge in plastic waste contaminating the land, water bodies, and the atmosphere, thereby inducing pollution (Oceng et al., 2023). To address this concern, there is a compelling need to enhance the knowledge base of the local populace, as insufficient awareness among tourism stakeholders adversely affects the environment, resulting in inadequate waste management (Febryano et al., 2022). It is vital to intensify efforts concerning the collection of non-biodegradable waste and its proper categorization to facilitate recycling (Velvizhi et al., 2020).

Consequently, in these regions, the adoption of a circular economy becomes a necessity, offering a sustainable approach to managing waste that cannot be naturally processed or decomposes over extended periods (Podlevska & Podlevskyi, 2023). This approach underscores the imperative for sustainable rural tourism to adopt an eco-friendly stance, thereby ensuring optimal utilization of available resources within the rural community while concurrently preserving them.

Efforts from the local community are crucial in attracting potential tourists to rural tourism activities through well-planned events and comprehensive tourism products (Folorunso Adeyinka-Ojo & Khoo-Lattimore, 2013). To develop a compelling tourist offering, it is essential for a rural area to possess specific tourism potentials. Without these potentials, it becomes challenging to establish a thriving tourism sector. Therefore, conducting research on the tourism potential of a particular area is necessary before developing the tourist offer (Prevolšek et al., 2020). This paper focuses on exploring the rural tourism potential of Semberija. From the development studies conducted in this region, it has been concluded that Semberija should base its growth on agriculture, tourism, and entrepreneurship. The area exhibits promising prospects for the development of rural tourism, serving as the foundation for creating a model that determines rural tourism potential using Semberija as an example.

Various criteria can be employed to assess rural tourism potential, including natural, cultural, historical, and socio-economic aspects (Yan et al., 2017). A comprehensive evaluation of these potentials necessitates an overarching approach (Nedeljković et al., 2022). This can be accomplished through the utilization of the multi-criteria analysis (MCDA) method. MCDA is employed when comparing different available alternatives, with evaluations based on diverse criteria (Jokić et al., 2021; Stević et al., 2021). In assessing the tourism capacity potential in Semberija, a decision-making model utilizing fuzzy logic will be applied.

To evaluate rural tourism potential effectively, a model must be developed, enabling experts to evaluate specific options using predefined criteria. This model, when implemented, is rooted in the application of fuzzy set theory alongside corresponding multi-criteria methodologies. Thus far, this approach has been deployed to ascertain the potential of rural tourism (Puška et al., 2021), ecotourism (Balist et al., 2019), cultural-historical spatial tourism (Vukoičić et al., 2022), medical tourism (Nilashi et al., 2019), and urban

tourism (Yazdani et al., 2020). These studies and akin endeavours substantiate the utility of the fuzzy set approach, which hinges on expert evaluations in terms of evaluating tourism potential in the region of Semberija. Upon the results of these evaluations, experts will assess rural tourism potentials, identify their strengths and weaknesses, and provide guidelines for potential improvements in Semberija's rural potentials, as this paper's contribution is the development of an innovative approach for examining the rural tourism potential. Previous studies have utilized questionnaires and mathematical models to evaluate criteria weights (Yan et al., 2017), relevance-determination analysis (RDA) and competitive-performance analysis (CPA) to assess demand and attractiveness of tourist potentials (Mikulić et al., 2016), qualitative and hierarchical attribute weighting and evaluation of the discrimination parameter (Sánchez Rivero et al., 2014), SWOT analysis to identify important aspects of success, challenges, and tourism potentials in the countryside and mountainous settings (Lun et al., 2016), geocaching for identifying potential tourist locations (Boys et al., 2017), fuzzy logic matrix for assessing coastal rural tourism potential (Ullah et al., 2009), examination of tourism potential in a planned economy (Halseth & Meiklejohn, 2009), among others. These previous research efforts employed various methodologies for assessing tourism potential, highlighting the novelty of investigating rural tourism potential using an approach that facilitates decision-making.

This paper makes a scientific contribution by offering a comprehensive approach to evaluating tourism potential through expert assessment and the application of fuzzy logic. The proposed model will be utilized to assess rural tourism potential using various criteria, enabling the identification of strengths and weaknesses for each potential. Furthermore, based on the established model and the obtained results, guidelines are going to be provided for enhancing rural tourism potential in Semberija. The findings will shed light on the present-day condition of rural tourism potential in the area, facilitating the acquisition of valuable information for improving the tourist offerings. This, in turn, will aid rural communities in Semberija to enhance their current tourism offerings, attracting new tourists and subsequently increasing the income of local citizens through the purchase of local products. The findings of this study will also benefit managers of tourist facilities, enabling them to improve their business operations. Moreover, this research will have broader implications for the overall development of the local community, as tourists play a vital role in driving regional and national progress.

