Uluslararası Sosyal Araştırmalar Dergisi
The Journal of International Social Research
Cilt: 10 Sayı: 52 Volume: 10 Issue: 52
Ekim 2017 October 2017
www.sosyalarastirmalar.com Issn: 1307-9581
Doi Number: http://dx.doi.org/10.17719/jisr.2017.1954

FUZZY AHP-FUZZY PROMETHEE APPROACH IN EVALUATION OF E-SERVICE QUALITY: CASE OF AIRLINE WEB SITES[*]

Pelin ÇELİK[**]
A. Cansu GÖK KISA[***]

Abstract

In recent years, as internet access facilities have become widespread, companies are in the position of using their websites effectively so as to compete and reach their customers easily. Therefore, organizations have begun to attach importance to the notion of electronic service quality in order to increase the quality of services presented over the internet. Because it is difficult to measure e-service quality, the use of the Fuzzy decision-making approach, which enables an assessment under uncertain circumstances, emerges as an effective problem-solving tool. In this context, the aim of the paper is to evaluate the e-service quality of websites by Fuzzy multi-criteria decision-making (MCDM) methods. Firstly, the level of significance of e-service quality dimensions that are presented by Parasuraman et al. (2005) is determined by Fuzzy Analytic Hierarchy Process (FAHP) according to the surveys which are fulfilled by a decision-making team. Afterwards, the e-service quality performance of websites of the airline corporations is assessed with the Fuzzy PROMETHEE method by using the data obtained from customers through surveys. In the application of the study, the websites of four companies which operate in the Turkish aviation industry, Onur Air, Pegasus, Sun Express and Turkish Airlines, are taken into consideration and ranked with regards to their e-service quality performances.

Keywords: Fuzzy AHP, Fuzzy PROMETHEE, E-Service Quality, Airlines.

1. Introduction

Thanks to improvements in information and communication technology, the services submitted over the internet diversified and increased in time and began taking part in every field of life. Therefore, tough competition between sectors has moved to the electronic environment and companies that enable online shopping have become popular. For this reason, firms have had to adopt changes and use their web sites influentially and serve and fulfill their customers' expectations. For the aim of improving the quality of services presented over the internet, the concept of electronic service (e-service) quality is taken into consideration.

The service quality is hard to quantify because of its intangible, heterogenic, and inseparable characteristics. It is defined as a perception resulting from a comparison of consumer expectations with actual service performance (Parasuraman et al., 1985: 42). Many researchers criticized service quality theory and its dimensions (Grönross, 1982; Parasuraman et al., 1985; Zeithaml et al., 1988; Carman, 1990; Cronin & Taylor 1992, 1994; Dabholkar et al., 2000, Brady & Cronin, 2001). Parasuraman et al. (1985) developed a scale named SERVQUAL for assessing the service quality. From this point, the SERVQUAL concept has been examined for years and associated with the developments of today's information and technology age. Now, the services have been said to be available on the internet. So, the term of e-service quality that states the quality of services purchased via website has come to the forefront. Zeithaml et al. (2000, 2002) and Parasuraman et al. (2005) defined e-service quality and introduced the e-service quality measuring model. According to Parasuraman et al. (2005), e-service quality (E-SQ) is used to, "*broadly involve all phases of a customer's interactions with a web site: the extent to which a web site facilitates efficient and effective shopping, purchasing, and delivery*".

In relevant e-service quality literature, it was studied with various measuring scales and generally presented solutions with structural equation models. Yoo and Donthu (2001) improved a scale named SITEQUAL and used structural equation model; Cox and Dale (2001) evaluated the effects of the classical SERVQUAL dimensions on online shopping; Zeithaml et al. (2002) presented a conceptual model for measuring e-service quality; Parasuraman et. al (2005) developed an E-SQ measuring scale and tested it with structural equation model. Also, Cristobal et al. (2007) evaluated the e-service quality of e-shopping sites for measuring the impact on customer loyalty using the structural equation model; Sahadev and Purani (2009) studied the Parasuraman et al. (2005)'s E-SQ scale in internet retailing; Sun et al. (2009) used Parasuraman et

[*] This study was presented as an abstract paper at 23rd Multiple Criteria Decision Making Conference (MCDM, 2015) in Hamburg.
[**] Research Asst., Karadeniz Technical University, Department of Business Administration.
[***] Assist. Prof. Dr., Hitit University, Department of Int. Trade and Logistics Management.

al. (2005)'s E-SQ scale for evaluating internet banking with structural equation model; Udo et al. (2010), examined e-service quality regarding customer perception with a 7 point Likert scale; Tsao and Tzeng (2011) searched the impact of e-service quality on online shopping behavior using the structural equation model. In addition, Doherty et al. (2015) examined the role of e-service quality management in online retailing sector; Stamenkov and Dika (2015) studied sustainable e-service quality models in the banking industry and used the structural equation model with a modified scale from Parasuraman et al. (2005)'s E-SQ scale.

In contrast with the literature, this study emphasizes using the Fuzzy Multi Criteria Decision Making (FMCDM) model to evaluate e-service quality. Since the e-service quality term is relative and hard to measure, the use of Fuzzy decision-making methods presents an efficient solution in this regard. Additively, Fuzzy decision-making methods enable the ability to carry out the decision process in cases involving uncertainty. In this context, the aim of this study is to evaluate e-service quality of airline websites by using FMCDM methods. For this aim, an integrated Fuzzy AHP-Fuzzy PROMETHEE approach is proposed to assess the e-service quality.

In recent studies, Fuzzy AHP is regularly used in supplier selection problems (Xia and Wu, 2007; Chamodrakas and Martakos, 2010; Kılınçcı and Önal, 2011; Rezaei, 2014; Bronja and Bronja, 2015; Sultana et al., 2015). Fuzzy AHP is also used in different fields by the following researchers: Enea and Piazza (2004), for project selection; Jyoti and Deshmukh (2008), in the performance evaluation of national R&D companies; Güngör et al. (2009), in personnel selection problems; Isaai et al. (2011), to evaluate intelligent timetable; Belgin (2015), in optimization of multi objective simulation system; Beskese et al. (2015), in the landfill site selection; Chen et al. (2015), to evaluate teaching performance; Chou et al. (2012), to evaluate the criteria for human resource for science and technology ; Kara and Cheikhrouhou (2014), in selection of software; Kumar (2015), for analyzing customer preferences; Mangla et al. (2015), to evaluate risk analysis in green supply chain; and Nguyen et al. (2015), in the selection of machine tools.

On the other hand, Fuzzy PROMETHEE is used in different fields in the literature. Ballı et al. (2007) selected the best vehicle; Chou et al. (2007) evaluated suitable ecaotechnology; Liu and Guan (2009) evaluated the quality of the railway passenger service; Moreira (2009) ranked equipment failure modes; Zhang et al. (2009) ranked contemned sites based on the risk assessment paradigm; Aloini et al. (2010) selected logistics service; Perçin and Ayan (2010) selected flexible manufacturing systems; Tuzkaya et al. (2011) evaluated material handling system alternatives; Ghazinoory et al. (2014) developed a model for integrating decisions in technology road mapping; and Ustasüleyman and Çelik (2014) selected the convenient destination by using Fuzzy PROMETHEE method.

