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Evaluation of the airline website quality with the intuitionistic fuzzy TOPSIS method

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Abstract

The importance of the concept of e-commerce, which has become an indispensable part of today's society due to the rapid development in information technology, has been confirmed once again during the Covid-19 pandemic period. Within the scope of e-commerce, the value of websites that provide customer interactions has also increased. Fast and effective communication is carried out through websites by all airline companies that provide services on an international scale. Since it is the first point of interaction with customers, it is of great importance that these channels are designed effectively and that they have the quality and performance level to meet customer expectations. In this study, a solution proposal containing Intuitionistic Fuzzy TOPSIS (IF TOPSIS) method has been developed to measure the quality performance of airline companies' websites. The most important criteria for the quality of airline companies' websites have been determined as security and information quality. It has also concluded that the airline company with the highest website quality is "Ryanair". To test the robustness of the proposed approach, the same problem is solved using IF-EDAS and IF-WASPAS methods. The results are compared. This research is an attempt to develop a research framework that will aid in determining and prioritizing airline website evaluation criteria and selecting the best site among alternatives in an IF environment.

1. Introduction

Rapid advances in information technology, increase and diversification in customer expectations, development in the phenomenon of quality, commoditization and near-zero profitability are just a few of the factors driving global business competition. The driving force behind the competition is the customer. In this context, it has become necessary to continuously improve service quality in order to meet customer demand on time and in a cost-effective manner.

The e-business structure has emerged as a determining factor in service quality due to the rapid advancement of information technologies, particularly the Covid 19 pandemic process. Customer satisfaction is directly related to the quality of websites, which are the interfaces through which the user interacts with the e-business structure.

The internet is regarded as a platform for the generation of new revenue streams. Because the internet is now so widely available, international businesses have begun to use their websites to communicate and transact with customers all over the world (Chakraborty et al., 2005). To avoid using agents, most airlines have established their own websites and they are increasingly focused on online communication and transactions (Xie and Barnes, 2008). Airlines also use websites to exchange information with current and potential customers, raise brand

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awareness and provide certain services online. In recent years, websites have evolved into an important business communication and promotion tool. The websites of airlines provide services on a global scale allowing for quick and effective communication. Customer Relationship Management (CRM) applications are now available on websites, making it easier to maintain long-term customer loyalty. Furthermore, providing additional services such as car rental and hotel reservations on airline websites generates significant revenue (Harison and Boostra, 2008).

Because these channels are the first point of contact for customers, it is critical that they are well-designed and have the quality and performance to meet customer expectations. When a website has a successful design and adheres to basic quality standards such as timeliness and reliability customer satisfaction increases. Customer satisfaction allows existing customers to become permanent and speeds up the acquisition of new customers by providing positive feedback to their physical and virtual environments (Bilsel et al., 2006).

Airlines must understand the quality of their websites if they are to be more successful in their processes. This is a strategy for increasing market share and competing with other companies in the industry. However, the majority of them are unaware of how successful their sites are or how much of a gap should be filled between their current status and an ideal e-commerce site. At this point, it is critical to define the ideal e-commerce website and identify the shortcomings of the companies' existing websites (Lee and Kozar, 2006).

The evaluation of a website's quality is a multi-criteria decision-making (MCDM) problem. The most appropriate and closest solution that meets the specified requirements and criteria must be found in MCDM problems. TOPSIS is an MCDM approach that evaluates both positive and negative solutions in order to find the best fit for the requirements. Decision makers may find it difficult to determine the significance of criteria in these and similar selection and ranking problems, as well as to clearly evaluate alternatives based on the criteria. The IF sets developed by Atanassov (1986) is an appropriate method for dealing with this challenge. IF sets have been used to solve a wide range of decision-making problems, including uncertainty and have proven to be very effective in doing so (Memari et al., 2019). When combined with IF sets, the TOPSIS approach has a high chance of success when evaluating the quality of a company's website.

Based on fleet size and seat capacity, this study assesses the website quality of the world's ten biggest airline companies. Every decision maker perceives e-service quality differently and decision makers may not be familiar with all features of all criteria. As a result of this situation decisions are made with uncertainty. The IF TOPSIS method is proposed in this study because IF sets are one of the most effective methods for making decisions in uncertain environments. The proposed method is intended to evaluate the website quality of airline companies effectively. Furthermore, the proposed method aims to help researchers theoretically better understand the website evaluation problem, to assist managers in making decisions and to support airline companies in improving the performance of their websites. This is hoped to contribute to the literature in a variety of ways. The majority of airline website quality research is based on content analysis or customer surveys (Chong and Law, 2018). There have been few studies that use MCDM methods in evaluation with fuzzy sets. Furthermore, no literature exists using IF set-based MCDM methods in airline website evaluation. This study aims to fill that gap as well. It also has an original quality due to the combination of the IF-TOPSIS, IF-EDAS and IF-WASPAS methods in the evalution of website quality.

This article is categorized into five main sections. The following section generates a literature review on the quality performance of airline websites. The third section contains in-depth information about the research methodology. The analysis of the data collected will be presented in the fourth section along with the results discussed in relation to the literature review. The final section discusses the research's strengths and weaknesses, as well as the findings and future recommendations.

2. Literature review

Businesses now must assess the quality of their websites and identify weak website capabilities. The following are some of the studies conducted for this purpose using various MCDM methods.

Gong et al. (2021) proposed a new integrated approach based on linguistic hesitant fuzzy sets (LHFSs) and the TODIM (Portuguese abbreviation for interactive and multi-criteria decision making) method for evaluating and selecting the best e-learning website. Gavcar and Organ (2020) chose the best travel agency using AHP-based GIA and WASPAS methods. In their study, Ostovare and Shahraki (2019) used the PROMETHEE and GAIA

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methods to evaluate five-star hotel websites. Liang et al. (2019) presented a Pythagorean fuzzy VIKOR approach based on TODIM for evaluating bank websites. Ozbek and Engur (2018) used the EDAS method to evaluate logistics company websites. Buyukozkan et al. (2018) evaluated hospital websites using the Intuitionistic fuzzy Choquet method. Buyukozkan and Guleryuz (2016) used the fuzzy TOPSIS method to evaluate logistics company websites and Kang et al. (2016) used it to evaluate e-commerce websites. The PROMETHEE method was used by Akincilar and Dagdeviren (2014) to evaluate hotel websites. Lin (2010) evaluated the course websites using the fuzzy AHP method. Dundar and colleagues (2007) used the fuzzy TOPSIS method to evaluate virtual store websites.

The majority of airline website evaluation studies include online questionnaires and passenger surveys (Shchiglik and Barnes, 2004; Hidalgo et al., 2007; Xie and Barnes, 2008; Apostolou and Economides, 2008; Alwahaishi et al., 2009). The following are some studies that used MCDM methods to evaluate airline website quality.

Using a sample of five Asian flag carriers (Cathay Pacific, Japan Airlines, Korea Airlines, Malaysia Airlines and Singapore Airlines), Jati (2009) evaluated the quality of airline websites. The analytical hierarchy process (AHP) method was used in the study. In evaluation, accessibility error, broken link, design optimization, frequency of update, load time, markup validation, number of items, page rank, response time, size and traffic criteria were used. According to the results Malaysia Airlines had the best website with the highest score in comparison.

Tsai et al. (2011) used the Decision Making Trial and Evaluation Laboratory (DEMATEL) method, the Analytic Network Process (ANP) method and the modified VIsekriterijumska optimizacija I KOmpromisno Resenje (VIKOR) method to analyze the websites of five Taiwanese airlines. The study was based on information quality criteria (currency, relevance), service quality criteria (credibility, reliability, responsiveness) and system quality criteria (navigability, personalization, security). China Airlines and Eva Air had the best websites, while Mandarin Airlines had the worst according to the results.

