A MULTI-ATTRIBUTE DECISION SUPPORT MODEL FOR THE SELECTION OF TOURISTIC ACTIVITIES

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ABSTRACT

People who wish to travel or participate in a touristic activity often do not have certain information about available travel destinations, group tours, and touristic events. Furthermore, they have their own personal expectations and preferences, especially regarding time and budget limitations. Therefore, they do not want to spend their limited time collecting information about travelling instead of actually travelling. Besides, the individualistic dimensions of tourism planning and marketing studies have a significant importance on national economies all over the world, particularly for nations whose tourism income is becoming a bigger share of their total national income. This study aims to develop a touristic suggestion model for tourist candidates with regards to their personal expectations and preferences about tourism. The Analytic Hierarchy Process (AHP) and Technique for Order Preference by Similarity to Ideal Solution TOPSIS multi-attribute decision-making methods are used in this study to analyze the problem. The proposed model was built in three main phases: structuring, modeling and analyzing. The AHP method was used for prioritizing the related criteria obtained from the tourist candidates, and then TOPSIS was used for assessing global preference of alternatives. Finally, a recommendation to the decision maker is made with the most appropriate alternative.

Keywords: Touristic preferences; touristic decision factors; touristic activity alternatives; AHP; TOPSIS

1. Introduction: tourism and tourism planning

The notion of tourism can be defined in two different ways. The individual meaning includes travelling with the intention of resting, being amused, sightseeing, recognition, and so forth. The social meaning includes economic, cultural and technical endeavors in a region or country to attract tourists (Turkish Language Institution, 2012). A tourist is a person who fits the individual definition of the word described above. Because a tourist is a person who performs the touristic activity de facto, we use the notion of "tourist candidate" in this paper. Our decision maker is not the tourist; he/she is a candidate who wishes to travel places that he/she is not familiar with.

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Tourism activity is the tourist's visit to an area or participation in the activities which are organized in regions where the tourist's knowledge is limited or does not exist. Another name for touristic activities in the literature is tourist attraction. Lew (1987) states that without tourist attractions there would be no tourism and without tourism there would be no tourist attractions. In essence, tourist attractions consist of all elements of a non-home place that draw discretionary travelers away from their homes. They usually include landscapes to observe, activities to participate in and experiences to remember. Tourist candidates usually have limited information regarding alternative touristic activities from which to choose. In addition to this scarcity of information, each tourist candidate has distinct preferences, expectations, and time and budget limitations. Also, they do not want to spend their restricted time collecting information about touristic attractions. It is necessary for a touristic attraction that is being suggested to be appropriate to the tourist candidate's expectations and preferences because of the nature of tourism (regarding its features of recreation, entertainment and leisure time). This means that tourism planning is a personalized or individualized activity and should be approached individualistically.

Tourism planning also has social and economic meaning. The service industry is considerably important for many countries, and tourism is a very important part of it. Tourism income can be crucial particularly for underdeveloped and developing countries that possess limited raw materials and production resources, or that suffer from economic, political or technological difficulties. Nevertheless, tourism can also be a very important component of a national economy which already has manufacturing competences and proficiencies. The tourism industry has a sensibility that needs to be paid attention to in terms of both national economies and industrial constituents because tourism companies (agencies, hotels, suppliers, etc.) are important parts of national economies in terms of foreign exchange entering the country.

The authors of this paper, acting as decision analysts, developed a recommended model for the selection of touristic activities considering tourist candidate's expectations, preferences, time, and budget limitations. The aim of this model is to reduce or eliminate the required time spent collecting information about touristic activity alternatives, and to find the best fit between tourist candidate's expectation and suggestions of touristic activities (or selection) that are provided.

2. Literature review

Forty-four papers were examined and classified in this study, and, a taxonomy was built that divided the research into several classes in terms of their concepts, purposes, methods and technological resources used and inclusion of cognitive processes (Table 1).

The first part of the taxonomy included papers introducing mathematical models for tour planning and routing; these studies rarely have common traits. The methods utilized are linear programming (Kurata, 2009, 2010), mixed integer linear programming (Zhu et al., 2010), partial solved constraint satisfaction (Seifert, 2007b), constraint network (Seifert et al., 2010), orienteering and team orienteering problem (Vansteenwegen et al., 2011), arc orienteering problem (Souffriau et al., 2011) and a special mathematical method aiming to determine a fitness function for genetic algorithm processing (Maruyama et al., 2004; Brilhante et al., 2015; Lee et al., 2009; Garcia et al, 2011).

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Table 1
Taxonomy of literature on tourism research

	MATHEMATICAL MODELING	GOAL					METHOD AND TECHNOLOGY USED									APPLICATION	COGNITIVE PROCESSES
		Classification	Touristic Prioritization	Routing	Developing Individualistic Tours	Developing Group Tours	MCDM	Vector Similarity	Artificial Intelligence	Genetic Algorithms	Heuristic Methods	User Involvement	Computer Technologies	Maps	Statistics		
Zhu vet al. (2010)	X				X					X	X		X			X	
Kurata (2009)	X		X		X		X						X	X			
Kurata (2010)	X		X		X		X	X				X	X	X			
Alptekin and Büyüközkan (2010)			X		X		X		X				X				
Seifert et al. (2007)	X			X	X							X					X
Seifert (2007a)					X						X	X	X			X	X
Seifert (2007b)	X			X	X							X	X	X		X	X
Tenbrink and Seifert (2010)		X			X										X	X	X
Huang and Bian (2007)			X		X		X					X	X	X		X	
Niaraki and Kim (2009)			X	X			X					X	X	X		X	
Yim and diğ. (2004)				X			X		X			X	X			X	
Souffriau and Vansteenwegen (2010)		X							X								
Vansteenwegen et al. (2011)	X	X		X					X	X	X		X				
Souffriau et al. (2011)	X			X	X						X		X			X	
Tomai et al. (2005)			X		X				X			X	X			X	X
Ricci and Werthner (2002)					X				X				X				
Lew (1987)		X	X														
Richter et al. (2004)				X										X			X
Schiefelbusch et al. (2007)		X														X	X
Lew and McKercher (2006)		X		X													
Maruyama et al. (2004)	X				X						X	X	X	X		X	
Garcia et al. (2010)			X		X						X	X	X	X			

Table 1 (continued)
Taxonomy of tourism research

	MATHEMATİCAL MODELING	GOAL					METHOD AND TECHNOLOGY USED									APPLICATION	COGNITIVE PROCESSES
		Classification	Touristic Prioritization	Routing	Developing Individualistic Tours	Developing Group Tours	MCDM	Vector Similarity	Artificial Intelligence	Genetic Algorithms	Heuristic Methods	User Involvement	Computer Technologies	Maps	Statistics		
Kang et al. (2006)			X		X			X				X	X			X	
Srisuwan and Srivihok (2007)			X		X							X	X		X	X	
Nagata et al. (2006)			X	X		X				X		X	X	X		X	
Schiaffino and Amandi (2007)			X		X				X			X	X			X	
Su and Chang (2010)				X							X		X	X		X	
Shoval and Raveh (2004)		X											X		X	X	
Um and Crompton (1990)		X													X	X	X
Lorenzi et al. (2011)			X		X				X				X			X	
Koceski and Petrevska (2012)			X		X	X			X			X	X	X		X	
Batet et al. (2012)			X		X			X	X			X	X			X	
Lucas et al. (2013)			X		X				X			X	X			X	
Kurata and Hara (2013)			X	X						X			X			X	
Lee et al. (2009)	X			X	X						X	X	X	X		X	
Garcia et al. (2011)	X		X		X						X		X	X		X	
Moreno et al. (2013)			X	X	X				X				X	X		X	
Mutinda and Mayaka (2012)		X													X	X	
Cheng et al. (2013)		X					X								X	X	
Bifulco and Leone (2014)				X			X						X	X	X	X	
Umanets et al. (2014)			X		X				X			X	X	X		X	
Büyüközkan and Ergün (2011)			X		X				X			X	X			X	
Brilhante et al. (2015)	X		X		X				X				X			X	
Yeh and Cheng (2015)			X		X		X		X			X	X			X	

The second part of taxonomy classified the papers in terms of their goals. This classification built five different groups of goals.