In this study, the integrated Fuzzy AHP-Fuzzy PROMETHEE approach is used to evalute the e-service quality performance of the four companies which operate in the Turkish aviation industry; Onur Air, Pegasus, Sun Express, and Turkish Airlines. Within this scope, e-service quality dimensions developed by Parasuraman et al. (2005) are taken into consideration as the evaluation criteria of decision-making. The remaining of the paper organized as follows. In the second section, the research methodology is presented. Applied FMCDM methods (Fuzzy AHP-Fuzzy PROMETHEE) are explained and the e-service quality dimensions and proposed evaluation model are described. In third section, the real case application of the study and results are given. Finally, the last section clarifies the conclusion and future suggestions.

2. Research Methodology

2.1. Fuzzy AHP Method

The Analytic Hierarchy Process (AHP) is the most widely used model in decision-making which was developed by Saaty (1980). In AHP, weight measurement is calculated by pairwise comparison of the relative importance of two factors (Lin, 2010: 881). However when assessing a problem, the AHP cannot take into account uncertainty influentially because of the usage of human thoughts with exact numerical values (Lee et al., 2010: 2238). Generally, indefinite and incomplete data information is introduced to decision-making problems and explains why it is more logical to present the data by fuzzy numbers instead of crisp numbers (Gu and Zhu, 2006: 401).

Fuzzy AHP is used in this research to incorporate uncertainties in the decision maker's opinions. Fuzzy AHP approach uses a range of values and decision makers can select the value that reflects their preferences. Due to the fuzzy nature of the comparison procedure, decision makers find it more reliable to make interval judgments (Kahraman et al., 2003: 387). After the first study with Fuzzy AHP (Van Laarhoven and Pedrycz, 1983) was proposed, Buckley (1985) carried out another method for Fuzzy AHP using trapezoidal fuzzy numbers. Then, Chang (1996) introduced a new approach with the use of triangular fuzzy numbers in the comparison process.

Triangular fuzzy numbers are the most commonly used fuzzy numbers in literature and practice because of their calculation conveniences. A triangular fuzzy number that is defined in *R* set can be described as $\tilde{M}$ = (*l*, *m*, *u*) where *l* is the minimum, *m* is the most possible and *u* is the maximum value of a fuzzy case. Its membership function is characterized below: (Pedrycz and Gomide, 1998: 135; Deng, 1999: 217).

$$\mu_{\tilde{M}}(x) = \begin{cases} (x-l)/(m-l), & l \le x \le m \\ (x-u)/(m-u), & m \le x \le u \\ 0, & x < l \text{ or } x > u \end{cases} \quad (1)$$

Basic operations of two triangular fuzzy numbers are summarized in Table 1.

Table 1: Basic Operations with Fuzzy Numbers

Operation	Notation	Function	
Addition	$\tilde{A}_1 (+) \tilde{A}_2$	$(l_1, m_1, u_1) (+) (l_2, m_2, u_2) = (l_1+l_2, m_1+m_2, u_1+u_2)$	
Subtraction	$\tilde{A}_1 (-) \tilde{A}_2$	$(l_1, m_1, u_1) (-) (l_2, m_2, u_2) = (l_1+u_2, m_1-m_2, u_1-l_2)$	
Multiplication	$\tilde{A}_1 (x) \tilde{A}_2$	$(l_1, m_1, u_1) (x) (l_2, m_2, u_2) = (l_1xl_2, m_1xm_2, u_1xu_2)$	$l_i>0, m_i>0, u_i>0$
Division	$\tilde{A}_1 (/) \tilde{A}_2$	$(l_1, m_1, u_1) (/) (l_2, m_2, u_2) = (l_1/u_2, m_1/m_2, u_1/l_2)$	$l_i>0, m_i>0, u_i>0$

The Fuzzy AHP weights used for this work are calculated based on Chang (1996)'s extent analysis method. The following section outlines the extent analysis method (Chang, 1996: 649; Isaai et al., 2011: 3720; Yalcin et al., 2012: 355; Mandic et al., 2014: 31; Kumar et al., 2015: 449; Mosadeghi et al. 2015: 58):

Let X ={x_1 , x_2 ,..., x_n } be an object set, and G={g_1 ,g_2 ,...,g_m} be a goal set. M extent analysis values for each object can be obtained as $M_{gi}^1, M_{gi}^2, \ldots, M_{gi}^m$, *i*= 1,2,...,*n*.

Step 1: The values of fuzzy extensions for the *i*-th object are given in Expression (2);

$$S_i = \sum_{j=1}^{m} M_{gi}^{j} \otimes \left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^{j} \right]^{-1} \quad (2)$$

In order to obtain the expression $\left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^{j} \right]$ it is necessary to perform additional fuzzy operations with *m* values of the extent analysis, which is represented in Expression (3) and (4);

$$\sum_{j=1}^{m} M_{gi}^{j} = \left(\sum_{j=1}^{m} l_j, \sum_{j=1}^{m} m_j, \sum_{j=1}^{m} u_j \right) \quad (3)$$

$$\left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^{j} \right] = \left(\sum_{i=1}^{n} l_i, \sum_{i=1}^{n} m_i, \sum_{i=1}^{n} u_i \right) \quad (4)$$

And it is required to calculate the inverse vector above by using Expression (5);

$$\left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^{j} \right]^{-1} = \left(\frac{1}{\sum_{i=1}^{n} u_i}, \frac{1}{\sum_{i=1}^{n} m_i}, \frac{1}{\sum_{i=1}^{n} l_i} \right) \quad (5)$$

Step 2: While M_1 and M_2 are triangular fuzzy numbers, the degree of possibility for $M_2 \ge M_1$ is defined as:

$$V(M_2 \ge M_1) = \sup_{y \ge x} \left[\min(\mu_{M_1}(x), \mu_{M_2}(y)) \right] \quad (6)$$

It can be represented in the following manner by Expression (7);

$$V(M_2 \ge M_1) = hgt(M_2 \cap M_1)\ \mu M_2(d)$$

$$= \begin{cases} 1, & if \quad m_2 \ge m_1 \\ 0, & if \quad l_1 \ge u_2 \\ \dfrac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)}, & otherwise \end{cases} \quad (7)$$

Where *d* is the ordinate of the highest intersection point *D* between μM_1 and μM_2.

To compare μM_1 and μM_2, values of both, $V(M_2 \geq M_1)$ and $V(M_1 \geq M_2)$ are needed.