Dominic and Jati (2011) used the linear weightage model (LWM), analytical hierarchy process (AHP) and fuzzy analytical hierarchy process (FAHP) to evaluate the website quality of Asian airlines (Cathay Pacific, Japan Airlines, Korea Airlines, Malaysia Airlines and Singapore Airlines). Accessibility errors, broken links, design optimization, frequency of update, load time, markup validation, number of items, page size, page rank, response time and traffic were among the study's evaluation criteria. According to the findings, the majority of Asian websites performed poorly in terms of performance and quality criteria with Cathay Pacific and Malaysia Airlines performing the best.

Dominic and Khan (2014) used the analytical hierarchy process (AHP) and the fuzzy analytical hierarchy process (FAHP) to assess and compare the website quality of four Malaysian airlines (Air Asia, Malaysia Airlines, Singapore Airlines and Thai Airways). The following criteria were used to evaluate the websites: availability, broken links, design optimization, load time, mark-up validation, number of items, page rank, page score, page size, response time and traffic. As a result, Singapore Airlines' website was ranked first among competitors.

Vatansever and Akgul (2018) evaluated the website performance of 11 Turkish airlines (Anadolujet Airlines, Borajet Airlines, Corendon Airlines, Freebird Airlines, Izair Airlines, Onur Airlines, Pegasus Airlines, Sky Airlines, SunExpress, Tailwind Airlines and Turkish Airlines) using seven criteria (broken links, design optimization, load time, mark up, page rank, response time and traffic). Entropy and gray relational analysis methods were used in the study. The study confirmed that performance and quality criteria for airline websites had been neglected.

Several studies have been conducted on the evaluation of airline websites using fuzzy sets. However, no literature exists using IF set-based MCDM methods in airline website evaluation. This study's method seeks to contribute to the literature by developing a more effective and reliable set of criteria for dealing with uncertainty. The research is unique in that it is the first to use intuitionistic fuzzy methods to evaluate the quality of airline websites. It also has an original quality due to the combination of the IF-TOPSIS, IF-EDAS and IF-WASPAS methods in evaluation.

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3. Methodology

3.1 IF set theory

The fuzzy set theory of Zadeh (1965) is an effective method of dealing with uncertainty in human decision-making (Rouyendegh, 2020). It has been used successfully in a wide range of fields, including engineering, management and economics. Atanassov (1986) established the IF set theory by incorporating improvements to the fuzzy set theory (FST). While the degree of membership in FST is defined in the range [0,1], the degree of non-membership in IF set theory is defined in addition to the degree of membership (Yildirim, 2019). A variety of criteria must be considered in order to find the best solution for MCDM challenges. However, because decision makers' (DMs') feedback can be ambiguous at times, acquiring and evaluating DMs' judgments can be difficult. As a result, IF sets are used to reduce uncertainty and better express DM preferences. In studies, IF clusters were discovered to be a powerful strategy for dealing with ambiguity in decision dilemmas (Buyukozkan and Guleryuz, 2016).

3.2 IF-TOPSIS method

The definitions for the IF-TOPSIS approach are found in this section. To begin, the criteria C and alternative A sets are defined. ($A = \{A_1, A_2, \ldots\ldots A_m\}$ and $C = \{C_1, C_2, \ldots\ldots C_n\}$) The DM group, which is not identical, contains a variety of DM. Because DMs have different levels of experience and knowledge, they have different levels of relevance. λ is the DMs' weight vector. ($\lambda = \{\lambda_1, \lambda_2, \ldots\ldots \lambda_l\}$ $\lambda_k \geq 0, k = 1,2, \ldots\ldots l$ $\sum_{k=1}^{1} \lambda_k = 1.$) $R^{(k)} = (r_{ij}^{(k)})_{m\times n}$ k. is the decision matrix (DMX) of the DM and $r_{ij}^{(k)} = (\mu_{ij}^{(k)}, \nu_{ij}^{(k)}, \pi_{ij}^{(k)})_{m\times n}$ is the IF value obtained from the j. criteria of i. alternative given by the DMs'. Using these concepts, the steps of the IF-TOPSIS technique are detailed below (Boran et al., 2009).

Step 1: Determine the DMs' weights. Assume that the decision group consists of l DM. Within the sphere of IF numbers, the DM's significance is viewed as linguistic terms.
Let$D_k = [\mu_k, \nu_k, \pi_k]$be an IF number to rate kth DM. The following equation can be used to calculate the weight of the kth DM:

$$\lambda_k = \frac{\left(\mu_k + \pi_k \left(\frac{\mu_k}{\mu_k + \nu_k}\right)\right)}{\sum_{k=1}^{l}\left(\mu_k + \pi_k \left(\frac{\mu_k}{\mu_k + \nu_k}\right)\right)}$$

and $\sum_{k=1}^{l} \lambda_k = 1$ (1)

Step 2. Create a single IF DMX based on the DMs' perspectives. To construct a unified IF DMX in the group DMP, all individual decision perspectives must be incorporated in a group view. As a result, the IFWA operator proposed by Xu (2007) is used.

$$r_{ij} = IFWA_\lambda\left(r_{ij}^{(1)}, r_{ij}^{(2)}, \ldots\ldots r_{ij}^{(l)}\right) = r_{ij}^{(1)}\lambda_1 \oplus r_{ij}^{(2)}\lambda_2 \oplus \ldots\ldots \oplus r_{ij}^{(l)}\lambda_l$$

$$=\left[1 - \prod_{k=1}^{l}\left(1 - \mu_{ij}^{(k)}\right)^{\lambda_k}, \prod_{k=1}^{l}\left(\nu_{ij}^{(k)}\right)^{\lambda_k}, \prod_{k=1}^{l}\left(1 - \mu_{ij}^{(k)}\right)^{\lambda_k} - \prod_{k=1}^{l}\left(\nu_{ij}^{(k)}\right)^{\lambda_k}\right] \quad (2)$$

Here $r_{ij} = \left(\mu_{Ai}(x_j), \nu_{Ai}(x_j), \pi_{Ai}(x_j)\right) (i = 1,2 \ldots. m; j = 1,2 \ldots. n)$.
The following is the definition of the combined IF DMX:

$$R : \begin{bmatrix} (\mu_{A1}(x_1), \nu_{A1}(x_1), \pi_{A1}(x_1)) & (\mu_{A1}(x_2), \nu_{A1}(x_2), \pi_{A1}(x_2)) \ldots. & (\mu_{A1}(x_n), \nu_{A1}(x_n), \pi_{A1}(x_n)) \\ (\mu_{A2}(x_1), \nu_{A2}(x_1), \pi_{A2}(x_1)) & (\mu_{A2}(x_2), \nu_{A2}(x_2), \pi_{A2}(x_2)) \ldots. & (\mu_{A2}(x_n), \nu_{A2}(x_n), \pi_{A2}(x_n)) \\ \vdots & \vdots & \vdots \\ (\mu_{Am}(x_1), \nu_{Am}(x_1), \pi_{Am}(x_1)) & (\mu_{Am}(x_2), \nu_{Am}(x_2), \pi_{Am}(x_2)) \ldots & (\mu_{Am}(x_n), \nu_{Am}(x_n), \pi_{Am}(x_n)) \end{bmatrix}$$

$$R = \begin{bmatrix} r_{11} & r_{12} \cdots & r_{1m} \\ r_{21} & r_{22\ldots\ldots} & r_{2m} \\ r_{31} & r_{32\ldots\ldots} & r_{3m} \\ \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots \\ r_{n1} & r_{n2\ldots\ldots} & r_{nm} \end{bmatrix}$$

Step 3. Determine the criteria's weights. It's possible that not all criteria are equally important. W has a variety of intensity levels to choose from. To produce W, all unique DM viewpoints must be integrated due to the importance of each criterion.