Based on the aforementioned background, the research objectives are as follows:

1. Develop a framework for assessing rural tourism potential using fuzzy logic.
2. Conduct an expert assessment to evaluate the current state of the tourist offerings.
3. Assess rural tourism potential and provide recommendations for enhancing the tourist offerings.

The paper is divided into five sections, including the introduction. Section 2 presents the theoretical foundation for analysing tourism potential, highlights the tourism potential of Semberija, and provides an overview of previous studies employing MCDA methods to determine tourism potential and the appealing aspects of particular destinations. This section continues with outlining the research methodology, including the research framework, the MCDA methods utilized, and the data collection process. In Sect. 3, the rural tourism potential is assessed using the MCDA model and methods, generating results for each rural settlement. Section 4 comprises a discussion of the obtained results and offers recommendations for increasing Semberija's rural tourism potential. Finally, Sect. 5 summarizes

the key findings, addresses the limitations of the study, and proposes directions for future research.

2 Data and methods

Determining the potential of rural tourism necessitates an interdisciplinary approach, as solely assessing the rural potential in Semberija lacks objectivity in decision-making. Semberija, situated in the north-eastern part of the Republic of Srpska and encompassing the municipality of Bijeljina (Fig. 1), is bounded by the Sava and Drina rivers to the north and east, while the slopes of the Majevica Mountain form its southwestern border. Consequently, the advancement of tourist industry in these areas should focus on rural tourism. Given its advantageous geographical setting and picturesque surroundings, Semberija offers opportunities for the enhancement and advancement of various types of rural and agrotourism. Additionally, the region offers a range of opportunities for activities such as hunting, mountain tourism, ecotourism, cultural events, wellness activities, historical exploration, religious experiences, and gastronomy-related tourism.

Fig. 1 Semberija's location

The rural areas of Semberija host numerous events of different nature, rooted in historical, cultural, and religious heritage. Moreover, Semberija's potential for agrotourism lies in the integration of traditional agricultural activities with the promotion of customs, gastronomy, and cultural heritage. The advancement of tourism for rural areas of Semberija ought to be based on the provision of recreational and educational establishments, sports and recreational amenities, as well as an array of gastronomic offerings (Puška et al., 2021).

Semberija's rural areas possess inherent potential for the aforementioned tourism types, stemming from its natural resources, cultural traditions, and favourable conditions for cultivating various crops, including specific fruit varieties. Consequently, it can be inferred that favourable conditions exist for the growth of rural tourism in Semberija. This study focuses on six rural settlements, which serve as the sample and alternatives for examination: Popovi (V1), Banjica (V2), Amajlije (V3), Suvo Polje (V4), Janja (V5), and Dvorovi (V6).

The populated place Popovi is located in the eastern part of Semberija near the river Drina. Due to the proximity of the river Drina, there are great potentials for fishing tourism. The proximity to the border with the Republic of Serbia determines the economic character of this settlement and its surroundings. As a border settlement, the village of Popovi offers the possibility of frequent tourist cooperation and visits. By arrangement the Drina river bed, the tourism infrastructure gains importance and the number of tourists increases, as does the range of their activities. In the vicinity of the centre of the village, there are a number of tourist destinations, the most famous of which is the ethnic village of Stanišići, which is an attractive location for tourists visiting it from all over the region; it is also the driving force behind the development of tourism in Semberija. Banjica is a rural settlement located on the slopes of the Majevica Mountain. This settlement is adorned by the medieval Tavana Monastery. The settlement provides ideal conditions for trekking tourism, and hiking trips are regularly organized in this area during which natural pearls such as Skakavac waterfall, Šuplja stijena, or Novakova pećina are discovered again and again. Every year, a traditional camp is organized in this settlement, which takes place at the beginning of August. The rural settlement of Amajlije is located in the east of the country next to the river Drina and the already mentioned populated place Popovi. Due to the natural environment, the city's Eco Camp Amajlije is located in this settlement. Traditional local restaurants on the Drina River are located nearby. Also, beaches for swimming in the Drina river have been laid out, which further enables the development of rafting tourism. The rural settlement of Suvo Polje is located in the southwest of Semberija. The monastery complex is located in this settlement, as well as a local hunting ground for roe deer and pheasants. The slightly hilly terrain of this settlement offers the possibility of an active holiday with opportunities for hunting and trekking tourism as well as cycling. The rural settlement of Janja is situated on a stretch of the Drina River. Because of its position, it has great potential in the form of fishing tourism. This border area and its valuable hosts offer enormous potential for the development of the economy and, therefore, tourism. As with the previously mentioned settlements, the Drina River has a great influence on their tourism. In relation to the previously analysed places, Janja represents a settlement with a much more organized infrastructure and, therefore, a local organization that at some point represents an important factor in the planning and implementation of economic and tourist activities. The settlement Dvorovi is located in the northeast of Semberija. This rural settlement is adorned by the widely known Banja Dvorovi, which is one of the hallmarks of Semberija. The healing thermal mineral water of the spa was discovered in 1957 at a depth of 1345 m, when drilling the ground in search of oil. In addition to the medical block, there are also several swimming pools, including an Olympic-sized one and accommodation spa facilities that attract tourists from all over the region. What additionally adorns Banja

