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AN INTEGRATED FUZZY MCDM MODEL FOR HOTEL WEBSITE EVALUATION

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Keywords
Website Evaluation, E-commerce, Fuzzy Sets, MCDM, Tourism.

Abstract

Changing and increasing customer expectations with the development of technology have also led to strategic changes in the tourism sector. The websites where the hotels offer their services are the first platforms they encounter with the customers. They should pay attention to various evaluation criteria in order to draw the attention of the customer and gain an advantage in the competitive market. This study aims to present a practical, useful, comprehensive, and integrated method for the evaluation of hotels' websites. In this study, a two-fold MCDM approach was proposed by taking into account the vagueness and complexity of the assessments. Firstly, criteria weights are found using the interval type-2 fuzzy AHP method. Secondly, hotel websites are ranked using the hesitant fuzzy TOPSIS method. An application study to evaluate five alternative hotel websites based on five main criteria and 19 subcriteria is also presented. While trust and information quality are the two most significant factors, reservation information, security, and special discounts are the three leading sub-factors.

OTEL WEB SİTESİ DEĞERLENDİRMESİ İÇİN ENTEGRE BİR BULANIK ÇKKM MODELİ

Anahtar Kelimeler
Web Sitesi Değerlendirmesi, E-ticaret, Bulanık Kümeler, ÇKKM, Turizm.

Öz

Teknolojinin gelişmesiyle birlikte değişen ve artan müşteri beklentileri turizm sektöründe de stratejik değişimlere yol açmıştır. Otellerin hizmet sunduğu web siteleri, müşterilerle ilk karşılaştıkları platformlardır. Müşterinin dikkatini çekmek ve rekabetçi piyasada avantaj elde etmek için çeşitli değerlendirme kriterlerine dikkat etmelidirler. Bu çalışma, otellerin web sitelerinin değerlendirilmesi için etkili, kullanışlı, kapsamlı ve bütünleşik bir yöntem sunmayı amaçlamaktadır. Bu çalışmada, değerlendirmelerin belirsizliği ve karmaşıklığı dikkate alınarak ikili bir ÇÖKV yaklaşımı önerilmiştir. İlk olarak, aralık tip-2 bulanık AHP metodu kullanılarak kriter ağırlıkları bulunur. İkinci olarak, otel web siteleri tereddütlü bulanık TOPSIS yöntemi kullanılarak sıralanır. Beş alternatif otel web sitesini beş ana kriter ve 19 alt kritere göre değerlendiren bir uygulama çalışması da sunulmaktadır. Güven ve bilgi kalitesi en önemli iki faktör olurken, rezervasyon bilgisi, güvenlik ve özel indirimler en önemli üç alt faktör olarak bulunmuştur.

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Highlights

- An integrated approach of interval type-2 fuzzy AHP and hesitant fuzzy TOPSIS is applied.
- Sensitivity analysis is conducted to observe the dependency among criteria.
- Evaluation criteria of websites are examined both theoretically and practically.
- Integrated model is validated with an application study.

Purpose and Scope

The purpose of this study is to propose an effective, easily applicable, comprehensive, and integrated method for the assessment of hotel websites. Thus, it is anticipated that the efficiency of e-commerce in the tourism sector is enhanced.

Design/methodology/approach

A two-stage MCDM approach is proposed, taking into account the uncertainty and complexity of the assessments. In the first stage, the main and sub-criteria weights were calculated using the interval type-2 fuzzy AHP method. Afterward, hotel websites were ranked from best to worst using the hesitant fuzzy TOPSIS method. The sensitivity analysis method was used to measure the effect of the weights of the main criteria in the model on the ranking.

Findings

With the effect of the pandemic, the importance of e-commerce has raised in the tourism sector, as in all sectors. Hotel websites, which are the first meeting platform with the customer, should be designed by considering the criteria of trust, information quality, customer relations, design, and cost. Findings indicate that the most significant criterion is trust and the least significant one is the criterion of design. According to the results of the sensitivity analysis, no significant change was observed in the ranking of the hotels as the weights of the main criteria changed.

Originality

This study applies a two-stage integrated decision-making methodology for the evaluation and ranking of hotel websites.

1. Introduction

Technology has led to significant changes in the strategies of tourism organizations, as in every sector. These changes and enhancements play a vital role in organizations to maintain their sustainable marketing structure by providing a competitive advantage in the marketplace (Buhalis, 2019). This advancement of technology has also changed the pre-travel processes of visitors. Most customers access this service online, rather than at travel agency offices. Thus, customers can access all information about many hotels, both through the websites of the hotels and online travel sites, and can access the comments of the customers who have visited the hotels before (Çaylak, 2019). Developments in web technologies have brought concepts such as user experience and website quality to the forefront (Samanlioglu et al, 2020). Therefore, it is suggested that strategy managers in the tourism sector should focus on the information management process of their organizations.

Furthermore, the most crucial factor in digitalization being such a focal point is the Covid-19 pandemic that has affected the whole world in the last few years (Hasanat et al, 2020). The researches show that customers have became to meet all their demands through e-commerce sites in order to avoid in-person contact. For these reasons, strategy managers of organizations need to transform the web technologies that provide the connection between the organization and the customer, with an innovative perspective, into a form that is user-friendly, more effective, and meet customer demands (Tran, 2021). It is very crucial for hotels to have quality websites in order to gain an advantage against reservation sites and to maintain their presence in the sector during challenging pandemic conditions. Many hotels cooperate with one or more booking sites, either because these booking sites offer customers the ability to compare various hotels. Furthermore, they are attractive to customers because of the

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special offers and discounts they provide. However, hotels actually prefer customers to make reservations through their own websites, as the booking sites demand commissions and discounts from the hotels in order to collaborate with hotels (Chang et al., 2019).