- Classification: cognitive layers in decision making (Tenbrink & Seifert, 2010), operations research techniques in tour planning (Shoval & Raveh, 2004; Souffriau and Vansteenwegen, 2010; Vansteenwegen et al., 2011), classification of touristic attractions (Lew, 1987; Mutinda & Mayaka, 2012), divergence distance from accommodation region (Lew & McKercher, 2006), sustainable tourism planning methods (Schiefelbusch et al., 2007; Cheng et al., 2013), and tourist attitudes (Um & Crompton, 1990).

- Touristic prioritization: tour or touristic activity suggestions considering tourists' preferences (Tomai et al., 2005; Kang et al., 2006; Nagata et al., 2006; Huang & Bian, 2007; Schiaffino & Amandi, 2007; Kurata, 2009, 2010; Niaraki &Kim, 2009; Alptekin & Büyüközkan, 2010; Garcia et al., 2010; Büyüközkan & Ergün, 2011; Garcia et al., 2011; Lorenzi et al., 2011; Batet et al., 2012; Koceski et al., 2012; Kurata & Hara, 2013; Lucas et al., 2013; Moreno et al., 2013; Umanets et al., 2014; Brilhante et al., 2015; Yeh & Cheng, 2015).

- Tour planning in terms of human cognitive decision making (Richter et al., 2004; Lew & McKercher, 2006; Seifert, 2007b; Seifert et al., 2007) or in terms of intercity transportation modes and so on (Yim et al., 2004; Nagata et al., 2006; Niaraki & Kim, 2009; Lee et al., 2009; Su & Chang, 2010; Souffriau et al., 2011; Vansteenwegen et al., 2011; Kurata and Hara, 2013; Bifulco and Leone, 2014).

- Individualistic tour planning aims to determine a touristic tour plan just for an individual tourist candidate (Ricci & Werthner, 2002; Maruyama et al., 2004; Tomai et al., 2005; Kang et al., 2006; Huang and Bian, 2007; Schiaffino & Amandi, 2007; Seifert, 2007a, 2007b; Seifert et al., 2007; Sirisuwan and Sirivihok, 2007; Kurata, 2009, 2010; Alptekin & Büyüközkan, 2010; Garcia et al., 2010; Tenbrink & Seifert, 2010; Zhu et al., 2010; Souffriau et al., 2011; Büyüközkan and Ergün, 2011; Garcia et al., 2011; Lorenzi et al., 2011; Batet et al., 2012; Koceski et al., 2012; Kurata & Hara, 2013; Lucas et al., 2013; Moreno et al., 2013; Umanets et al., 2014; Brilhante et al., 2015; Yeh and Cheng, 2015).

- Group tour planning aims to determine a touristic tour plan for groups of tourist candidates (Nagata et al., 2006; Koceski et al., 2012).

The third part of the taxonomy was created according to the methods and technological resources the papers used. The methods varied from multi-criteria decision-making techniques and statistics to the intelligent methods like artificial intelligence and genetic algorithms. The sub-components of the technological resources are the usage of computers (computer programming software included) and maps. With respect to their concept, aim and scope, only five papers did not use the methods or technologies mentioned above (Lew, 1987; Lew & McKercher, 2006; Schiefelbusch et al., 2007; Mutinda & Mayaka, 2012; Cheng et al., 2013). The studies utilized from two to three methods in several harmonized ways instead of just one method while accepting its advantages and disadvantages. In this way, a method's inadequate and failing feature(s) can be removed by another adapted method(s). Meanwhile, it should be noted that no

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paper which proposed a methodology for touristic attraction using merely multi-criteria decision-making method(s) could be found in the tourism research literature.

The fourth part of the taxonomy is the study's inclusion of application regarding the proposed models or methods. The majority of the literature introduced applications showing the model's functionality and practicality. For example, while Moreno et al. (2015) designed a recommendation system (SigTur/E-Destination) applied to Spain's most attractive tourist destinations, Yeh and Cheng (2015) applied their model in Taiwan. Similar touristic attraction recommendation models are applied by Tomai et al. (2005), Büyüközkan and Ergün (2011), Umanets et al. (2014), Bifulco and Leone (2014) etc.

The last part of the taxonomy included the papers concerning research about tourist's cognitive processes, attitudes and behaviors. For example, Seifert et al. (2007), Seifert (2007a; 2007b) and Tenbrink & Seifert (2010) examine routing problems of tourists having partial information about touristic destinations and they took behavioral decision making principles and tourist's cognitive processes into account while recommending alternative routes.

3. Decision making: AHP & TOPSIS

Decision making can be described as a selection process of a possible alternative from among whole alternatives, while the selected alternative should be the most convenient to the decision maker's goal or goals (Evren and Ulengin, 1992). Topcu (2000) described decision making as problem solving with selecting, ranking, or sorting available decision options (alternatives). In general, decision making can be accepted as a conscious process that intends to select, apply, and control the best course of action in order to achieve a goal. A problem needs two different features to be qualified as a decision-making problem (Ozden, 1989): "the presence of multiple courses of action (alternatives)" and "differing results of each course of actions from the others."

Keeney (1982) demonstrated 12 factors contributing to the complexity of decision problems which are as follows: multiple objectives, difficulty of identifying good alternatives, intangibles, long-time horizons, many impacted groups, risk and uncertainty, risks to life, interdisciplinary substance, several decision makers, value tradeoffs, risk attitude of decision makers and sequential nature of decisions. These difficulties and the complexity encountered in decision making make the decision process a vital managerial problem that needs to be solved attentively.

Decision making is a complex process that can be affected from different and discrete factors, or it can have multiple different goals. The decision process usually takes into account different courses of action or alternatives. Saaty (2004) stated that "decision making involves criteria and alternatives to choose from. The criteria usually have different importance and the alternatives in turn differ in our preference for them on each criterion. To make such tradeoffs and choices we need a way to measure. Measuring needs a good understanding of methods of measurement and different scales of measurement." Thus, we can exploit multi-criteria decision making (MCDM) methods to achieve this measurement. MCDM can be defined as the evaluation of alternatives for the purpose of selection or ranking, using a number of qualitative and/or quantitative criteria that have different measurement units (Ozcan, Celebi, & Esnaf, 2011). MCDM methods can be used to keep the decision process under control and acquire decision results quickly and easily when there are several alternatives and criteria (Heriscakar, 1999).

