TECHNOLOGICAL AND ECONOMIC DEVELOPMENT OF ECONOMY
ISSN 2029-4913 / eISSN 2029-4921

2014 Volume 20(4): 758–782
doi:10.3846/20294913.2014.915596

A HYBRID BANKING WEBSITES QUALITY EVALUATION MODEL USING AHP AND COPRAS-G: A TURKEY CASE

Fatih ECER

International Trade and Finance, Faculty of Economics and Administrative Sciences, ANS Campus, Afyon Kocatepe University, 03030 Afyonkarahisar, Turkey

Received 10 June 2013; accepted 01 December 2013

Abstract. The quality of websites can directly influence bank's effectiveness. Therefore, the effective evaluation of the quality of bank websites is a point of concern for customers, owners, and researchers. The primary goal of the study is to propose a hybrid model of AHP and COPRAS-G methods for evaluating the website quality of banks. Furthermore, this study sheds light on understanding weights of evaluation criteria related to quality of bank websites. In this study, the weights of the evaluation criteria are computed by AHP method. Next, COPRAS-G is used to assess the quality levels of the websites and to rank them. A case study of evaluating the quality of bank websites of seventeen banks in Turkey is used to demonstrate the applicability and the effectiveness of this model. Empirical findings show that banks in Turkey utilize the Internet to its full potential to improve their websites. Furthermore, Garanti Bankasi has the best overall performance, followed by TEB, and Ziraat Bankasi. Additionally, the top-five evaluation criteria in order of importance are relevance, richness, understandability, navigability, and response time. Overall, the results show that this model provides a comprehensive and systematic approach that quantitatively measures a website's quality.

Keywords: website quality, COPRAS-G, AHP, banking, grey system theory.

JEL Classification: C44, C65, G21.

Introduction

Nowadays, many firms will switch their business models from the physical to the virtual market. The physical distribution of goods through banks, stores, bookstores, mail and newspapers, among others, is gradually moving to the virtual market (Lee *et al.* 2011). A firm's website represents their public face to the world. Websites are frequently the first point of contact between a firm and their customers (Gregg, Walczak 2010). Effective use of a website

Corresponding E-mail:
fecer@aku.edu.tr

Routledge
Taylor & Francis Group

can enhance public recognition, build brand image, improve service to existing customers, supply information to potential employees, and reduce the time and effort required to acquire profitable new customers (Chou, Cheng 2012).

Huge advancements in information technology have extremely affected the financial services industry, as is evident in the development of online banking in recent years (Lee *et al.* 2011). Online banking can be defined as the services which allow customers to conduct financial transactions on a secure website operated by a retail or virtual bank, credit union or building society. However, online banking mostly depends on the quality of service delivered by the website. As building long term customer relationships generate positive customer value on the Internet, effective evaluation and monitoring of website quality have become prerequisites for profitable online banking (Bauer *et al.* 2005; Jayawardhena 2004; Jun, Cai 2001; Lee, Chung 2009; Kaya, Kahraman 2011). In other words, the higher the bank website's quality, the higher the bank's effectiveness is (DeLone, McLean 2003).

In line with the many potential criteria must be considered in the evaluation procedure of website quality, the problem is a kind of multi-criteria decision making (MCDM) problems. MCDM is capable of dealing with the multiple dimensions of evaluation problems and is a rapidly developing area in operational research and management science (Turskis *et al.* 2009; Shee, Wang 2008). The complete MCDM process involves the following basic elements: criteria, preference structure, alternatives, and performance values. While the final decision will be made based on the performance of alternatives, evaluation criteria and preference structure are key influential factors and should be prepared in advance. In order to obtain the evaluation criteria and preference structure, a hierarchical analysis must be carried out (Shee, Wang 2008). Over the past decades there had been a large number of refined MCDM methods developed and they differ from each other in the required quality and quantity of additional information, the methodology used, the user-friendliness, the sensitivity tools used, and the mathematical properties they verify (Zavadskas, Turskis 2011). Despite the fact that many attempts have been made to address website evaluation for different website categories, there is no universally accepted method or technique for website evaluation. Previous studies of website evaluation have provided a comprehensive and systematic approach. Different techniques have been employed to evaluate websites using subjective approaches based on individual preferences, such as the Analytic Hierarchy Process (AHP) (e.g. Lee, Kozar 2006; Shee, Wang 2008), Fuzzy AHP (FAHP) (e.g. Büyüközkan, Ruan 2007), Fuzzy Analytic Network Process (FANP) (e.g. Chou, Cheng 2012), Fuzzy TOPSIS (e.g. Büyüközkan, Ruan 2007; Law 2007), PROMETHEE (e.g. Bilsel *et al.* 2006), ELECTRE (e.g. Kaya, Kahraman 2011), Decision-Making Trial and Evaluation Laboratory (DEMATEL) (e.g. Tsai *et al.* 2010), Fuzzy VIKOR (e.g. Büyüközkan *et al.* 2007), and content analysis (e.g. Wan 2002; Cai *et al.* 2004; Baloglu, Pekcan 2006; Kasli, Avcikurt 2008). For example, Chou and Cheng (2012) aimed to build a hybrid approach that combines the FANP and fuzzy VIKOR for evaluating website quality of the top-four certified public accountant firms in Taiwan. They found that the top-five criteria to evaluate website quality are richness, understandability, assurance, relevance, and reliability. Tsai *et al.* (2010) proposed a hybrid model for evaluating national park websites in Taiwan. The authors first applied

the DEMATEL to cope with the interdependencies between evaluation criteria. Next, they used the ANP to compute weights for each criterion. Finally, they used the VIKOR to rank websites. Büyüközkan *et al.* (2007) aimed to measure the e-learning websites' performance. They investigated 10 worldwide and 11 locally successful websites according to seven criteria with the Fuzzy VIKOR method. Lee and Kozar (2006) applied AHP to evaluate electronics and travel websites. The authors identified the different weight of each website quality factor and priority of alternative websites across e-business domains and between stakeholders. Büyüközkan and Ruan (2007) used Fuzzy AHP and Fuzzy TOPSIS to rank 13 Turkish government websites with respect to six criteria. Kaya and Kahraman (2011) used an integrated FAHP-ELECTRE approach for developing e-banking website quality assessment. In the proposed approach, the weights of the evaluation criteria are generated by a FAHP method. Next, fuzzy ELECTRE is used to assess the quality levels of the websites. In the last step, a fuzzy dominance relation approach is used to rank the alternatives. Cai *et al.* (2004), Baloglu and Pekcan (2006) and Kasli and Avcikurt (2008) utilized content analysis to analyze the websites of tour operators, hotels, and tourism departments at universities, respectively, using a measurement variable of yes/no.