The development of visually appealing and highly informative websites has become significant for organizations as customers use their websites to search for hotels that match their expectations and then select the most suitable hotel and make reservations. In short, a website designed by focusing on the right criteria can turn a visitor into a customer (Ostovare and Shahraki, 2019). There are many competitive criteria to be taken into account in the evaluation process of hotel websites. Therefore, in this study, multi-criteria decision making (MCDM) methods are utilized to handle the complexity. MCDM approaches are extended with fuzzy sets in order to deal with the uncertain, hesitant, and subjective evaluations of decision makers (Cevik Onar et al., 2014). In this paper, interval type-2 fuzzy sets and hesitant fuzzy sets (HFSs) are combined with the decision making approaches. While the interval type-2 fuzzy sets (Zadeh, 1975) are chosen because they can better cope with the vagueness and uncertainty situations and the membership values are also fuzzy sets; the hesitant fuzzy sets are preferred to overcome in cases where the decision maker hesitates by having difficulty in making a single choice (Torra, 2010).

In this paper, a two-fold MCDM method using interval type-2 fuzzy AHP and hesitant fuzzy TOPSIS approaches has been proposed for a hotel website evaluation and selection problem. The criteria weights are computed via the interval type-2 fuzzy AHP method by considering pairwise comparison matrices. Afterward, alternatives are evaluated using TOPSIS method based on HFSs, and also a possible rank of each alternative are obtained based on subcriteria by considering different judgments of experts. Therefore, in the integrated methodology used in this study, a multi-criteria evaluation model is presented considering fuzzy sets in both discrete and continuous form. For the application study, all criteria are determined based on a detailed literature review. As a result, five hotel alternatives located in the Cappadocia region are ranked from the best to the worst.

The remainder of this paper is organized as follows. In Section 2, the literature review for the hotel website evaluation problem is presented. Section 3 presents the proposed integrated methodology in detail. The application study is given in Section 4. Lastly, the discussions and conclusions are given in Section 5.

2. Literature Survey

Hotels ought to have functional and user-friendly websites to reach new customers, retain current customers, and enhance the brand value. An organization with a successfully designed website will provide a competitive advantage in the sector as it will attract more customers (Ageeva et al., 2018). This situation has brought about the website assessment of a hotel to become a crucial research area. However, as a result of the literature reviews, it shows that there is less research than expected on this subject. Some of these researches, which evaluate hotel websites using different methods, are presented as follows.

Akıncılar and Dagdeviren (2014) proposed a hybrid model consisting of two MCDM methods which are Analytic Hierarchy Process (AHP) and Preference Ranking Organisation Method for Enrichment Evaluations (PROMETHEE) to evaluate five-star hotel websites. Wang et al. (2015) analysed the relationship between hotel website quality, and trust and reservation intention and concluded they have a positive connection. Leung et al. (2016) developed an evaluation model using statistical tests, named Mann-Whitney, and Kruskal-Wallis to assess the hotel websites' performance.

In the literature, the most widely used methods for hotel website evaluation are some statistical approaches. Exploratory Factor Analysis (EFA), Structural Equation Modeling, and Confirmatory Factor Analysis (CFA). Ageeva et al. (2018) focused on the factors affecting the performance of the corporate website and their impacts on brand value and image using qualitative comparative analysis (QCA), CFA, and EFA approaches. Di Fatta et al. (2018) proposed a model that examines the factors affecting the number of visitors to a website and the rate of purchase using QCA, and exploratory regression analysis approaches. Jawabreh et al. (2022) utilized one of the statistical tools, ANOVA, to analyse the context of hotels2 websites in Jordan. which are The decision making methods applied for hotel website assessment are summarized as follows. Roy et al. (2019) proposed a weighted interval rough number (WIRN) based complex proportional assessment (COPRAS) method to deal with inconsistent and subjective information for evaluating hotel websites. Ostovare and Shahraki (2019) proposed an integrated method of fuzzy Delphi, Shannon entropy, and PROMETHEE for the evaluation of hotel websites. Baki (2020) evaluated and ranked the alternatives of 5 hotel websites based on 5 main criteria by using fuzzy AHP and fuzzy TOPSIS methods. Samanlioglu et al. (2020) evaluated and ranked the alternative hotel websites as well as digital solution supplier companies by integrating fuzzy Best Worst Method (BWM) and fuzzy TOPSIS method. Tseng et al. (2021) investigated the significant factors while selecting the best third-party booking system by using AHP method. Recently, Çınaroğlu and Zaralı (2022) evaluated the quality of websites for the Cappadocia hotels by using intuitionistic fuzzy EDAS approach.

3. Material and Method

A crisp set can be defined as a set of elements that are either a full member or non-member. Membership degrees of the elements of these sets are either 0 (non-member) or 1 (full member). Fuzzy set theory lets an element be a partial member of the set, in other words, an element can be a member of more than one set with different membership degrees. Membership degrees that the elements forming fuzzy sets can take all real numbers in the continuous interval [0, 1]. Functions that show the degree to which they belong to a set for elements of any value range are called membership functions (Zadeh, 1965). Various mapping functions like triangle, trapezoid, bell curve are used to express these functions (Kahraman et al., 2010).

3.1. Interval Type-2 Fuzzy Sets

The ordinary fuzzy sets are the most common to be encountered in practice. An ordinary (type-1) fuzzy set (Zadeh, 1965) consists of elements that each individual element has a membership degree and the value might be any real continuous value in the interval [0, 1]. Since the values used in the development of ordinary membership functions are mostly extremely precise, several other types of fuzzy membership functions have been proposed as generalized membership functions. If the level of knowledge is not sufficient to determine membership functions in a high precision level, the upper and lower limits of membership degrees are specified for each unique element in a fuzzy set. This type of fuzzy sets refers to interval-valued membership function (Cevik Onar et al., 2014). Since fuzzy numbers can better handle vagueness and uncertainties, type-2 fuzzy sets with fuzzy membership values are introduced by Zadeh (1975). An interval type-2 fuzzy set is a special case of general type-2 fuzzy sets where all the secondary membership functions of $\tilde{\tilde{a}}$ are equal to 1 (Zadeh, 1975). The formulation of secondary membership grades is given in Eq.(1).

$$\tilde{\tilde{a}} = \int_{x \epsilon X} \int_{u \epsilon J_x} 1/(x, u) \qquad (1)$$

where u is the secondary variable in domain J_x at each $x \epsilon X$. J_x is called the primary membership of x, and the secondary membership grades of $\tilde{\tilde{a}}$ all equal to 1, $J_x \subseteq [0,1]$ and $\int$ denote union over all admissible x and u.