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Let$W_j^{(k)} = [\mu_j^{(k)}, \nu_j^{(k)}, \pi_j^{(k)}]$be an IF number assigned to criterion Xj by the kth DM. The weights of the criterion are then determined using the IFWA operator:

$$W_j = IFWA_\lambda(W_j^{(1)}, W_j^{(2)}, \dots\dots W_j^{(l)}) = \lambda_1 W_j^{(1)} \oplus \lambda_2 W_j^{(2)} \oplus \dots\dots \oplus \lambda_l W_j^{(l)}$$

$$= \left[1 - \prod_{k=1}^{l} (1 - \mu_j^{(k)})^{\lambda_k}, \prod_{k=1}^{l} (\nu_j^{(k)})^{\lambda_k}, \prod_{k=1}^{l} (1 - \mu_j^{(k)})^{\lambda_k} - \prod_{k=1}^{l} (\nu_j^{(k)})^{\lambda_k}\right] \quad (3)$$

$W = [W_1, W_2, W_3 \dots\dots W_j]$here$W_j = (\mu_j, \nu_j, \pi_j)(j = 1,2 \dots . n)$

Step 4. Create a weighted combined IF DMX. The combined weighted IF DMX is generated using the following equation after the criterion weights (W) and the combined IF DMX have been determined:

$$R \otimes W = \{(x, \mu_{Ai}(x). \mu_w(x) + \nu_{Ai}(x). \nu_w(x) - \nu_{Ai}(x). \nu_w(x)) | x \in X\} \quad (4)$$

And

$$\pi_{A_i w}(x) = 1 - \nu_{Ai}(x) - \nu_w(x) - \mu_{Ai}(x). \mu_w(x) + \nu_{Ai}(x). \nu_w(x) \quad (5)$$

The weighted combined IF DMX are found as follows:

$$R: \begin{bmatrix} (\mu_{A1W}(x_1), \nu_{A1W}(x_1), \pi_{A1W}(x_1)) & (\mu_{A1W}(x_2), \nu_{A1W}(x_2), \pi_{A1W}(x_2)) \dots . & (\mu_{A1W}(x_n), \nu_{A1W}(x_n), \pi_{A1W}(x_n)) \\ (\mu_{A2W}(x_1), \nu_{A2W}(x_1), \pi_{A2}(x_1)) & (\mu_{A2W}(x_2), \nu_{A2W}(x_2), \pi_{A2W}(x_2)) \dots . & (\mu_{A2W}(x_n), \nu_{A2W}(x_n), \pi_{A2W}(x_n)) \\ \vdots & \vdots & \vdots \\ (\mu_{AmW}(x_1), \nu_{AmW}(x_1), \pi_{AmW}(x_1)) & (\mu_{AmW}(x_2), \nu_{AmW}(x_2), \pi_{AmW}(x_2)) \dots & (\mu_{AmW}(x_n), \nu_{AmW}(x_n), \pi_{AmW}(x_n)) \end{bmatrix}$$

$$R' = \begin{bmatrix} r'_{11} & r'_{12} \dots . & r'_{1m} \\ r'_{21} & r'_{22\dots\dots} & r'_{2m} \\ r'_{31} & r'_{32\dots\dots} & r'_{3m} \\ \vdots & \vdots & \vdots \\ \vdots & \vdots & \vdots \\ r'_{n1} & r'_{n2\dots\dots} & r'_{nm} \end{bmatrix}$$

$r'_{ij} = \{\mu'_{ij}, \nu'_{ij}, \pi'_{ij}\} = \{\mu_{A_iW}(x_j), \nu_{A_iW}(x_j), \pi_{A_iW}(x_j)\}$is an element of the combined weighted IF DMX.

Step 5: Determine whether a negative ideal solution (IF NIS) exists and whether a positive ideal solution (IF PIS) exists. J_1 *and* $J_2$are cost and benefit criterion, respectively. A^* is an IF PIS and $A^-$is an IF NIS. Then, $A^*$and A^- are obtained as:

$$A^* = \{\mu_{A^*W}(x_j), \nu_{A^*W}(x_j)\} \text{and} A^- = \{\mu_{A^-W}(x_j), \nu_{A^-W}(x_j)\} \quad (6)$$

Where

$$\mu_{A^*W}(x_j) = ((max_i \mu_{A_iW}(x_j) | j \in J_1), (min_i \mu_{A_iW}(x_j) | j \in J_2)) \quad (7)$$

$$\nu_{A^*W}(x_j) = ((min_i \nu_{A^*W}(x_j) | j \in J_1), (max_i \nu_{A^*W}(x_j) | j \in J_2)) \quad (8)$$

$$\mu_{A^-W}(x_j) = ((min_i \mu_{A_iW}(x_j) | j \in J_1), (max_i \mu_{A_iW}(x_j) | j \in J_2)) \quad (9)$$

$$\nu_{A^-W}(x_j) = ((max_i \nu_{A^*W}(x_j) | j \in J_1), (min_i \nu_{A^*W}(x_j) | j \in J_2)) \quad (10)$$

Step 6: Determine the separation criteria. To distinguish between alternatives in the IF set, Euclidean distance, Hamming distance and their normalized distance measurements can be utilized. Following the selection of the distance measure, the separation measurements are calculated. S_{i^*} and S_{i^-} of each alternative from IF PIS and NIS are determined. In this paper, the Hamming distance is used.

$$S_{i^*} = \frac{1}{2} \sum_{j=1}^{n} [|\mu'_{ij} - \mu'^*_j| + |\nu'_{ij} - \nu'^*_j| + |\pi'_{ij} - \pi'^*_j|] \; i = 1,2 \dots . m \quad (11)$$

$$S_{i^-} = \frac{1}{2} \sum_{j=1}^{n} [|\mu'_{ij} - \mu'^-_j| + |\nu'_{ij} - \nu'^-_j| + |\pi'_{ij} - \pi'^-_j|] \; i = 1,2 \dots . m \quad (12)$$

Step 7. Determine the intuitionistic ideal solution's relative closeness coefficient. With respect to IF PIS, the relative closeness coefficient of an alternative A_i is defined as follows:

$$C_i^* = \frac{S_i^-}{S_i^* + S_i^-}, 0 \le C_i^* \le 1, i = 1,2, \dots\dots m \quad (13)$$

Step 8. Sort the options in order of preference. Following the determination of each alternative's relative closeness coefficient, the alternatives are sorted in descending order of C_i^* 's.

4. Application

Customer satisfaction in the airline industry can be achieved by providing quality service to current and prospective customers. Because most airlines' websites are their first point of contact, service quality is critical in terms of customer satisfaction. Customer satisfaction ensures that existing customers remain loyal and speeds up the acquisition of new customers by providing positive feedback to their physical and virtual environments. The performance of the websites of the world's 10 biggest airline companies (American Airlines-AA, Delta Air

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Lines-DA, Southwest Airlines-SA, United Airlines-UA, Ryanair-RA, China Southern Airlines-CSA, China Eastern Airlines-CEA, Easyjet-EJ, Turkish Airlines-TA and Air China-AC) is evaluated in this study. Figure 1 depicts the websites of these companies. A decision-making team of four experts who have graduated from the aviation management department and have a career in aviation is formed within the scope of the study. With the authors and decision-making team a literature search is conducted and six main criteria and seventeen sub-criteria that can define the performance of airline companies' websites are identified. The criteria determined and their explanations are shown in Table 1.