Step 3: The degree of possibility for a convex fuzzy number to be greater than k convex numbers M_i (i=1,2,...,k) can be defined by expression (8);

$$V(M \geq M_1, M_2,..., M_k) = V[(M \geq M_1), (M \geq M_2), \ldots, (M \geq M_k)] = \min V(M \geq M_i),\ i=1,2,3,\ldots,k \quad (8)$$

Assume that Expression (9) is;

$$d'(A_i) = \min V(S_i \geq S_k) \quad (9)$$

for k=1,2,...,n; $k \neq i$. So the weight vector is obtained by Expression (10);

$$W' = (d'(A_1), d'(A_2),..., d'(A_n))^T \quad (10)$$

where, A_i (i =1,2,...,n) consists of n elements.

Step 4: Through normalization, the weight vectors are reduced to Expression (11);

$$W = (d(A_1), d(A_2),..., d(A_n))^T \quad (11)$$

where W represents an absolute number.

2.2. PROMETHEE Method

The PROMETHEE (The Preference Ranking Organization Method for Enrichment Evaluation) is a multi-criteria decision making method developed by Jean-Pierre Brans (1982).

The PROMETHEE method has 7 steps which are explained below (Chou et al., 2004: 50; Macharis et al., 2004: 310; Albadvi et al., 2007: 674; Anand and Kodali, 2008: 42; Dağdeviren and Erarslan, 2008: 70; Abath and Almeida, 2009: 59; Rao and Patel, 2010: 4670; Ishikaza and Nemery, 2011: 960):

Step 1: Creating a data matrix:

For k criteria and n alternatives the data matrix is generated as shown in Table 2.

Table 2: Data Matrix

	a_1	a_2	…	a_n
f_1	$f_1(a_1)$	$f_1(a_2)$	…	$f_1(a_n)$
f_2	$f_2(a_1)$	$f_2(a_2)$	…	$f_2(a_n)$
…	…	…	…	…
f_k	$f_k(a_1)$	$f_k(a_2)$	…	$f_k(a_n)$

Step 2: Defining Preference Functions: The decision maker determines the proper preference function among six types of functions for the decision problem.

Step 3: Defining common preference functions:

For a and b alternatives, common preference functions are defined as:

$$P(a,b) = \begin{cases} 0 , & f(a) \leq f(b) \\ p[f(a) - f(b)] , & f(a) > f(b) \end{cases} \quad (12)$$

Step 4: Defining preference index:

wi: weights

k: criteria

$\pi(a,b)$: preference index

$$\pi(a,b) = \frac{\sum_{i=1}^{k} w_i P_i(a,b)}{\sum_{i=1}^{k} w_i} \quad (13)$$

Step 5: Defining the outgoing (Φ^+) and incoming flow (Φ^-):

$$\Phi^+(a) = \sum \pi(a,x)$$

$$\Phi^-(a) = \sum \pi(x,a)$$

Step 6: Determining preorder by PROMETHEE I:

If a is a better alternative than b;

i. $\Phi^+(a) > \Phi^+(b)$ and $\Phi^-(a) < \Phi^-(b)$

ii. $\Phi^+(a) > \Phi^+(b)$ and $\Phi^-(a) = \Phi^-(b)$

iii. $\Phi^+(a) = \Phi^+(b)$ and $\Phi^-(a) < \Phi^-(b)$

If a is the same as b alternative;

i. $\Phi^+(a) = \Phi^+(b)$ and $\Phi^-(a) = \Phi^-(b)$

When a and b alternatives are incomparable;

i. $\hat{O}^+(a) > \Phi^+(b)$ and $\Phi^-(a) > \Phi^-(b)$

ii. $\hat{O}^+(a)$ $\hat{O}^+(b)$ and $\hat{O}^-(a)$ $\hat{O}^-(b)$

Step 7: Determining total preorder by PROMETHEE II:

$\hat{O}(a) = \hat{O}^+(a) - \hat{O}^-(a)$

i. If $\hat{O}(a) > \Phi(b)$, a is a better alternative than b.

ii. *If* $\hat{O}(a) = \Phi(b)$, a and b are incomparable.

2.3. Fuzzy PROMETHEE Method

In the F-PROMETHEE method the performance of each scenario to each criterion is introduced as a fuzzy number.

In this paper the ratings of qualitative criteria are considered as linguistic variables. These linguistic variables can be expressed in positive triangular fuzzy numbers as described in Table 3 (Bilsel et al., 2006: 1192).

Table 3: Linguistic Variables for the Alternatives

SDA	Strongly Disagree	(0, 0, 0.15)
DA	Disagree	(0.15, 0.15, 0.15)
LDA	Little Disagree	(0.30, 0.15, 0.20)
NC	No Comment	(0.50, 0.20, 0.15)
LA	Little Agree	(0.65, 0.15, 0.15)
A	Agree	(0.80, 0.15, 0.20)
SA	Strongly Agree	(1, 0.20, 0)

While F-PROMETHEE method is applied in the study, the fifth preference function was used. It is represented as follows:

$$\Omega_j(\alpha,\beta) = \Omega_j(d_j) = \begin{cases} 0 & d_j < q \\ \dfrac{d_j - q}{p - q} & q \le d_j \le p \\ 1 & d_j > p \end{cases} \tag{14}$$

If d_j is expressed as a fuzzy number (m, a, β), then the preference function equation is defined below:

$$\tilde{P} = \begin{cases} 0 & m - \alpha \le 0 \\ \dfrac{(m,\alpha,\beta) - q}{p - q} & q \le m - \alpha \ \ and \ \ m + \beta \le p \\ 1 & m + \beta \ge p \end{cases} \tag{15}$$

According to (12), the degree of preference comparison of the alternatives *a* and *b*, with the criterion *f*, can be defined as:

$$P_j(\tilde{f}(a) - f(\tilde{b})) = P_j(\tilde{d}) \tag{16}$$
$$= (P_j(m), (P_j(m) - P_j(m - \alpha)), (P_j(m + \beta) - P_j(m))$$

The multi criteria preference index is expressed as:

$$\tilde{\pi}(a,b) = \frac{\sum_{i=1}^{k} w_i \tilde{P}_i(a,b)}{\sum_{i=1}^{k} w_i} \tag{17}$$

The preference index is calculated as a fuzzy number. By using the *yager index,* which is seen below, it should be transformed into an absolute number.

$$f(m,\alpha,\beta) = \frac{1}{3}(3m - \alpha + \beta) \tag{18}$$

After transformation of all fuzzy numbers to absolute numbers, they can be ranked by the PROMETHEE II method.