The most important issue in MCDM is that the measurements being used include the decision maker's personal preferences and subjectivity levels of these preferences; that is, the preferences and expectations differ from one decision maker to another. Thus, the decision result or output will be defined according to the decision maker's goal and opinion because the importance of each decision factor is determined by the decision maker's preferences and expectations.

In this paper we aim to develop a touristic activity suggestion model depending on the tourist candidate's expectations, preferences, and time and budget boundaries. Therefore, this model has 33 preference factors that should be considered in touristic decision problems. The AHP is used for prioritizing the related criteria obtained from the tourist candidates, and then TOPSIS is used for assessing the global preference of alternatives. The matrix possesses two main information constituents which include the importance of the factors presenting the decision maker's opinions, expectations and limitations and the points of each alternative which will be collected separately from tourism experts and agencies depending on each decision factor.

3.1 The Analytic Hierarchy Process (AHP)

Plenty of decision-making methods have been developed in the literature. The Analytic Hierarchy Process (AHP), developed by Saaty in the 1970s, is one of the most preferred of these methods, and has a wide area of usage in decision-making problems. AHP relies on the prioritization of decision alternatives by considering and analyzing the factors that can possibly affect the decision.

The AHP is a theory of relative measurement on absolute scales of both tangible and intangible criteria based on paired comparison judgment of knowledgeable experts (Ozdemir & Saaty, 2006). It includes the decision maker's personal experience, information, preferences and expectations in the decision process. Thus, it may be said that the AHP is a powerful decision-making methodology to determine priorities among different criteria (Isiklar & Buyukozkan, 2007). Besides the individualization characteristic, AHP is a suitable method for group decision making analyses according to the features of problem. However, the method needs some modifications to make it convenient for group decision making in order to provide consistency between integrated decision points; for example, calculating the weighted means of comparison points of multiple decision makers (Saaty, 1999).

The AHP includes five basic steps summarized as follows:

i. Building the hierarchy of the decision model: First of all, the problem should be described and exhibited clearly. AHP methodology needs the decision model to be decomposed into a hierarchy including a goal (touristic activity selection in this study) at the top level, decision criteria (33 different factors, e.g. cost, type of activity, or type of accommodation) and sub-criteria (e.g. thematic activities, sporting activities, or resting) at the following level and the decision alternatives (10 selected touristic activity, e.g. Cappadocia, Blue Cruise, or Cultural Treasures of Central European) at the bottom level of the hierarchy. A common hierarchy is given in Figure 1.

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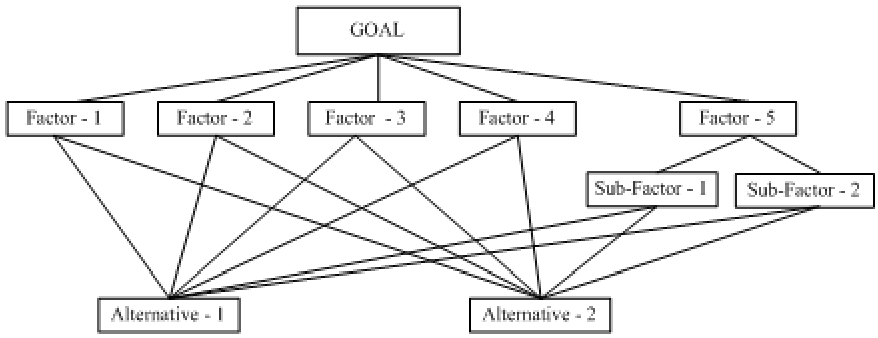

Figure 1. General framework of decision hierarchy

ii. Building the comparison matrices: The AHP helps the decision maker to reflect on his/her personal thoughts, emotions, and preferences in the decision process. The method makes this possible by building the factor comparison matrices or the alternative comparison matrices, according to the factors, separately. The decision maker can use the fundamental 1–9 scale as shown in Table 2 which is was designed to assess the priority scores: 1 indicates equal importance, 3 moderately more, 5 strongly more, 7 very strongly, and 9 indicates extreme importance (Saaty, 1980). These points show the importance assessments between two compared objects and the cells in the matrix will be completed using these points. We should build an "$n \times n$" matrix sorting the row and column elements with the same array while "n" factors or alternatives were being compared. Then, the following rules are applied.

Table 2
Basic prioritization scale

Numerical assessment	Linguistic meaning
1	Equal important
3	Moderately more important
5	Strongly more important
7	Very strongly important
9	Extremely more important
2, 4, 6, 8	Intermediate values of importance
Reverse to the multiplication	If element i is more important than element j, this is the importance points of element j to the element i.

a_{ij} is the relative importance point of element i with respect to element j. In this instance, Equation 1 represents A as the comparison matrix.

$$A = (a_{ij}) \qquad a_{ij} > 0 \qquad i,j=1, 2, \ldots, n \qquad (1)$$

a_{ji} is the relative importance point of element j with respect to element i. This gains its importance from the "reverse to the multiplication" value of a_{ij} (Saaty, 1980).

$$a_{ji} = 1 / a_{ij} \qquad a_{ij} > 0 \qquad i,j=1, 2, \ldots, n \qquad (2)$$

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Hence, if the decision-making problem consists of *n* criteria and *m* alternatives, the decision matrix takes the form as given in Equation 3.

iii. Determining the factor's importance and alternative's preference points: After the comparison matrices have been built, the matrix should be converted to an eigenvector in order to determine the percentage of the importance grade for all elements. In an eigenvector, the sum of the importance for all elements is 100% (Saaty, 1980).

$$A = \begin{pmatrix} 1 & a_{12} & \dots & a_{1n} \\ \frac{1}{a_{12}} & 1 & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ \frac{1}{a_{1n}} & \frac{1}{a_{2n}} & \dots & 1 \end{pmatrix} \quad (3)$$

iv. Calculating the consistencies: AHP also calculates a consistency ratio to reflect the consistency of the decision maker's judgments during the evaluation phase. In this way, AHP methodology aims to control the decision process. It needs this control operation because the decision maker's opinion and preferences cannot be controlled easily. If the equation "a_{ij} x a_{jk} = a_{ik}" is valid for all *i*, *j*, and *k* elements, we can accept that the "*A*" matrix is consistent (Taha, 2007). Basically, a decision process cannot be totally consistent. For this reason, the existence of an acceptable inconsistency should be determined. AHP calculates a consistency ratio (CR) and requires that the ratio should not exceed the 10% threshold. The closer the consistency ratio is to zero, the greater the consistency. If a convenient ratio cannot be obtained, the decision maker can go back to the second step and redo the calculations of comparison.

v. Determining the alternative's preference points and making a decision: The decision maker decides to choose an alternative in this step. The matrices which were found consistent will be synthesized as follows, in order to help the decision maker and to conclude numerical preference values for each alternative.

a. Each column matrix showing the preference of alternatives is inserted into a new matrix's column. Sorting of this column insertion should be at the same sequence of factors.

b. An integrated matrix consisting of the preferences of all alternatives and the column matrix consisting of the importance of factors are multiplied. Each alternative's global preference point is determined as a result of this multiplication.

c. When the preferences are sorted in descending order, an order of preference regarding the alternatives is formed. The alternative that has the biggest weight as a result of AHP indicates the most appropriate one according to the decision maker's preferences.

