Engineering and Technology Journal

Ecotourist and Picnic Area Assessment Using AHP Analytical Tools in Sulaimani– Tourism Region, Iraq

Awa A. Ahmad [a], Ako R. Hama[b,a]*, Imzahim A. Alawn[c]

[a] Civil Engineering Dept, College of Engineering, University of Sulaimania,., Sulaimani, KR, Iraq
[b] Civil Engineering Dept, Komar University of Science and Technology, Sulaimani , KR, Iraq
[c] Civil Engineering Dept, University of Technology-Iraq, Alsina'a street,10066 Baghdad, Iraq.
*Corresponding author Email: ako.rashed@komar.edu.iq

HIGHLIGHTS

- Ecotourism land and picnic area ranking
- AHP analysis technics
- Multicriteria decision making

ARTICLE INFO

ABSTRACT

Renovation of the naturally existing area for ecotourist and investments that attracting site-visitors, picnickers and tourists for Iraq, Kurdistan Region, Sulaimani need to promote a reliable decision-making technique so as to raise the level of the tourist-based economy. In this study, the most available public well known and recognized tourist and picnic area by the people and associated governmental directories were studied and assessed for their tourism reliability and capacity. The study area of this research covered tourist area and they were forty-three (43) locations and all the related data collected, analyzed and categorized as main and sub-main criterions. The analytical hierarchy process (AHP) has been used for assessment of that area which was ranked accordingly from the highest to lowest capacity and efficiency's reliability of tourism. The opinion of experts from tourism agencies, related tourism officials and people from the local area also taken into consideration and translated and used in the AHP assessment tool. Weight factors of the main and sub-main criterions were founded and analyses for their inconsistency. The main criterions and their pairwise weights as per AHP assessment were climate, available green area, root distance, easy of transportation, essential requirements, entertainment tools, provided security and healthcare, respectively.

1. Introduction

Tourism is considered as the industry with the most vitality and development potential. Nowadays, it's considered as one of the largest industries in the world. It's not only recognized by developed countries, but also distinguished as an important industry by more developing countries [1]. Eco-tourism is a type of tourism that promotes concept of a sustainable development [2-4]. It plays an important role in reducing the negative impacts on society, economy, and environment [3-5]. Eco-tourism has a crucial impact in preserving the cultural identity of people, biodiversity, and natural resources [4,6-7]. It can also be defined as the responsible travel with the aim of conserving natural environments along with sustaining the well-being of local community [4,8]. Ecotourism can also be defined as an adventure that's environmentally responsible intended to appreciate the nature experiences and cultures [9]. Nowadays, most of the developed countries trying to find a sustainable source of their country's economy, besides of their national economy sources specially oil and gas. Their main sustainable source is tourism, as it's dependent on the beauty of the nature of the region and places for all picnickers and visitors who want to spend money and searching for relaxation. Also, the developing countries like Iraq and its Kurdistan Region who their main source of economy is 98% dependences on mainly oil and gas produce income on their revenue. The tourism-based economy considered nowadays, to be an important and mainly alternative resource for the income to the countries and a safe grad. Enhancement and investing in tourism field, needs accurate study and reasonable excuses and support, and here the main goal of this study is to give a clear view for the governmental associated directories and officials to work on them and give priority to really needed area and ranked locations. Iraq in general and specially Kurdistan region have several other sources could be considered as a substitute for the oil and gas and the best of them is agriculture and tourisms. As in Kurdistan and mainly Sulaimani a wide area filled with the beauty of the nature and mountains and natural spring wide green area, hills, comfort temperature and atmosphere, all mentioned

points make tourism a wise choice and assessment of those existing area very important and necessary for the governmental directories as well as private sector for sorting the existing nominated area and worth to select and improve them as per a priority list, the fact and reason behind this research. Strategic planning to develop ecotourism area is not measured in terms of the landscape only, but many factors should be considered such as topography, climate area, and many more. The AHP is a structured technique that's used in organizing and analyzing complex decisions, on the basis of psychology and mathematics [10]. AHP has application in group decision making and is widely used in the world in a variety of decision-making situations [10]. AHP can be used in the fields such as government, business, industry, healthcare, tourism and education [11]. AHP helps decision makers to find a decision that's ideal and unique to their own purposes and their understanding of the problem. It provides a complete framework in defining the problem, in representation and qualifying its elements, and for relating those elements to overall goals, and for the evaluation of alternative solutions [11]. The use of AHP model is important for sectors of eco-tourism development and has various benefits such as identifying potential tourist destinations, and tourism site suitability [12].

2. Theoretical Section

The analysis and assessment of the suitability of lands and areas that could be used as a tourist area, has been studied by several researchers and agencies from the economic point of view. Analytic Hierarchy Process (AHP) was one and an efficient way for this kind of assessment in a condition of taking the opinions of experts. Gunen integrated the GIS, AHP and MCDM analyses tools for the purpose of site suitability assessment of solar photovoltaic (PV) farms in Kahramanmaras, Turkey [13]. In his research, a total of three (3) main criteria have been chosen climate, geography, and location along, with fourteen (14) sub-criteria which consisted of aspect, slope, land use/cover, GHI, precipitation, temperature, humidity, distance from settlements, road transportation network, railway transportation network, lakes and dams, fault lines, rivers, and power line network. Each criterion was given a specific weight through AHP method by implementing pairwise comparison matrix. It is worth mentioning that GHI, aspect, distance from power line networks, LULC, and annual average temperature were among the most necessary sub-criteria. The research's result mentioned that 9.62% of study area are very low, 20.15% is low, 22.5% is moderate, 23.98% is high and 23.74% is very high, while 26% of the study area is unsuitable for solar PV farms. The northern districts of Kahramanmaras have been selected as the most suitable location for solar PV farm construction. [14] (Albraheem & Alabdulkarim, 2021) proposed a spatial multi-criteria decision analysis, (MCDA) method for the purpose of the identification of adequate solar power energy projects which consisted of performing geospatial analysis, spatial decision support system and visualization in Ryadh, Saudi Arabia which consists of 22 cities and villages. In their research, GIS and AHP have been applied and the selected criteria for the study included were solar radiation, temperature, distance from (roads, power lines, building areas), elevation, slope, and orientation. Their study concluded that the north and northwest of Riyadh were the most ideal areas having a total area of 6,748 km² with an 80% suitability degree. The study also revealed that the largest and the most suitable city in Riyadh was Afif city with the average solar radiation of 2.631687 MWh/m²/year and low temperatures averaging $26.3C^{\circ}$ along with having flat areas with slope under 5 degrees. The model of sensitivity analysis has been applied for the purpose of validating results along with comparing the results to those of ground-based stations. Maaiah et al. proposed another different method for the nature-based tourism (NBT) mapping in Jordan through using GIS, AHP & remote sensing through considering the costs and distance [15]. The proposed AHP model was based on a multi-criteria assessment method which includes accessibility, landscape, facilities and infrastructures criteria. For this purpose, a total of 150 people has been interviewed from different travel agencies. NBT include four clusters which are water and desert attractions, forests, and nature reserves as detailed in table 1. in their research. A value of attractiveness was added to the factors in each cluster. The travel agencies were tasked to give two different types of values one which is 1 to 9, another is a value from 1 to 1/9 which is detailed in table 2 in their research. Their study concluded that the integration of AHP, GIS and remote sensing was highly effective in the tourist attractions processes in Jordan. They concluded that the AHP model has given the highest priority to the desert attractions and, forest areas respectively, while a lower priority was given towards water criteria attractions. Ecotourism land suitability has been studied by Mansour et al.using GIS and AHP multicriteria analysis tools and spatially assessing the study area in Masirah island in Oman [16]. Site selection, planning of suitable locations and ecotourism was mainly done using the AHP model. For this purpose, evaluating the suitability of the ecotourism sites, thirteen (13) criteria have been identified including topographical, environmental, ecological, and natural domains. The criterion list consisted seven spatial criteria turtle beach, birds beach, sand beach, road network, mangrove trees, coral reefs, and buildup area and six (6) physical criteria such as elevation, aspects, slopes, geology, fault lines and soil types. Choosing the mentioned criteria were based on local knowledge, literature review, and field work. The results reveal that integrating GIS with AHP provides an important support in decision making regarding facility planning, and utilizing natural resources, at which 37.39 km² 2 5.96% of the study area are highly suitable, 288.84 km² 46% are moderately suitable, and 294.46 km² 47% have minimal suitability for a sustainable development of ecotourism across the island. The multicriteria analysis in this study has proved to be beneficial for ecotourism planners and decision makers in Oman. Parvar et al. presented a method for identification and prioritization of eco-tourism sites in Hamadan township, Iran [17]. In their study which was based on using GIS & AHP assessment methods seven (7) criteria were chosen; slope, aspect, distance from water and road, land use, and vegetation. Expert's view was used for specifying criteria and sub-criteria, after which a final map of the area was produced by using Weighted Linear Combination (WLC) and Ordered Weighted Averaging (OWA) in GIS environment. The research concludes that 15,049 ha of the study area has achieved first class potential which implies that it's highly suitable, while 114,919 ha of the study area has second class potential 122,589 ha has third class potential, and 26,292 ha has four class potential based on using WLC method. Eftekhari & Mahdavi proposed another method for the assessment and possibilities for the establishment of a natural tourism development area in Lavasan-e Kuchak district in Iran using analytic network process (ANP) in GIS environment. In their study, a land suitability map has been produced by using ten (10) different