3.1. Hesitant Fuzzy Sets

The classical fuzzy set theory developed by Zadeh (1965) considers the uncertain aspect of human decisions with triangular or trapezoidal membership values. Since it is inadequate in hesitant situations where the decision maker has difficulty making a single choice, Torra (2010) has defined hesitant fuzzy sets (HFS). Membership function is depicted in Eq. (2).

$$A = \{< x, h_A(x) > | x \in X\} \qquad (2)$$

where h is a set of values in [0, 1], representing the membership degree by which an element x is associated with a set A.

For example, in classical fuzzy sets, one alternative can be compared with another with expressions such as “excellent”, “very high”, “high”, “medium”, “low”, “very low” or “not at all”, on the other hand, “high”, “medium low”, The expressions “greater than high”, “moderate to very high” are some linguistic terms used for comparison in hesitant fuzzy sets. These expressions are more appropriate for linguistic judgments in situations where it is difficult and hesitant to make a decision with a single fuzzy linguistic expression (Rodriguez et al., 2012).

3.3. Integrated Methodology

In this study, two significant generalized fuzzy sets named, interval type-2 fuzzy sets and hesitant fuzzy sets are used to deal with imprecise information that multiple sources of uncertainty arise simultaneously. In the subsections, these two methods are expressed, and the proposed methodology is presented.

3.3.1. Interval Type-2 Fuzzy AHP

AHP is a well-known MCDM method that is frequently used in the literature. The purpose of this method initiated by Saaty (1985) is to be able to choose the best or determine a set of optimal alternatives from a range of competing alternatives, considering many criteria. In the literature, it is used either individually or in integration with other MCDM methods to assess the suppliers and decide the most suitable one. Pairwise comparison matrices form the basis of this method. Decision makers make their pairwise comparisons using a linguistic scale. In the standard AHP method, the linguistic scale includes levels from one to nine, then this scale is expanded using different types of fuzzy numbers. Thus, the fuzzy AHP method is also used in situations where imprecise, uncertain judgments exist (Cevik Onar et al., 2014). If the level of knowledge is not sufficient to determine membership functions at a high precision level, the upper and lower limits of membership degrees are specified for each unique element in a fuzzy set. At this point, interval type-2 fuzzy set which refers to a fuzzy set characterized by uncertain or unknown membership being depicted by a confined area known as the footprint of uncertainty is preferred. The footprint of uncertainty is created by two membership functions: an upper membership function which represents the highest bound and a lower membership function which displays the lower bound. The main steps of the interval type-2 fuzzy AHP approach are explained as follows (Kahraman and Kaya, 2010):

1) The problem is defined. The target, alternatives, criteria, and subcriteria (if any) are defined and the hierarchy of the problem is constructed as exemplified in Figure 3. Afterward, the pairwise comparison matrix for criteria is developed using the evaluations of decision makers via linguistic scales presented in Figure 1.

Linguistic Variables	Trapezoidal Interval Type-2 Fuzzy Scales
Very Satisfied (VS)	(7,8,9,9;1,1), (7.3,8.3,8.7;0.7,0.7)
Satisfied (S)	(5,6,8,9;1,1),(5.3,6.3,7.7,8.7;0.7,0.7)
Very Dissatisfied (VDS)	(3,4,6,7;1,1), (3.3,.4.3,5.7,6.7;0.7,0.7)
Dissatisfied (DS)	(1,2,4,5;1,1),(1.3,2.3,3.7,4.7;0.7,0.7)
Null (N)	(1,1,1,1;1,1),(1,1,1,1;1,1)

Figure 1. Linguistic variables and corresponding trapezoidal fuzzy scales

2) The evaluations of the experts are collected in the pairwise comparison matrices as given below.

$$\tilde{\tilde{A}} = \begin{bmatrix} 1 & \cdots & \tilde{\tilde{a}}_{1n} \\ \vdots & \ddots & \vdots \\ 1/\tilde{\tilde{a}}_{1n} & \cdots & 1 \end{bmatrix}$$

where $\tilde{\tilde{a}}=((a_{11}^U, a_{12}^U, a_{13}^U, a_{14}^U; H_1(a_{12}^U), H_2(a_{13}^U)), (a_{21}^L, a_{22}^L, a_{23}^L, a_{24}^L; H_1(a_{22}^L), H_2(a_{23}^L)))$ and

$1/\tilde{\tilde{a}} = ((\frac{1}{a_{14}^U}, \frac{1}{a_{13}^U}, \frac{1}{a_{12}^U}, \frac{1}{a_{11}^U};\ H_1(a_{12}^U), H_2(a_{13}^U)), (\frac{1}{a_{24}^L}, \frac{1}{a_{23}^L}, \frac{1}{a_{22}^L}, \frac{1}{a_{21}^L};\ H_1(a_{22}^L), H_2(a_{23}^L)))$

3) The fuzzy pairwise comparison matrices are controlled based on their consistency level. As long as the consistency level is not appropriate, the matrix must be rebuilt.

4) The evaluations of the experts for each criterion are aggreagted via calculating the geometric mean as given in Eq.(3).

$$\tilde{\tilde{a}}_{ij} = [\tilde{\tilde{a}}_{ij}^1 \otimes \ldots \otimes \tilde{\tilde{a}}_{ij}^n]^{\frac{1}{n}} \qquad (3)$$

where

$$\sqrt[n]{\tilde{\tilde{a}}_{ij}} = ((\sqrt[n]{a_{ij1}^u}, \sqrt[n]{a_{ij2}^u}, \sqrt[n]{a_{ij3}^u}, \sqrt[n]{a_{ij4}^u}; H_1^u(a_{ij}), H_2^u(a_{ij})), \quad (\sqrt[n]{a_{ij1}^l}, \sqrt[n]{a_{ij2}^l}, \sqrt[n]{a_{ij3}^l}, \sqrt[n]{a_{ij4}^l}; H_1^l(a_{ij}), H_2^l(a_{ij})))$$