Dvorovi is its proximity to the city area, as well as the main road that passes right through the populated place and connects it with almost all important road routes in the country.

Drawing from relevant studies, including those by Do and Chen (2013), Zhou (2014), Zhou et al. (2015), Mikulić et al. (2016), Topolansky Barbe et al. (2016), Peng and Tzeng (2017), Yan et al. (2017), Puška et al. (2019), as well as Puška et al. (2021), a model was constructed based on qualitative indicators. The model encompasses 4 primary criteria: C1 (natural resources), C2 (culture), C3 (social factors), and C4 (economic resources). To ensure the model's comprehensiveness, each primary criterion was further elaborated upon, and corresponding sub-criteria were defined (Fig. 2).

To evaluate rural settlements and their tourism potential, an expert assessment approach was employed. The research methodology used in this study is outlined in Table 1.

Evident from the methodology, various MCDA methods were employed to evaluate rural tourism potential. These methods will be elaborated on in the subsections that follow.

2.1 MCDA methods used in the study

When conducting this research, MCDA methods were used, employing a combination of subjective and objective approaches. The weight of the main criteria was determined subjectively using the FAHP method, while the weight of the auxiliary criteria was calculated using the Entropy method. The ranking of alternatives was performed through the FTOPSIS method, which will help identify the rural settlement in Semberija with the greatest potential for tourism development.

The FAHP method is an extension of the AHP method developed for fuzzy sets. It relies on the subjective evaluation of experts who compare the criteria in pairs and determine their relative importance (Božanić et al., 2015; Sivaprakasam & Angamuthu, 2023). This allows them to compare the criteria based on their own preferences (Puška et al., 2018), using a subjective assessment. The decision maker compares each pair of criteria and establishes which one holds greater significance, according to their opinion (Đukić et al.,

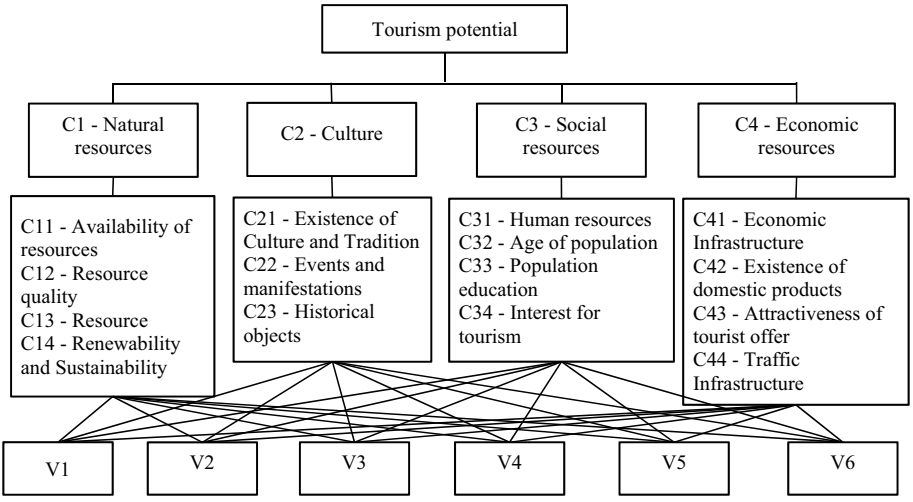

Fig. 2 Model of tourist potential

Table 1 Research methodology

Research phase	Decision on researching the potential for rural tourism Determining the parameters to assess rural tourism potential Identification of six rural areas for assessing rural tourism potential Engagement of tourism experts for expert decision-making
Determining criterion weights and alternative values	Expert evaluation of the weights for the main criteria Utilization of the FAHP method in determining the weight of the main criteria Assessment of rural tourism potential by applying linguistic values and forming a decision-making matrix Conversion of linguistic values into fuzzy numbers Utilization of the entropy method to determine the weights of the sub-criteria
Ranking of alternatives	Implementation of the FTOPSIS method in determining the value of alternatives for the main criteria using the weights obtained using the entropy method Forming final ranking by weighting the values obtained using the FTOPSIS with the values of the weight of the criteria obtained using the FAHP method

2022; Radovanović et al., 2023). To facilitate this process, a linguistic scale for the importance of all criteria was formed and is presented in Table 2.