3.2 Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method was developed by Hwang & Yoon (1981) with the aim of supporting the decision maker and easing their decision processes. The method is based on the interpretation of the

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decision problem, which is illustrated on a geometric plane and includes n evaluation criteria and m decision alternatives. The logic behind the method is that m points should be represented in n-dimensional space (Yoon & Hwang, 1995).

The TOPSIS method is based on choosing the best alternative having the shortest distance to the ideal solution and the farthest distance from the negative-ideal solution. The ideal solution (A*) is the solution that maximizes the benefit and also minimizes the total cost. On the contrary, the negative-ideal solution (A-) is the solution that minimizes the benefit and also maximizes the total cost (Işıklar & Büyüközkan, 2007). Equations 4 and 5 denote the mathematical context of the ideal and negative-ideal solutions.

$A^* = (x_1^*, x_2^*, \dots, x_n^*)$ x_j^* : the value of the best alternative for the j^{th} factor (4)

$A^- = (x_1^-, x_2^-, \dots, x_n^-)$ x_j^- : the value of the worst alternative for the j^{th} factor (5)

TOPSIS method has six steps as follows (Yoon & Hwang, 1995):

i. Calculation of the normalized values: TOPSIS begins with normalizing the factors in the decision matrix in order to make the factor convenient for the comparison. Equation 6 gives the normalized value (r_{ij}) of the decision element a_{ij}.

$$r_{ij} = \frac{a_{ij}}{\sqrt[2]{\sum_{i=1}^{m} a_{ij}^2}} \tag{6}$$

ii. Building the weighted normalized decision matrix: Each evaluation factor (decision criterion) has different importance that shows the factor's degree of influence. A performance value of an alternative with respect to a factor which can be seen in the row representing that alternative and in the column representing the factor is multiplied with the factor's weight (w_j). Thus, after all the multiplication operations are done, the weighted normalized decision matrix has been built. Equation 7 presents the calculation of the weighted normalized values. The sum of the importance of these (w_j) should be 1.

$$v_{ij} = w_j \, x \, r_{ij} \tag{7}$$

iii. Determining the ideal and negative-ideal solutions: The ideal solutions are determined by considering the aforementioned information. This process is like that presented in Equation 8 for the ideal solution and Equation 9 for the negative-ideal solution. Cluster J_1 specifies the benefit criteria and cluster J_2 specifies the cost criteria.

$$\begin{aligned} A^* &= \{v_1^*, v_2^*, \dots, v_n^*\} \\ &= \{(\max_i v_{ij} \mid j \in J_1), (\min_i v_{ij} \mid j \in J_2), \; i = 1, \dots, m\} \end{aligned} \tag{8}$$

$$\begin{aligned} A^- &= \{v_1^-, v_2^-, \dots, v_n^-\} \\ &= \{(\min_i v_{ij} \mid j \in J_1), (\max_i v_{ij} \mid j \in J_2), \; i = 1, \dots, m\} \end{aligned} \tag{9}$$

iv. Calculating the separation measures: The separation measures are calculated one by one using the n-dimensional Euclidean distance which are given in Equation 10 for the separation from the ideal (S_i^*) and Equation 11 for the separation from the negative-ideal solutions (S_i^-). The number of these values is equal to the number of alternatives.

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$$S_i^* = \sqrt{\sum_{j=1}^{n}(v_{ij} - v_{ij}^*)^2} \quad (10)$$

$$S_i^- = \sqrt{\sum_{j=1}^{n}(v_{ij} - v_{ij}^-)^2} \quad (11)$$

v. Calculation of the relative closeness to the ideal solution: The closeness measure which is given in Equation 12 is calculated using (S_i^*) and (S_i^-) values. It is evident that $0 \leq C_i^* \leq 1$ is provided and $C_i^* = 0$ occurs if $A_i = A^-$ and $C_i^* = 1$ occurs if $A_i = A^*$.

$$C_i^* = \frac{S_i^-}{S_i^- + S_i^*} \quad (12)$$

vi. Ranking the preference order: The decision alternatives are ranked in descending or ascending order based on the relative closeness measures. The winning alternative has the maximum C_i^* in TOPSIS. The chosen alternative is then recommended to the decision maker.

The details of the proposed model using AHP and TOPSIS are given in the next section. In this model, AHP provides the importance of decision factors and TOPSIS analyzes the decision matrix which includes the importance of factors and the points of the alternatives with respect to the decision factors determined by the tourism experts. TOPSIS is more appropriate to the touristic decision problems because it allows one to take the real assessment points from the well-informed experts while AHP does not. The AHP method can only be operated by the decision maker and needs only the decision maker's opinion which can be uninformed in this situation. TOPSIS combines the information which is taken separately from the decision maker and the tourism experts in a matrix.

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4. Touristic activity suggestion model based on combined AHP – TOPSIS methods

4.1 The importance of the problem and the aim of the paper

The service industries, e.g. tourism, banking and insurance, have gained a density in recent years for the economies of developed countries because they have moved their manufacturing lines to underdeveloped or developing countries. This choice is based on several motives like low labor cost or tax allowance. The Organization for Economic Co-operation and Development (OECD) supports this indication and points out that service industries of affiliated countries have a greater portion in their annual internal revenues, approximately 70%. The revenue portion of tourism, one of the most important service sub-industries, has a large influence on a national economy although its share differs.

Countries try to attend or arrange international organizations where they have a chance to promote themselves in order to announce their touristic and cultural beauties and raise awareness of their tourist attractions. Quality, customer satisfaction, and continuous improvement are vital notions for service companies as with manufacturing companies. Thus, planning activities is important within the tourism industry.

Both countries and tourism firms have to work on increasing their tourism attractions because of high competition in the global tourism industry. In spite of political or economic disagreements between countries and the interdiction of internal or external tourism in some totalitarian countries, people's "travelling, resting, and discovering" requirements have endless and permanent features. These tourist candidates need a comprehensive tourism guidance because they can be totally uninformed or have inadequate information regarding possible touristic activities. The touristic selection problem has many alternatives and factors which could affect the tourist candidate's decision. Hence, the tourist candidates need help deciding where to go or which activity to attend. Huang & Bian (2009) argue that a travel plan consists of a number of stages, such as choosing destinations, selecting tourist attractions, choosing accommodations, deciding routes, and so forth. The problem has several criteria to be considered simultaneously which makes it ideal for the use of multiple criteria decision-making methods.

4.2 Building the model and the running principles

The model was built with three steps: structuring the problem (S), modeling the problem (M), and analyzing the problem (A). Figure 2 shows the framework for the model. The abbreviations Si, Mi and Ai show the sub-steps of the problem while the intermittent lines separate the main steps.

(S) Structuring the problem

While a decision problem needs to be structured, the decision maker should clarify all components regarding the problem in detail. The elements of the problem and the relationships among them should be described fairly and clearly for this purpose. The AHP's hierarchy-based methodology allows the exhibition these relationships within the content of the decision problem as required.