The AHP method was developed by Saaty (1980) to provide an overarching view of the complex relationships inherent in the problem and helps the decision makers assess whether evaluation criteria are of the same order of magnitude (Lee, Kozar 2006). Recently, a compromise ranking method, namely the COmplex PRoportional ASsessment of alternatives with Grey relations (COPRAS-G) has been presented as an applicable method for implementation within MCDM (e.g. Datta *et al.* 2009; Chatterjee, Chakraborty 2012; Bitarafan *et al.* 2012; Aghdaie *et al.* 2013).

In this vein, the paper aims to propose a hybrid model that combines AHP and COPRAS-G for evaluating and ranking the quality of bank websites. Till date, COPRAS-G method has very limited applications in the economic field. Using the information systems (IS) success model (DeLone, McLean 2003), this paper explores information quality, service quality, and system quality as main evaluation criteria. For the determination of the weights of main criteria and sub-criteria, AHP method is used since it is based on pairwise comparisons. Then, the weights obtained through AHP method are combined with COPRAS-G to assess and rank the quality of bank websites. Furthermore, in order to verify the usefulness of this hybrid model, a case study of the top seventeen public and private bank websites in Turkey is offered. The findings of this paper can help banks for a clear picture of their websites' quality level and then prioritize the strategies for improvement. Additionally, this paper will be a valuable contribution to achieving desired quality levels. Hence, this hybrid model represents an effective tool for evaluating bank websites.

The rest of this paper is organized as follows. First, website quality is reviewed, AHP and COPRAS-G methods are explained in detail in Section 2. An illustrating example is given and the empirical results are examined in Section 3. Finally, the conclusion is drawn out in the last section.

1. Website quality

Awareness of quality issues has affected every sector in recent years. Quality is a characteristic of a product or service that reflects how well it meets the needs of its consumers. On the other hand, dimensions of web quality may be different from the traditional practice of quality in that web quality to be a complex thing and multi-dimensional measurement in nature (Chou, Cheng 2012; Aladwani, Palvia 2002). Website quality refers to the attributes of a website that contribute to its usefulness to consumers (Gregg, Walczak 2010). Prior website quality researches have identified numerous website quality dimensions. Table 1 gives a summary of the dimensions used in website quality evaluation models in prior studies.

Table 1. Website evaluation studies

Year	Authors	No. citiation	Dimensions
2000	Liu and Arnett	1001	Design quality, system use, playfulness, information, service
2001	Smith	118	Information (content, services, privacy, orientation to website, currency, metadata, accuracy, external recognition), ease of use (accessibility, design, links, feedback mechanisms, navigability)
	Jun and Cai	328	Customer service, product, online systems
	Barnes and Vidgen	282	Information, usability, service interaction
2002	Agarwal and Venkatesh	551	Promotion, emotion, ease of use, content, made for the medium
	Koufaris	1339	Perceived ease of use, perceived usefulness, perceived control, shopping enjoyment, concentration
	Loiacono *et al.*	42	Entertainment, ease of use, complementary relationship, usefulness
	Ranganathan and Ganapathy	656	Security, privacy, information, design.
	Palmer	1036	Interactivity, information and content, download speed, navigation and organization, responsiveness
	Torkzadeh and Dhillon	411	Online payment, trust, product choice, shipping errors, shopping travel
2003	Delone and McLean	3472	System, information, service
	Wu *et al.*	261	Privacy, impartiality, enjoyment, user empowerment, visual appearance, information, technical support, navigation, cognitive outcomes, organization of information, credibility
2004	Delone and McLean	470	System, information, satisfaction, individual impact, organizational impact, use
	Jayawardhena	108	Trust, website interface, attention, access, credibility
	Kim and Stoel	148	Ease of understanding, relative advantage, trust, tailored communication, online completeness, visual appeal, innovativeness, emotional appeal, consistent image, intuitive operations, information, response time
	Iwaarden *et al.*	137	Assurance, reliability, responsiveness, tangibles, empathy

Continued Table 1

Year	Authors	No. citiation	Dimensions
2005	Yang *et al.*	352	Privacy/security, usefulness of content, accessibility, information, usability, interaction
	Bauer *et al.*	131	Transaction support, basic services, cross-buying service, added values, responsiveness, security and trust,
2006	Barnes and Vidgen	87	Trust, information, usability, empathy, design
	Lee and Kozar	153	Reputation, security, understandability, price savings, empathy, reliability, responsiveness, navigability, response time, relevance, telepresence, awareness, personalization, currency
	Moustakis *et al.*	14	Design and structure, navigation, appearance and multimedia, uniqueness, content
2007	Ahn *et al.*	237	Perceived ease of use, service, playfulness, perceived usefulness, information, attitude toward use, behavioral intention to use, system
	Loiacono *et al.*	209	Usefulness, ease of use, entertainment, trust, and response time
2008	Bai *et al.*	125	Usability, customer satisfaction, functionality
2009	Sun and Lin	44	Familiarity, ease of use, trust, use of time, communication, confidence, security, proficiency, past experience, practicality, information
	Swaid and Wigand	35	Information quality, website usability, reliability, responsiveness, assurance, personalization
	Liang and Chen	23	Information, system and service
2010	Rolland and Freeman	11	Ease of use, information content, fulfillment reliability, security/privacy, customer service
2011	Kaya and Kahraman	17	Costumer service, information, product
	Hur *et al.*	2	Information, interaction, design
	Islam and Tsuji	4	Accessibility, Information, design,
	Lee *et al.*	14	Perceived usefulness, perceived ease of use, offline trust
2012	Chou and Cheng	4	Richness, understandability, assurance, relevance, reliability
	Mittal *et al.*	–	Load time, response time, mark-up validation, broken link, accessibility error, size, page rank, frequency of update, traffic and design
2013	Zech *et al.*	–	Clarity, ease of navigation, interactivity, usefulness, currency, accuracy, attractiveness

1.1. Dimensions of web quality

DeLone and McLean's IS success model consists of the following quality factors: information quality, service quality, and system quality. The three quality factors of a website will play an important role in affecting the users' perceptions (Cao *et al.* 2005). The details of each quality factor are described below.