2.4. E- Service Quality Dimensions and Evaluation Model

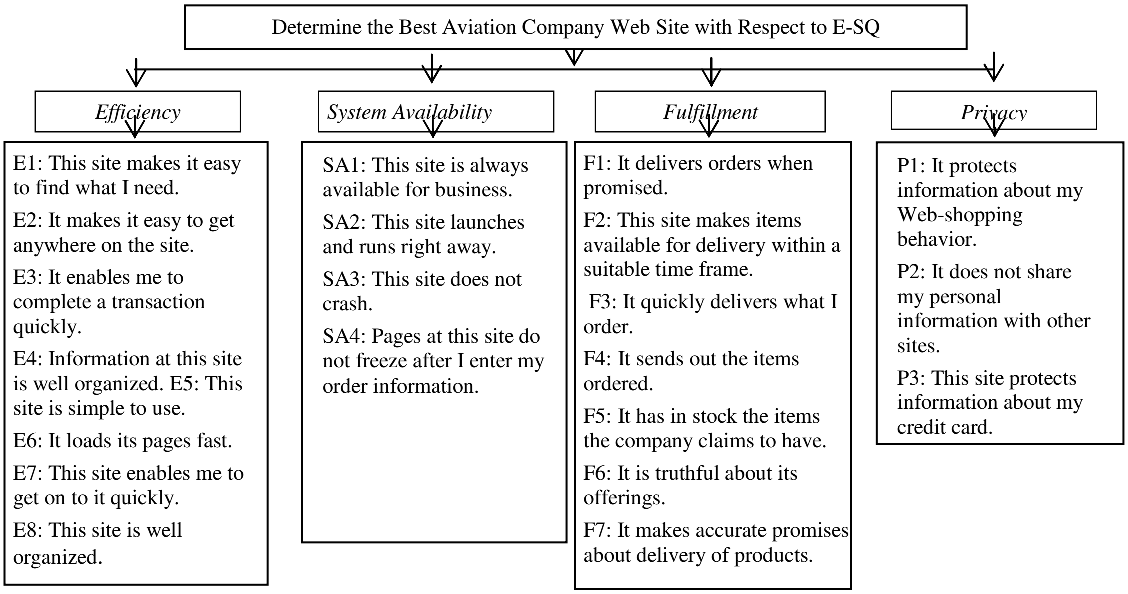
The E-SQ measuring scale that is used in the study consists of 4 dimensions and 22 evaluation factors as part of these dimensions. Hereunder, E-SQ dimensions (Parasuraman et al., 2005) are described:

1. *Efficiency:* The ease and speed of accessing and using the site.
2. *System Availability:* The extent to which the site's promises about order delivery and item availability are fulfilled.
3. *Fulfillment:* The correct technical functioning of the site.

4. *Privacy:* The degree to which the site is safe and protects customer information.

Within this framework, the proposed hierarchic evaluation model with respect to E-SQ dimensions and factors is generated as in Figure 1.

Figure 1: Evaluation Model of E-Service Quality Performance



3. Application: Evaluation of E-Service Quality Performance of Airline Companies' Websites

In this paper, to evaluate the E-SQ of airline companies, the level of significance (importance weights) of e-service quality dimensions is determined by Fuzzy AHP approach as a result of the surveys, which are obtained from the expert team. After that stage, with the help of the survey data obtained from customers, the E-SQ performance of airline corporations' websites is assessed by the Fuzzy PROMETHEE method. In the application, 12 experts' opinions that consist of five academics, four aviation industry and three information technology executives are utilized. Four hundred and five customers that used the websites of given airline companies are surveyed. At the end, the ranking of the companies is acquired according to their E-SQ performance. The application steps are summarized in two stages.

3.1. ***Determining the evaluation criteria weights with Fuzzy AHP Approach:***

Firstly, each decision maker practiced pair-wise comparisons of E-SQ dimensions and evaluation factors by using Saaty's 1-9 scale. Using the survey data acquired from these experts, integrated pair-wise comparison matrices are formed by combining all expert opinions through Expression (19), as *K* states the number of decision makers (Chen at. al, 2006). Thus, the pair-wise comparison values are converted to triangular fuzzy numbers and fuzzy pair-wise comparison matrices are created as in Tables 4-8.

$$l_{ij} = \min_k \{a_{ijk}\}, \quad m_{ij} = \frac{1}{K}\sum_{k=1}^{K} b_{ijk}, \quad u_{ij} = \max_k \{d_{ijk}\} \qquad (19)$$

Table 4: Fuzzy pair-wise comparison matrix of E-SQ dimensions

	Efficiency	System Availability	Fulfillment	Privacy
Efficiency	(1, 1, 1)	(0.333, 2.777, 5)	(0.2, 0.51, 1)	(0.2, 0.243, 0.33)
System Av.	(0.2, 1.177, 3)	(1, 1, 1)	(1, 1.667, 3)	(0.2, 0.288, 0.333)
Fulfillment	(1, 3, 5)	(1, 1.667, 3)	(1, 1, 1)	(0.2, 0.287, 0.33)
Privacy	(3, 4.333, 5)	(3, 3.667, 5)	(3, 3.667, 5)	(1, 1, 1)

Table 5: Fuzzy pair-wise comparison matrix of "Efficiency"

	E1	E2	E3	E4	E5	E6	E7	E8
E1	(1, 1, 1)	(3, 4.333, 5)	(1, 2.333, 5)	(0.33, 1.443, 3)	(3, 4.333, 5)	(0.33, 3.443, 5)	(3, 4.333, 5)	(0.2, 1.4, 3)
E2	(0.2, 0.243, 0.33)	(1, 1, 1)	(0.2, 1.843, 5)	(0.2, 1.177, 3)	(3, 3.667, 5)	(0.33, 2.11, 5)	(1, 3.667, 5)	(0.2, 1.843, 5)
E3	(0.200, 0.733, 1)	(0.2, 2.733, 5)	(1, 1, 1)	(0.2, 1.843, 5)	(0.2, 2.733, 7)	(0.2, 0.733, 1)	(0.2, 2.067, 3)	(0.2, 2.733, 5)
E4	(0.330, 1.443, 3)	(0.33, 2.777, 5)	(0.2, 2.733, 5)	(1, 1, 1)	(1, 3, 5)	(1, 2.333, 5)	(0.33, 2.11, 5)	(1, 2.333, 5)
E5	(0.2, 0.243, 0.33)	(0.2, 0.287, 0.33)	(0.14, 2.047, 5)	(0.2, 0.51, 1)	(1, 1, 1)	(0.2, 0.287, 0.33)	(0.2, 0.343, 0.5)	(0.2, 0.3, 0.5)

E6	(0.2, 1.133, 3)	(0.2, 1.4, 3)	(1, 2.333, 5)	(0.2, 0.733, 1)	(3, 3.667, 5)	(1, 1, 1)	(3, 4.333, 5)	(0.2, 2.733, 5)
E7	(0.2, 0.243, 0.33)	(0.2, 0.467, 1)	(0.33, 1.887, 5)	(0.2, 1.4, 3)	(3, 4.333, 5)	(0.2, 0.243, 0.33)	(1, 1, 1)	(0.2, 0.51, 1)
E8	(0.33, 2.11, 5)	(0.2, 2.733, 5)	(0.2, 1.843, 5)	(0.2, 0.733, 1)	(5, 5, 5)	(0.2, 1.843, 5)	(1, 3, 5)	(1, 1, 1)

Table 6: Fuzzy pair-wise comparison matrix of "System Availability"