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(S1-a) Determining the preference factors: The model needs to include the determination factors which the tourist candidates take into account when making a decision because it aims to suggest the most appropriate touristic alternative. The literature and the websites serving the tourism consultancy introduce the factors affecting touristic preferences that can be classified into six types which include type of activity, transportation mode, type of accommodation, season, security level, and cost.

(S1-b)Determining the alternative restrictive factors: By considering a restriction procedure revealing the tourist candidate's (decision maker's) preferences regarding some features of the alternatives we aim to reduce the number of alternatives. This will accelerate the use of the model and shortens the time needed by the system. This is important especially when we consider that the model is operated on the computer because the decision matrix includes and analyzes only the alternatives which the tourist candidate is actually interested in. The available websites provide just this operation to help the tourist candidates. The alternative restrictive factors are as follows: date range, cost range, type of tourist candidate (single, married couple, married with children), and features of alternative (the existence of wi-fi, airport shuttle service, outdoor or indoor swimming pool, guarded parking lots, etc.). In addition, preference factors can be used for this operation, for example the convenience between the tourist candidate's opinion about the type of activity or transportation mode and what the activity provides. For example, if a tourist candidate wants an activity to involve an outdoor swimming pool, the model won't contain the alternatives that do not have one.

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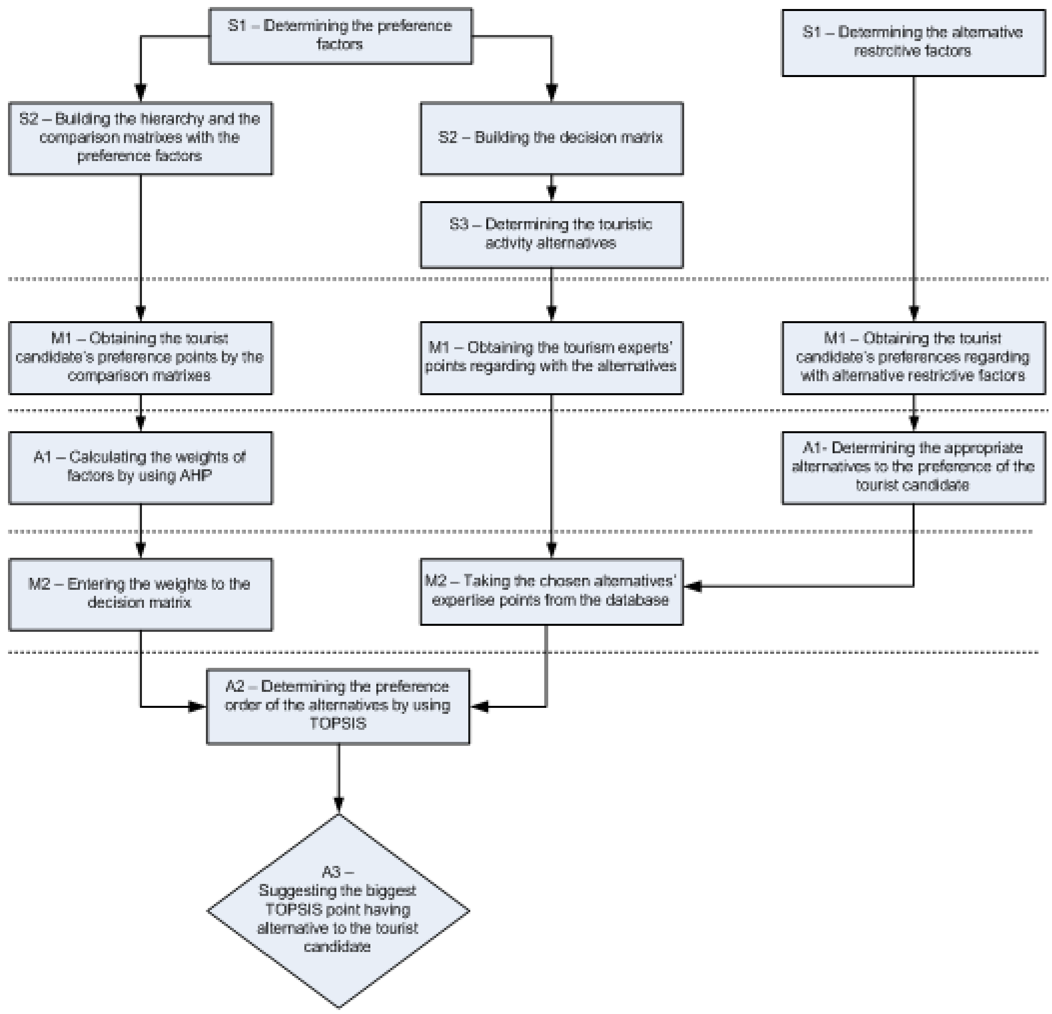

Figure 2. The frame of the proposed touristic suggestion model

(S2-a) Building the hierarchy with the preference factors: It is vital that determined factors should be combined in a decision matrix in order to be analyzed using AHP with the purpose of calculating the factor's importance and showing the tourist candidate's preferences. AHP methodology uses the hierarchic logic to exhibit the main factors with their sub-constituents together in a tree shape, including a goal on the top, the factors and sub-factors on the first and following levels, and the alternatives on the bottom level of the tree. Figure 3 presents the hierarchy of the touristic activity selection problem.

(S2-b) Building the decision matrix: The decision matrix is a structured and operational matrix that allows suggestion of a touristic activity to the individual tourist candidate by combining the importance of touristic preferences and the points showing the expert's assessments for touristic activity alternatives. The matrix's rows include the alternatives and their points obtained from the tourism experts with respect to factors in the corresponding columns. The importance of the factors resides in the second row after the row including the factor's names. The touristic activity suggestion model's decision matrix is given in Table 3.

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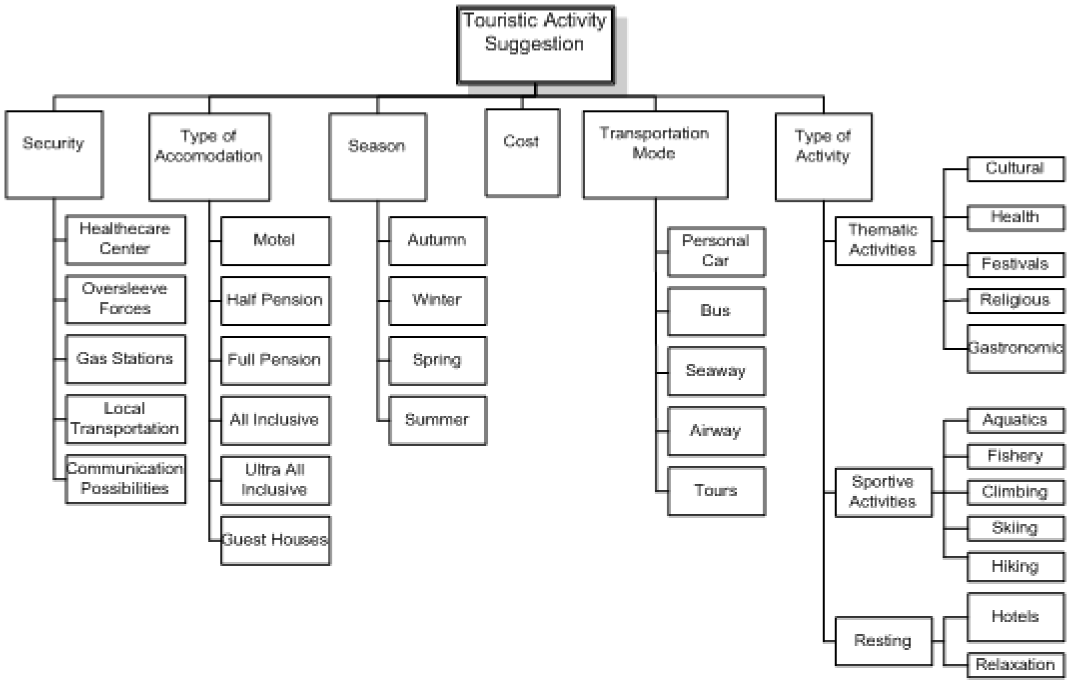