5) Calculation of fuzzy weights ($\tilde{\tilde{p}}_l$) using the geometric mean ($\tilde{\tilde{r}}_l$) for each criterion (Eq. (4)). The fuzzy weight obtained from the pairwise comparison matrix represents the local weights.

$$\tilde{\tilde{p}}_l = \tilde{\tilde{r}}_l \otimes [\tilde{\tilde{r}}_1 \oplus \ldots \oplus \tilde{\tilde{r}}_l \oplus \ldots \oplus \tilde{\tilde{r}}_n]^{-1} \qquad (4)$$

6) Fuzzy weights are defuzzified by DTtrT approach (Kahraman et al., 2014) presented in Eq. (5) and the importance of the weights is calculated.

$$DTtrT = \frac{\frac{(u_U - l_U) + (\beta_U . m_{1U} - l_U) + (a_U . m_{2U} - l_U)}{4} + l_U + [\frac{(u_L - l_L) + (\beta_L . m_{1L} - l_L) + (a_L . m_{2L} - l_L)}{4} + l_L]}{2} \qquad (5)$$

3.3.2. Hesitant Fuzzy TOPSIS

The TOPSIS method was originally initiated by Hwang and Yoon (1981) to rank the preferences of decision makers. In this method, after calculating the positive ideal solution (PIS) (A*) by maximizing the benefit criteria, and computing the negative ideal solution (NIS) (A-) by minimizing the cost criteria for the worst case, the relative closeness of each alternative to the ideal solution is evaluated and ranked from the closest to farthest based on relative closeness value (Hwang and Yoon, 1981). The alternative which has the shortest geometric distance from

PIS and longest geometric distance from NIS, with the highest relative closeness, is chosen. A hesitant fuzzy number is represented as:

$$h_{ij} = \{\gamma_{1j}, \gamma_{2j}, \dots, \gamma_{mj}\} \, ;$$

where 'h_{ij}' denotes the set of positive real values for criterion/subcriterion j, and each γ_{ij}, which refers to degrees of hesitation or satisfaction, belongs to the range [0, 1], where i = 1,2, ...,m.

Steps of hesitant fuzzy TOPSIS approach are explained as indicated below (Senvar and Bolturk, 2016):

1) Positive and negative ideal solutions are described with Eqs. (6) and (7).

$$A^{*} = \left\{h_1^{*}, h_2^{*}, \dots, h_j^{*}\right\} ; \tag{6}$$

where

$$h_j^{*} = \cup_{i=1}^{m} h_{ij} = \cup_{\gamma_{1j}} \in \; h_{1j}, \dots, \gamma_{mj} \in \; h_{mj} \, max \left\{\gamma_{1j}, \gamma_{2j}, \dots, \gamma_{mj}\right\} \qquad j = \{1,2\dots,n\}$$

$$A^{-} = \{h_1^{-}, h_2^{-}, \dots, h_j^{-}\} ; \tag{7}$$

where

$$h_j^{-} = \cap_{i=1}^{m} h_{ij} = \cap_{\gamma_{1j}} \in \; h_{1j}, \dots, \gamma_{mj} \in \; h_{mj} \, min \left\{\gamma_{1j}, \gamma_{2j}, \dots, \gamma_{mj}\right\} \qquad j = \{1,2\dots,n\}$$

2) The distances to the PIS and NIS are calculated for each alternative by using Eqs. (8) and (9), respectively. In this study, the separation measure is calculated using the weighted hesitation normalized Hamming distance (Eq. (10)). The distance of an alternative to PIS (D^{+})and NIS (D^{-}) is calculated as follows:

$$D_i^{\,+} = \sum_{j=1}^{n} w_j \times \left\|h_{ij} - h_j^{*}\right\| \tag{8}$$

$$D_i^{\,-} = \sum_{j=1}^{n} w_j \times \left\|h_{ij} - h_j^{-}\right\| \tag{9}$$

$$\|h_1 - h_2\| = \sum_{j=1}^{l} \left|h_{1\sigma(j)} - h_{2\sigma(j)}\right| / l \tag{10}$$

where w_j denotes importance degree of j^{th} criterion.

3) The relative closeness to the ideal solution is calculated via Equation (11) for each alternative.

$$C_i = \frac{D_i^{-}}{D_i^{-} + D_i^{+}} \tag{11}$$

4) Finally, the alternatives are ranked in descending order of relative closeness. The highest relative closeness means the farthestfrom the anti-ideal solution. Therefore, the alternative with the greatest value is selected as the most appropriate.

In this study, an integrated model was created by combining the interval type-2 fuzzy AHP and hesitant fuzzy TOPSIS methods. The flow chart of the proposed methodology is given in Figure 2.

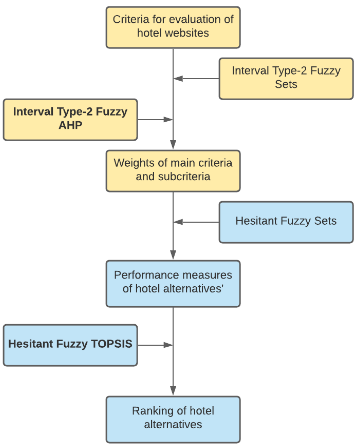

Figure 2. The flowchart of proposed integrated methodology

4. Application Study

The main problem is to determine the most significant factors for a hotel website and select the one with the highest quality. It is aimed to develop a beneficial, efficient, and extensive methodology to enable the assessment and selection of hotel websites. Before determining the evaluation criteria and alternatives, detailed information was collected by examining the studies conducted in the fields of hotel, tourism, and travel.