	SA1	SA2	SA3	SA4
SA1	(1, 1, 1)	(3, 3.667, 5)	(0.14, 3.38, 5)	(0.2, 0.513, 1.14)
SA2	(0.2, 0.287, 0.333)	(1, 1, 1)	(0.14, 1.157, 3)	(0.2, 0.78, 1.14)
SA3	(0.2, 2.467, 7)	(0.333, 3.443, 7)	(1, 1, 1)	(0.14, 0.493, 1.14)
SA4	(5, 5.667, 7)	(1, 4.333, 7)	(5, 6.333, 7)	(1, 1, 1)

Table 7: Fuzzy pair-wise comparison matrix of "Fulfillment"

	F1	F2	F3	F4	F5	F6	F7
F1	(1, 1, 1)	(3, 5.667, 9)	(1, 4.333, 7)	(0.11, 1.147, 3)	(0.11, 0.48, 1)	(0.11, 0.437, 1)	(0.14, 0.713, 1)
F2	(0.11, 0.213, 0.33)	(1, 1, 1)	(0.2, 3.4, 7)	(0.11, 0.213, 0.33)	(0.11, 0.213, 0.33)	(0.11, 0.17, 0.2)	(0.14, 0.447, 1)
F3	(0.14, 0.447, 1)	(0.14, 1.823, 5)	(1, 1, 1)	(0.14, 0.323, 0.5)	(0.14, 0.447, 1)	(0.11, 0.17, 0.2)	(0.11, 1.37, 3)
F4	(0.33, 4.11, 9)	(3, 5.667, 9)	(3, 5, 7)	(1, 1, 1)	(0.11, 2.037, 3)	(0.11, 0.47, 1)	(0.33, 2.11, 5)
F5	(1, 5, 9)	(3, 5.667, 9)	(1, 4.333, 7)	(0.33, 3.22, 9)	(1, 1, 1)	(0.11, 0.257, 0.33)	(1, 3, 5)
F6	(1, 5, 9)	(5, 6.333, 9)	(5, 6.333, 9)	(1, 4.333, 9)	(3, 5, 9)	(1, 1, 1)	(3, 5.667, 9)
F7	(1, 3, 7)	(1, 4.333, 7)	(0.33, 3.443, 9)	(0.2, 0.51, 1)	(0.33, 0.61, 1)	(0.11, 0.213, 0.33)	(1, 1, 1)

Table 8: Fuzzy pair-wise comparison matrix of "Privacy"

	P1	P2	P3
P1	(1, 1, 1)	(0.11, 0.213, 0.33)	(0.11, 0.15, 0.2)
P2	(3, 5.667, 9)	(1, 1, 1)	(0.11, 0.437, 1)
P3	(5, 7, 9)	(1, 5, 9)	(1, 1, 1)

The synthetic values of each main criterion are first calculated by Eq. (2);

$$S_1 = (1.73,4.53,7.33) \otimes (0.025,0.037,0.058) = (0.043,0.166,0.423)$$
$$S_2 = (2.4,4.131,7.333) \otimes (0.025,0.037,0.058) = (0.06,0.151,0.423)$$
$$S_3 = (3.2,5.953,9.33) \otimes (0.025,0.037,0.058) = (0.08,0.218,0.538)$$
$$S_4 = (10,12.667,16) \otimes (0.025,0.037,0.058) = (0.25,0.464,0.923)$$

The obtained synthetic values are compared by using Eq. (7);

Comparison of S1 with the others:

$$V(S_1 \geq S_2) = 1$$
$$V(S_1 \geq S_3) = 0.868$$
$$V(S_1 \geq S_4) = 0.367$$

Comparison of S2 with the others:

$$V(S2 \geq S1) = 0.963$$
$$V(S2 \geq S3) = 0.837$$
$$V(S2 \geq S4) = 0.356$$

Comparison of S3 with the others:

$$V(S3 \geq S1) = 1$$
$$V(S3 \geq S2) = 1$$
$$V(S3 \geq S4) = 0.540$$

Comparison of S4 with the others:

$$V(S4 \geq S1) = 1$$

V(S4≥S2) = 1

V(S4≥S3) = 1

Then, the importance weights are calculated by using Eq. (9):

d′(S_1)= min (1, 0.878, 0.367) = 0.367
d′(S_2)= min (0.9623, 0.837, 0.356) = 0.356
d′(S_3)= min (1, 1, 0.540) = 0.540
d′(S_4)= min (1, 1, 1) = 1
The weight vector is W′ = (0.367, 0.356, 0.540, 1)^T.

After the normalization, the weight vector for the main criteria is obtained as follows:
W= (0.162, 0.157, 0.239, 0.442)^T.

After acquiring the fuzzy comparison matrices, importance weights of e-service quality dimensions and evaluation criteria are calculated by the FAHP method and shown in Table 9. According to the calculated criteria weights, the most important evaluation dimension is "privacy" with 0.442 importance weight and the evaluation factor is "protection of the information about customer's credit card" with a 0.2586 importance value.

Table 9: Importance Weights of E-Service Quality Evaluation Criteria

Dimensions	Criteria	Local Weights	General Weights
Efficiency (0.162)	E1: This site makes it easy to find what I need.	0.148	0.0230
	E2: It makes it easy to get anywhere on the site.	0.133	0.0216
	E3: It enables me to complete a transaction quickly.	0.131	0.0211
	E4: Information at this site is well organized.	0.139	0.0225
	E5: This site is simple to use.	0.068	0.0109
	E6: It loads its pages fast.	0.136	0.0220
	E7: This site enables me to get on to it quickly.	0.107	0.0174
	E8: This site is well organized.	0.139	0.0225
System Availability (0.157)	SA1: This site is always available for business.	0.255	0.0400
	SA2: This site launches and runs right away.	0.058	0.0091
	SA3: This site does not crash.	0.281	0.0441
	SA4: Pages at this site do not freeze after I enter my order information.	0.406	0.0637
Fulfillment (0.239)	F1: It delivers orders when promised.	0.146	0.0341
	F2: This site makes items available for delivery within a suitable time frame.	0.068	0.0163
	F3: It quickly delivers what I order.	0.079	0.0189
	F4: It sends out the items ordered.	0.174	0.0417
	F5: It has in stock the items the company claims to have.	0.182	0.0435
	F6: It is truthful about its offerings.	0.206	0.0491
	F7: It makes accurate promises about delivery of products.	0.148	0.0354
Privacy (0.442)	P1: It protects information about my Web-shopping behavior.	0.000	0.000
	P2: It does not share my personal information with other sites.	0.415	0.1834
	P3: This site protects information about my credit card.	0.585	0.2586

3.2. ***Ranking the alternatives by Fuzzy PROMETHEE method with respect to e-service quality:***

For the evaluation of E-SQ performances of mentioned airline websites, Fuzzy PROMETHEE approach is conducted with the collected data of customer surveys. Primarily, the linguistic variables of the alternatives are created thusly in Table 10.