Figure 3. The decision hierarchy of the touristic activity suggestion model

(S3) Determining the touristic activity alternatives: A touristic activity can be defined as an activity that an individual or a tourist group may join, be attracted to or appreciate; for example tour packages, camping, thematic activities. The activity alternatives should be appropriate to the hierarchy's type of activity branch. These alternatives could be selected from several extents, for example a region, country, geographic location, or around the world. The scope of the extent of the activity is determined by the tourist candidates, tourism experts, or tourism consultants considering their capacity. For the example application, five domestic and five outbound activities were selected. They can be found in the decision matrix's first column (Table 3). These alternatives have different focuses, for example a skiing focused alternative, a blue tour focused alternative, or a cultural tour in east Europe are included.

(M) Modeling the problem
After the determination of the decision problem's components, a decision model must be built. This phase has two main operations: 1) obtaining the data from the tourist candidate regarding their touristic preferences and the data from the tourism experts regarding their assessment points; 2) completing the decision matrix by putting the data in the proper cells of the matrix. Between these two operations, the problem must be analyzed using the AHP.

(M1-a) Obtaining the tourist candidate's preference points by the comparison matrices: In this phase, the tourist candidate completes the survey in order to obtain the date which will be used in AHP to calculate the importance of the tourist candidate's preferences, opinions, and expectations. The survey allows comparison of the decision factors with each other. Then these comparison points are entered into the comparison matrices. The consistency of the matrices will be obtained providing that the tourist

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candidate compares all the factors and does not void any question in the survey. The results of this phase are comparison matrices which will be analyzed by the AHP in "Analyzing the problem (A)".

(M1-b) Obtaining the tourism expert's points regarding the alternatives: All of the factors, except the sixth one which is cost, have a non-quantized character and need assessment by the experts. This will provide each factor with a point that can be used in the numerical analysis. The cost has its real numerical value and can be used directly in the matrix. Table 3 by TOPSIS is used to obtain the expert points of the alternatives which will be used in analyzing the decision matrix. All points relating to all alternatives are collected and saved in a database in order to allow them to be used in the following steps of the model. The scoring of the main factors and the sub-factors located on the branches will be done using the measures below.

- *Type of activity:* Points are determined by selecting 0 or 1, for example if an activity contains a cultural event, it is assigned a 1; otherwise it is assigned a 0 for the cultural activity branch of the type of activity.

- *Transportation mode:* Points are determined by selecting 0 or 1, for example if an activity can be arrived at by air, it is assigned a 1; otherwise, it is assigned a 0 for the airway branch of the transportation mode.

- *Type of accommodation:* Points are selected between 0 and 100 showing the service quality of the accommodations, for example a full pension hotel's service quality may be is assigned an 80, however if the tourist candidate wants to swim in sea and the hotel has some disadvantages concerning its distance to the sea, its point can decline to 70 or 60.

- *Season:* Points are determined by selecting 0 or 1, for example if an activity is appropriate for the winter season, it is assigned a 1; otherwise, it is assigned a 0 for the winter branch of the season.

- *Security:* Points are selected between 0 and 100 showing the possibilities of internet connection, and so on or availability and proximity of hospitals, police stations, and so forth.

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Table 3
The decision matrix

	TYPE OF ACTIVITY (0-1)												**TRANSPORTATION MODE (0-1)**				
	Cultural Activity	**Heath-related Activity**	**Festivals**	**Religious Organization**	**Gastronomic Activity**	**Aquatics**	**Fishery**	**Climbing**	**Skiing**	**Hiking**	**Hotels**	**Relaxation**	**Personal Car**	**Bus**	**Seaway**	**Airway**	**Tours**
IMPORTANCE	0,125	0,021	0,204	0,013	0,058	0,006	0,002	0,004	0,001	0,019	0,077	0,01	0,017	0,033	0,095	0,006	0,045
Cultural Treasures of East Europe	1	0	1	0	1	0	0	0	0	0	1	1	0	0	0	1	1
Greek Islands	1	0	1	0	1	1	1	0	0	1	1	1	0	0	1	0	1
South Korea & Japan	1	1	1	1	1	0	0	1	0	1	1	1	0	0	0	1	1
Heaven on Earth - Zanzibar	1	0	0	0	1	1	0	0	0	1	1	1	0	0	1	1	1
Salzburg Austria Skiing Tour	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	1	1
Urgup & Goreme & Cappadocia	1	0	0	1	1	0	0	0	0	0	1	0	1	1	0	0	1
From A to Z Black Sea	1	1	1	0	1	1	1	0	0	1	1	0	1	1	1	1	1
Blue Cruise	1	0	0	0	1	1	1	0	0	1	1	1	0	0	1	0	1
Assos & Troy & Dardanelle	1	0	0	0	1	0	0	0	0	1	1	0	1	1	1	0	1
Iznik Sansarak Canyon Hiking	0	1	0	0	0	0	0	1	0	1	0	0	1	1	1	0	1

Table 3 (continued)
The decision matrix

	TYPE OF ACCOMMODATION (0-100)						SEASON (0-1)				SECURITY (0-100)					COST (TL)
	Motel	Half Pension	Full Pension	All Inclusive	Ultra	Guest Houses	Autumn	Winter	Spring	Summer	Healthcare Care	Overseleeve	Gas Stations	Local Transportation	Communication Possibilities	
IMPORTANCE	0,006	0,006	0,021	0,041	0,03	0,004	0,007	0,002	0,013	0,03	0,028	0,002	0,001	0,008	0,012	0,053
Cultural Treasures of East Europe	0	40	40	90	90	0	0	0	1	1	100	100	100	80	100	1500
Greek Islands	0	0	0	100	90	0	1	0	1	1	70	40	0	0	100	2200
South Korea & Japan	0	90	90	100	100	0	0	0	1	1	100	100	100	100	100	6700
Heaven on Earth - Zanzibar	0	50	90	90	0	0	1	0	1	1	90	60	60	50	80	4500
Salzburg Austria Skiing Tour	0	0	80	80	0	0	0	1	0	0	100	90	60	20	60	1800
Urgup & Goreme & Cappadocia	50	90	90	100	100	60	1	1	1	1	60	80	60	40	60	290
From A to Z Black Sea	50	80	90	100	100	70	1	0	1	1	50	70	40	30	50	780
Blue Cruise	0	0	80	100	60	0	1	0	1	1	40	40	0	0	80	1750
Assos & Troy & Dardanelle	70	70	80	70	0	30	1	0	1	1	80	90	20	60	90	200
Iznik Sansarak Canyon Hiking	0	0	0	0	0	0	1	0	1	1	0	60	50	0	30	75

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- *Cost:* The concerned activity's real cost will be entered to the matrix.