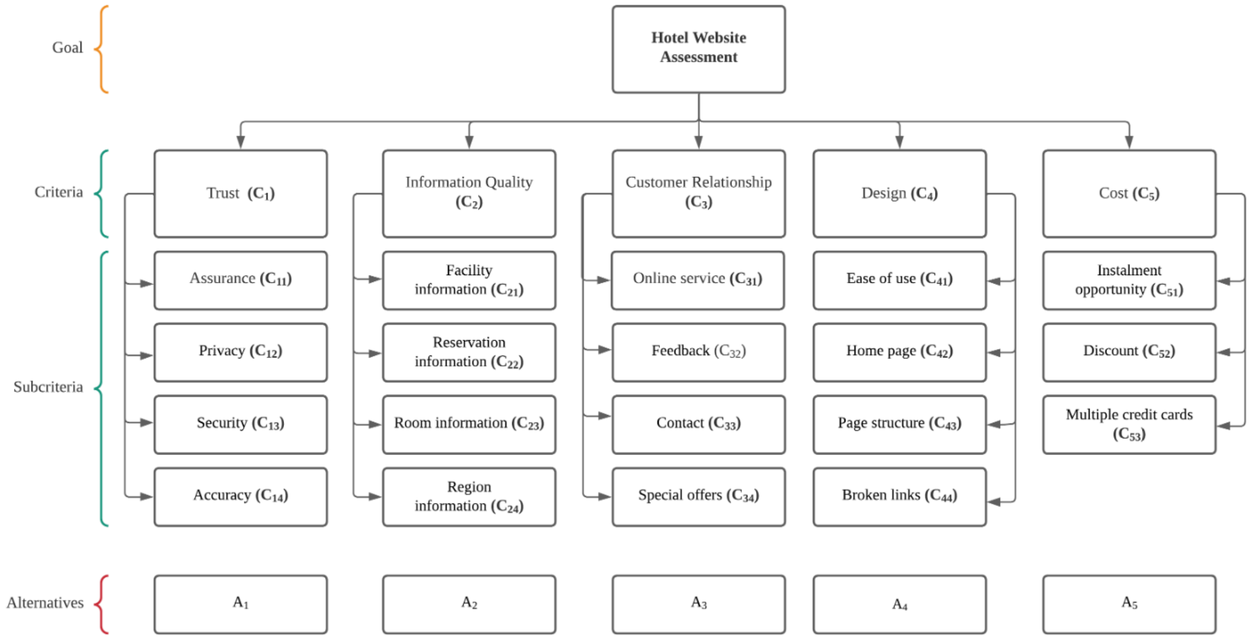

Figure 3. The Hierarchy of the Hotel website evaluation problem

There are mainly decision makers working in the sectors of engineering and computer science. The criteria determined by the literature review were updated with experts' feedback and took the final form presented in Figure 3. In the first stage, the weights of the five main criteria and 19 subcriteria are determined by regarding the evaluations of the decision makers via interval type-2 fuzzy AHP method. In the second phase, five alternative hotel websites are evaluated by decision makers according to existing criteria and ranked via using hesitant fuzzy TOPSIS method.

4.1. Determination of the (sub)Criteria Weights Via Interval Type-2 Fuzzy AHP

In the first stage, interval type-2 fuzzy AHP method is used to determine the relative weights of both main criteria and subcriteria. According to the linguistic evaluation scales given in Figure 1, the pairwise comparison matrix regarding linguistic evaluations of decision makers is presented in Figure 4. The consistency levels of the matrices formed by four decision makers are checked. Ultimately, evaluations are found to be consistent.

	C1				C2				C3				C4				C5			
	E1	E2	E3	E4	E1	E2	E3	E4	E1	E2	E3	E4	E1	E2	E3	E4	E1	E2	E3	E4
C1	N	N	N	N	S	DS	1/S	1/VDS	VDS	DS	1/S	DS	S	VDS	N	1/VS	S	VDS	N	1/DS
C2	1/S	1/DS	S	VDS	N	N	N	N	S	VDS	1/VDS	1/DS	S	VDS	1/S	1/DS	VDS	DS	N	1/VDS
C3	1/VDS	1/DS	S	1/DS	1/S	1/VDS	VDS	DS	N	N	N	N	VDS	DS	1/VDS	1/VDS	VDS	DS	DS	1/DS
C4	1/S	1/VDS	N	VS	1/S	1/VDS	S	DS	1/VDS	1/DS	VDS	VDS	N	N	N	N	DS	1/VS	1/VDS	1/DS
C5	1/S	1/VDS	N	DS	1/VDS	1/DS	N	VDS	1/VDS	1/DS	1/DS	DS	1/DS	VS	VDS	DS	N	N	N	N

Figure 4. Experts' evaluations on main criteria

After applying all the steps given in Section 3.3.1, the weights of each criterion and subcriterion are presented in Table 1.

According to the weights of the main criteria, it is implied that the most significant criterion is trust (C_1); the lowest significant one is found to be the criterion of design (C_4). The criteria with moderate weight levels are information quality (C_2), customer relationship (C_3), and cost (C_5), respectively. When the weights of the subcriteria are examined, the highest level of importance belongs to both reservation information (C_{22}) and discount (C_{52}) and the following subcriterion with the 2nd highest importance security (C_{13}). On the other hand, the broken links criterion (C_{44}) has the lowest level of importance among all subcriteria.

Table 1. Criteria and subcriteria weights

CRITERIA	SUBCRITERIA	DEFUZZIFIED WEIGHTS	NORMALIZED WEIGHTS	CRITERIA WEIGHTS
C1	C_{11}	0.052	0.050	**0.247**
	C_{12}	0.062	0.061	
	C_{13}	0.079	0.077	
	C_{14}	0.058	0.057	
C2	C_{21}	0.048	0.047	**0.222**
	C_{22}	0.083	**0.081**	
	C_{23}	0.060	0.058	
	C_{24}	0.037	0.036	
C3	C_{31}	0.050	0.049	**0.198**
	C_{32}	0.047	0.046	
	C_{33}	0.058	0.056	
	C_{34}	0.059	0.058	
C4	C_{41}	0.068	0.066	**0.155**
	C_{42}	0.028	0.028	
	C_{43}	0.038	0.037	
	C_{44}	0.026	**0.025**	
C5	C_{51}	0.035	0.034	**0.178**
	C_{52}	0.083	**0.081**	
	C_{53}	0.057	0.056	

4.2. Evaluation of the Alternatives via Hesitant Fuzzy TOPSIS

The decision makers, who specialized in different fields, evaluated five hotel website alternatives anonymously based on each subcriterion. The hesitant decision matrix that all decision makers presented their evaluations for alternative hotel websites according to the subcriteria is presented in Table 2. Hesitant fuzzy decision matrix is a matrix in which decision makers specify how superior one alternative is to another for a criterion or sub-criterion on a [0,1] scale. For the current application study, each of the four experts compared the importance of each alternative with other alternatives for each sub-criterion and provided their evaluations as a hesitant fuzzy membership function value on the [0,1] scale. For instance, hesitant fuzzy element values for C_{11} sub-criterion are obtained by the experts on behalf of the performance of the 1st alternative as h_{11}={0.4,0.6,0.7,0.8} in Table 2. In order to find the best hotel website, the hesitant fuzzy TOPSIS method is applied by following the steps explained in Section 3.3.2.