The FAHP method consists of the following steps:

Step 1 Defining the problem and establishing research objectives.

Step 2 Formulating the problem in a hierarchical structure, as depicted in Fig. 1.

Step 3 Assigning specific values to the criteria through pairwise comparisons and determining their respective weights (Table 2).

$$A = \begin{bmatrix} 1 & a_{12} & \cdots & a_{1n} \\ 1/a_{12} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ 1/a_{1n} & 1/a_{2n} & \cdots & 1 \end{bmatrix} \tag{1}$$

Step 4 Constructing fuzzy numbers based on linguistic evaluations of the criteria

Table 2 Importance of linguistic scale

Linguistic scale of importance	Triangular fuzzy numbers	Reciprocal value of triangular fuzzy numbers
Equally Strong (ES)	(1, 1, 1)	(1, 1, 1)
Very Low Strong (LS)	(3/4, 1, 4/3)	(4/3, 1, 3/4)
Slightly Strong (SS)	(1/2, 1, 3/2)	(2/3, 1, 2)
Medium Strong (MS)	(1, 3/2, 2)	(1/2, 2/3, 1)
Fairly Strong (FS)	(3/2, 2, 5/2)	(2/5, 1/2, 2/3)
Preferred Strong (PS)	(2, 5/2, 3)	(1/3, 2/5, 1/2)
Very Strong (VS)	(5/2, 3, 7/2)	(2/7, 1/3, 2/5)
Very High Strong (VH)	(3, 7/2, 4)	(1/4, 2/7, 1/3)
Absolutely Strong (AS)	(7/2, 4, 9/2)	(2/9, 1/4, 2/7)

$$A = \begin{bmatrix} 1 & a_{12}, b_{12}, c_{12} & \cdots & a_{1n}, b_{1n}, c_{1n} \\ 1/c_{12}, 1/b_{12}, 1/a_{12} & 1 & \cdots & a_{2n}, b_{2n}, c_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ 1/c_{1n}, 1/b_{1n}, 1/a_{1n} & 1/c_{2n}, 1/b_{2n}, 1/a_{2n} & \cdots & 1 \end{bmatrix} \tag{2}$$

where is a a is the first element, b is the second element, and c is the third element of the fuzzy number.

Step 5 Normalization of the decision matrix.

$$r_{ij} = \frac{a_{ij}}{\sum_{j=1}^{n} a_{ij}}, \frac{b_{ij}}{\sum_{j=1}^{n} b_{ij}}, \frac{c_{ij}}{\sum_{j=1}^{n} c_{ij}} \tag{3}$$

Step 6 Calculating criteria weights used geometric mean

$$w_{ia} = \sqrt[n]{a_{i1} \cdot a_{i2} \cdot \cdots \cdot a_{in}} \tag{4}$$

After that, the weights obtained for the fuzzy numbers are defuzzified and a crisp number which indicates the weight of the criteria is obtained (Puška et al., 2018)

$$A = \frac{g_{ij} + 4h_{ij} + l_{ij}}{6} \tag{5}$$

The entropy method was utilized to determine the weights of the auxiliary criteria. This method objectively determines the criteria's weight based on evaluations of the alternatives. If there is a higher degree of divergence in the experts' responses, the criterion's importance will be greater.

The method involves the following steps.

Step 1 Calculating the entropy value using the following expression:

$$e_j = -k \sum_{i=1}^{n} r_{ij} \ln r_{ij}, j = 1, 2, \ldots, m. \tag{6}$$

where r_{ij} is the normalized value, and k represents a constant that is equal to the reciprocal of the natural logarithm of the total number of alternatives (n). It is denoted as follows:

$$k = 1/\ln n, \tag{7}$$

Step 2 Calculating degree of divergence (d_j) using:

$$d_j = 1 - e_j, j = 1, 2, \ldots, m. \tag{8}$$

Step 3 Normalizing the individual values of the criteria's weights and obtaining the final weights of the subcriteria.

$$w_j = \frac{d_j}{\sum_{j=1}^{m} d_j} \tag{9}$$

The FTOPSIS method is an adaptation of the TOPSIS method using fuzzy sets. It ranks alternatives based on their positive or negative ideal values (Narang et al., 2023). The rationale behind applying the FTOPSIS method is that it allows expressing alternative values using linguistic terms, which aligns decision-making with human thinking (Rana et al., 2023). The method consists of the following steps:

Step 1 Formation of the initial decision matrix based on linguistic evaluations of the alternatives by experts (Table 3).