1. American Airlines	**https://www.aa.com**
2. Delta Air Lines	**https://www.delta.com**
3. Southwest Airlines	**https://www.southwest.com**
4. United Airlines	**https://www.united.com**
5. Ryanair	**https://www.ryanair.com**
6. China Southern Airlines	**https://www.csair.com**
7. China Eastern Airlines	**https://us.ceair.com**
8. EasyJet	**https://www.easyjet.com**
9. Turkish Airlines	**https://www.turkishairlines.com**
10. Air China	**http://www.airchina.com**

Figure 1. Airline companies and online addresses

Table 1. Criteria and explanations

Criteria	Explanations	References
Information quality	Information accuracy(**C1**): Consistency	Apostolou and Economides, 2008; Lin, 2010; Tsai et al., 2011; Chou and Chen, 2012
	Up-to-dateness of information(**C2**): Topicality	Lin, 2010; Tsai et al., 2011; Ozbek, 2018; Ozbek, 2020
	The wealth of information(**C3**): Wide scope	Dundar et al., 2007; Apostolou and Economides, 2008; Alwahaishi et al., 2009; Chou and Chen, 2012; Buyukozkan and Guleryuz, 2016; Ozbek, 2020
Visual and physical structure	Ease of use(**C4**): Functionality	Xie and Barnes, 2008; Ozbek, 2018; Liang et al., 2019; Ostavare and Shahraki, 2019; Ozbek, 2020
	Design(**C5**): Visual appeal	Dundar et al., 2007; Xie and Barnes, 2008; Jati, 2009; Dominic and Khan, 2014; Buyukozkan and Guleryuz, 2016; Ozbek, 2018
	Speed(**C6**): Website speed	Lin, 2010; Dominic and Jati, 2011; Buyukozkan et al., 2018
Responding	Customer relations(**C7**): Availability of direct interactive forms for customer requests and complaints	Akıncılar and Dagdeviren, 2014; Buyukozkan and Guleryuz, 2016
	Interactivity(**C8**): Online dating	Akıncılar and Dagdeviren, 2014; Buyukozkan and Guleryuz, 2016
	Technical performance(**C9**): Accessibility	Hidalgo et al., 2007; Lin, 2010; Dominic and Jati, 2011; Buyukozkan and Guleryuz, 2016
Reliability	Specialization(**C10**): Presence of an expert authority	Buyukozkan and Guleryuz, 2016
	Standardization(**C11**): Compliance with standards	Buyukozkan and Guleryuz, 2016
	Reputation(**C12**): Awareness	Buyukozkan and Guleryuz, 2016; Yalcin and Yagli, 2020
Confidentiality/	Confidentiality(**C13**): Keeping customer data	Liang et al., 2019;

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Security	confidential	Ostavare and Shahraki , 2019; Buyukozkan et al., 2018
	Security(**C14**): Ensuring the security of financial data	Tsai et al., 2011; Ostavare and Shahraki, 2019; Yalcin and Yagli, 2020; Gong et al., 2021
Empaty	Personalization(**C15**): Personalized interest / offer, storage of past customer information	Tsai et al., 2011; Akincilar and Dagdeviren, 2014; Gong et al., 2021
	Link(**C16**): Links with institutions and websites	Buyukozkan and Guleryuz, 2016; Ostavare and Shahraki, 2019
	Customer care(**C17**): Care / guidance	Alwahaishi et al., 2009; Chou and Chen, 2012; Buyukozkan and Guleryuz, 2016

The structure of the IF TOPSIS model created for the best web site selection is shown in Figure 2.

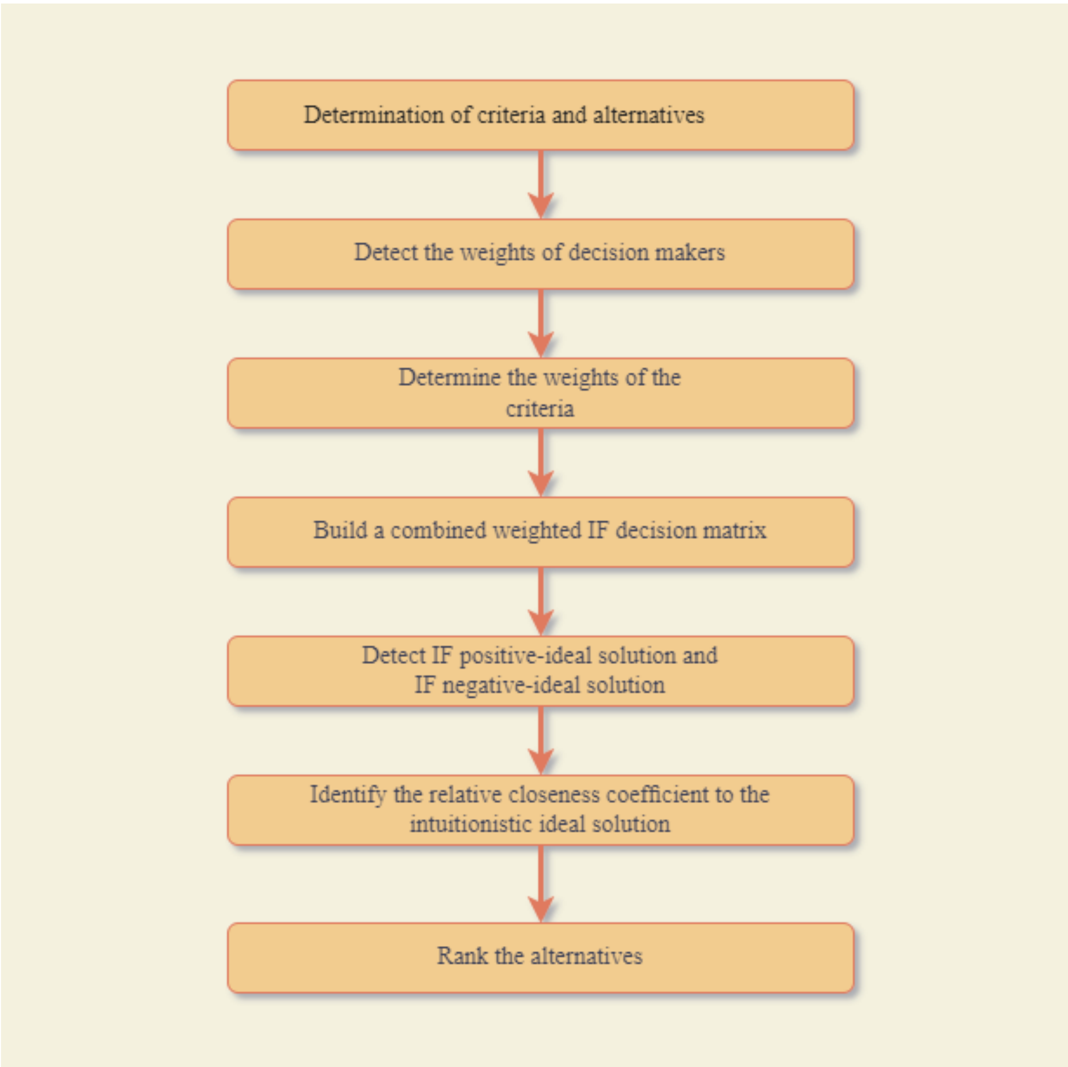

Figure 2. The structure of the IF TOPSIS model

The application steps of the model are explained below.

Step 1. Calculating the weights of DM. The significance of DMs is treated as a linguistic variable. To assess the weight of decision makers, linguistic concepts are stated with IF numbers, as shown in Table 2.