(M1-c) Obtaining the tourist candidate's preferences regarding the alternative restrictive factors: The tourist candidate will be asked to specify his/her preferences about the alternative restrictive factors which are given in the (S1-b) phase. When the tourist candidate selects the range between $750 and $1000 for the cost of the activity, the activities which are priced below $750 and over $1000 will be eliminated and not be included in the decision matrix. Thus, the number of alternatives will be reduced and the operation of the model is accelerated.

After the M1 step is done, the first phase (A1-a – calculating the importance of the factors using AHP) of the "Analyzing the problem (A)" step will be operated and its outputs will be used in the M2-a phase. Otherwise, the result of the M1-b and A1-b (determining the appropriate alternatives to the preference of the tourist candidate) phases will be used in M2-b phase.

(M2-a) Entering the importance to the decision matrix: In the A1-a phase, the importance of the 33 factors is determined by the AHP methodology so that all the factors will be weighted as 1; that is, the sum of the factor importance is 1. In this phase, these numerical values are entered into the "importance" row of the decision matrix (Table 3), under the related names of the factors.

(M2-b) Taking the chosen alternative's expertise points from the database: The model has determined the alternatives that will be analyzed in the decision matrix after the A1-b alternative elimination phase. In this phase, the model retrieves the expert points of chosen alternatives from the database and enters them into the decision matrix.

The output of the "Modeling the problem (M)" step is the decision matrix which will be analyzed in the A2 phase (determining the preference order of the alternatives by using TOPSIS).

(A) Analyzing the problem
This step has three phases and includes the AHP and TOPSIS. The result of this step is the decision (touristic activity) suggestion for the decision maker (tourist candidate).

(A1-a) Calculating the importance of factors using AHP: After gathering the data in the M1-a phase, these data are analyzed by the AHP to calculate importance which shows the degree of the tourist candidate's preference according to each one of the decision factors. After analyzing the comparison matrices, the importance result should be combined with the logic of AHP. Here we give a brief example. The main factor "security" and it sub-factor's importance are 5.1% for the main factor; 54.4% for the healthcare center; 3.2% for the over-sleeve forces; 3.1% for the gas station; 15.3% for the local transportation and 24% for communication possibilities. Now, the importance of the main factor and the sub-factor's importance should be multiplied one by one in order to allocate the main factor's weight to the sub-factors.

Healthcare Center:	5.1% x 54.4% = 2.8%
Over-sleeve Forces:	5.1% x 3.2% = 0.2%
Gas Station:	5.1% x 3.2% = 0.1%

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Local Transportation: 5.1% x 15.3% = 0.8%
Communication Possibilities: 5.1% x 24% = 1.2%

We have determined the importance of all 33 factors and we are ready to enter them into the decision matrix through the M2-a phase.

(A1-b) Determining the appropriate alternatives to the preference of the tourist candidate: In the M1-c phase, the model obtained the preferences regarding the restrictive factors. In this phase, the model determines the proper alternatives and sends this information to the M2-b phase in order to retrieve data about the chosen alternatives from the database.

(A2) Determining the preference order of the alternatives using TOPSIS: The result of the M2 phase is the decision matrix. The model analyzes the matrix in this phase using TOPSIS to order the alternatives according to their fitness to the tourist candidate's preferences represented with the importance determined by AHP. TOPSIS needs three types of information: the factor's importance, chosen alternatives, and the alternative's factor points assigned by the experts and saved in the database. The result of TOPSIS is the sequencing of the alternatives so that the most appropriate alternative is ordered first, and the least appropriate one is ordered last. For this purpose, the model uses C_i^* (relative closeness to the ideal solution) values to sequence them in descending order.

(A3) Suggesting the most appropriate alternative to the tourist candidate: The model suggests the biggest C* value having alternative to the tourist candidate as the most appropriate one to their expectations, preferences, opinions, and senses. Thus, the model allows the suggestion of a touristic activity for the individualistic tourist candidates. The organization or the website using this model online has a chance to suggest several alternatives as they are ordered, and the ultimate decision may be left to the tourist candidate allowing for the greatest touristic satisfaction.

5. A case study

As described in the previous section, the AHP-TOPSIS combined decision suggestion model aims to help lead the tourist candidate, who can be uninformed or have limited information about available touristic activity alternatives, in choosing an activity so that their desired pleasure is maximized. The model needs some information which is obtained from the tourist candidate. These data and expert points were obtained from the person of interest. We have employed the model for an individual tourist candidate as an example.

The data obtained from the tourist candidate will be entered into the comparison matrices and the matrices will be analyzed with AHP. This analysis gives the importance of all the decision factors (AHP hierarchy in Figure 3). The main factor's comparison matrix and the importance are given in Table 4. First, the determination of the main factor's importance, then the sub-factors showed as the branch of each main factor, except the "cost", should be calculated. The ultimate importance was calculated by the multiplication operation of the main factors and their branches, as mentioned previously, and it means that the main factor's importance weight is distributed to sub-factors one by one. The most important factor was found to be "Type of Activity" for this tourist candidate. The ultimate importance of the total 33 decision factors are presented in Table

5. The importance of these is the numerical representation of the tourist candidate's preferences and they will be entered into the relevant row of the decision matrix (Table 3).

Table 4
The comparison matrix and the importance of the main factors

	Type of Activity	Transportation Mode	Type of Accommodation	Season	Security	Cost	**Importance**
Type of Activity	1	7	9	7	9	4	**54,10%**
Transportation Mode	0,14	1	3	4	7	3	**19,61%**
Type of Accommodation	0,11	0,33	1	3	3	3	**10,79%**
Season	0,14	0,25	0,33	1	1	1	**5,16%**
Security	0,11	0,14	0,33	1	1	2	**5,06%**
Cost	0,25	0,33	0,33	1	0,5	1	**5,29%**

According to the TOPSIS methodology, the decision matrix was first normalized, then weighted and produced the weighted normalized decision matrix. This matrix analyzed as the method required and S_i^* (the separation from the ideal solution) and S_i^- (the separation from the negative-ideal solution) values were calculated. The C_i^* TOPSIS sequencing point was calculated using these two values, and the results and the preference order of the alternatives are given in Table 6. The alternative with the highest value was "From A to Z Black Sea", and it should be suggested to the tourist candidate as the alternative which is the most appropriate for his/her preferences.

These results indicate that this tourist candidate wants accommodations in an all-inclusive hotel in the summer season, to attend festivals and cultural activities or rest in the hotel, to be transported by a boat, have a healthcare center near the activity region and does not give great importance to the cost. The Black Sea alternative will be suggested for this tourist candidate having these preferences.