1.2. Information quality

According to Chiou *et al.* (2010), information quality is the second most used factor in IS studies (82%). Information quality means the quality of the information produced and delivered by a system and is considered to be a key factor affecting IS success. If the system does not provide the needed information, users will be dissatisfied and then leave it. Having useful and updated information, however, keeps a client visiting the website. To entice users to revisit, the website needs to provide with appropriate, complete, and clear information. Typical characteristics of information quality include relevance, understandability, richness, and currency (Lee, Kozar 2006; Bai *et al.* 2008; Roxas *et al.* 2000; DeLone, McLean 2003; Chou, Cheng 2012).

1.2.1. Relevance

Relevance includes relevant depth and scope and completeness of information. Different parts of the website should be designed to meet the needs of different groups of visitors, such as accountants, researchers, students, and local citizens (Lee, Kozar 2006; Cao *et al.* 2005; Tsai *et al.* 2010).

1.2.2. Understandability

Understandability includes easing of understanding and clearness of the information, such as documents written in plain language (Lee, Kozar 2006; Chou, Cheng 2012).

1.2.3. Currency

Currency involves updating of the information. Last update/review date is a critical way of notifying users of the currency of content (Smith 2001; Lee, Kozar 2006).

1.2.4. Richness

Richness refers to detailed level and scope of information content. In other words, information contained on the website is rich in content (Bilsel *et al.* 2006).

1.3. Service quality

Service quality refers to the overall support delivered by the website. That is, how well a delivered service level matches customer expectations. Service quality can be measured using reliability, assurance, and empathy (Ahn *et al.* 2007; Chou, Cheng 2012; Lee, Kozar 2006).

1.3.1. Reliability

Reliability involves the website's consistency of performance and dependability, focusing on whether the website is accurate, useful, and dependable. It is parallel to the technical function of the site such as speed and ability to quickly download information (Negash *et al.* 2003; Madu, C. N., Madu, A. A. 2002; Chou, Cheng 2012; Zeithaml 2002).

1.3.2. Assurance

Assurance involves the ability of the personnel behind the firm's website to inspire trust and confidence, as well as display knowledge and courtesy (Madu, C. N., Madu, A. A. 2002; Chou, Cheng 2012; Zhou *et al.* 2009; Webb, H. W., Webb, L. A. 2004).

1.3.3. Empathy

Empathy refers to the extent to which a website provides caring, individualized information, and attention to users and has a user's best interest at heart, such as an easy way to sign up for the monthly newsletter and e-mail reminders before tax season (Cao *et al.* 2005; Carr 2003; Roxas *et al.* 2000; Chou, Cheng 2012).

1.4. System quality

System quality is not only a measure of the information processing system itself but also a technology use performance characteristic. High level of system quality may provide users with more convenience and privacy. System quality can be measured using accessibility, navigability, and response time (Ahn *et al.* 2007; Chou, Cheng 2012; Negash *et al.* 2003).

1.4.1. Accessibility

Accessibility evaluates whether information can be accessed efficiently and whether the site can be located using standard resource discovery tools. Accessibility is also the ability of the website to be accessed by disabled users (Smith 2001; Mohanty *et al.* 2007).

1.4.2. Navigability

Navigability measures how easy it is to navigate around the site, how easy it is to return to the home page of the site, how easy it is to find relevant information, how many links are required to get from one point in a site to another, and what search tools the site provides (Miranda-Gonzalez, Banegil-Palacios 2004; Smith 2001; Tsai *et al.* 2010).

1.4.3. Response time

Fast response time is important to increase system quality in that online users are unwilling to wait more than a few seconds for a response (Lee, Kozar 2006). In particular, the response time is to be desired minimum by online customers in the banking sector.

2. Methodology

Over the past two decades, the complexity of economic decisions has increased rapidly, thus highlighting the importance of developing and implementing sophisticated and efficient quantitative analysis methods for supporting and aiding economic decision making (Zavadskas, Turskis, 2011; Aghdaie *et al.* 2013). MCDM is an advanced field of operations research, provides decision makers and analysts with a wide range of methodologies, which

are overviewed and well suited to the complexity of economic decision problems (Hwang, Yoon 1981; Zopounidis, Doumpos 2002; Figueira *et al.* 2005; Aghdaie *et al.* 2013). In this paper, a hybrid AHP and COPRAS-G model is proposed in order to evaluate the quality of bank websites. The detailed descriptions of these methods are elaborated in the following subsections.

2.1. Analytic Hierarchy Process (AHP)

As one of the most utilized MCDM methods, the AHP method was developed by Saaty (1980) (Gao, Hailu 2013; Ecer, Küçük 2008). AHP has many advantages. For example, AHP provides a measure of consistency in decision makers' judgments or preferences. AHP also allows decision makers to start from pairwise comparisons that are simple enough to work with and often are preferred by the decision makers (Gao, Hailu 2013). The basic steps of this method are as follows (Yu *et al.* 2011; Barker, Zabinsky 2011).

Step 1: Compose AHP structure. With the AHP, the objectives, evaluation criteria and alternatives are arranged in a hierarchical structure. Usually, a hierarchy has three levels such as goal, criteria, and alternatives.