layers of information and three criteria which consisted of site feature, services & infrastructures, risk & sensitive areas [18]. The ten (10) nominated criteria that were chosen from the main ones included aspect, slope, vegetation, land use, distance from main road, distance from settlement, distance from tourist sites, distance from fault, distance from protected areas, and distance from rivers. Those 10 layers were then converted into a raster format followed by applying spatial analysis for the purpose of implementing ANP in GIS for the database establishment. In the next step, weight was given to the chosen criteria through ANP with overlaying being done in GIS after which the map went through a reclassification process into five (5) categories from least suitable to most suitable areas. In their study, they conclude that around 15.87% of the Lavasan-e Kuchak district is the most suitable for the establishing tourism development. Adewumi et al. have integrated a GIS and AHP model for the selection of the most suitable location of landfill in Lokoja, Nigeria [19]. A total of five (5) criteria were selected including proximity to major road, power line, water body, landfill areas and buildup areas. The use of GIS in the study included digitizing spatial features related to landfill suitability sites at which 19 candidate landfill sites were identified from GIS analysis through which 11 sites were chosen as high priority sites due to having areas more than 1 km² while the remaining sites were nixed due to having areas less than 1 km². The use of mixed AHP and GIS model results in choosing an ideal landfill site out of eleven (11) chosen places. The least preferable area that was chosen by AHP model was site sixteen (16) in Ganaja village which has an area of 2.5680 km², and approximate distance of 2430.75m, 594.04m, 1980m, and 200.68m from minor road, nearest water body, power line and buildup areas, respectively. The study concludes that the findings will serve as a guide in selecting landfill sites in states of developing countries. In 2019, Gašparović,I. & Gašparović, M. proposed a method for the determination of the optimum solar power plant location in Croatia using the integration of remote sensing with AHP and GIS [20]. Their study was based on using the socio-economic, population, unemployment, number of tourist nights and consumption of electricity along with the use of spatial, climate, environmental and geomorphological parameters. A software called GRASS GIS was used during their investigation for the application of spatial analysis at which a creation process of raster of all parameters was carried out. They used AHP model in the process for assigning raster with weight coefficients at which the sum of all raster's coefficients gives the final result for the ideal solar plant location in the study area. This final raster named F1 was expressed in a formula 4 inside the research. The accuracy of the results was tested through performing a sensitivity analysis by the use of different weight coefficients criteria of the parameters. Based on the statistical values of sensitivity analysis, it was concluded that the raster of F1 gives the optimal result for solar power plant location. Also the main parameters that had a great role in the determination of location for plant included land cover, distance to the network of electricity and GHI. Harun & Samat studied GIS-based multi-criteria evaluation (MCE) method for tourism planning and development in environmentally sensitive areas (ESA) in Langkawi Island, Malaysia [21]. Two different set of criteria were used in this study, one set has been used for determining ESA which included coastline, topography, natural resources, forest and tourism sites, while the second set of criteria has been used for determination of the suitable tourism development places in the study area which included proximity from and to existing transportation network, existing infrastructure and industrial sites. Both two sets of criteria were given weights through interviewing experts such as engineers, environmental officer and planner, academician, decision maker, and land administrator. The study concludes that the new buildup area can only be bordered within the pre-existing urban area for the purpose of ensuring and preserving tourism sites and ESA. Mahdavi et al. used another method for the selection of the development of ecotourism in Khorram-Abad county in Iran [22]. Their investigation method depends on the use of fuzzy multi-criteria decision-making method (FMCDM). In the research, the method of Delphi has been used for the creation of five (5) main and fourteen (14) sub-criteria for the purpose of locating adequate locations for ecotourism development through interviewing experts. The main criterions included: climate, topography, geo-pedology, environmental, and socio-economy, while sub-criteria include precipitation and temperature, slope, aspect, elevation, and soil type, petrology and erosion, vegetation type and density, water resources and distance from road and settlements, distance from negative factors, and distance from recreational tourist attractions as shown in table 2, Afterwards the influence level and degree was given to the chosen criteria through using methods of fuzzy set theory, linguistic value hierarchical structure analysis, and fuzzy analytic hierarchy process (FAHP). The method of weighted linear combination in GIS environment was used for the preparations and combining different layers. The study ended with that 6.57% and 38.65% of the locations were ideal and have a good potential for the development of ecotourism. The study also reassures that the usage of FAHP and GIS is a powerful combination for planning of land use. In 2013, Abomeh & Nuga used GIS techniques for managing tourism in Victoria Island Lagos[23]. In their study [23] , they included different destinations and places such as beach, museum, resort and parks, hotels, restaurants, cinemas, fitness centers along different available services such as police post, clinic and hospitals. The captured data were grouped into four categories which included facilities, services and tourist destinations for which each of them were given different unique identifiers. An existing road map of Victoria Island was also used and converted into a digital map and was georeferenced using the reference system of Universal Traverse Mercator (UTM) and Projection of Zone31N. Geographic coordinates along with the corresponding attributes of the mentioned destinations were collected and used for the purpose of creating a database in Arc Map 9.3 software. They used GIS analytic tools and central feature analysis in modeling accessibility to the nominated destinations in the area of the study. The result is showing that the use of GIS is successfully aiding the authorities and government agencies to plan, visualize and access different tourist destinations, facility and services in the island along with giving ability to determine the fastest and shortest route towards destined areas for the tourists from their current location. In 2011, Bunruamkaew & Murayam presented another method for tourism site assessment in the province of Surat Thai, Thailand [24]. GIS and AHP analytical tools were used in the assessment process, at which several suitability indicators factors have been identified including landscape/naturalness, wildlife, topography, accessibility and community characteristics. Total of nine criteria have been chosen which were visibility, land use/cover, protection/reservation, diversity of species, evaluation, slope, proximity to cultural locations, and distance from roads and size of settlements as shown in table 2 of the research. The suitability factor rating was ranged from high to moderate, then marginal and not suitable. The selection of the chosen factors was carried out based on the view of experts. The use of AHP method was