Table 10: Linguistic Variables of the Alternatives

Criteria	E1	E2	E3	E4	E5	E6	E7	E8	SA1	SA2	SA3	SA4
Alternatives												
THY	SA	A	SA	A	A	SA	SA	SA	A	A	SA	A
Pegasus	A	LA	A	LA	A	A	A	LA	LA	A	A	A
SunExpress	A	LA	LA	LA	A	A	A	LA	LA	LA	A	LA
Onur Air	LA	LA	A	LA	A	A	A	LA	LA	A	A	A

Criteria	F1	F2	F3	F4	F5	F6	F7	P1	P2	P3
Alternatives										
THY	SA	SA	A	SA	A	A	A	SA	SA	SA
Pegasus	A	A	A	A	A	A	A	SA	SA	SA
SunExpress	A	SA	A	A	A	A	A	SA	SA	SA
Onur Air	A	A	A	A	A	A	A	SA	SA	SA

By the help of criteria weights, Fuzzy PROMETHEE steps are completed and the websites of airline companies are ranked from the best to the worse. Results of the application are submitted in Table 11.

Table 11: E-Service Quality Evaluation Scores

Alternatives	$\Phi^{+}(\alpha)$	$\Phi^{-}(\alpha)$	$\Phi^{net}(\alpha)$	*Ranking*
THY	0,1116	0,0000	0,1116	*1*
Pegasus	0,0261	0,0257	0,0004	*2*
SunExpress	0,0127	0,0899	-0,0772	*4*
Onur Air	0,0202	0,0551	-0,0348	*3*

When the obtained e-service quality performance scores (Φ^{net}) are examined, ranking of the alternatives is as follows: Turkish Airlines, Pegasus Airlines, Onur Air, and Sun Express.

4. Conclusion

Together with the alteration of information and communication technologies, presented services are quite varied. Especially as the services in the electronic environment become popular, firms have to keep up with these changes in e-service sectors for competing with their opponents. Therefore, unlike previous studies, this paper studies e-service quality with FMCDM method. In line with this purpose, an integrated Fuzzy AHP-Fuzzy PROMETHEE approach is conducted for evaluating the e-service quality performance of Turkish airline companies' websites. The results in Table 11 showed that the website of Turkish Airlines performed the best e-service quality. Respectively, Pegasus Airlines, Onur Air, and Sun Express's web sites are aligned. In addition, according to Table 9, the most important evaluation dimension and factor of e-service quality come in sight respectively "privacy" and "protection of the information about customer's credit card". The least important factor is "protection of web shopping behaviors of customers".

This study objects to making contributions about using the FMCDM model to evaluate e-service quality. It takes advantage of the E-SQ measuring scale while evaluating the E-SQ of airline websites. The proposed evaluation model can be used as an effective decision making approach and guides managers to provide customer satisfaction and competition power by assessing the importance of e-service quality dimensions. In addition, different MCDM models like TOPSIS, ELECTRE, Grey Relational Analysis, Analytic Network Process, Entropy etc. methods can be used for future research. Also, other various evaluation criteria about e-service quality can be taken into consideration. Consequently, this paper presents an advisor approach to researchers and practitioners regarding complicated decision problems such as the evaluation of e-service quality.

REFERENCES

ABATH, Juliana Regueira & ALMEIDA, Adiel Teixeira de (2009). "Outsourcing Multicriteria Decision Model Based On PROMETHEE Method", *Journal of Academy of Business and Economics*, 9 (1), pp. 58-61.
ALBADVI, Amir, CHAHARSOOGHI, S. Kamal & ESFAHANIPOUR, Akbar (2007). "Decision Making in Stock Trading: An Application Of Promethee", *European Journal Of Operational Research*, 177 (2), pp. 673-683.
ALOINI, Davide, DULMIN, Riccardo & MININNO, Valeria (2010). "A Hybrid Fuzzy-PROMETHEE Method for Logistics Service Selection: Design of a Decision Support Tool", *International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems*, 18 (4), pp. 345 – 369.
ANAND G. & KODALI Rambabu (2008). "Selection of Lean Manufacturing Systems Using the PROMETHEE", *Journal of Modelling in Management*, 3 (1), pp. 40-70.
BALLI, Serkan, KARASULU, Bahadır & KORUKOĞLU, Serdar (2007). "En Uygun Otomobil Seçimi Problemi için Bir Bulanık PROMETHEE Yöntemi Uygulaması", *D.E.U.I.I.B.F. Dergisi*, 22 (1), pp. 139 – 147.
BELGİN, Önder (2015). "Multi-Objective Simulation Optimization Using Grey-Based Taguchi Method With Fuzzy AHP Weighting", *Sigma Journal of Engineering & Natural Sciences*, 33 (3), pp. 341 – 350.
BESKESE, Ahmet, DEMİR H. Handan, ÖZCAN, H. Kurtuluş & ÖKTEN, H. Eser (2015). "Landfill Site Selection Using Fuzzy AHP and Fuzzy TOPSIS: A Case Study for Istanbul", *Environment Earth Science*, 73, pp. 3513 – 3521.
BİLSEL, R. Ufuk, BÜYÜKÖZKAN, Gülçin & RUAN, Da (2006). "A Fuzzy Preference-Ranking Model for a Quality Evaluation of Hospital Web Sites", *International Journal of Intelligent Systems*, 21, pp. 1181 – 1197.
BRADY, Michael K. & CRONIN, J. Joseph Jr. (2001). "Some New Thoughts on Conceptualizing Perceived Service Quality: A Hierarchical Approach", *Journal of Marketing*, 65(3), pp. 34-49.
BRONJA, Harun & BRONJA, Haris (2014). "Two-Phase Selection Procedure of Aluminized Sheet Supplier By Applying Fuzzy AHP and Fuzzy TOPSIS Methodology", *Tecnicki Vjesnik*, 22 (4), pp. 821 – 828.
BUCKLEY, J. J. (1985). "Fuzzy Hierarchical Analysis", *Fuzzy Sets and Systems*, 17, pp. 233–247.
CARMAN, James M. (1990). "Consumer Perceptions of Service Quality: An Assessment of the SERVQUAL Dimensions", *Journal of Retailing*, 66(1), pp. 33-55.
CHAMODRAKAS, I., B., D. & MARTAKOS, D. (2010). "Supplier Selection in Electronic Marketplaces Using Satisficing and Fuzzy AHP", *Expert Systems With Applications*, 37, pp. 490-498.
CHANG, Da Yong (1996). "Applications of the Extent Analysis Method on Fuzzy AHP", *European Journal of Operational Research*, 95, pp. 649-655.
CHEN, Chen-Tung, LIN, Ching-Torng & HUANG, Sue-Fn (2006). "A Fuzzy Approach for Supplier Evaluation and Selection in Supply Chain Management", *International Journal of Production Economics*, 102, pp. 289–301.
CHEN, Jeng-Fung, HSIEH, Ho-Nien & DO, Quang-Hung (2015). "Evaluating Teaching Performance Based On Fuzzy AHP and Comprehensive Evaluation Approach", *Applied Soft Computing*, 28, pp. 100 – 108.