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Table 2. Linguistic terms used to determine the importance levels of the expert team

Linguistic terms	IF numbers
VI (Very Important)	0,80-0,10
I (Important)	0,50-0,30
M (Medium)	0,50-0,50
U (Unimportant)	0,30-0,50
VU (Very Unimportant)	0,20-0,70

According to their field experience, the DMs' importance levels are identified as "Ex1: very important" and "Ex2=Ex3=Ex4:important," and the weight values are calculated and reported in Table 3.

$$\lambda_{Ex1} = \frac{(0{,}80 + 0{,}10.\frac{0{,}80}{0{,}90})}{\left(0{,}80 + 0{,}10.\frac{0{,}80}{0{,}90}\right) + \left(0{,}50 + 0{,}30.\frac{0{,}50}{0{,}80}\right) + \left(0{,}50 + 0{,}30.\frac{0{,}50}{0{,}80}\right) + (0{,}50 + 0{,}30.\frac{0{,}50}{0{,}80})} = 0{,}301$$

$$\lambda_{Ex2} = \lambda_{Ex3} = \lambda_{Ex4} \frac{(0{,}50 + 0{,}30.\frac{0{,}50}{0{,}80})}{\left(0{,}80 + 0{,}10.\frac{0{,}80}{0{,}90}\right) + \left(0{,}50 + 0{,}30.\frac{0{,}50}{0{,}80}\right) + \left(0{,}50 + 0{,}30.\frac{0{,}50}{0{,}80}\right) + (0{,}50 + 0{,}30.\frac{0{,}50}{0{,}80})} = 0{,}233$$

Table 3. Weight values of the DM's

	Ex1	Ex2	Ex3	Ex4
Linguistic terms	VI	I	I	I
Weight value	0,301	0,233	0,233	0,233

Step 2: Create an aggregated IF DMX based on DM's options. The combined DMX is created by combining the DMs' evaluations of the various options.

Table 4. Linguistic terms (LT) and IF numbers

LT	IF numbers
VG (Very good)	0,75-0,10-0,15
G (Good)	0,60-0,25-0,15
M (Medium)	0,50-0,50-0,00
B (Bad)	0,25-0,60-0,15
VB (Very bad)	0,10-0,75-0,15

Four DM's use the linguistic concepts in Table 4 to evaluate alternatives according to the criteria. Table 5 shows the results of each DM's evaluation of alternatives based on the criteria.

Table 5. Evaluation of DM's

	Criteria	Ex1	Ex2	Ex3	Ex4		Criteria	Ex1	Ex2	Ex3	Ex4
AA	C1	VG	VG	G	VG	DA	C1	VG	VG	VG	VG
	C2	VG	VG	VG	VG		C2	VG	VG	G	VG
	C3	G	G	G	VG		C3	VG	M	M	VG
	C4	G	M	M	VG		C4	B	VG	G	M
	C5	G	M	G	G		C5	G	M	VG	B
	C6	M	VG	VG	M		C6	M	VG	G	M
	C7	G	G	M	VG		C7	G	VG	B	G

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	C8	M	M	G	M		C8	M	G	G	M
	C9	M	G	M	VG		C9	VB	M	M	VG
	C10	G	VG	G	G		C10	M	B	M	G
	C11	G	G	M	VG		C11	G	M	VG	VG
	C12	VG	G	VG	VG		C12	VG	G	G	VG
	C13	G	M	M	VG		C13	G	M	G	VG
	C14	M	G	M	VG		C14	M	G	M	VG
	C15	M	M	G	VG		C15	M	M	VG	VG
	C16	VG	B	G	VG		C16	M	G	M	VG
	C17	G	G	VG	G		C17	G	M	VG	M
	Criteria	Ex1	Ex2	Ex3	Ex4		Criteria	Ex1	Ex2	Ex3	Ex4
	C1	VG	G	VG	VG		C1	VG	VG	VG	VG
	C2	VG	VG	M	VG		C2	VG	VG	M	VG
	C3	VG	M	B	VG		C3	M	M	M	VG
	C4	VG	VG	G	B		C4	M	VG	G	G
	C5	M	G	M	M		C5	M	G	VG	VG
	C6	VG	VG	VG	VG		C6	M	G	B	M
	C7	VG	G	M	M		C7	M	VG	G	M
	C8	G	B	VG	B		C8	B	G	M	B
SA	C9	VG	VB	VG	VG	UA	C9	M	VB	M	B
	C10	M	B	G	B		C10	G	VB	G	M
	C11	G	G	M	VG		C11	G	G	G	VG
	C12	VG	G	VG	VG		C12	VG	G	VG	VG
	C13	M	G	B	VG		C13	G	M	VG	VG
	C14	M	G	G	VG		C14	G	G	G	VG
	C15	G	M	G	VG		C15	G	M	M	VG
	C16	VG	B	VG	VG		C16	VG	G	VG	VG
	C17	G	M	M	B		C17	G	G	G	M
	Criteria	Ex1	Ex2	Ex3	Ex4		Criteria	Ex1	Ex2	Ex3	Ex4
	C1	VG	VB	VG	VG		C1	VG	G	VG	VG
	C2	VG	VG	VG	VG		C2	VG	VG	G	VG
	C3	VG	G	G	VG		C3	VG	G	M	VG
	C4	VG	VG	M	M		C4	G	VG	G	G
	C5	G	G	G	B		C5	M	M	G	G
RA	C6	VG	VG	M	VG	CSA	C6	VG	G	VG	G
	C7	VG	G	VG	VG		C7	G	G	B	M
	C8	VG	G	G	VG		C8	B	B	M	B
	C9	VG	G	M	G		C9	M	G	B	G
	C10	G	M	G	G		C10	M	M	G	M
	C11	G	G	B	VG		C11	G	B	VG	VG
	C12	VG	G	VG	VG		C12	G	VB	M	VG

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	C13	VG	B	G	VG		C13	M	B	VG	VG
	C14	VG	G	M	VG		C14	M	G	G	VG
	C15	G	G	VG	VG		C15	G	M	G	VG
	C16	VG	B	G	VG		C16	VB	B	G	VG
	C17	G	G	VG	VG		C17	M	M	M	M
CEA	Criteria	Ex1	Ex2	Ex3	Ex4	EJ	Criteria	Ex1	Ex2	Ex3	Ex4
	C1	VG	G	G	VG		C1	VG	G	M	VG
	C2	VG	VG	M	VG		C2	VG	VG	G	VG
	C3	G	M	G	VG		C3	G	M	G	VG
	C4	M	G	VG	VG		C4	G	VG	VG	VG
	C5	M	M	VG	G		C5	G	M	G	G
	C6	M	G	M	M		C6	VG	G	G	M
	C7	G	G	VG	B		C7	G	VG	M	G
	C8	B	B	G	B		C8	B	G	G	VG
	C9	M	B	B	M		C9	M	G	G	G
	C10	M	M	M	G		C10	G	VB	VG	G
	C11	G	B	VG	VG		C11	G	G	M	VG
	C12	G	VB	G	VG		C12	VG	G	VG	VG
	C13	M	G	M	VG		C13	M	B	B	VG
	C14	M	B	G	VG		C14	M	B	G	VG
	C15	G	M	M	G		C15	G	M	VG	VG
	C16	G	M	VG	VG		C16	VG	G	M	VG
	C17	M	M	G	M		C17	G	G	VG	G
TA	Criteria	Ex1	Ex2	Ex3	Ex4	AC	Criteria	Ex1	Ex2	Ex3	Ex4
	C1	VG	VG	VG	VG		C1	VG	G	M	VG
	C2	VG	VG	VG	VG		C2	VG	VG	G	VG
	C3	VG	M	VG	G		C3	G	G	M	VG
	C4	G	VG	G	G		C4	G	G	VG	B
	C5	G	G	VG	G		C5	M	G	B	B
	C6	VG	G	M	M		C6	VG	G	G	M
	C7	G	VG	VG	VG		C7	G	VG	M	M
	C8	VG	G	VG	VG		C8	VG	B	M	B
	C9	VG	M	M	G		C9	G	M	B	B
	C10	G	G	M	G		C10	G	VB	VG	M
	C11	G	G	VG	M		C11	G	B	G	VG
	C12	VG	G	M	G		C12	VG	VB	B	M
	C13	G	M	G	G		C13	G	B	M	VG
	C14	M	VG	G	M		C14	M	M	VG	VG
	C15	G	M	VG	VG		C15	G	G	B	VG
	C16	M	B	B	M		C16	M	M	G	VG
	C17	G	G	VG	G		C17	G	G	M	B

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The opinions of all DMs should be merged into group thinking without any loss of information during the group DMP. The unified DMX is obtained using the IFWA operator. The information provided by the four decision makers is combined with the IFWA operator to create the unified DMX. Table 6 shows the combined DMX.