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Table 5
The ultimate importance of the decision factors

Type of Activity	54.1%			
	Thematic Activity	77.90%	42.1%	
		Cultural	29.80%	**12.6%**
		Health	4.90%	**2.1%**
		Festivals	48.60%	**20.5%**
		Religious Org.	3.00%	**1.3%**
		Gastro-nomic	13.70%	**5.8%**
	Sporting Activity	*6,00%*	3.2%	
		Aquatics	20.00%	**0.6%**
		Fishery	5.40%	**0.2%**
		Climbing	11.30%	**0.4%**
		Skiing	4.10%	**0.1%**
		Hiking	59.20%	**1.9%**
	Resting	*16,10%*	8.7%	
		Hotel	88.90%	**7.7%**
		Relaxation	11.10%	**1.0%**
				54.1%
Trans-portation Mode	19.6%			
	Personal Car	8.70%	**1.7%**	
	Bus	16.90%	**3.3%**	
	Seaway	48.10%	**9.4%**	
	Airway	3.20%	**0.6%**	
	Tours	23.10%	**4.5%**	
			19.6%	
Type of Accommodation	10.8%			
	Motel	5.90%	**0.6%**	
	Half Pension	5.10%	**0.6%**	
	Full Pension	19.80%	**2.1%**	
	All Inclusive	37.30%	**4.0%**	
	Ultra All Inclusive	28.00%	**3.0%**	
	Guest Houses	3.90%	**0.4%**	
			10.8%	
Season	*5.2%*			
	Autumn	13.20%	**0.69%**	
	Winter	3.40%	**0.18%**	
	Spring	25.00%	**1.30%**	
	Summer	58.40%	**3.04%**	
			5.20%	
Security	*5.1%*			
	Healthcare Center	54.40 %	**2.8%**	
	Oversleeve Forces	3.20%	**0.2%**	
	Gas Station	3.10%	**0.2%**	
	Local Transportation	15.30 %	**0.8%**	
	Communication Possibilities	24.00 %	**1.2%**	
			5.1%	
Cost	5.3%		**5.3%**	

Table 6
Separation measures and TOPSIS points

	S_i^*	S_i^-	C_i^*	Order
From A to Z Black Sea	***0,0136***	***0,1326***	***0,9071***	***1***
Greek Islands	0,0299	0,1285	0,8112	2
Cultural Treasures of East Europe	0,0477	0,1235	0,7212	3
South Korea & Japan	0,0587	0,1213	0,6737	4
Assos & Troy & Dardanelle	0,1044	0,0839	0,4456	5
Blue Cruise	0,106	0,0786	0,4257	6
Urgup & Goreme & Cappadocia	0,1104	0,0761	0,4081	7
Heaven on Earth – Zanzibar	0,1091	0,0741	0,4044	8
Iznik Sansarak Canyon Hiking	0,1193	0,0627	0,3444	9
Salzburg Austria Skiing Tour	0,1244	0,0459	0,2695	10

6. Conclusions and future research

We have chosen to apply the multiple attribute decision-making (MADM) methods (AHP & TOPSIS) because the MADM methods can be used to quantify the individual (tourist candidate for the problem analyzed) sense, thought and preferences. The MADM methods need to determine the decision factors affecting the tourist candidate's preferences. The literature has furnished 33 factors within six main factors (type of activity, transportation mode, season, cost, security and the type of accommodation). The proposed suggestion model utilizes AHP and TOPSIS; AHP is used for the weighting of the tourist candidate's preferences and TOPSIS is used to analyze the decision problem represented as a matrix form. The tourist candidate provides the data model required by completing a survey with the aim of comparing the factors and sub-factors compatibly with the AHP methodology.

The decision matrix includes two inputs: the importance calculated by the AHP and the assessment points of the alternatives determined by the tourism experts. The TOPSIS method analyzes the decision matrix evaluating the points and importance and combines the tourist candidate's and tourism expert's opinions together with regard to planning the touristic activity. This assessment results in an alternative suggestion of a touristic activity which is the most compatible with the tourist candidate's preferences. Furthermore, this model can also be used by an individual tourist candidate or a group of tourists who want the model to suggest an activity which satisfies their combined and complex preferences. The model requires some modifications about data collecting and processing.

The literature indicates that the papers that have developed a touristic decision support model include the MADM methods in relation with some others, for example genetic programming, fuzzy logic, artificial intelligence, but there is no paper using only MADM methods to suggest an activity to the tourist candidates. With this paper, we aimed to fill this gap by exhibiting a decision support model utilizing only a combination of the AHP and TOPSIS methods.

After operating the model for the sufficient number of tourist candidates, we have reached three important conclusions.

- The model suggests the alternative which has been given the most appropriate points from the biggest importance having factors. Thus, the model is consistent and logical because the aim of the model is the determination of the best alternative according to the tourist candidate's expectations and preferences.

- The "cost" decision factor is the most important one for the majority of tourist candidates who used the model.

- The importance of the first four factors having the highest value ranges from 45% to 64%, and the arithmetic mean of these values is 53%. According to this result, we can state that the first four factors having the highest importance constitute half of the importance forming the decision. Therefore, we can determine that the number of decision factors may be reduced. A broader application of the survey can be useful for the final decision to lessen the number of factors.

The fast development of information and communication technologies and the global spread of the internet and electronic business have changed the structures of industries around the world. The accelerating and synergistic interaction between technology and tourism has brought fundamental changes and created new opportunities for tourism companies in marketing, tourism destination planning and advertising processes. Therefore, future research could look at the digitalization of the proposed model which would allow it to be used on the internet by the touristic service providers. The electronic presentations of tourism like this can be named as "e-tourism". The survey which gathers the tourist candidate's preferences can be completed through the tourism agent's website, the mathematical operations of the model can be done in a relational database and the chosen activity can be suggested to the tourist candidate through the internet. With this simplistic model, the tourist candidate has spent very little of his/her limited time using the website while he/she was at home or in the office. Additionally, this system could be the first one in its area because the current websites that support the tourist candidate's decisions restrict the number of alternatives and therefore address only a branch of the proposed model. Our model approaches the problem in a holistic way.

The second suggestion is the study of the usage of other methods in order to determine their relevance for this decision problem, for example Elimination Et Choix Traduisant la Realité (ELECTRE) or Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE). The application results of the combined methods could be compared and discussed, then the most useful and appropriate one could be implemented in the operation according to the fit between the activity and the tourist's pleasure obtained from the proposed activity.

The third suggestion is the elimination of the individualistic focus of the model. This would allow it to be used for evaluating and planning activity selections and areas and organizing these in a more general way. First, we could implement the survey with a sufficient number of tourists who had participated in the activity in the region, and then we could calculate the geometric mean of these assessment points in the modeling phase of the model in order to be informed about a region or activity. A method like this could be useful for gathering tourist's opinions and allow the authorities of the region to change the planning processes or orient the investments to align with the tourist's expectations about the region.

The final suggestion is to research the elimination of the individualistic focus of the model and direct it to operate for a group of tourist candidates (a couple, a family, a team, a group of friends, etc.). The change within the data collecting and its processing could be the same as in the previous proposition. Each group member could complete the survey and the geometric mean could be useful to determine a collective decision.

For the last two suggestions, some modifications would be required to the model. For the third suggestion, the alternative restriction function should be discarded because the model will be used for all the activity selections in the inspected region; that is, we do not need it, or we can add new factors relating to the region's requirements. For the fourth suggestion, other methods could be used, for example group decision-making techniques or fuzzy logic. These modifications allow the model to be practical for the discussed future goals.

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