CHOU, Tien-Yin, LIN, Wen-Tzu, LIN, Chao-Yuan, CHOU, Wen-Chieh & HUANG, Pi-Hui (2004). "Application of the PROMETHEE Technique To Determine Depression Outlet Location and Flow Direction in DEM", *Journal of Hydrology*, 287, pp. 49-61.

CHOU, Ying-Chyi, SUN, Chia-Chi & YEN, Hsin-Yi (2012). "Evaluating the Criteria for Human Resource for Science and Technology (HRST) Based on an Integrated Fuzzy AHP and Fuzzy DEMATEL Approach", *Applied Soft Computing*, 12: pp. 64-71.

CHOU, Wen-Chieh, LIN, Wen-Tzu & LIN, Chao-Yuan. (2007). "Application of Fuzzy Theory and PROMETHEE Technique to Evaluate Suitable Ecotechnology Method: A Case Study in Shihmen Reservoir Watershed, Taiwan", *Ecological Engineering*, 31, pp. 269–280.

COX, J. & DALE, B. (2001). Service Quality and E-commerce: an Exploratory Analysis, *Managing Service Quality*, 11(2), pp. 121-31.

CRISTOBAL, Eduard, FLAVIAN, Carlos & GUINALIU, Miguel (2007). "Perceived E-service Quality (PeSQ): Measurement Validation and Effects on Consumer Satisfaction and Web Site Loyalty", *Managing Service Quality*, 17(3), pp. 317-340.

CRONIN, J. Joseph Jr. & TAYLOR, Steve (1992). "Measuring Service Quality: A Reexamination and Extension", *Journal of Marketing*, 56(3), pp. 55-68.

CRONIN, J. Joseph Jr. & TAYLOR, Steve (1994). "SERVPERF versus SERVQUAL: Reconciling Performance-Based and Perceptions-Minus-Expectations Measurement of Service Quality", *Journal of Marketing*, 58(1), pp. 125-131.

DABHOLKAR, Pratibha A., SHEPHERD, C. David & THORPE, D. I. (2000). "A Comprehensive Framework for Service Quality: An Investigation of Critical Conceptual and Measurement Issues Through a Longitudinal Study", *Journal of Retailing*, 76(2), pp. 139-173.

DAĞDEVİREN, Murat & ERASLAN, Ergün (2008)." PROMETHEE Sıralama Yöntemi ile Tedarikçi Seçimi", *Gazi Üniversitesi Mühendislik Mimarlık Fak. Dergisi*, 23 (1), pp. 69-75.

DENG, Hepu (1999). "Multicriteria Analysis with Fuzzy Pairwise Comparison", *International Journal of Approximate Reasoning*, 21, pp. 215-231.

DOHERTY, Neil F., SHAKUR, Mahani & ELLIS-CHADWICK, Fiona (2015). "The Role of E-Service Quality Management in the Delivery Business Value", *Journal of Retailing and Consumer Services*, 27, pp. 52–62.

ENEA, Mairo & PIAZZA, Tommaso (2004). "Project Selection by Constrained Fuzzy AHP", *Fuzzy Optimization and Decision Making*, 3, pp. 39-62.

GHAZINOORY, Sepehr, DANESHMAND, Maryam & ARASTI, Mohammed Reza (2014). "Developing a Model for Integrating Decisions in Technology Roadmapping by Fuzzy PROMETHEE", *Journal of Intelligent & Fuzzy Systems*, 26, pp. 625 – 645.

GRÖNROOS, Christian (1982). "An Applied Service Marketing Theory", *European Journal of Marketing*, 16(7), pp. 30-41.

GU, Xiangbai & ZHU, Qunxiong (2006). "Fuzzy-Multi Attribute Decision-Making Method Based on Eigenvector of Fuzzy Attribute Evaluation Space", *Decision Support Systems*, 41, pp. 400 – 410.

GÜNGÖR, Zülal, SERHADLIOĞLU, Gürkan & KESEN, Saadettin Erhan (2009). "A Fuzzy AHP Approach to Personnel Selection Problem", *Applied Soft Computing*, 9, pp. 641-646.

ISAAI, Mohammed T., KANANI, Aram, TOOTOONCHI, Mahshid & AFZALI, Hamdi R. (2011). "Intelligent Timetable Evaluation Using Fuzzy AHP", *Expert Systems with Applications*, 38, pp. 3718-3723.

ISHIZAKA, Alessio & NEMERY, Philippe (2011). "Selecting The Best Statistical Distribution with Promethee and Gaia", *Computers & Industrial Engineering*, 61 (4), pp. 958-969.

JYOTI, B. D. K & DESHMUKH, S.G. (2008). "Evaluating Performance of National R&D Organizations Using Integrated DEA-AHP Technique", *International Journal of Productivty and Performance Management*, 57, pp. 370-388.

KAHRAMAN, Cengiz, CEBECİ, Ufuk & ULUKAN, Ziya (2003). "Multi-criteria Supplier Selection Using Fuzzy AHP", *Logistics Information Management*, 16(6), pp. 382-394.

KILINÇCI, Özcan & ÖNAL, Suzan Aslı (2011). "Fuzzy AHP Approach for Supplier Selection in a Washing Machine Company", *Expert Systems With Applications*, 38, s. 9656-9664.

KUMAR Ajay, SHANKAR, Ravi , DEBNATH, Roma Mitra & JAIDEEP Prabhu (2015). "Analyzing Customer Preference And Measuring Relative Efficiency in Telecom Sector: A Hybrid Fuzzy AHP/DEA Study", *Telematics and Informatics*, 32, pp. 447-462.

LEE, Seong Kon, MOGI, Gento, LEE Sang Kon, HUI, K. S. & KIM, Jong Wook (2010). "Econometric Analysis of the R&D Performance in the National Hydrogen Energy Technology Development For Measuring Relative Efficency: The Fuzzy AHP/DEA Integrated Model Approach", *International Journal of Hydrogen Energy*, 35, pp. 2236 – 2246.

LIN, Hsiu-Fen (2010). "An Application of Fuzzy AHP for Evaluating Course Website Quality", *Computer & Education*, 54, pp. 877 – 888.

LIU, Peide & GUAN, Zhongliang (2009). "Evaluation Research on the Quality of the Railway Passenger Service Based on the Linguistic Variables and the Improved PROMETHEE-II Method", *Journal of Computers*, 4 (3), pp. 265 – 270.

MACHARIS, Cathy, SPRINGAEL, Johan, BRUCKER, Klaas De & Verbeke, Alain (2004). "PROMETHEE and AHP: The Design of Operational Synergies in Multicriteria Analysis: Strengthening PROMETHEE With Ideas of AHP", *European Journal of Operational Research*, 153, pp. 307-317.