Step 2: Establish a pairwise comparison matrix. In order to determine the weight of evaluation criteria, the second step is the pair comparison of criteria. The pairwise comparison matrix contains numerical judgments assigned to each criterion, sub-criterion, and alternative. In AHP, multiple pairwise comparisons are from a standardized comparison scale of nine levels shown in Table 2. Suppose that $C = \{C_j, j = 1, 2, ..., n\}$ be the set of evaluation criteria. Evaluation matrix can be gotten, in which every element $a_{ij}(i, j = 1, 2, ..., n)$ represents the weights of the evaluation criteria illustrated:

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix}, \tag{1}$$

where $a_{ij}(i, j = 1, 2, ..., n)$ has complied with following condition:

$$a_{ij} = \frac{1}{a_{ji}}, \; a_{ii} = 1, \; a_{ji} > 0. \tag{2}$$

Table 2. The fundamental scale of pairwise comparisons

Definition	Value
1	Equal importance
3	Weak importance
5	Essential importance
7	Demonstrated importance
9	Extreme importance
2, 4, 6, 8	Intermediate values

Step 3: Calculate the criteria weights. By the equation:

$$AW = \lambda_{\max} W . \tag{3}$$

The $\lambda_{\max}$ can be acquired. If the $\lambda_{\max}$ is equal to n and the rank of matrix A is n, A is consistent. In this case, the relative criteria can be discussed. The weight of each criterion will be calculated by normalizing any of the rows or columns of the matrix A.

Step 4: Test consistency. AHP must meet the requirement that the matrix A is consistent. There are two parameters, consistency index (CI) and consistency ratio (CR). Both of them are defined as follows:

$$CI = \frac{\lambda_{\max} - n}{n-1}; \tag{4}$$

$$CR = \frac{CI}{RI}, \tag{5}$$

where RI is random index. For the different count of criteria, it has a different value demonstrated in Table 3. If CR is less than 0.10, the result can be accepted and the matrix A is sufficient consistency. Otherwise, we have to return to step 1 and repeat again.

Table 3. The relationship between RI value and count of criterion

n	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49

2.2. The COPRAS-G method

In order to evaluate the overall efficiency of an alternative, it is necessary to identify evaluation criteria, to assess information relating to these criteria, and to develop methods for evaluating the criteria to meet the participant's needs. Decision analysis is concerned with the situation in which a decision maker has to choose among several alternatives by considering multiple evaluation criteria (Aghdaie *et al.* 2013). For this reason COmplex PRoportional ASsessment (COPRAS) method that was first announced by Zavadskas *et al.* (1994) can be applied. COPRAS method assumes direct and proportional dependences of the significance and utility degree of the available alternatives under the presence of mutually conflicting criteria. It considers the performance of the alternatives according to different evaluation criteria and the corresponding criteria weights. Finally, this method selects the best alternative considering both the ideal and the ideal-worst solutions (Chatterjee *et al.* 2011). This method has already been successfully applied to solve various problems in the field of construction, property management, etc. (Kaklauskas *et al.* 2006; Viteikiene, Zavadskas 2007; Banaitiene *et al.* 2008; Podvezko 2011; Chatterjee *et al.* 2011).

However, most of the MCDM problems cannot be determined or predicted by certain and exact attribute values, but it can be expressed in terms of fuzzy values or with values in some intervals. So, it becomes necessary to extend the applications from white numbers (crisp values) to grey numbers for real time applications. Grey number is basically a concept of Grey System Theory (GST) to deal with the insufficient and incomplete

information (Chatterjee, Chakraborty 2012). The GST was introduced by Deng (1982) to supplement the limitations of using traditional statistical methods. Grey relational analysis (GRA) is useful for capturing the correlations between the reference factor and other factors which can be compared within a system (Deng 1988; Huang *et al.* 2008). One of the features of GRA is that both qualitative and quantitative relationships can be identified among complex factors with insufficient information. It also involves simple calculations; it requires smaller samples; a typical distribution of samples is not needed; the quantified outcomes from the grey relational grade do not result in contradictory conclusions about the qualitative analysis; and the grey relational grade model is a transfer functional model that is effective in dealing with discrete data (Cheng *et al.* 2010; Zavadskas *et al.* 2008).

Hence, Zavadskas *et al.* (2008) presented the main ideas of COPRAS-G method to deal with the problem of matching managers to construction projects. The idea of COPRAS-G method is based on the real conditions of decision making and applications of the GST. It uses a stepwise ranking and evaluating procedure of the alternatives in terms of significance and utility degree (Hashemkhani Zolfani *et al.* 2012a).

In recent years, the COPRAS-G method has been applied to the solution of complicated MCDM problems in social sciences. The recent developments of decision making models based on COPRAS-G method is listed below:

- Ginevičius and Podvezko (2008) evaluated of banks from the perspective of their reliability for customers;
- Datta *et al.* (2009) and Hashemkhani Zolfani *et al.* (2012a) used COPRAS-G method for employee selection;
- Bindu Madhuri *et al.* (2010) selected the best websites based on COPRAS-G;
- Sahu *et al.* (2012) and Hashemkhani Zolfani *et al.* (2012b) presented the evaluation and selection of suppliers;
- Aghdaie *et al.* (2013) used COPRAS-G method for market segment evaluation and selection;
- Tavana *et al.* (2013) applied COPRAS-G method to select the most suitable social media platform.

The procedure of the COPRAS-G method consists of the following steps (Zavadskas *et al.* 2008):

Step 1. Selection of the available set of the most important evaluation criteria, which describes alternatives. To apply COPRAS-G method, the type of evaluation criteria (maximizing or minimizing) is determined. The best values of minimizing criteria are the smallest values, while the largest values are the best for maximizing criteria.

Step 2. Constructing the decision making matrix X:

$$X = \begin{bmatrix} [s_{11};b_{11}] & [s_{12};b_{12}] & \cdots & [s_{1m};b_{1m}] \\ [s_{21};b_{21}] & [s_{22};b_{22}] & \cdots & [s_{2m};b_{2m}] \\ \vdots & \vdots & \ddots & \vdots \\ [s_{n1};b_{n1}] & [s_{n2};b_{n2}] & \cdots & [s_{nm};b_{nm}] \end{bmatrix}; \; i=1,2,...,m; \; j=1,2,...,n, \tag{6}$$

where s_{ij} the smallest value, b_{ij} the biggest value.

Step 3. Determining weights of the evaluation criteria q_j.