In the first phase of the method, the PIS and NIS should be calculated by using the maximum (A*) and minimum (A^-) membership values. For instance, these values (h_1* and h^-_1) for the 1st criterion (C_1) can be determined as follows:

$$h_1^* = \max\{0.4,0.6,0.7,0.8,0.5,0.6,0.7,0.8,0.2,0.3,0.5,0.6,0.5,0.6,0.7,0.9,0.5,0.6,0.7,0.9\}=0.9$$

$$h_1^- = \min\{0.4,0.6,0.7,0.8,0.5,0.6,0.7,0.8,0.2,0.3,0.5,0.6,0.5,0.6,0.7,0.9,0.5,0.6,0.7,0.9\}=0.2$$

Table 2. Hesitant fuzzy decision matrix

	A1	A2	A3	A4	A5
C11	{0.4,0.6,0.7,0.8}	{0.5,0.6,0.7,0.8}	{0.2,0.3,0.5,0.6}	{0.5,0.6,0.7,0.9}	{0.5,0.6,0.7,0.9}
C12	{0.3,0.4,0.5,0.6}	{0.5,0.6,0.7,0.9}	{0.1,0.2,0.3,0.4}	{0.5,0.6,0.7,0.9}	{0.2,0.3,0.5,0.6}
C13	{0.3,0.5,0.6,0.7}	{0.6,0.7,0.8,0.8}	{0.1,0.2,0.3,0.4}	{0.4,0.5,0.6,0.8}	{0.2,0.4,0.5,0.7}
C14	{0.2,0.3,0.4,0.5}	{0.5,0.4,0.5,0.7}	{0.1,0.2,0.3,0.4}	{0.3,0.4,0.5,0.8}	{0.2,0.3,0.4,0.5}
C21	{0.2,0.4,0.6,0.7}	{0.4,0.6,0.7,0.9}	{0.1,0.4,0.5,0.7}	{0.4,0.6,0.7,0.8}	{0.4,0.5,0.6,0.7}
C22	{0.3,0.4,0.5,0.6}	{0.2,0.3,0.4,0.9}	{0.2,0.3,0.4,0.5}	{0.5,0.7,0.8,0.9}	{0.4,0.5,0.6,0.7}
C23	{0.2,0.5,0.6,0.7}	{0.2,0.3,0.5,0.8}	{0.3,0.4,0.5,0.6}	{0.3,0.5,0.7,0.9}	{0.3,0.4,0.5,0.6}
C24	{0.4,0.5,0.6,0.7}	{0.3,0.4,0.6,0.8}	{0.1,0.2,0.3,0.4}	{0.1,0.5,0.6,0.7}	{0.2,0.3,0.4,0.5}
C31	{0.4,0.5,0.6,0.7}	{0.1,0.4,0.6,0.7}	{0.1,0.2,0.3,0.6}	{0.1,0.5,0.6,0.7}	{0.2,0.4,0.5,0.6}
C32	{0.3,0.4,0.5,0.6}	{0.1,0.5,0.6,0.9}	{0.2,0.3,0.4,0.5}	{0.1,0.4,0.6,0.8}	{0.2,0.5,0.6,0.7}
C33	{0.3,0.4,0.5,0.6}	{0.1,0.6,0.7,0.9}	{0.1,0.2,0.5,0.6}	{0.1,0.6,0.7,0.8}	{0.3,0.4,0.5,0.8}
C34	{0.4,0.6,0.7,0.8}	{0.2,0.3,0.5,0.7}	{0.1,0.2,0.3,0.4}	{0.2,0.5,0.6,0.9}	{0.2,0.3,0.4,0.5}
C41	{0.3,0.4,0.5,0.6}	{0.5,0.6,0.7,0.8}	{0.1,0.2,0.3,0.6}	{0.3,0.4,0.5,0.6}	{0.3,0.4,0.5,0.6}
C42	{0.2,0.3,0.4,0.7}	{0.4,0.5,0.6,0.7}	{0.1,0.2,0.4,0.8}	{0.4,0.5,0.6,0.7}	{0.2,0.3,0.4,0.5}
C43	{0.3,0.4,0.5,0.9}	{0.3,0.4,0.5,0.6}	{0.1,0.2,0.3,0.6}	{0.3,0.4,0.5,0.9}	{0.3,0.4,0.5,0.6}
C44	{0.3,0.4,0.5,0.7}	{0.4,0.5,0.6,0.7}	{0.1,0.2,0.4,0.6}	{0.4,0.5,0.6,0.7}	{0.4,0.5,0.6,0.5}
C51	{0.4,0.5,0.6,0.7}	{0.3,0.4,0.5,0.6}	{0.2,0.3,0.4,0.5}	{0.3,0.4,0.5,0.8}	{0.3,0.5,0.6,0.7}
C52	{0.1,0.3,0.4,0.9}	{0.6,0.7,0.8,0.9}	{0.1,0.2,0.3,0.4}	{0.2,0.5,0.6,0.7}	{0.1,0.3,0.4,0.5}
C53	{0.2,0.3,0.6,0.7}	{0.3,0.4,0.5,0.9}	{0.1,0.2,0.5,0.6}	{0.3,0.4,0.5,0.7}	{0.2,0.3,0.4,0.5}