Table 6. The combined DMX

	C1	C2	C3
AA	(0,729 0,124 0,147)	(0,757 0,100 0,144)	(0,642 0,202 0,156)
DA	(0,757 0,100 0,144)	(0,729 0,124 0,147)	(0,785 0,211 0,004)
SA	(0,729 0,124 0,147)	(0,715 0,145 0,140)	(0,631 0,221 0,148)
UA	(0,757 0,100 0,144)	(0,715 0,145 0,140)	(0,575 0,344 0,081)
RA	(0,757 0,100 0,144)	(0,757 0,100 0,144)	(0,698 0,153 0,149)
CSA	(0,729 0,124 0,147)	(0,729 0,124 0,147)	(0,681 0,180 0,139)
CEA	(0,698 0,153 0,149)	(0,715 0,145 0,140)	(0,623 0,231 0,146)
EJ	(0,681 0,180 0,139)	(0,729 0,124 0,147)	(0,623 0,231 0,146)
TA	(0,757 0,100 0,144)	(0,757 0,100 0,144)	(0,681 0,180 0,139)
AC	(0,681 0,180 0,139)	(0,729 0,124 0,147)	(0,623 0,231 0,146)
	C4	C5	C6
AA	(0,533 0,057 0,410)	(0,579 0,285 0,136)	(0,638 0,236 0,126)
DA	(0,544 0,329 0,127)	(0,563 0,283 0,154)	(0,596 0,292 0,112)
SA	(0,650 0,188 0,162)	(0,525 0,425 0,100)	(0,757 0,099 0,144)
UA	(0,617 0,249 0,134)	(0,657 0,201 0,142)	(0,479 0,444 0,077)
RA	(0,664 0,211 0,125)	(0,537 0,298 0,165)	(0,715 0,145 0,140)
CSA	(0,642 0,202 0,156)	(0,549 0,362 0,089)	(0,698 0,153 0,149)
CEA	(0,657 0,201 0,142)	(0,596 0,292 0,112)	(0,525 0,425 0,100)
EJ	(0,712 0,128 0,160)	(0,579 0,285 0,136)	(0,644 0,223 0,133)
TA	(0,642 0,202 0,156)	(0,642 0,202 0,156)	(0,626 0,262 0,112)
AC	(0,585 0,224 0,191)	(0,427 0,463 0,110)	(0,644 0,223 0,133)
	C7	C8	C9
AA	(0,623 0,231 0,146)	(0,525 0,425 0,100)	(0,596 0,292 0,112)
DA	(0,585 0,224 0,191)	(0,549 0,362 0,089)	(0,492 0,388 0,120)
SA	(0,626 0,262 0,112)	(0,520 0,295 0,185)	(0,673 0,160 0,167)
UA	(0,596 0,292 0,112)	(0,411 0,499 0,090)	(0,371 0,573 0,056)
RA	(0,729 0,124 0,147)	(0,698 0,153 0,149)	0,644 0,223 0,133)
CSA	(0,513 0,350 0,137)	(0,318 0,612 0,070)	(0,505 0,377 0,118)
CEA	(0,585 0,224 0,191)	(0,352 0,521 0,127)	(0,397 0,544 0,059)
EJ	(0,623 0,231 0,146)	(0,567 0,312 0,121)	(0,460 0,308 0,241)
TA	(0,712 0,128 0,160)	(0,729 0,124 0,147)	(0,626 0,262 0,112)
AC	(0,533 0,057 0,410)	(0,524 0,335 0,141)	(0,436 0,429 0,135)
	C10	C11	C12
AA	(0,518 0,314 0,168)	(0,623 0,231 0,146)	(0,729 0,124 0,147)
DA	(0,479 0,444 0,077)	(0,662 0,186 0,152)	(0,698 0,153 0,149)
SA	(0,427 0,463 0,110)	(0,623 0,231 0,146)	(0,729 0,124 0,147)
UA	(0,492 0,369 0,139)	(0,642 0,202 0,156)	(0,729 0,124 0,147)
RA	(0,579 0,285 0,136)	(0,585 0,224 0,191)	(0,729 0,124 0,140)
CSA	(0,525 0,425 0,100)	(0,629 0,194 0,177)	(0,545 0,298 0,247)
CEA	(0,525 0,425 0,100)	(0,629 0,194 0,177)	(0,568 0,253 0,179)

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EJ	(0,568 0,253 0,179)	(0,623 0,231 0,146)	(0,729 0,124 0,147)
TA	(0,579 0,285 0,136)	(0,623 0,231 0,146)	(0,644 0,223 0,133)
AC	(0,545 0,298 0,157)	(0,585 0,224 0,191)	(0,504 0,352 0,144)

	C13	C14	C15
AA	(0,533 0,057 0,410)	(0,596 0,292 0,112)	(0,596 0,292 0,112)
DA	(0,623 0,231 0,146)	(0,596 0,292 0,112)	(0,638 0,236 0,126)
SA	(0,557 0,305 0,138)	(0,617 0,249 0,134)	(0,623 0,231 0,146)
UA	(0,662 0,186 0,152)	(0,642 0,202 0,156)	(0,538 0,057 0,410)
RA	(0,650 0,188 0,162)	(0,681 0,180 0,139)	(0,679 0,159 0,162)
CSA	(0,603 0,246 0,151)	(0,617 0,249 0,134)	(0,623 0,231 0,146)
CEA	(0,596 0,292 0,112)	(0,557 0,305 0,138)	(0,556 0,336 0,108)
EJ	(0,487 0,374 0,139)	(0,487 0,374 0,139)	(0,662 0,186 0,152)
TA	(0,579 0,285 0,136)	(0,596 0,292 0,112)	(0,662 0,186 0,152)
AC	(0,563 0,283 0,154)	(0,638 0,236 0,126)	(0,585 0,224 0,191)

	C16	C17
AA	(0,650 0,188 0,162)	(0,642 0,202 0,156)
DA	(0,596 0,292 0,112)	(0,533 0,057 0,410)
SA	(0,686 0,152 0,162)	(0,487 0,412 0,101)
UA	(0,729 0,124 0,147)	(0,579 0,285 0,136)
RA	(0,650 0,188 0,162)	(0,679 0,159 0,162)
CSA	(0,470 0,345 0,185)	(0,500 0,500 0,000)
CEA	(0,662 0,186 0,152)	(0,525 0,425 0,100)
EJ	(0,681 0,180 0,139)	(0,642 0,202 0,156)
TA	(0,397 0,544 0,059)	(0,642 0,202 0,156)
AC	(0,596 0,292 0,112)	(0,513 0,350 0,137)

Step 3: Determine the criteria's weights. The weights of each criterion are not equal in the choice issue. The significance of the criteria varies depending on the decision maker. As a result, each decision maker's IF values for the criteria should be pooled. Table 7 lists the linguistic phrases used by decision makers to assess the value of the criteria.

Table 7. LT and IF numbers

Linguistic Terms	IF numbers
VI (Very Important)	0,75-0,10-0,15
I (Important)	0,60-0,25-0,15
M (Medium)	0,50-0,50-0,00
U (Unimportant)	0,25-0,60-0,15
VU (Very Unimportant)	0,10-0,75-0,15

Table 8 shows the importance levels assigned to the criterion by each DM. In Table 7 linguistic words have been converted to IF numbers.

Table 8. Evaluations of the DMs for the criteria

Criteria	Ex1	Ex2	Ex3	Ex4
C1	VI	VI	VI	VI
C2	VI	VI	I	VI

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C3	I	U	I	I
C4	I	VI	VI	VI
C5	I	VU	VI	I
C6	VI	U	VI	VI
C7	M	I	VI	VI
C8	I	I	I	I
C9	I	I	I	VI
C10	I	VU	I	I
C11	I	VU	I	I
C12	I	U	VI	VI
C13	VI	I	I	VI
C14	VI	VI	VI	VI
C15	I	I	VI	VI
C16	I	U	U	VI
C17	I	I	VI	VI

The IFWA operator and Equation 3 calculations are used to derive the weight values of the criteria. Table 9 shows the results achieved.