Step 4. Normalization of the decision making matrix $\overline{X}$. The normalized values of this matrix are calculated as:

$$\overline{s_{ij}} = \frac{2s_{ij}}{\sum_{j=1}^{n} s_{ij} + \sum_{j=1}^{n} b_{ij}}; \quad \overline{b_{ij}} = \frac{2b_{ij}}{\sum_{j=1}^{n} (s_{ij} + b_{ij})}. \tag{7}$$

In Eq. (7) s_{ij} is the lower value of the j^{th} criterion in the i^{th} alternative of a solution; b_{ij} – the upper value of the j criterion in the i alternative of a solution; m – the number of evaluation criteria; n – the number of the alternatives compared. After this step, we get the normalized decision making matrix:

$$\overline{X} = \begin{bmatrix} [\overline{s_{11}};\overline{b_{11}}] & [\overline{s_{12}};\overline{b_{12}}] & \cdots & [\overline{s_{1m}};\overline{b_{1m}}] \\ [\overline{s_{21}};\overline{b_{21}}] & [\overline{s_{22}};\overline{b_{22}}] & \cdots & [\overline{s_{2m}};\overline{b_{2m}}] \\ \vdots & \vdots & \ddots & \vdots \\ [\overline{s_{n1}};\overline{b_{n1}}] & [\overline{s_{n2}};\overline{b_{n2}}] & \cdots & [\overline{s_{nm}};\overline{b_{nm}}] \end{bmatrix}. \tag{8}$$

Step 5. Calculating the weighted normalized decision matrix $\hat{X}$. The weighted normalized values $\hat{x}_{ij}$ are calculated as follows:

$$\hat{s}_{ij} = \overline{s_{ij}} . q_j; \tag{9}$$

$$\hat{b}_{ij} = \overline{b_{ij}} . q_j.$$

Here q_j is weight of the j^{th} criterion.

Then, the weighted normalized decision making matrix is:

$$\hat{X} = \begin{bmatrix} [\hat{s}_{11};\hat{b}_{11}] & [\hat{s}_{12};\hat{b}_{12}] & \cdots & [\hat{s}_{1m};\hat{b}_{1m}] \\ [\hat{s}_{21};\hat{b}_{21}] & [\hat{s}_{22};\hat{b}_{22}] & \cdots & [\hat{s}_{2m};\hat{b}_{2m}] \\ \vdots & \vdots & \ddots & \vdots \\ [\hat{s}_{n1};\hat{b}_{n1}] & [\hat{s}_{n2};\hat{b}_{n2}] & \cdots & [\hat{s}_{nm};\hat{b}_{nm}] \end{bmatrix}. \tag{10}$$

Step 6. Calculating the sums P_j of criteria whose larger values are more preferable (i.e. optimization direction is maximization):

$$P_j = \sum_{i=1}^{k} (\hat{s}_{ij} + \hat{b}_{ij}) \Big/ 2. \tag{11}$$

In Eq. (11), k is the number of criteria which must be maximized.

Step 7. Calculating the sums R_j of criteria whose smaller values are more preferable (i.e. optimization direction is minimization):

$$R_j = \sum_{i=k+1}^{m} (\hat{s}_{ij} + \hat{b}_{ij}) \Big/ 2; \; i = k,...,m. \tag{12}$$

In Eq. (12), $(m-k)$ is number of criteria which must be minimized.

Step 8. Determining the minimal value of R_j:

$$R_{\min} = \min_j R_j;\ j = j,...,m. \tag{13}$$

Step 9. Calculating the relative importance of each alternative Q_j:

$$Q_j = P_j + \frac{\sum_{j=1}^{n} R_j}{R_j \sum_{j=1}^{n} \frac{1}{R_j}}. \tag{14}$$

Step 10. Determining the optimality criterion K:

$$K = \max_j Q_j;\ j = 1,...,n. \tag{15}$$

Step 11. Determining the priority order of the alternatives. The greater relative importance of alternative Q_j, the higher is the priority of the alternative. The relative importance Q_j of alternative j indicates the satisfaction degree of the needs of the respondents. In case of $Q_{\max}$, the satisfaction degree is the highest.

Step 12. Calculating the utility degree of each alternative. The utility degree is determined by comparing the analyzed alternatives with the best one. The values of the utility degree are from 0% to 100% between the worst and the best alternatives. The utility degree N_j of each alternative j is calculated by the equation:

$$N_j = \frac{Q_j}{Q_{\max}} \cdot 100\%, \tag{16}$$

where Q_j and $Q_{\max}$ are the significance of alternatives obtained from Eq. (14).

3. Evaluation of bank website quality

3.1. Conceptual framework

The primary goal is to utilize a hybrid model in bank website quality evaluation. Furthermore, this hybrid model can be used to compare between the qualities of websites and to identify a path for improvement of a website. Fig. 1 summarizes the proposed hybrid model.

3.2. Measurement

The evaluation criteria used in the present study were adapted from the previous web quality studies and its applications. Besides, this study was composed of three main criteria: (a) information quality; (b) service quality; (c) system quality. The first part of the questionnaire included demographic questions such as age, gender, education, income, and occupation. Additionally, there was a table in the second part of the questionnaire that allows respondents pairwise comparisons.

In addition, sub-criteria related to quality of web sites were adapted from the study by DeLone and McLean (2003). These constructs have been well researched, developed, validated and adopted in several previous studies (e.g. Hasan, Abuelrub 2011; Chou, Cheng 2012).

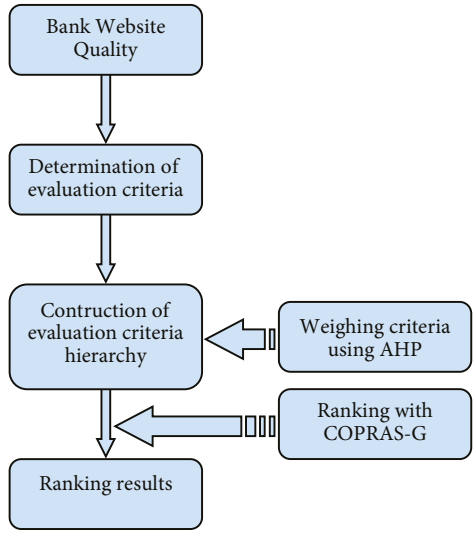

Fig. 1. The proposed hybrid model

3.3. Sampling

385 questionnaires were distributed and 364 were returned, which represents a response rate of 94.5%. Furthermore, banking customers as respondents were from one of several kinds of organizations (managers, scientists, owners, teachers, web designers etc.).