The entire set of maximum and minimum membership values are given below:

$A^* = \{h_1^*, h_2^*, \ldots, h_{19}^*\}$ = {0.9,0.9,0.8,0.8,0.9,0.9,0.9,0.8,0.7,0.9,0.9,0.9,0.8,0.8,0.9,0.7,0.8,0.9,0.9}

$A^- = \{h_1^-, h_2^-, \ldots, h_{19}^-\}$ = {0.2,0.1,0.1,0.1,0.1,0.2,0.2,0.1,0.1,0.1,0.1,0.1,0.1,0.1,0.1,0.1,0.2,0.1,0.1}

In the next step, the PIS (D^+) and NIS (D^-) values are calculated by using the hesitant fuzzy decision matrix, normalized weights and membership values in Eqs. (6, 7 and 8). An example computation is given for the first alternative (A1).

$$D^+ = \left[0.05 * \frac{|0.4-0.9|+|0.6-0.9|+|0.7-0.9|+|0.8-0.9|}{4}\right] + \cdots + [0.056 * \frac{|0.2-0.9|+|0.3-0.9|+|0.6-0.9|+|0.7-0.9|}{4}] = 0.344$$

$$D^- = \left[0.05 * \frac{|0.4-0.2|+|0.6-0,2|+|0.7-0.2|+|0.8-0.2|}{4}\right] + \cdots + [0.056 * \frac{|0.2-0.1|+|0.3-0.1|+|0.6-0.1|+|0.7-0.1|}{4}] = 0.468$$

Lastly, relative closeness values are calculated with the computation given in Eq.(9). For instance, the relative closeness value of the 1st alternative is found as 0.53 as represented below.

$$C_1 = \frac{0.468}{0.344+0.468} = 0.527$$

The same steps were followed for each alternative and relative closeness values were calculated as in Table 3. The highest relative closeness value is inferred as the best alternative. In this case, the website of the A_2 is the best alternative. It is followed by A_4, A_1 and A_5, respectively. As presented in Table 3, A_3 is evaluated as the worst website.

Table 3. Separation values, relative closeness and final rank of each alternative

ALTERNATIVES	D+	D-	C_i	RANK
A_1	0.347	0.387	0.527	3
A_2	0.286	0.448	0.611	1
A_3	0.538	0.195	0.266	5
A_4	0.299	0.434	0.592	2
A_5	0.437	0.297	0.405	4

4.3. Sensitivity Analysis

Any change in the weights of the five main criteria used in decision making problem of evaluating the hotels' websites might affect the final decision. Therefore, a sensitivity analysis was carried out depending on the weight of each main criterion. In the sensitivity analysis performed using MS Excel version 2016, the relative closeness values of the alternatives were examined by changing the degree of the total significance weight of each main criterion in the range [0-1]. The relative closeness values calculated according to the weight change of all alternatives are given in Tables 4 and 5. The values are also illustrated in Figure 5.

Table 4. Sensitivity analysis values for "Trust", "Information Quality" and "Customer Relationship"

	TRUST					INFORMATION QUALITY					CUSTOMER RELATIONSHIP				
WEIGHT	A1	A2	A3	A4	A5	A1	A2	A3	A4	A5	A1	A2	A3	A4	A5
0.0	0.47	0.54	0.39	0.55	0.45	0.52	0.59	0.47	0.55	0.52	0.52	0.60	0.47	0.55	0.52
0.1	0.49	0.56	0.38	0.56	0.45	0.52	0.59	0.46	0.56	0.52	0.52	0.59	0.46	0.55	0.51
0.2	0.51	0.57	0.37	0.57	0.44	0.51	0.60	0.45	0.57	0.51	0.52	0.59	0.45	0.54	0.51
0.3	0.53	0.58	0.37	0.57	0.44	0.51	0.60	0.44	0.57	0.51	0.52	0.59	0.44	0.54	0.50
0.4	0.54	0.59	0.36	0.58	0.43	0.51	0.61	0.44	0.58	0.51	0.52	0.59	0.44	0.54	0.50
0.5	0.55	0.60	0.36	0.58	0.43	0.51	0.62	0.43	0.58	0.50	0.51	0.59	0.43	0.54	0.50
0.6	0.55	0.60	0.35	0.59	0.42	0.51	0.62	0.43	0.58	0.50	0.51	0.60	0.42	0.54	0.50
0.7	0.56	0.61	0.35	0.59	0.42	0.51	0.62	0.42	0.59	0.50	0.51	0.60	0.42	0.54	0.49
0.8	0.57	0.61	0.35	0.59	0.42	0.51	0.63	0.42	0.59	0.50	0.51	0.60	0.42	0.53	0.49
0.9	0.57	0.62	0.35	0.59	0.42	0.51	0.63	0.42	0.59	0.50	0.51	0.60	0.41	0.53	0.49
1.0	0.58	0.62	0.34	0.60	0.42	0.50	0.63	0.41	0.59	0.50	0.51	0.60	0.41	0.53	0.49

Table 5. Sensitivity Analysis Values for "Design" and "Cost"

	DESIGN					COST				
WEIGHT	**A1**	**A2**	**A3**	**A4**	**A5**	**A1**	**A2**	**A3**	**A4**	**A5**
0.0	0.54	0.58	0.47	0.55	0.52	0.54	0.58	0.47	0.55	0.53
0.1	0.53	0.58	0.46	0.54	0.51	0.53	0.58	0.47	0.54	0.52
0.2	0.52	0.58	0.46	0.54	0.50	0.53	0.58	0.46	0.54	0.51
0.3	0.51	0.58	0.45	0.54	0.49	0.52	0.58	0.45	0.53	0.50
0.4	0.50	0.58	0.44	0.54	0.48	0.52	0.58	0.44	0.53	0.50
0.5	0.49	0.57	0.44	0.54	0.48	0.51	0.58	0.44	0.53	0.49
0.6	0.49	0.57	0.44	0.54	0.47	0.51	0.58	0.43	0.53	0.49
0.7	0.48	0.57	0.43	0.54	0.47	0.51	0.58	0.43	0.52	0.48
0.8	0.48	0.57	0.43	0.54	0.46	0.51	0.58	0.42	0.52	0.48
0.9	0.48	0.57	0.43	0.54	0.46	0.50	0.58	0.42	0.52	0.48
1.0	0.47	0.57	0.42	0.54	0.46	0.50	0.59	0.42	0.52	0.47