effective in the calculation of the factor details and weight of classes. The study concludes that the combination of both AHP & GIS was successful in the identification of the ecotourism sites by mixing criteria which are considered important with the actual province resources. Saaty mentioned that; AHP is a measurement theory using pairwise comparison that depends on expert decisions for deriving priority scales[25]. These scales play an important role in the measurement process of intangibles. A scale of absolute judgments is used in the comparison process that implies the domination of one element over another with respect of a given attribute. The function of AHP involves improving the judgements, measuring inconsistency, and getting determination of the available knowledge, structuring the decision hierarchy from the top which includes criteria and alternatives, implementation of pairwise comparisons, and weighting the priorities obtained from the comparisons and continuing the procedure until all the priorities of the alternatives are obtained. The priority scales that are driven are combined through multiplication by the priority of their parent nodes and adding for all such nodes. The AHP has been used in several different decision-making settings such as determining relocation sites for Adaparazi city in Turkey which was devastated by earthquake. British airways have also used the model for choosing the most suitable vendor for providing entertainment system for its airplanes. Saaty concludes by implying that for a group to make a decision, they would need to do it in an organized way through collecting information relevant to them, determining crucial factors with discussing their understanding, values and beliefs [25]. Zhang & Yang used GIS and multi criteria analysis method MCAM for spatial distribution of rural tourism in Ningbo City, China [26]. The study showcased a method for finding the ranking of the locations of rural tourism development levels. GIS and multi criteria decision analysis (MCDA) techniques have been used in calculating the priority utilities for tourism development needs. MCDA is a process consisting of seven (7) components: problem definition, evaluation criteria, alternatives, criterion weights, decision rules, sensitivity analysis and recommendation as shown in Figure 1 of the study. Evaluation criteria includes tourism resources, transportation, economics, and developed districts of tourism in neighborhood. The study was concluded that by the use of those mentioned methods, the ranking of the location of rural tourism in Ningo city will be successful and that the use of multicriteria decision analysis is crucial for providing a distribution plan for rural tourism areas spatially.
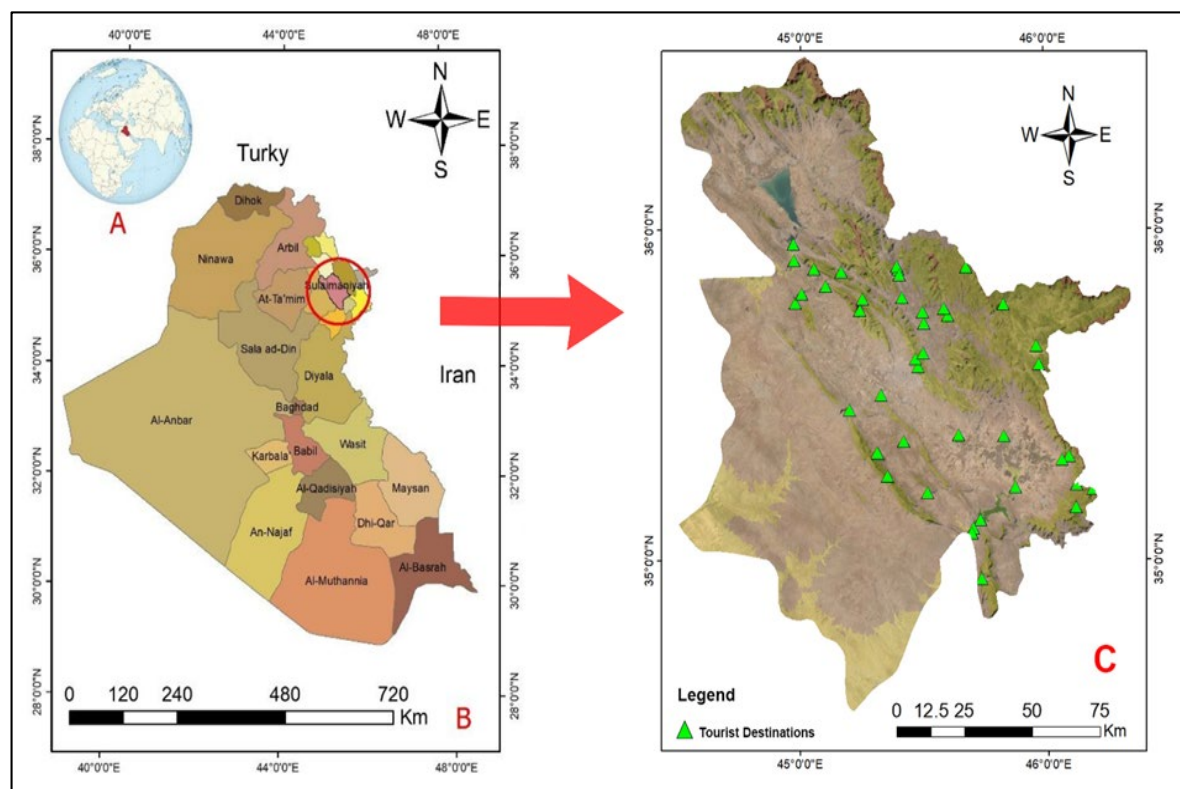

Figure 1: Study area for AHP analysis of tourism in Sulaimani Kurdistan Region, Iraq

3. The Study Methodology

3.1 Study Area

The study area of this research is within a radius of 110 km of Sulaimani governorate which has a total area of 20,144 km². Sulaimani province is a hilly and mountainous region in the Kurdistan region, Iraq and located in 35.5466° N, 45.3004° E. Capital of culture of the Kurdish region and has a diverse topography and characteristics including mountainous landscapes, lakes, springs, historical and heritage spots that makes it ideal for developing successful eco-tourism sites. And even from neighbor countries such as (Turkey, Iran, Syria) the city attracting people from international and local areas across all the Iraq cities.

3.2 Data Source and Methods

Data used in this research were collected from different sources. The main data source was from the site visit of a total forty-three 43 tourist destinations and locations across the study area. Another data source, covered site survey and questionnaires which have been answered by experts and related travel and tourist agencies in Sulaimani. The questionnaires related to specifying important factors and criteria which are crucial for eco-tourism in Sulaimani governorate. The data collection procedure commenced during the period between September 2021 to October 2021. Analytical tourist season in the area A total of nine (9) main multi criteria including climate, green area, water body, root distance, easy of transportation, essential tourism, entertainment, security condition, and health care, and twenty three (23) sub-main multi criteria including temperature, humidity, MSL, hotel, motel, shops, restaurants, W.C, mosque, petrol station, electricity, natural spring, natural lake, natural stream, natural fountain, artificial lake, artificial fountain, tent, swimming pool, water sports, safari, play yard, and heritage area have been considered for assessment process as in Figure 2.
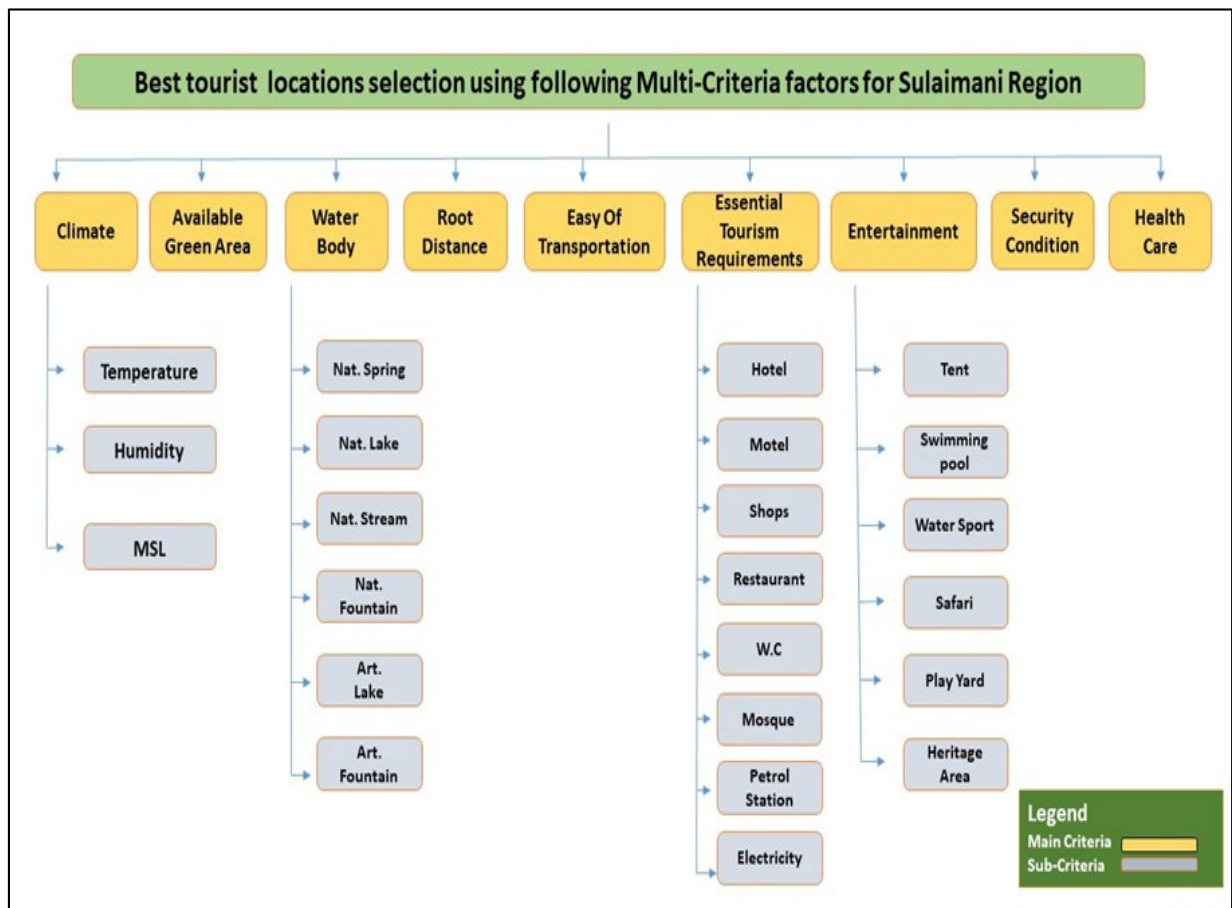