Step 2 Normalization of the decision matrix.

For benefit normalization, i.e. criteria where higher values are preferred:

$$r_{ij} = \left(\frac{a_{ij}}{c_j^+}, \frac{b_{ij}}{c_j^+}, \frac{c_{ij}}{c_j^+} \right), \tag{10}$$

For cost normalization, i.e. criteria where lower values are preferred:

$$r_{ij} = \left(\frac{a_j^+}{c_{ij}}, \frac{a_j^+}{b_{ij}}, \frac{a_j^+}{a_{ij}} \right), \tag{11}$$

Step 3 Weighted multiplication of the normalized decision matrix.

Step 4 Determining the ideal positive and negative solution using the Euclidean distance.

$$d_i^+ = \sum_{j=1}^{n} d_v(\tilde{v}_{ij}, \tilde{v}_j^+),\ i = 1, 2, \ldots, m \tag{12}$$

$$d_i^- = \sum_{j=1}^{n} d_v(\tilde{v}_{ij}, \tilde{v}_j^-),\ i = 1, 2, \ldots, m \tag{13}$$

Step 5 Determining the relative proximity of alternatives in relation to ideal solutions

$$Q_i = \frac{d_i^-}{d_i^+ + d_i^-},\ i = 1, 2, \ldots, m \tag{14}$$

The best alternative is the one with the highest value according to the FTOPSIS method, and vice versa.

2.2 Data for analysis

Expert decision-making was employed in this research. The study proceeded as follows: First, six rural settlements with the most favourable conditions for rural tourism were selected from the total number of rural settlements. Second, potential experts were

Table 3 Linguistic variable for rating

Linguistic variable	Fuzzy numbers
Very poor (VP)	(0, 0, 1)
Poor (P)	(0, 1, 3)
Fair (F)	(1, 3, 5)
Good (G)	(3, 5, 7)
Very good (VG)	(5, 7, 9)
Excellent (E)	(7, 9, 10)
Exceptional (EX)	(9, 10, 10)

identified in collaboration with the Tourist Organization of the Municipality of Bijeljina. Seven experts were chosen to assess the rural tourism potential: three experts specialized in rural development (DM 1–3) and four experts in tourism (DM 4–7). Third, the selected rural settlements were presented to the experts, and organized visits to these locations were arranged. Through these visits, the experts gained essential information about the tourist potential of each rural settlement. Moreover, they engaged in conversations with the local population to further gather necessary information for their evaluations. The experts were also introduced to the traditions, culture, customs, and local events taking place in these areas. Fourth, based on these visits and presentations, the experts evaluated the tourist potential of the rural settlements in Semberija.

3 Results

The first step in assessing the tourism potential of rural settlements in Semberija involves determining the weight of the main criteria using the FAHP method. Based on expert assessments, the criteria's importance in determining rural tourism potential was identified, with higher ratings given to those considered more significant (Table 4).

Following the experts' determinations, their evaluations expressed as linguistic values were transformed into fuzzy values (Table 2), and the average values of these evaluations were calculated (Table 5).

Subsequently, the data in the summary decision matrix were normalized by dividing individual values by the corresponding column's sum. The geometric mean was then calculated for the normalized decision matrix. However, as the sum of individual values of fuzzy numbers obtained through the geometric mean may not equal unity, it was necessary to normalize these individual values of fuzzy numbers. The next step involved defuzzification of fuzzy numbers and the calculation of criteria weights (Table 6).