5. Discussion and Conclusion

Today, with the enhancement of information technologies, competition between firms is increasing with each passing day. Subsequently, most companies serving in the tourism sector have started to adopt different marketing strategies considering web-based innovations in the service processes. The first platform on which hotels exhibit their services is their websites. Therefore, a good website ought to capture the dynamic changes in the marketplace by evaluating all aspects of the innovations brought into throughout the time period. In this study, a model is proposed to enable hotels, especially marketing managers, to improve the performance of current hotel websites in line with customer expectations. Utilizing the proposed model, in addition to the evaluation of the websites of the hotels, the criteria that hotels should pay attention to while designing their websites are also presented. The evaluation of hotels' websites under different perspectives of decision makers is a complex, subjective and ambiguous problem. Therefore, criteria determined by utilized from detailed literature review and expert feedback and opinions are prioritized via interval type-2 fuzzy AHP approach. Afterward, alternatives are evaluated according to criteria via hesitant fuzzy TOPSIS method.

In the application study, the criteria are ranked in decreasing importance: Trust, Information Quality, Customer Relations, Cost and Design (C_1-C_2-C_3-C_5-C_4). According to weights of the criteria calculated, the best alternative is A_2, while the worst alternative is A_3. In the results of sensitivity analysis, it was determined that the alternative rank presented does not have a significant sensitivity based on the criterion weights.

For future studies, different MCDM approaches might be combined. The results of this study and new integrated method can be compared. In this study, only the hotels' websites were assessed. Due to the increasing interest in social media platforms today, the performance evaluations of hotels on these platforms can also be considered as a new criterion. In this context, the scope of study might be expanded with dynamic analysis with the help of artificial intelligence and machine learning methods in further studies.

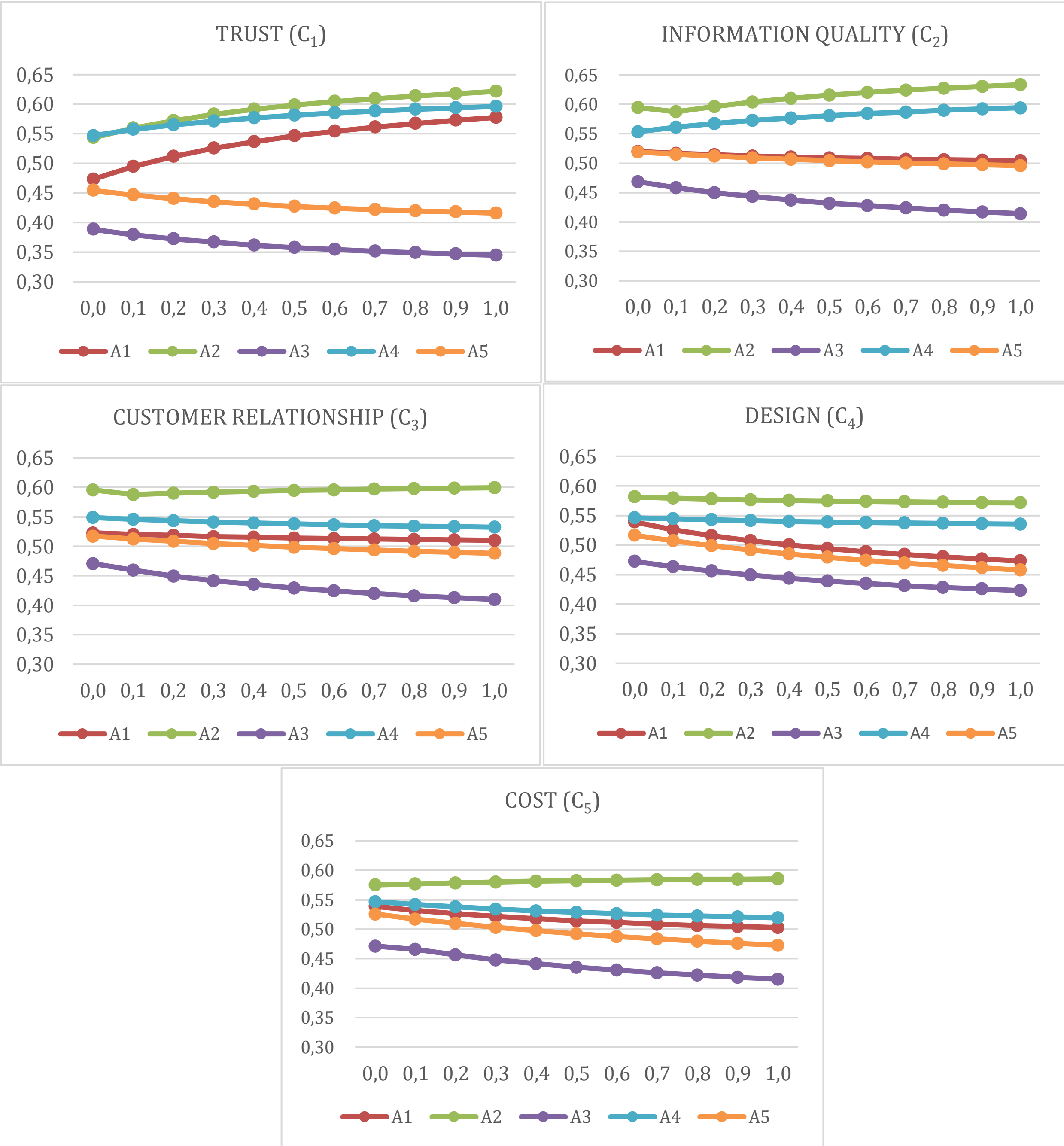

Figure 5. Sensitivity Analysis Graphs of Main Criteria in Changing Importance Weights

Conflict of Interest

No conflict of interest was declared by the authors.

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