Figure 2: Multi-criteria used in the AHP assessment for the tourist area in Sulaimani Region

4. Development of AHP based model for Multi-Criteria Decision Making

In this research, a AHP model was developed based on multi-criteria evaluation of attractiveness. A tool as it was developed by [27] for the purpose of providing solid basis for calculating criteria [24, 28 ,29]. The creation of hierarchical structure was done through applying weight to each criterion in the entire process of decision making. The value of weight determines the importance of one criterion over another through creating pairwise comparison matrix of all criteria, choosing two criteria at a time. The attractiveness value is assigned to each criterion [15, 30]. These values are calculated based on the average responses of questionnaires that passed the test of consistency ratio. Values from 1-9 in a pairwise manner were assigned from each travel agency and experts to each criterion a_i, a_j in case criteria a_i is more attractive than a_j, otherwise value from 1-1/9 should be implemented. Table 1 shows attractiveness values at which 1 corresponds to equally attractive while 9 corresponds to extremely attractive [15, 27, 30].

Table 1: Criteria relative importance scale [15,27,30]

Attractiveness level	Ranking, a_i is more costly than a_j	Ranking, a_i is less costly than a_j: inverse comparison
Equally attractive	1	1
Equally attractive to slightly more attractive	2	1/2
Slightly more attractive	3	1/3
Slightly more attractive to much more attractive	4	1/4
Much more attractive	5	1/5
Much more attractive to very much more attractive	6	1/6
Very much more attractive	7	1/7
Very much more attractive to extremely attractive	8	1/8
Extremely attractive	9	1/9

*a_i and **a_j are criterions.

The determination of performance values in the rows and columns of the matrix is being done through the use of values of a_{ij} when ($i = 1,2,3 \ldots, m$) and ($j = 1,2,3 \ldots, n$). The comparison criteria value is being set on the higher diagonal triangle of the matrix, while the reciprocal values of the upper diagonal is being set on the bottom triangle of the matrix. For this process, Equation 1 was used [31, 32].

$$a_{ji} = \frac{1}{a_{ij}}$$ (1)

Where, i and j in a_{ij} correspond to the elements of row and column of the matrix, respectively. The below matrix can be used for the criteria's relative importance as follows:

$$\begin{bmatrix} a_{11} & a_{12} & \ldots & a_{1n} \\ a_{21} & a_{22} & \ldots & a_{2n} \\ . & . & \ldots & . \\ . & . & \ldots & . \\ . & . & \ldots & . \\ a_{m1} & w_{m2} & \ldots & w_{mn} \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ . \\ . \\ \vdots \\ w_n \end{bmatrix}$$

Geometric principles have been used for the calculation of eigenvectors through multiplication the value of each criterion in each column in the same row of the pair—wise comparison matrix and applying it to each row which can be represented as below [33]:

$$Eg_i = (a_{11} * a_{12} * a_{13} \ldots * a_{1n})^{\frac{1}{n}}$$ (2)

Where Eg_i = row (i) eigenvalue; n = element numbers in row (i)

AHP weight determination can be carried out through the normalization of the eigenvalue to 1 (divided by their sum) [33] as follows:

$$P_{ri} = \frac{Eg_i}{(\sum_{i=1}^{n} Eg_i)}$$ (3)

The below equation is for the calculation of lambda λ_{max} which can be obtained through the products' summation between the components of the priority vector and the sum of columns of the reciprocal matrix [33]:

$$\lambda_{max} = \sum_{j=1}^{n} \left[w_j \sum_{i=1}^{m} a_{ij} \right]$$ (4)

Where (a_{ij}) represents criteria in each column of the matrix, W_i is the criterion's weight value corresponding to the priority vector in each decision matrix.

The consistency index portrays the correspondent comparative element's mean deviation and the standard deviation of the evaluation errors from the correct ones [34], that's frequently larger than the value expressing a fully congruous matrix for the purpose of providing a measure of severity to this deviation [33].

$$CI = \frac{\lambda_{max} - n}{(n-1)}$$ (5)

Where CI represents consistency index, represents matrix size. The division of the value of consistency index (CI) by random index value such as ($RI = 1.45$), and n is the matrix size n=9, gives the value of consistency ratio (CR). Table 2 presents random inconsistency indices for different values of n.

$$CR = \frac{CI}{RI}$$ (6)

Table 2: Random inconsistency indices for different values of n [27, 35, 36]

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

The criterion weight which is based on interview answers of 40 travel agencies in Sulaimani along with expert's opinions as presented in Table 3:

Table 3: Main criteria weights determination

Factor	Climate	Green Area	Water Body	Root Distance	Ease of Transportation	Essential Tourism Requirements	Entertainment	Security Condition	Health Care
Climate	1	1/5	1/6	1/5	1/4	1/5	1/5	6	5
Green Area	5	1	1	6	5	2	3	7	8
Water Body	6	1	1	5	3	3	2	7	8
Root Distance	5	1/6	1/5	1	1	1/4	1/4	4	5
Easy Of Transportation	4	1/5	1/3	1	1	1/5	1/5	5	7
Essential Tourism Requirements	5	1/2	1/3	4	5	1	1	6	8
Entertainment	5	1/3	1/2	4	5	1	1	5	8
Security Condition	1/6	1/7	1/7	1/4	1/5	1/6	1/5	1	1
Health Care	1/5	1/8	1/8	1/5	1/7	1/8	1/8	1	1

The sub-criterion weights for climate, water body, essential tourism requirements and entertainments were also founded and the results shown in Tables 4, 5, 6 and 7, respectively.