Questionnaires were completed in different places around the Afyonkarahisar, Turkey in 2013, during different times of day and on different days during the data collection period. Hence, the resulting sample was well distributed regardless of demographic information. The questionnaire consisted of questions related to possible criteria affecting the quality of bank websites.

3.4. Data and evaluation criteria selection

The descriptive statistics of the respondents' demographic characteristics were analyzed and presented in Table 4. According to Table 4, most of the participants were male. Moreover, the majority of the respondents fell into the 3140 year-old age group. They were distributed among a variety of professional industries such as banking, manufacturing, and medicine. Finally, the bulk of the respondents use the online banking platform 45 times per month.

In order to find the prioritization of websites quality criteria for respondents, the best method is to directly ask them. Therefore the 364 respondents were asked to prioritize the three main criteria and their sub-criteria as follows.

– Information quality sub-criteria:
  Relevance $x_1 - [s_{i1}; b_{i1}]$;
  Understandability $x_2 - [s_{i2}; b_{i2}]$;
  Currency $x_3 - [s_{i3}; b_{i3}]$;
  Richness $x_4 - [s_{i4}; b_{i4}]$;

- Service quality sub-criteria:
  Reliability $x_5 - [s_{i5}; b_{i5}]$;
  Assurance $x_6 - [s_{i6}; b_{i6}]$;
  Empathy $x_7 - [s_{i7}; b_{i7}]$;
- System quality sub-criteria:
  Accessibility $x_8 - [s_{i8}; b_{i8}]$;
  Navigability $x_9 - [s_{i9}; b_{i9}]$;
  Response time $x_{10} - [s_{i10}; b_{i10}]$;

Optimization directions of selected sub-criteria as follows:

- $x_1, ..., x_9 \xrightarrow{optimization\ \ direction} \max$;
- $x_{10} \xrightarrow{optimization\ \ direction} \min$.

Table 4. Demographic characteristics of the respondents

Demographics	Frequency	Percent (%)
Gender		
Male	216	59.3
Female	148	40.7
Age		
21–30	46	12.6
31–40	244	67.0
41–50	53	14.6
Over 50	21	5.8
Education		
Under high school	65	17.9
University	281	77.2
Masters/PhD	18	4.9
Respondents' industry		
Finance	42	11.5
Service	156	42.9
Manufacturing	78	21.4
Others	88	24.2
Frequency of using online banking (per month)		
Less than once	24	6.6
2–3 times	89	24.5
4–5 times	186	51.0
Over 5 times	65	17.9

3.5. Prioritization criteria for bank websites evaluation

The aim of using AHP is to determine the weights of the evaluation criteria that will be employed in COPRAS-G method. For pairwise comparison decision making in AHP, a questionnaire was applied to 364 respondents. The paired comparison matrix is one of the matrices that were completed with information of respondents. After the AHP method is used for prioritizing, all comparisons and weighing process are done and the overall weights of each criterion are obtained. By the way, the consistencies for all pairwise comparison matrices were checked with the *CI* and *CR*s were found smaller than 0.10.

Hence, Fig. 2 shows a graphical plot of the weights. For respondents using bank websites, *information quality* had the highest weight of 0.539, followed by *system quality* (0.298), and *service quality* (0.163). Additionally, relevance, richness, understandability, navigability, and response time were the top website quality criteria. Empathy, however, had the lowest weight of 0.028. The weights will be used in COPRAS-G method later.

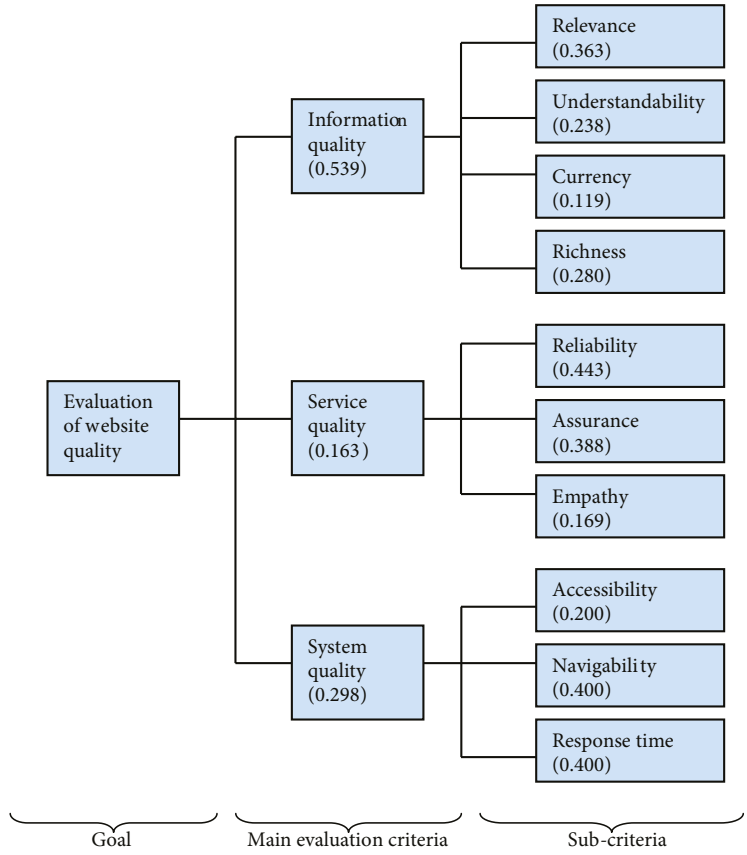

Fig. 2. Weights of main criteria and sub-criteria

3.6. Evaluation of the bank website quality

At this stage, respondents evaluated each bank website as to each criterion and then the initial decision matrix (Table 5) developed. The relevant information for the three main criteria and sub-criteria are presented in this table. All sub-criteria are maximizing criteria with the exception of "response time" which is a minimizing sub-criterion. The weights are determined through the AHP method. The values presented in the initial decision matrix are all interval values.

The initial decision making matrix has been normalized first as discussed in Section 2. The normalized decision making matrix is presented in Table 6. The weighted decision making matrix presented in Table 7 was constructed next.