Table 9. The obtained weight values

W	Obtained weight values		
W1	(0,900	0,100	0,000)
W2	(0,876	0,117	0,007)
W3	(0,688	0,258	0,054)
W4	(0,868	0,123	0,009)
W5	(0,728	0,242	0,030)
W6	(0,846	0,152	0,002)
W7	(0,764	0,223	0,013)
W8	(0,575	0,373	0,052)
W9	(0,763	0,206	0,031)
W10	(0,585	0,364	0,051)
W11	(0,604	0,343	0,053)
W12	(0,749	0,239	0,012)
W13	(0,847	0,138	0,015)
W14	(0,900	0,100	0,000)
W15	(0,813	0,175	0,012)
W16	(0,689	0,281	0,030)
W17	(0,837	0,145	0,018)

Step 4: Create the combined weighted DMX. Equations 4 and 5 are used to produce a weighted combined DMX after the weights of the criterion and the combined DMX have been created. Table 10 shows the weighted combined DMX that was obtained.

Table 10. Weighted combined DMX

	C1			C2			C3		
AA	(0,656	0,212	0,132)	(0,663	0,205	0,132)	(0,442	0,408	0,150)
DA	(0,681	0,190	0,129)	(0,639	0,226	0,135)	(0,540	0,415	0,045)
SA	(0,656	0,212	0,132)	(0,626	0,245	0,129)	(0,434	0,422	0,144)
UA	(0,681	0,190	0,129)	(0,626	0,245	0,129)	(0,396	0,513	0,091)
RA	(0,681	0,190	0,129)	(0,663	0,205	0,132)	(0,480	0,372	0,148)

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CSA	(0,656 0,212 0,132)	(0,639 0,226 0,135)	(0,469 0,392 0,140)
CEA	(0,628 0,238 0,134)	(0,626 0,245 0,129)	(0,429 0,429 0,142)
EJ	(0,613 0,262 0,125)	(0,639 0,226 0,135)	(0,429 0,429 0,142)
TA	(0,681 0,190 0,129)	(0,663 0,205 0,132)	(0,469 0,392 0,140)
AC	(0,613 0,262 0,125)	(0,639 0,226 0,135)	(0,429 0,429 0,142)
	C4	C5	C6
AA	(0,463 0,173 0,364)	(0,422 0,458 0,120)	(0,540 0,352 0,108)
DA	(0,472 0,412 0,116)	(0,410 0,457 0,134)	(0,504 0,400 0,096)
SA	(0,564 0,288 0,148)	(0,382 0,564 0,054)	(0,640 0,236 0,124)
UA	(0,536 0,341 0,123)	(0,478 0,394 0,127)	(0,405 0,529 0,066)
RA	(0,576 0,308 0,116)	(0,391 0,468 0,141)	(0,605 0,275 0,120)
CSA	(0,557 0,300 0,143)	(0,400 0,516 0,084)	(0,591 0,282 0,128)
CEA	(0,570 0,299 0,130)	(0,434 0,463 0,103)	(0,444 0,512 0,043)
EJ	(0,618 0,235 0,147)	(0,422 0,458 0,120)	(0,545 0,341 0,114)
TA	(0,557 0,300 0,143)	(0,467 0,395 0,138)	(0,530 0,374 0,096)
AC	(0,508 0,319 0,173)	(0,311 0,593 0,096)	(0,545 0,341 0,114)
	C7	C8	C9
AA	(0,476 0,402 0,122)	(0,302 0,639 0,059)	(0,455 0,438 0,107)
DA	(0,447 0,397 0,156)	(0,316 0,600 0,084)	(0,375 0,514 0,111)
SA	(0,478 0,427 0,095)	(0,299 0,558 0,143)	(0,513 0,333 0,153)
UA	(0,455 0,450 0,095)	(0,236 0,686 0,078)	(0,283 0,661 0,056)
RA	(0,557 0,319 0,124)	(0,401 0,469 0,130)	(0,491 0,383 0,126)
CSA	(0,392 0,495 0,113)	(0,183 0,757 0,060)	(0,385 0,505 0,109)
CEA	(0,447 0,397 0,156)	(0,202 0,700 0,098)	(0,303 0,638 0,059)
EJ	(0,476 0,402 0,122)	(0,326 0,569 0,105)	(0,351 0,451 0,198)
TA	(0,544 0,322 0,134)	(0,419 0,451 0,130)	(0,478 0,414 0,108)
AC	(0,407 0,267 0,325)	(0,301 0,583 0,116)	(0,333 0,547 0,121)
	C10	C11	C12
AA	(0,303 0,564 0,133)	(0,376 0,495 0,129)	(0,546 0,333 0,121)
DA	(0,280 0,646 0,073)	(0,400 0,465 0,135)	(0,523 0,355 0,122)
SA	(0,250 0,658 0,092)	(0,376 0,495 0,129)	(0,546 0,333 0,121)
UA	(0,288 0,599 0,113)	(0,388 0,476 0,137)	(0,546 0,333 0,121)
RA	(0,339 0,545 0,116)	(0,353 0,490 0,156)	(0,546 0,333 0,121)
CSA	(0,307 0,634 0,059)	(0,380 0,470 0,150)	(0,408 0,466 0,126)
CEA	(0,307 0,634 0,059)	(0,380 0,470 0,150)	(0,425 0,432 0,143)
EJ	(0,332 0,525 0,143)	(0,376 0,495 0,129)	(0,546 0,333 0,121)
TA	(0,339 0,545 0,116)	(0,376 0,495 0,129)	(0,482 0,409 0,109)
AC	(0,319 0,554 0,128)	(0,353 0,490 0,156)	(0,377 0,507 0,116)
	C13	C14	C15
AA	(0,451 0,187 0,361)	(0,536 0,363 0,101)	(0,485 0,416 0,100)
DA	(0,528 0,337 0,135)	(0,536 0,363 0,101)	(0,519 0,370 0,112)
SA	(0,472 0,401 0,127)	(0,555 0,324 0,121)	(0,506 0,366 0,128)
UA	(0,561 0,298 0,141)	(0,578 0,282 0,140)	(0,437 0,222 0,341)
RA	(0,551 0,300 0,149)	(0,613 0,262 0,125)	(0,552 0,306 0,142)
CSA	(0,511 0,350 0,139)	(0,555 0,324 0,121)	(0,506 0,366 0,128)
CEA	(0,505 0,390 0,105)	(0,501 0,375 0,124)	(0,452 0,452 0,096)

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EJ	(0,412 0,460 0,127)	(0,438 0,437 0,125)	(0,538 0,328 0,133)
TA	(0,490 0,384 0,126)	(0,536 0,363 0,101)	(0,538 0,328 0,133)
AC	(0,477 0,382 0,141)	(0,574 0,312 0,113)	(0,476 0,360 0,165)

	C16	C17
AA	(0,448 0,416 0,136)	(0,537 0,318 0,145)
DA	(0,411 0,491 0,098)	(0,446 0,194 0,360)
SA	(0,473 0,390 0,137)	(0,408 0,497 0,095)
UA	(0,502 0,370 0,128)	(0,485 0,389 0,127)
RA	(0,448 0,416 0,136)	(0,568 0,281 0,151)
CSA	(0,324 0,529 0,147)	(0,419 0,573 0,009)
CEA	(0,456 0,415 0,129)	(0,439 0,508 0,052)
EJ	(0,469 0,410 0,120)	(0,537 0,318 0,145)
TA	(0,274 0,672 0,054)	(0,537 0,318 0,145)
AC	(0,411 0,491 0,098)	(0,429 0,444 0,126)

Step 5. Determine the IF PIS and the IF NIS.
All criteria addressed in the problem are utility criteria. IF PIS value A* and IF NIS value A− for each alternative are calculated using Equation 6. These values are given in Table 11.