Table 4: Sub-criteria weights' determination for climate

Factor	Temperature	Humidity	MSL
Temperature	1	5	3
Humidity	1/5	1	1/3
MSL	1/3	3	1

Table 5: Sub-criteria weights' determination for water body

Table 6:

Factor	Natural Spring	Natural Lake	Natural Stream	Natural Fountain	Artificial Lake	Artificial Fountain
Natural Spring	1	1/6	1/5	1/5	3	6
Natural Lake	6	1	1	3	6	8
Natural Stream	5	1	1	2	6	7
Natural Fountain	5	1/3	1/2	1	6	7
Artificial Lake	1/3	1/6	1/6	1/6	1	5
Artificial Fountain	1/6	1/8	1/7	1/7	1/5	1

Table 7: Sub-criteria weights' determination for essential tourism requirements

Factor	Hotel	Motel	Shops	Restaurant	W.C	Mosque	Petrol Station	Electricity
Hotel	1	1/3	1/4	1/7	1/4	7	1	5
Motel	3	1	1/3	1/6	1/4	7	1	5
Shops	4	3	1	1/4	1/2	6	4	5
Restaurant	7	6	4	1	4	9	6	8
W.C	4	4	2	1/4	1	6	3	7
Mosque	1/7	1/7	1/6	1/9	1/6	1	1/7	1
Petrol Station	1	1	1/4	1/6	1/3	7	1	6
Electricity	1/5	1/5	1/5	1/8	1/7	1	1/6	1

Table 8: Sub-criteria weights' determination for entertainment

Factor	Tent	Swimming pool	Water Sport	Safari	Play Yard	Heritage Area
Tent	1	7	6	6	2	5
Swimming pool	1/7	1	1/4	1/4	1/6	2
Water Sport	1/6	4	1	1	1/6	3
Safari	1/6	4	1	1	1/7	4
Play Yard	1/2	6	6	7	1	6
Heritage Area	1/5	1/2	1/3	1/4	1/6	1

5. Results and Discussion

The main aim of this study was to assess the most suitable tourist and picnic area and land destinations across110 km radius in Sulaimani governorate. For a set of critical and mainly effected criterion used a total of nine (9) main multi criteria and a total of twenty-three (23) sub main multi- criteria used in AHP assessment model. In the AHP models, criterions were given Nine (9) main multi criteria and twenty-three (23) submain multi criteria were used in a specific weight value based on thirty-five (35) expert's reviews and questionnaires answers from fifty (15) travel agencies in Sulaimani city. The weight values for the main multi criteria have been calculated and at which green area has the highest rate 24.5% followed by the availability of water body at 22.9%. meanwhile, security condition and health care criteria have the lowest rate which is 2.0%, 1.6% respectively as shown in figure 3. The obtained consistency ratio (CR) of these values is 8%, which is less than the allowable limit of 10% which indicates that the weight values of the AHP matrix are consonant response to questionnaires values and the model gives meaningful results and were reasonable weights. The calculated values of CI, RI for n = 9 were 0.116, and 1.45; respectively.
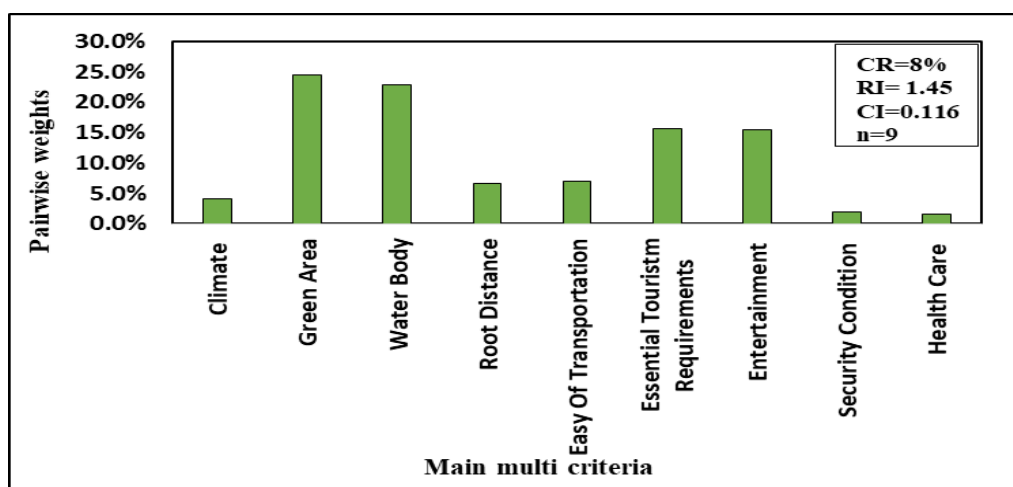

Figure 3: Main multi-criteria AHP analysis of the tourist area of the study area

Four of the mentioned main multi criteria namely (climate, water body, essential tourism requirement, entertainment) have been also classified into twenty-three (23) sub-main multi criteria. The climate sub-main multi criteria rates at which temperature has the highest rate 63.7% due to the fact that the most of the site visits to the tourist destinations done in the early spring season till the end of summer at which having a lower temperature is more favorable over higher degrees respectively and as shown in figure 4. It's also worth mentioning that the humidity has the lowest rate of 10.5% effects and the calculated values of CR, CI and RI for n = 3 were 0.04, 0.023, and 0.58 respectively.
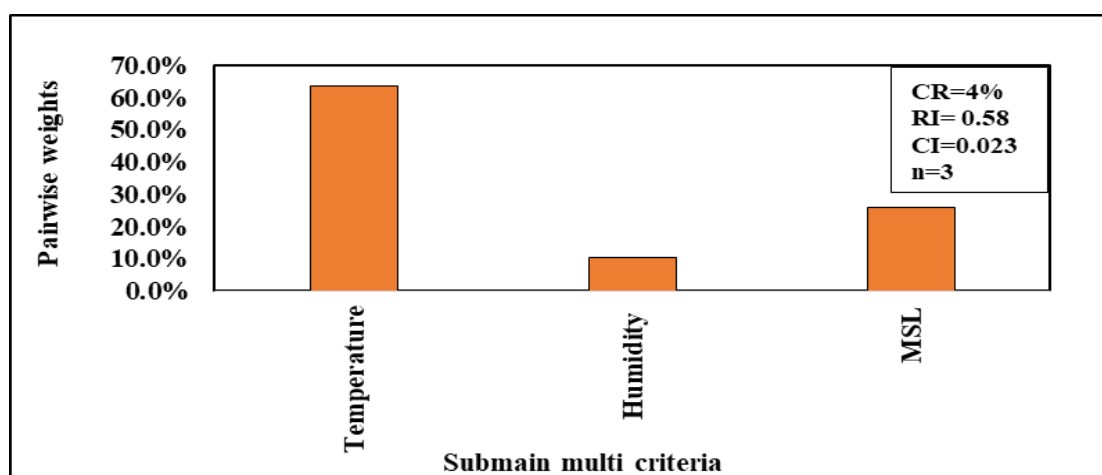

Figure 4: Climate sub-main multi-criteria AHP analysis of the tourist area of the study area

The water body sub-main multi criteria at which natural lake and natural stream have the highest rate 34.1% and 29.4% respectively as shown in figure 5 and that's due to the fact that in case of having a natural lake, there will be more entertainment