Table 5. The initial decision making matrix

	Information Quality						Service Quality								System Quality					
	Relevance		*Understandability*		*Currency*		*Richness*		*Reliability*		*Assurance*		*Empathy*		*Accessibility*		*Navigability*		*Response time*	
Optimization	max		max		max		max		max		max		max		max		max		min	
Weight	0.196		0.128		0.064		0.151		0.072		0.063		0.028		0.060		0.119		0.119	
	s_1	b_1	s_2	b_2	s_3	b_3	s_4	b_4	s_5	b_5	s_6	b_6	s_7	b_7	s_8	b_8	s_9	b_9	s_{10}	b_{10}
Ziraat Bankasi	70	95	80	95	50	65	85	95	75	95	70	90	70	90	80	100	65	95	75	90
Halk Bankasi	70	90	75	95	70	85	80	90	75	95	70	85	70	90	75	100	70	90	80	90
Vakıflar Bankasi	70	95	75	95	50	60	80	95	70	90	70	95	70	90	80	100	70	95	85	95
Akbank	65	85	70	90	70	90	75	85	65	80	60	85	60	75	80	95	60	80	85	95
Alternatif Bank	60	90	55	75	60	75	50	65	45	65	55	60	50	55	70	90	70	80	80	90
Anadolubank	50	75	55	70	70	85	55	70	40	60	50	60	45	50	70	85	60	70	80	90
Sekerbank	55	80	60	80	65	80	65	85	60	75	65	80	60	70	75	90	60	75	65	80
Tekstil Bankasi	50	75	50	75	65	85	50	65	50	70	60	70	50	55	70	90	55	65	80	100
Turkish Bank	55	80	50	70	70	85	50	65	55	65	50	65	40	55	60	80	50	60	75	95
TEB	80	100	80	95	60	75	70	95	70	95	70	95	70	90	70	90	70	95	70	90
Garanti Bankasi	85	100	80	100	50	60	80	100	75	100	70	100	70	90	75	95	65	95	85	95
Is Bankasi	75	90	80	90	60	70	80	95	75	95	65	90	70	90	70	100	75	95	85	90
Yapı ve Kredi	65	85	75	90	70	85	70	90	65	85	60	80	60	80	65	95	65	85	80	100
Denizbank	80	95	75	95	50	60	70	90	70	95	70	95	70	90	70	100	70	90	85	100
Finans Bank	65	85	65	80	60	80	60	85	65	80	60	80	65	80	70	90	70	75	90	100
HSBC	60	75	65	80	70	95	70	85	60	80	60	65	70	80	70	85	60	70	80	100
ING	60	80	60	75	70	90	65	80	65	75	65	70	70	85	65	95	65	80	70	90

Table 6. The normalized decision making matrix

	Relevance		*Understandability*		*Currency*		*Richness*		*Reliability*		*Assurance*		*Empathy*		*Accessibility*		*Navigability*		*Response time*	
	$\overline{s_1}$	$\overline{b_1}$	$\overline{s_2}$	$\overline{b_2}$	$f_j^* = \min_i$	$\overline{b_3}$	$\overline{s_4}$	$\overline{b_4}$	$\overline{s_5}$	$\overline{b_5}$	$\overline{s_6}$	$\overline{b_6}$	$\overline{s_7}$	$\overline{b_7}$	$\overline{s_8}$	$\overline{b_8}$	$\overline{s_9}$	$\overline{b_9}$	Q_i	$\overline{b_{10}}$
Ziraat Bank	0.054	0.073	0.062	0.073	0.042	0.055	0.066	0.073	0.060	0.077	0.057	0.074	0.059	0.076	0.057	0.072	0.052	0.076	0.051	0.061
Halk Bankasi	0.054	0.069	0.058	0.073	0.059	0.071	0.062	0.069	0.060	0.077	0.057	0.070	0.059	0.076	0.054	0.072	0.056	0.072	0.054	0.061
Vakıflar Bankasi	0.054	0.073	0.058	0.073	0.042	0.050	0.062	0.073	0.056	0.073	0.057	0.078	0.059	0.076	0.057	0.072	0.056	0.076	0.058	0.065
Akbank	0.050	0.066	0.054	0.069	0.059	0.075	0.058	0.066	0.052	0.065	0.049	0.070	0.051	0.063	0.057	0.068	0.048	0.064	0.058	0.065
Alternatif Bank	0.046	0.069	0.042	0.058	0.050	0.063	0.039	0.050	0.036	0.052	0.045	0.049	0.042	0.046	0.050	0.064	0.056	0.064	0.054	0.061
Anadolubank	0.039	0.058	0.042	0.054	0.059	0.071	0.042	0.054	0.032	0.048	0.041	0.049	0.038	0.042	0.050	0.061	0.048	0.056	0.054	0.061
Sekerbank	0.042	0.062	0.046	0.062	0.055	0.067	0.050	0.066	0.048	0.060	0.053	0.066	0.051	0.059	0.054	0.064	0.048	0.060	0.044	0.054
Tekstil Bankasi	0.039	0.058	0.038	0.058	0.055	0.071	0.039	0.050	0.040	0.056	0.049	0.057	0.042	0.046	0.050	0.064	0.044	0.052	0.054	0.068
Turkish Bank	0.042	0.062	0.038	0.054	0.059	0.071	0.039	0.050	0.044	0.052	0.041	0.053	0.034	0.046	0.043	0.057	0.040	0.048	0.051	0.065
TEB	0.062	0.077	0.062	0.073	0.050	0.063	0.054	0.073	0.056	0.077	0.057	0.078	0.059	0.076	0.050	0.064	0.056	0.076	0.048	0.061
Garanti Bankasi	0.066	0.077	0.062	0.077	0.042	0.050	0.062	0.077	0.060	0.081	0.057	0.082	0.059	0.076	0.054	0.068	0.052	0.076	0.058	0.065
Is Bankasi	0.058	0.069	0.062	0.069	0.050	0.059	0.062	0.073	0.060	0.077	0.053	0.074	0.059	0.076	0.050	0.072	0.060	0.076	0.058	0.061
Yapı ve Kredi	0.050	0.066	0.058	0.069	0.059	0.071	0.054	0.069	0.052	0.069	0.049	0.066	0.051	0.067	0.047	0.068	0.052	0.068	0.054	0.068
Denizbank	0.062	0.073	0.058	0.073	0.042	0.050	0.054	0.069	0.056	0.077	0.057	0.078	0.059	0.076	0.050	0.072	0.056	0.072	0.058	0.068
Finans Bank	0.050	0.066	0.050	0.062	0.050	0.067	0.046	0.066	0.052	0.065	0.049	0.066	0.055	0.067	0.050	0.064	0.056	0.060	0.061	0.068
HSBC	0.046	0.058	0.050	0.062	0.059	0.080	0.054	0.066	0.048	0.065	0.049	0.053	0.059	0.067	0.050	0.061	0.048	0.056	0.054	0.068
ING	0.046	0.062	0.046	0.058	0.059	0.075	0.050	0.062	0.052	0.060	0.053	0.057	0.059	0.072	0.047	0.068	0.052	0.064	0.048	0.061