Table 4 Weight rating of the main criteria

DM1	C1	C2	C3	C4
Natural resources C1	ES	ES	1/VS	1/MS
Culture C2	1/ES	ES	1/VS	1/MS
Social resources C3	VS	VS	ES	PS
Economic resources C4	MS	MS	1/PS	ES
DM2	C1	C2	C3	C4
Natural resources C1	ES	FS	LS	MS
Culture C2	1/FS	ES	SS	FS
Social resources C3	1/LS	1/SS	ES	SS
Economic resources C4	1/MS	1/FS	1/SS	ES
⋮	⋮	⋮	⋮	⋮
DM7	C1	C2	C3	C4
Natural resources C1	ES	ES	LS	FS
Culture C2	1/ES	ES	ES	MS
Social resources C3	1/LS	1/ES	ES	FS
Economic resources C4	1/FS	1/MS	1/FS	ES

Table 5 Aggregate fuzzy decision matrix

DM AVG	C_1	C_2	C_3	C_4
C_1	1.00, 1.00, 1.00	1.17, 1.33, 1.50	0.57, 0.75, 0.98	1.00, 1.39, 1.83
C_2	0.67, 0.75, 0.86	1.00, 1.00, 1.00	0.57, 0.75, 0.93	1.00, 1.39, 1.83
C_3	1.02, 1.33, 1.74	1.08, 1.33, 1.74	1.00, 1.00, 1.00	1.33, 1.83, 2.33
C_4	0.55, 0.72, 1.00	0.55, 0.72, 1.00	0.43, 0.55, 0.75	1.00, 1.00, 1.00
Sum	3.23, 3.80, 4.60	3.79, 4.39, 5.24	2.58, 3.05, 3.66	4.33, 5.61, 7.00

Table 6 The value of the criteria obtained by the FAHP method

	Geometric mean	Weights of fuzzy numbers	Weights of criteria
C_1	0.26, 0.26, 0.26	0.27, 0.26, 0.26	0.264
C_2	0.23, 0.23, 0.22	0.23, 0.23, 0.22	0.229
C_3	0.32, 0.33, 0.33	0.32, 0.33, 0.33	0.328
C_4	0.17, 0.18, 0.19	0.18, 0.18, 0.19	0.179
Sum	0.99, 1.00, 0.99	1.00, 1.00, 1.00	1.000

The results show (Table 6) that, according to experts, the most important criterion is social resources, followed by natural resources, then culture, and in their opinion, economic resources are the least significant.

The subsequent phase in the assessment process entailed determining the weights of auxiliary criteria using the Entropy method. To achieve this, an initial decision matrix was formed, also employed for the FTOPSIS method (Table 7). This matrix represented the assessment of rural settlements in Semberija using linguistic values for auxiliary criteria.

To determine the weights, it was necessary to first form fuzzy numbers using the membership function (Table 2) and then defuzzify these values. Afterwards, all experts were given the same importance, and the final grades were established based on the average value of these grades. An example using main criterion C1 demonstrates the procedure for calculating the weights of the auxiliary criteria (Table 8). Normalized final evaluations of the experts were calculated, followed by the natural logarithm of these normalized values, which were then multiplied with the normalized values. By adding these values for the auxiliary criteria and multiplying them by the negative value of the constant, the entropy value was obtained. Consequently, the degree of divergence value and the weight value were calculated. In this instance, auxiliary criterion C14 received the highest weight, while auxiliary criterion C12 received the lowest weight.

The same procedure was applied to other auxiliary criteria to calculate their respective weights (Table 9). To obtain the final weights, the weights of the auxiliary criteria were multiplied with the weights of the main criterion. These weights were utilized in the FTOPSIS method.

The third step in the results involved applying the FTOPSIS method. The initial step of the FTOPSIS method mirrored that of the entropy method, where the initial decision matrix with linguistic values was formed (Table 7). These values were subsequently transformed into fuzzy values (Table 3) and normalized (Expression 10). The normalized values were then multiplied with their respective weights, and the ideal positive and negative