options available for the visitors such as stopping by the edge of the lake, swimming, riding boat which is not available in all tourist destinations. Meanwhile artificial fountain area has the lowest rate 2.5%. The calculated values of CR, CI and RI for n = 6 were 0.07, 0.0868, and 1.24 respectively.
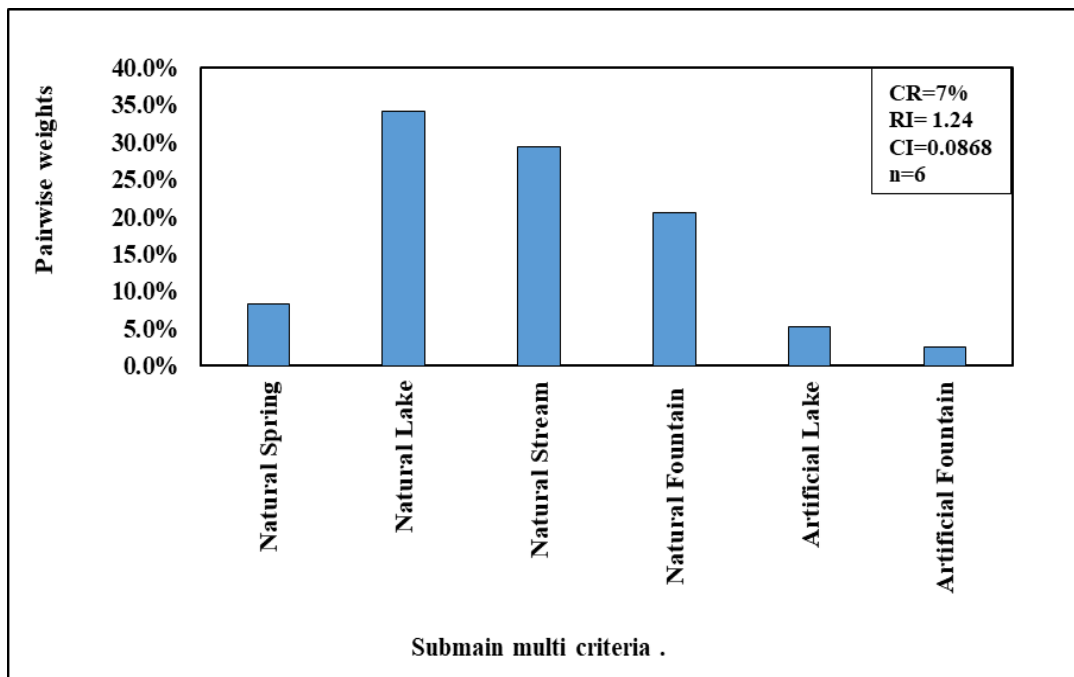

Figure 5: Water body sub-main multi-criteria AHP analysis of the tourist area of the study area

Figure 6 showcases essential tourism requirement sub- main multi criteria rates at which restaurant count for the highest rate 39.5% since the most of the tourists have at least one meal from restaurants in the destinations area that they visited it during their brief stay. This short time of the tourists stay at the destination is also considered to be a reason for motel and hotels to have lower rates since most tourists won't stay but they will come at early morning then leave at late evening. Meanwhile, the availability electricity counts for the lowest rate 2.1%. The calculated values of CR, CI, RI for n = 8 were 0.08, 0.1128, and 1.41; respectively.
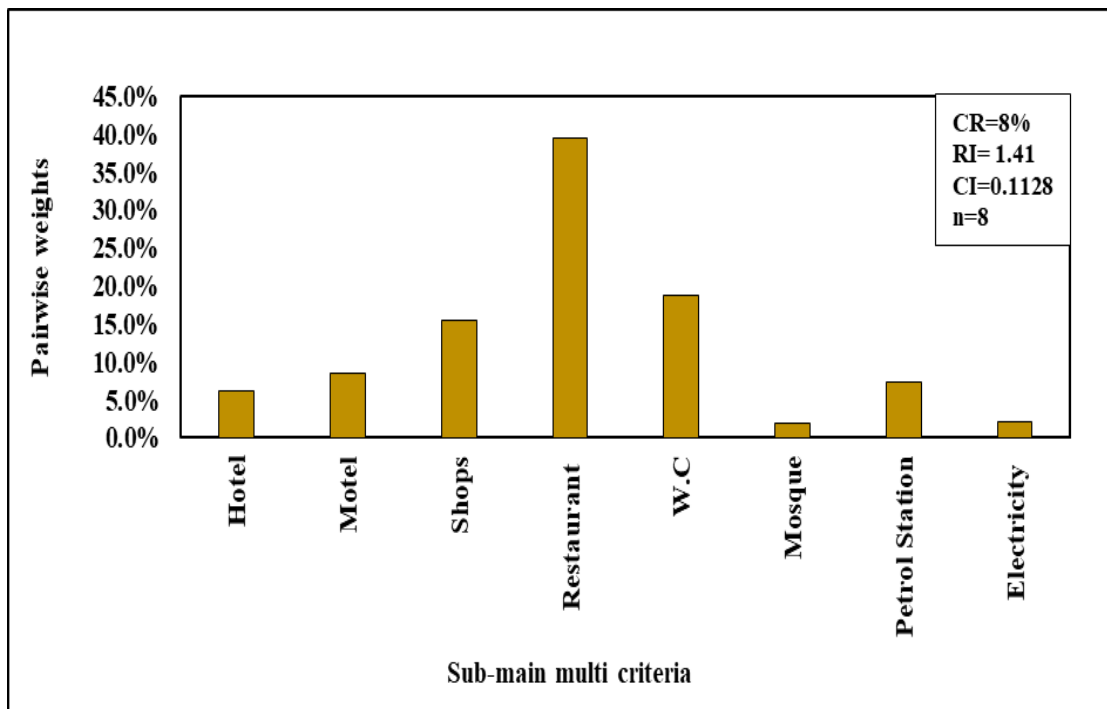

Figure 6: Essential tourism requirement sub-main multi-criteria AHP analysis of the tourist area of the study area

The entertainment sub-main multi criteria rates at which tent and play yard have the highest rate 40.3% and 33.5% respectively as shown in figure 7, and that's for the reason that tourists are a accompanying their families and children to the

destination area in which having a play yard of a high priority to those families, even not having tents is the most essential and the ecotourism during a quick stay at different tourist destinations in the study area. In the same chart, the artificial heritage area shows the lowest rate 3.8% and the calculated values of CR, CI and RI for n = 6 were 0.09, 0.1116, and 1.24 respectively.
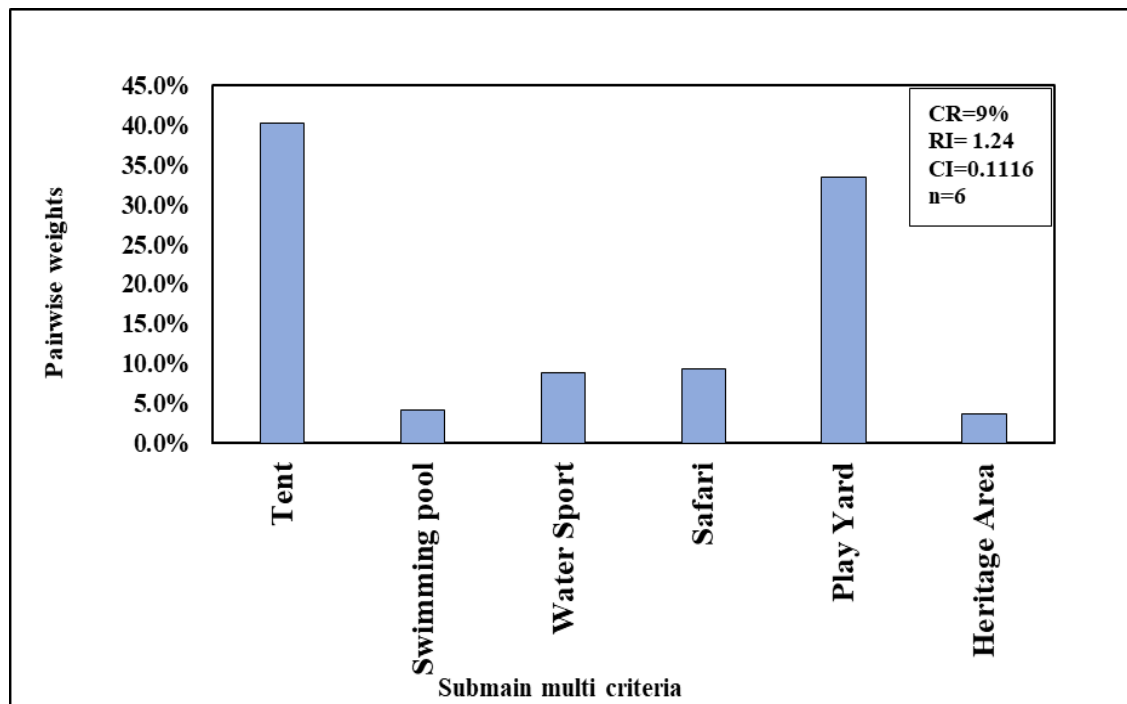