MANDIC, Ksenija, DELIBASİC, Boris, KNEZEVIC, Snezana & BENKOVIC, Sladjana (2014). "Analysis Of The Financial Parameters Of Serbian Banks Through The Application Of The Fuzzy AHP and TOPSIS Methods", *Economic Modelling*, 43, pp. 30-37.

MANGLA, Sachin Kumar, KUMAR, Pradeep, & MUKESH Kumar Barua (2015). "Risk Analysis in Green Supply Chain Using Fuzzy AHP Approach: A Case Study", *Resources, Conservations and Recycling*, 104, pp. 375 – 390.

MOREIRA, Marcela P., DUPONT, Carlos J. & VELLASCO, Marley M. B. R. (2009). "PROMETHEE and Fuzzy PROMETHEE Multicriteria Methods for Ranking Equipment Failure Modes", *15th International Conference on Intelligent System Applications to Power Systems*, pp. 1 – 6.

MOSADEGHI, Razieh, WARNKEN, Jan, TOMLINSON, Rodger & MIRFENDERESK, Hamid (2015). "Comparison of Fuzzy-AHP and AHP in a spatial Multi-Criteria Decision Making Model For Urban Land-Use Planning", *Computers, Environment and Urban Systems*, 49, pp. 54-65.

NGUYEN, Huu-Tho, Md DAWAL, Siti Zawiah, NUKMAN, Yusoff, AOYAMA, Hideki & CASE, Keith (2015). "An Integrated Approach for Fuzzy Linguistic Preference Based AHP and Fuzzy COPRAS for Machine Tool Evaluation", *Plos ONE*, pp. 1 – 24.

PARASURAMAN, A., ZEITHAML, Valerie A. & BERRY, Leonard L. (1985). "A Conceptual Model of Service Quality and Its Implications for Future Research". *Journal of Marketing*, 49(4), pp. 41-50.

PARASURAMAN, A., ZEITHAML, Valerie A. & MALHOTRA, Arvind (2005). "E-S-QUAL: A Multiple-Item Scale for Assessing Electronic Service Quality", *Journal of Service Research*, 7, pp. 213-233.

PEDRYCZ, Witold & GOMIDE, Fernando (1998). *An Introduction to Fuzzy Sets: Analysis and Design*. USA: The MIT Press.

PERÇİN, Selçuk & AYAN, Tuba Yakıcı (2010). "AHS ve Bulanık PROMETHEE Yaklaşımlarıyla Esnek Üretim Sistemleri Seçimi", *Marmara Üniversitesi İ.İ.B.F. Dergisi*, 29 (2), pp. 555 – 575.

RAO, Ventaka R. & PATEL, B. K. (2010). "Decision Making In The Manufacturing Environment Using An Improved PROMETHEE Method", *International Journal of Production Research*, 48 (16), pp. 4665-4682.
REZAEI, Jafar, FAHIM, Patrick B. M. & TAVASSZY, Lori (2014). "Supplier Selection in the Airline Retail Industry Using a Funnel Methodology: Conjunctive Screening Method and Fuzzy AHP", *Expert Systems with Applications*, 41, pp. 8165 – 8179.
SAATY, Thomas L. (1980). *The Analytic Hierarchy Process*. New York: McGraw-Hill.
SAHADEV, Sunil & PURANI, Keyoor (2008). "Modelling the consequences of E-service Quality", *Marketing Intelligence & Planning*, 26 (6), pp. 605-620.
STAMENKOV, Gjoko & DIKA , Zamir Dika (2015). "A Sustainable E-service Quality Model", *Journal of Service Theory and Practice*, 25(4), pp. 414-442.
SUN, Quan, WANG, Chuniei & CAO, Hao (2009). "Applying E-S-QUAL Scale to Analysis the Factors Affecting Consumers to Use Internet Banking Services, 2009 IITA International Conference on Services Science", *Management and Engineering*, pp. 242-245.
TSAO Wen-Chin & TSENG, Ya-Ling (2011). "The Impact of Electronic-Service Quality on Online Shopping Behaviour", *Total Quality Management & Business Excellence*, 22(9), pp. 1007-1024.
TUZKAYA, Gülfem, ÖZGEN, Doğan & GÜLSÜN, Bahadır (2011). "Malzeme Taşıma Sistemi Alternatiflerinin Değerlendirilmesinde Bulanık-PROMETHEE Yaklaşımı", *Doğuş Üniversitesi Dergisi*, 12 (1), pp. 144 – 155.
UDO, Godwin J., BAGCHI, Kallol K. & KIRS, Peeter J. (2010). "An Assessment of Customers' E-Service Quality Perception, Satisfaction and Intention", *International Journal of Information Management*, 30, pp. 481–492.
USTASÜLEYMAN, Talha & ÇELİK, Pelin (2014). "AHS ve Bulanık PROMETHEE Yöntemleriyle Destinasyon Seçimini Etkileyen Faktörlerin Önem Derecesinin Belirlenmesi ve En Uygun Destinasyon Seçimi", *Uluslararası İktisadi ve İdari İncelemeler Dergisi*, 7 (14), pp. 85 – 102.
VAN LAARHOVEN, P. J. M. & PEDRYCZ, W. (1983). "A Fuzzy Extension of Saaty's Priority Theory", *Fuzzy Sets and Systems*, 11(1-3), pp. 229-241.
XİA, Weijun & WU, Zhiming (2007). "Supplier Selection With Multiple Criteria in Volume Discount Environments", *Omega*, 35, pp. 494-504.
YALCIN, Neşe, BAYRAKDAROGLU, Ali & KAHRAMAN, Cengiz (2012). "Application of Fuzzy Multi-Criteria Decision Making Methods for Financial Performance Evaluation of Turkish Manufacturing Industries", *Expert Systems with Applications*, 39, pp. 350-364.
YOO, Boonghee & DONTHU, Naveen (2001). "Developing a scale to Measure the Perceived Quality of an Internet Shopping Site (SITEQUAL)", *Quarterly Journal of Electronic Commerce*, 2(1), pp. 31-47.
ZEITHAML, Valerie A., BERRY, Leonard L. & PARASURAMAN, A. (1988). "Communication and Control Processes in the Delivery of Service Quality", *Journal of Marketing*, 52(2), pp. 35-48.
ZEITHAML, Valerie A., PARASURAMAN, A. & MALHOTRA, Arvind (2000). "A Conceptual Framework for Understanding e-Service Quality: Implications for Future Research and Managerial Practice", Working paper, report No. 00-115, *Marketing Science Institute*, Cambridge, MA.
ZEITHAML, Valerie A., PARASURAMAN, A. & MALHOTRA, Arvind (2002). "Service Quality Delivery through Web Sites: A Critical Review of Extant Knowledge", *Journal of the Academy of Marketing Science*, 30(4), pp. 362-75.
ZHANG, Keijang, KLUCK, Cheryl & ACHARI, Gopal (2009). "A Comparative Approach for Ranking Contaminated Sites Based on the Risk Assessment Paradigm Using Fuzzy PROMETHEE", *Environmental Management*, 44, pp. 952 – 967.