Table 7 Expert evaluation of sub-criteria

DM1	V1	V2	V3	V4	V5	V6
C11—Availability of resources	VG	G	G	G	G	VG
C12—Quality of resources	E	VG	VG	F	VG	G
C13—Diversity of resources	VG	G	E	F	VG	E
C14—Renewability and sustainability	G	G	F	F	VG	VG
C21—Existence of culture and tradition	F	VG	E	G	G	EX
C22—Events and manifestations	P	VG	VG	F	VG	E
C23—Historical objects	F	E	E	F	VG	EX
C31—Human resources	P	P	F	G	F	G
C32—Age of the population	P	P	F	F	P	F
C33—Education of the population	F	F	F	F	F	F
C34—Interest in tourism	P	F	P	F	P	G
C41—Economic infrastructure	G	E	VG	VG	VG	VG
C42—Existence of domestic products	VG	VG	VG	G	M	VG
C43—Attractiveness of the tourist offer	G	VG	E	G	F	G
C44—Transport infrastructure	EX	EX	EX	EX	P	EX
DM2	V1	V2	V3	V4	V5	V6
C11—Availability of resources	VG	G	VG	F	G	VG
C12—Quality of resources	VG	F	G	F	F	VG
C13—Diversity of resources	E	F	VG	P	G	VG
C14—Renewability and sustainability	VG	G	G	F	G	G
C21—Existence of culture and tradition	G	F	G	F	G	VG
C22—Events and manifestations	G	VG	G	F	G	G
C23—Historical objects	VG	G	VG	F	G	E
C31—Human resources	P	G	F	F	G	F
C32—Age of the population	P	G	F	F	G	F
C33—Education of the population	F	F	F	G	VG	G
C34—Interest in tourism	VG	G	VG	F	F	G
C41—Economic infrastructure	F	G	G	VG	VG	G
C42—Existence of domestic products	G	G	VG	VG	E	G
C43—Attractiveness of the tourist offer	VG	G	VG	F	G	VG
C44—Transport infrastructure	G	VG	E	E	VG	E
⋮	⋮	⋮	⋮	⋮	⋮	⋮
DM7	V1	V2	V3	V4	V5	V6
C11—Availability of resources	VG	F	G	G	G	VG
C12—Quality of resources	VG	VG	G	G	G	G
C13—Diversity of resources	E	G	VG	F	VG	VG
C14—Renewability and sustainability	VG	VG	G	G	G	G
C21—Existence of culture and tradition	VG	G	G	F	G	G
C22—Events and manifestations	VG	G	VG	G	VG	G
C23—Historical objects	VG	VG	VG	G	VG	E
C31—Human resources	F	G	G	VG	VG	G
C32—Age of the population	F	VG	G	VG	G	G
C33—Education of the population	G	VG	G	VG	VG	G
C34—Interest in tourism	E	VG	E	G	G	VG

Table 7 (continued)

DM1	V1	V2	V3	V4	V5	V6
C41—Economic infrastructure	G	VG	VG	VG	VG	VG
C42—Existence of domestic products	G	VG	VG	VG	VG	G
C43—Attractiveness of the tourist offer	E	VG	E	G	VG	E
C44—Transport infrastructure	G	VG	E	E	G	E

Table 8 Calculating subcriteria weights using the entropy method

	C11	C12	C13	C14
Normalized defuzzified decision matrix				
V1	1.0000	1.0000	1.0000	1.0000
V2	0.6190	0.7445	0.5270	0.8947
V3	0.8095	0.7445	0.9257	0.6842
V4	0.6190	0.4818	0.2905	0.5789
V5	0.7143	0.6569	0.7703	0.8947
V6	1.0000	0.7445	0.9257	0.8947
Logarithmic decision matrix				
V1	0.0000	0.0000	0.0000	0.0000
V2	− 0.4796	− 0.2950	− 0.6405	− 0.1112
V3	− 0.2113	− 0.2950	− 0.0772	− 0.3795
V4	− 0.4796	− 0.7303	− 1.2360	− 0.5465
V5	− 0.3365	− 0.4202	− 0.2610	− 0.1112
V6	0.0000	− 0.2950	− 0.0772	− 0.1112
The product of the defuzzified decision matrix and logarithmized decision matrix				
V1	0.0000	0.0000	0.0000	0.0000
V2	− 0.2969	− 0.2196	− 0.3376	− 0.0995
V3	− 0.1711	− 0.2196	− 0.0715	− 0.2597
V4	− 0.2969	− 0.3518	− 0.3591	− 0.3164
V5	− 0.2403	− 0.2760	− 0.2011	− 0.0995
V6	0.0000	− 0.2196	− 0.0715	− 0.0995
Sum	− 1.0052	− 1.2868	− 0.7682	− 0.6756
Entropy value	0.5610	0.7182	0.4287	0.3771
Degree of divergence	0.4390	0.2818	0.5713	0.6229
Sub-criteria weights	0.2292	0.1472	0.2983	0.3253

Table 9 The value of the weight of the subcriteria

Subcriterion	Subcriterion 1	Subcriterion 2	Subcriterion 3	Subcriterion 4
C1	0.2292	0.1472	0.2983	0.3253
C2	0.2163	0.4810	0.3028	–
C3	0.2061	0.2351	0.2206	0.3382
C4	0.2556	0.2467	0.2174	0.2803

solutions were computed, along with the deviations from these solutions (Expressions 12 and 13). Ultimately, the final values of the FTOPSIS method were calculated (Table 10).

The rural settlement of Dvorovi exhibited the best results, indicating the highest potential for rural tourism, according to the experts. Conversely, the rural settlement of Suvo Polje achieved the worst results, signifying the currently weakest potential. Nevertheless, these potentials are variable and can be improved. Therefore, this analysis presents a snapshot of the current state of the rural tourism potential of the selected rural settlements in Semberija.