Figure 7: Entertainment sub-main multi-criteria AHP analysis of the tourist area of the study area

Based on field side visits to all total 43 tourist destinations in Sulaimani governorate, and expert's opinions along with questionnaires being answered by 40 travel agencies in the city, we came to a result shown in figure 8. From the above figure, we found out that Mergapan, Tawella (Awesar), and Snke destinations count for the highest rankings among other destinations, while Qzqapan Cave, Imam Zamn, and Jasana Cave count for the lowest rankings. The findings of this study state that that these three ideal tourism destinations in Sulaimani governorate are not only distinguished by astonishing climatic conditions but also with high volume of green area, availability of tent, restaurants. Starting with Mergapan which is distinguished by its short distance from the city which makes it the top destination in our study to visit during all seasons of the year. Mergapan is specified by its attractive climate condition at which it's 5 degrees below Sulaimani city in summer which makes it a crowed destination for tourist in this season, while it's the same case in winter especially during snowing period in winter people from across Iraq are visiting Megrapan to enjoy their time by taking photos with the snow and other entertainment activities in the area. It's worth mentioning that Mergapan is full of private properties at which people, picnics and land visitors are coming over on weekends to stay and spent time and bring guests to the area as well. This place is also having natural water springs. The second most suitable tourist destination in our study is Tawella (Awesar), this location is specified by containing diverse type of restaurants, dense trees, vast green area and adequate temperature. Having vast number of trees and green area makes this place a special destination for tourists especially from south cities of Iraq, these trees are giving a unique look to the area for taking pictures and spending time in spring, summer, and autumn, not to mention that Tawella (Awesar) is having a high altitude which makes a really ideal destination especially during summer season. Tawella (Awesar) is also a district that has its own security, hospital, bazaar, and residents which can be touted as a full-service area, also it has a mosque that contains a shrine full religious preachers in the area. Snke is third in the top ranking for most adequate tourist destinations, this place specializes in having a short distance from Sulaimani city center, vast green area, good climate condition, tent availability, stream, service areas including play yard. The least favorite tourist destinations in this study Qzqapan Cave, Imam Zamn, and Jasana Cave can be distinguished by the lack of having any services such as restaurants, play yards, tents, lakes. Also, these places lack having any noticeable green area and can mostly be counted as historical places that tourists can visit which is the reason as to why these destinations got the lowest ranking in this study.
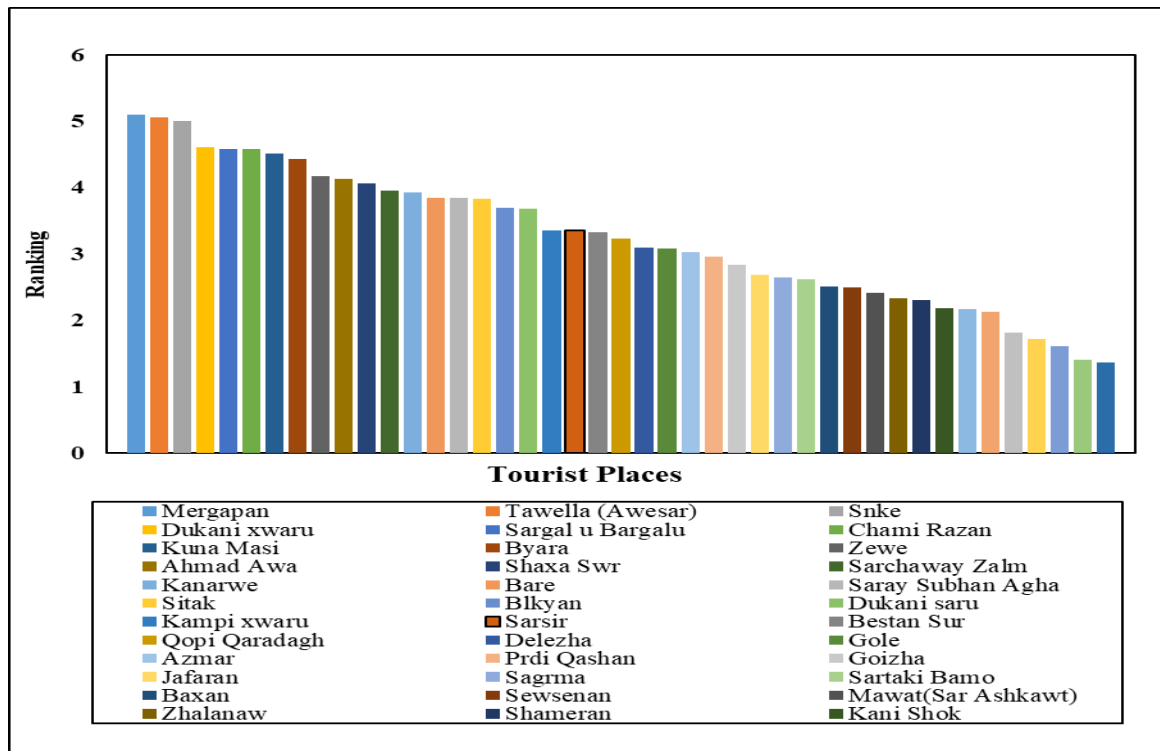
Figure 8: Designated tourist destinations' rankings

6. Conclusion

AHP model was the technique that's been used in this research for evaluating and choosing optimum tourist locations which is based on multi-criteria decision making. We've come with the following conclusions after applying AHP model on the study area:

1) The consistency ratio (CR) values for main criteria equals %8 which is a clear indication that the criteria weights are in harmony with questionnaires' values which proves that the model gives meaningful results with reasonable weights.
2) Green area criterion counted for the highest weight of 24.5% followed by the lowest rate of 1.6% for healthcare criterion.
3) Entertainment and essential tourism requirements criteria achieved a similar weight rate of 15.5% and 15.7% respectively.
4) The value of CR in climate area is 4% while RI is 0.58% followed by CI of 0.023 and consists of three sub-criteria including temperature, humidity and MSL. Temperature criterion obtained the highest weight value 63.7%.
5) Water body criterion has comprised of six sub-criteria with CR value of 7%. Natural lake counted for the highest weight value of 34.1% while artificial fountain obtained the lowest weight value of 2.5%.
6) The existence of restaurants' sub-criteria in tourist areas counted for the highest weight value of 39.5% among all other sub-criteria of essential tourism requirements main criterion.
7) The availability of tent sub-criterion in entertainment main criterion has obtained the highest weight value of %40.3 among all other sub-criteria while heritage area counted for the lowest weight value of 3.8%.
8) Mergapan achieved the highest ranking among all 42 other tourist areas with a ranking value of 5.091 while Jasana cave obtained the lowest ranking value of 1.361.
9) The second most suitable tourist area is Tawella (Awesar) with a ranking value of 5.060 followed by nine other destinations with the least ranking value of 4.065 for Shaxa Swr.
10) Total of 27 tourist areas obtained medium ranking value ranging from 3.949 for Sarchawai Zalm to 2.123 for Mawat.

Author contribution

Conceptualization, methodology, formal analysis, and validation by Awa A. Ahmad, Ako R. Hama, and Imzahim A. Alawn. Writing and original draft preparation, Awa A. Ahmad. Reviewing and editing: Ako R. Hama and Imzahim A. Alawn Supervision by Ako R. Hama and Imzahim A. Alawn. All authors have read and agreed to the published version of the manuscript."

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author.

Conflicts of interest

The authors declare no conflict of interest.

References

[1] X. Wei, Tourism Management System Based on GIS. In Journal of Physics: Conference Series , 1881, 2021,032005 IOP Publishing.