Table 11. IF PIS and IF NIS values

	A*			A-	
(0,681	0,190	0,129)	(0,613	0,262	0,125)
(0,663	0,205	0,132)	(0,626	0,245	0,129)
(0,540	0,415	0,045)	(0,396	0,513	0,091)
(0,618	0,235	0,147)	(0,463	0,173	0,364)
(0,478	0,394	0,127)	(0,311	0,593	0,096)
(0,640	0,236	0,124)	(0,405	0,529	0,066)
(0,557	0,319	0,124)	(0,392	0,495	0,113)
(0,419	0,451	0,130)	(0,183	0,757	0,060)
(0,513	0,333	0,153)	(0,283	0,661	0,056)
(0,339	0,545	0,116)	(0,250	0,658	0,092)
(0,400	0,465	0,135)	(0,353	0,490	0,156)
(0,546	0,333	0,121)	(0,377	0,507	0,116)
(0,561	0,298	0,141)	(0,412	0,460	0,127)
(0,613	0,262	0,125)	(0,438	0,437	0,125)
(0,552	0,306	0,142)	(0,437	0,222	0,341)
(0,502	0,370	0,128)	(0,274	0,672	0,054)
(0,568	0,281	0,151)	(0,408	0,497	0,095)

Step 6: Determine the positive and negative separation measures.
Table 12 shows the separation measures between IF PIS and IF NIS for each choice.
Step 7.Determining the values of the closeness coefficients for each alternative
The proximity coefficient values of the alternatives are determined and provided in Table 12 using the IF PIS and IF NIS.
Step 8: Choosing the best option
In the final step, the alternatives are ranked based on their proximity coefficient values. Raynair is the first option on the list. Delta Air Lines is ranked second. Turkish Airlines is ranked third. Southwest Airlines is ranked fourth. EasyJet is ranked fifth. American Airlines is ranked sixth. United Airlines is ranked seventh. Air

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China is ranked eight and China Southern Airlines is ranked ninth. China Eastern Airlines is ranked tenth. Raynair's website with the highest proximity coefficient is chosen as the best, while China Eastern Airlines' website with the lowest proximity coefficient is chosen as the worst of the alternatives.

Table 12. Closeness and proximity coefficients of alternatives

	Si*	Si-	Ci
AA	1,492	2,285	0,605
DA	0,531	2,313	**0,813**
SA	1,235	2,207	0,641
UA	1,684	1,641	0,494
RA	0,481	2,915	**0,858**
CSA	1,925	1,698	0,469
CEA	2,131	1,548	0,421
EJ	1,233	2,117	0,632
TA	1,055	2,341	**0,689**
AC	1,904	1,727	0,476

Comparative Analysis

The proposed strategy for rating airline websites has been subjected to a comparative study. The IF-EDAS and IF-WASPAS methods are used to solve the decision problem again and the ranking results are shown in Table 13. The algorithms used by the IF-EDAS and IF-WASPAS approaches are different. As a result, different techniques treat the same data in different ways. The best alternative in the EDAS approach is determined by the distance from the mean solution, whereas the best alternative in the WASPAS technique is determined by the weighted sum model and the weighted product model (Ecer, F.,2020). As shown in Table 13, there is no significant difference between the suggested approach and the compared methods in terms of the best alternative. In all three methods while Raynair is the best alternative, China Eastern Airlines has the lowest score.

Table 13. Comparative Analysis

	AA	DA	SA	UA	RA	CSA	CEA	EJ	TA	AC
Suggested Method	6	2	4	7	1	9	10	5	3	8
IF-EDAS	3	6	4	7	1	8	10	5	2	9
IF-WASPAS	2	6	4	7	1	9	10	5	3	8

5. Discussion and conclusions

The importance of the concept of e-commerce, which has become an indispensable part of today's society due to the rapid development of information technology, was confirmed once again during the Covid-19 pandemic period. In the context of e-commerce, the value of websites that provide customer interactions has also increased. Researchers are interested in determining website quality criteria and measuring website quality based on these criteria.

Website quality evaluation is a process that requires decision makers to consider multiple criteria simultaneously. As a result, the problem of evaluating airline websites is classified as a multi-criteria group decision problem. Decision makers seek to select the best alternative from a set of alternatives based on their decision situations. However, in some circumstances, none of the options can meet all of the established criteria at the highest level. On the basis of the stated needs and criteria, it is important to be able to generate the closest ideal solution to this selection problem. The TOPSIS method is a decision-making method that takes into account both the positive and negative solutions in order to determine the best alternative based on criteria for this and similar selection and ranking problems. IF sets are one of the methods that take linguistic evaluations of

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experts in the field into account, particularly when there is no solid basis or numerical data to evaluate the results of alternatives (Onat at.,2016). The IF-TOPSIS method is the approach in the TOPSIS method that uses IF numbers to perform analyses. The method is based on evaluating alternatives and criteria using IF numbers rather than exact numbers to overcome uncertainty, particularly in decision environments where uncertainty prevails (Yildirim, 2019). It is preferred in this study due to these benefits.

This study proposes an applicable model for measuring the quality performance of airline company websites. The proposed model evaluates the quality performance of the websites of the world's 10 biggest airline companies using six main criteria and seventeen sub-criteria. While the most important criteria for the quality of airline company websites are "confidentiality/security" and "information quality," the most important sub-criteria are "security" and "information accuracy." "Interactivity" is the criterion with the lowest level of significance. The weights of each alternative and criterion are given in linguistic terms and expressed in IF numbers during the evaluation process. In addition, the IFWA operator is used to gather opinions from decision-makers. The closeness coefficient values of the alternatives are obtained after calculating the IF positive and IF negative ideal solutions based on the hamming distance and it is concluded that the airline company with the highest website quality is "Raynair."

The IF set-based TOPSIS method is used in this study to present a solution to the airline website evaluation problem that takes into account multiple experts, numerous criteria and alternatives. Its goal is to develop a research framework to aid in determining and prioritizing airline website evaluation criteria, as well as selecting the best site among alternatives in an IF environment. Secondary objectives include solving the same problem using the IF-EDAS and IF-WASPAS methods and comparing the results to test the robustness of the proposed approach. Airlines looking to create higher-quality websites can use this research as a model. It is hoped that it will contribute to the literature and provide researchers with a theoretical understanding of the problem of website evaluation. Furthermore, no study has been found in the literature that uses IF set-based MCDM methods to evaluate airline website quality. In this context, the approach can be considered to be original.

This research evaluates the website quality of the world's 10 biggest airline companies based on fleet size and seat capacity. To evaluate airline company websites, 17 sub-criteria are developed based on various studies in the literature. These are the limitations of the study.

Changes in the criteria used in the analysis, as well as their significance will cause the ranking results to change. In this perspective, future research can evaluate airline company websites using a different variety of criteria. More criteria in the assessment can be added to the analysis to expand it. The study can be repeated with a longitudinal research perspective over numerous years and the development process of airline companies can be evaluated in terms of website quality. Various fuzzy or intuitionistic fuzzy MCDM approaches may be tried in the following studies. The obtained ranking results can be compared to the current study's findings. Correlation levels between ranking results can be investigated and combined ranking results can be generated.

Contribution of Researchers

Conceptualization: EÇ,FZ
Methodology: EÇ,FZ
Validation: EÇ,FZ
Investigation: EÇ,FZ
Resources: EÇ,FZ
Data Curation: EÇ,FZ
Writing - Original Draft: EÇ,FZ
Writing - Review & Editing: EÇ,FZ
Visualization: EÇ,FZ
Supervision: EÇ,FZ
Project administration: EÇ,FZ

EÇ: Eda Çınaroğlu
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Conflicts of Interest

The authors declared that there is no conflict of interest.

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