4 Discussion

The research reported in this paper developed a framework for assessing rural tourism potential utilizing various MCDA methods. The outcomes obtained from the implemented decision-making model revealed that the rural settlement Dvorovi demonstrates the highest tourism potential when considering all criteria, while Suvo Polje exhibits the lowest potential. The evaluation of tourism potential was based on four primary criteria and 15 additional criteria, with the results serving as indicators for these criteria.

Experts emphasize the significance of natural resources and culture, while economic resources are deemed less significant, with current scarcity in these areas. Improving economic resources can be achieved through infrastructure investments, whereas natural resources, culture, and tradition are not easily ameliorated. Hence, development policies, investments, and coordinated activities are necessary to enhance economic resources and improve the tourism product in rural settlements within Semberija (Anbalagan & Lovelock, 2014). Infrastructure investments, particularly in hotels and other tourist facilities, play a pivotal role in enhancing economic resources (Bassey, 2015). By investing in economic resources, living conditions in rural settlements can be improved, discouraging population outflow. Enhanced living standards and improved social resources contribute to the advancement of rural tourism potential in these areas.

To enhance the rural tourism potential in Semberija, a comprehensive analysis of individual criteria is necessary to identify areas in which rural settlements should focus their improvements. Based on the obtained results, it is evident that social potential is the weakest aspect across all rural settlements. Strengthening people's awareness of tourism in the Semberija area requires investment and education to fully utilize the tourism potential available in this region. Additionally, a favourable political environment should promote increased investment in rural development, with tourism as a primary focus.

Table 10 Calculation of the FTOPSIS method

	Sum d^-	Sum d^+	Q	FTOPSIS
V1	0.0156	0.0140	0.5275	5
V2	0.0161	0.0131	0.5521	3
V3	0.0179	0.0119	0.5997	2
V4	0.0139	0.0187	0.4258	6
V5	0.0161	0.0141	0.5333	4
V6	0.0195	0.0111	0.6372	1

This study demonstrated that the developed framework, employing MCDA approaches, effectively determines the rural tourism potential in Semberija. This model highlights the strengths and weaknesses of tourism potential in the area, offering valuable insights to direct efforts towards enhancing rural tourism in Semberija. Consequently, this study provides practical guidelines for improving tourism in these areas.

5 Conclusion

Determining the potential of tourism is an initial step in implementing tourism-related initiatives. In order to develop attractive tourism offerings, it is crucial to assess the tourism potential of specific locations. This research focused on exploring the rural tourism potential of Semberija. The outcomes of the model created for this study revealed that the reported rural communities possess significant prospective for tourism. Among them, the rural settlement of Dvorovi demonstrated the most promising results, while Suvo Polje exhibited comparatively lower tourism potential. For the aforementioned locations to maximize their tourism potential, socioeconomic assets must be enhanced.

The fact that the research did not encompass every rural area within Semberija, as that would have burdened the research, is one of its limitations. Thus, future studies can address this by considering a broader scope. The objective of this paper was to establish a model for assessing rural tourism potential, which can also serve as a foundation for evaluating other types of tourism. Subsequent research should focus on refining the developed model for application across various tourism sectors. Additionally, involving a larger number of experts will help identify key resources for tourism potential in specific branches of tourism. Based on the model presented in this study, it is possible to create new models tailored to assess the tourism potential within any tourism domain.

The research presented in this paper and the proposed methodology have established a strong foundation for developing a model to examine tourism potentials. Through this model, insights were gained on how to enhance rural tourism potential in Semberija, aligning with the research's objectives. Consequently, it can be concluded that the model and methodology employed in this study can be effectively utilized for assessing rural tourism potential.

In future research, it is imperative to delve deeper into the formulation of models that enhance rural tourism, grounded in the context of rural area tourism development. Subsequently, it becomes essential to scrutinize the ramifications of tourism development within these regions on environmental sustainability, nature conservation, water resources, and waste management. As the expansion of tourism within rural areas is invariably accompanied by these adverse consequences, it becomes paramount for future research to provide comprehensive guidelines that delineate how these regions can foster tourism while concurrently addressing the predicaments associated with its development, particularly its adverse environmental impacts. In the realm of rural tourism, concerted efforts must be invested to safeguard the natural allure of these rural communities, paving the way for the cultivation of eco-friendly tourism within these locales.

Data availability All data generated or analysed during this study are included in this published article.

Declarations

Conflict of interest The authors declare that they have no conflict of interest. The authors have no relevant financial or non-financial interests to disclose.

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