[2] K. Wickramasinghe, Ecotourism as a tool for sustainable forest management in Sri Lanka, J. Environ. Pro. Sri Lanka, 1 (2013) 16-29. http://doi.org/10.4038/jepsl.v1i2.5145

[3] D. D. G. L. Dahanayaka, H. D .Wimalasena, & V. Pahalawattaarachchi, Potential of the conservation oriented mangrove based eco-tourism; A case study of Kadolkele Mangrove Reserve, Negombo, Sri Lanka, J. nat'l. Aquat. Resour. Res Development Agency, 44 (2015) 31-44.

[4] N. Aloysius, S. Madhushanka, & C. Chandrika, Ecotourism Potential in the Northern Province of Sri Lanka. WNOFNS ., 42 (2022) 94-106.

[5] Cristina, Definition of eco-tourism. Journal of Sustainable Ecotourism Management 45 (2004) 123-128.

[6] F. Nelson, The evolution and impacts of community-based eco-tourism in northernTanzania. London. International Institute for Environment and Development 131 (2004) 1-40.

[7] Baromey, N. Ecotourism as a tool for sustainable rural community development and natural resources management in the Tonle Sap Biosphere Reserve. Kassel University Press GmbH, 2008.

[8] M.E. Wood, the Ecotourism Society-An International NGO Committed to Sustainable Development, Tour. Recreate. Res., 24 (1999) 19-23. https://doi.org/10.1080/02508281.1999.11014889

[9] Z. H. Mohd, & U. Ujang, Integrating multiple criteria evaluation and GIS in eco-tourism: a review. The International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences, 42 (2016) 351 https://doi.org/10.5194/isprs-archives-XLII-4-W1-351-2016

[10] T. L. Saaty, Relative measurement and its generalization in decision making why pairwise comparisons are central in mathematics for the measurement of intangible factors the analytic hierarchy/network process. RACSAM-Revista de la Real Academia de Ciencias Exactas, Fisicas y Naturales. Serie A. Matematicas, 102 (2008) 251-318.

[11] O. Mobaraki, M. Abdollahzadeh, & Z. Kamelifar, Site suitability evaluation for eco-tourism using GIS and AHP: A case study of Isfahan Townships, Iran. Manag. Sci. Lett., 4 (2014) 1893-1898. https://doi.org/10.1007/BF03191825

[12] S. Navale, R. Suryawanshi, & V. Bhagat, A Morphological Study for Identified the Potential of Ganpatipule Coastal Tourism in Western Maharashtra (India): Analytical Hierarchy Process, Appl Ecol Environ Sci., 9 (2021) 322-335. https://doi.org/10.12691/aees-9-3-2

[13] Gunen, M. A. A comprehensive framework based on GIS-AHP for the installation of solar PV farms in Kahramanmaraş, Turkey. Renew. Energy, 2021. https://doi.org/10.1016/j.renene.2021.06.078

[14] L.Albraheem, & L. Alabdulkarim, Geospatial Analysis of Solar Energy in Riyadh Using a GIS-AHP-Based Technique. ISPRS Int. J. Geo-Inf., 10 (2021) 291. https://doi.org/10.3390/ijgi10050291

[15] B. Maaiah, M. Al-Badarneh, & A. Al-Shorman, Mapping potential nature based tourism in Jordan using AHP, GIS and remote sensing, J. Ecotourism, (2021)1-21. https://doi.org/10.1080/14724049.2021.1968879

[16] S. Mansour, T. Al-Awhadi, & S. Al-Hatrushi, Geospatial based multi-criteria analysis for eco-tourism land suitability using GIS & AHP: a case study of Masirah Island, Oman. J.Ecotourism, 19 (2020) 148-167. https://doi.org/10.1080/14724049.2019.1663202

[17] Z. Parvar, B. Heshmat Nia, & K. Shayesteh, Site Suitability Evaluation for Ecotourism Using GIS & AHP: A Case Study of Hamedan Township. J. Environ. Sci. Technol., 21 (2019) 227-241. https://doi.org/10.22034/JEST.2019.22883.3190

[18] E. Eftekhari, & M. Mahdavi, Land suitability assessment using ANP in a GIS environment for Tourism Development Site Case study: Lavasan-e Kuchak Rural District, Tehran province, Iran, J. Hosp. Tour. Manag 8 (2019) 5-17.

[19] J. R. Adewumi, O. J. Ejeh, K. H. Lasisi, & F. O. Ajibade, A GIS–AHP-based approach in siting MSW landfills in Lokoja, Nigeria, SN Appl. Sci., 1 (2019) 1-18. https://doi.org/10.1007/s42452-019-1500-6

[20] I. Gašparović, & M. Gašparović, Determining optimal solar power plant locations based on remote sensing and GIS methods: A case study from Croatia, Remote Sens., 11 (2019) 1481. https://doi.org/10.3390/rs11121481

[21] N. Harun, & N. Samat, GIS-based multi-criteria evaluation approach in planning tourism development sites in environmentally sensitive areas. In SHS Web of Conferences, EDP Sciences, 23, 2016, 02001. https://doi.org/10.1051/shsconf/20162302001

[22] A. Mahdavi, M. Niknejad, & O. Karami, A fuzzy multi-criteria decision method for eco-tourism development, locating. CJES ., 13 (2021) 221-236.

[23] O. S. Abomeh, & O. B. Nuga, Utilisation of GIS technology for tourism management in Victoria Island Lagos, Eur. Sci. J., 9 (2013).

[24] K. Bunruamkaew, & Y. Murayam, Site suitability evaluation for eco-tourism using GIS & AHP: A case study of Surat Thani province, Thailand, Procedia Soc., 21 (2011) 269-278. https://doi.org/10.1016/j.sbspro.2011.07.024

[25] T. L. Saaty, & M. Sodenkamp, Making decisions in hierarchic and network systems, Int. J. Appl. Decis. Sci., 1 (2008) 24-79. https://doi.org/10.1504/IJADS.2008.017952

[26] H. Zhang, & Q. Yang, Rural tourism spatial distribution based on multi-criteria decision analysis and GIS. In Geoinformatics 2008 and Joint Conference on GIS and Built Environment: The Built Environment and Its Dynamics, SPIE ., 7144, 2008, 714425. https://doi.org/10.1117/12.812825

[27] Saaty, T. L. Theory and applications of the analytic network process: decision making with benefits, opportunities, costs, and risks. RWS publications, 2005.

[28] R. Handfield, S. V. Walton, R. Sroufe, & S. A. Melnyk, Applying environmental criteria to supplier assessment: A study in the application of the Analytical Hierarchy Process, Eur. J. Oper. Res., 141 (2002) 70-87. https://doi.org/10.1016/S0377-2217 (01)00261-2

[29] R. K. Singh, H. R. Murty, S. K. Gupta, & A. K. Dikshit, Development of composite sustainability performance index for steel industry, Ecol. Indic., 7 (2007) 565-588. https://doi.org/10.1016/j.ecolind.2006.06.004

[30] Saaty, T. Decision making with dependence and feedback, The analytic network process. RWS Publications.1996.

[31] K. Teknomo, Analytic hierarchy process (AHP) tutorial, Revoledu. com., 6 (2006) 1-20.

[32] M. Uyan, MSW landfill site selection by combining AHP with GIS for Konya, Turkey, Environ, Earth Sci., 71 (2014) 1629-1639. https://doi.org/10.1007/s12665-013-2567-9

[33] Saaty, T.L. The analytic hierarchy process: Planning, priority setting. Resour. Alloc. 1980.

[34] J. Sólnes, Environmental quality indexing of large industrial development alternatives using AHP, Environ. Impact Assess. Rev, 23 (2003) 283–303. https://doi.org/10.1016/S0195-9255(03)00004-0

[35] T. L. Saaty, & M. Sodenkamp, Making decisions in hierarchic and network systems, Int. J. Appl. Decis. Sci., 1 (2008) 24-79. https://doi.org/10.1504/IJADS.2008.017952

[36] J. A. Alonso, & M. T. Lamata, Consistency in the analytic hierarchy process: a new approach. Int. J. Uncertain., 14 (2006) 445-459. https://doi.org/10.1142/S0218488506004114