Table 7. The weighted normalized decision making matrix

	Relevance		*Understandability*		*Currency*		*Richness*		*Reliability*		*Assurance*		*Empathy*		*Accessibility*		*Navigability*		*Response time*	
	$\hat{s}_1$	$\hat{b}_1$	$\hat{s}_2$	$\hat{b}_2$	$\hat{s}_3$	$\hat{b}_3$	$\hat{s}_4$	$\hat{b}_4$	$\hat{s}_5$	$\hat{b}_5$	$\hat{s}_6$	$\hat{b}_6$	$\hat{s}_7$	$\hat{b}_7$	$\hat{s}_8$	$\hat{b}_8$	$\hat{s}_9$	$\hat{b}_9$	$\hat{s}_{10}$	$\hat{b}_{10}$
Ziraat Bankasi	0.011	0.014	0.008	0.009	0.003	0.003	0.010	0.011	0.004	0.006	0.004	0.005	0.002	0.002	0.003	0.004	0.006	0.009	0.006	0.007
Halk Bankasi	0.011	0.014	0.007	0.009	0.004	0.005	0.009	0.010	0.004	0.006	0.004	0.004	0.002	0.002	0.003	0.004	0.007	0.009	0.006	0.007
Vakıflar Bankasi	0.011	0.014	0.007	0.009	0.003	0.003	0.009	0.011	0.004	0.005	0.004	0.005	0.002	0.002	0.003	0.004	0.007	0.009	0.007	0.008
Akbank	0.010	0.013	0.007	0.009	0.004	0.005	0.009	0.010	0.004	0.005	0.003	0.004	0.001	0.002	0.003	0.004	0.006	0.008	0.007	0.008
Alternatif Bank	0.009	0.014	0.005	0.007	0.003	0.004	0.006	0.008	0.003	0.004	0.003	0.003	0.001	0.001	0.003	0.004	0.007	0.008	0.006	0.007
Anadolubank	0.008	0.011	0.005	0.007	0.004	0.005	0.006	0.008	0.002	0.003	0.003	0.003	0.001	0.001	0.003	0.004	0.006	0.007	0.006	0.007
Sekerbank	0.008	0.012	0.006	0.008	0.003	0.004	0.008	0.010	0.003	0.004	0.003	0.004	0.001	0.002	0.003	0.004	0.006	0.007	0.005	0.006
Tekstil Bankasi	0.008	0.011	0.005	0.007	0.003	0.005	0.006	0.008	0.003	0.004	0.003	0.004	0.001	0.001	0.003	0.004	0.005	0.006	0.006	0.008
Turkish Bank	0.008	0.012	0.005	0.007	0.004	0.005	0.006	0.008	0.003	0.004	0.003	0.003	0.001	0.001	0.003	0.003	0.005	0.006	0.006	0.008
TEB	0.012	0.015	0.008	0.009	0.003	0.004	0.008	0.011	0.004	0.006	0.004	0.005	0.002	0.002	0.003	0.004	0.007	0.009	0.006	0.007
Garanti Bankasi	0.013	0.015	0.008	0.010	0.003	0.003	0.009	0.012	0.004	0.006	0.004	0.005	0.002	0.002	0.003	0.004	0.006	0.009	0.007	0.008
Is Bankasi	0.011	0.014	0.008	0.009	0.003	0.004	0.009	0.011	0.004	0.006	0.003	0.005	0.002	0.002	0.003	0.004	0.007	0.009	0.007	0.007
Yapı ve Kredi	0.010	0.013	0.007	0.009	0.004	0.005	0.008	0.010	0.004	0.005	0.003	0.004	0.001	0.002	0.003	0.004	0.006	0.008	0.006	0.008
Denizbank	0.012	0.014	0.007	0.009	0.003	0.003	0.008	0.010	0.004	0.006	0.004	0.005	0.002	0.002	0.003	0.004	0.007	0.009	0.007	0.008
Finans Bank	0.010	0.013	0.006	0.008	0.003	0.004	0.007	0.010	0.004	0.005	0.003	0.004	0.002	0.002	0.003	0.004	0.007	0.007	0.007	0.008
HSBC	0.009	0.011	0.006	0.008	0.004	0.005	0.008	0.010	0.003	0.005	0.003	0.003	0.002	0.002	0.003	0.004	0.006	0.007	0.006	0.008
ING	0.009	0.012	0.006	0.007	0.004	0.005	0.008	0.009	0.004	0.004	0.003	0.004	0.002	0.002	0.003	0.004	0.006	0.008	0.006	0.007

It was followed the procedure described earlier and determined ranking of each alternative by calculating P_j using Eq. (11), R_j using Eq. (12), and Q_j using Eq. (14). Following this step, it was determined the utility degree of each alternative (N_j) using Eq. (16). Table 8 presents the P_j, R_j, Q_j, and N_j for the seventeen banks under consideration.

Table 8. The evaluation of the utility degree

	Optimization direction is maximization P_j	Optimization direction is minimization R_j	Banks' relative importances Q_j	Banks' utility degree N_j (%)	Rank
Ziraat Bankasi	0.0571	0.0067	0.0644	98.16	3
Halk Bankasi	0.0568	0.0069	0.0639	97.27	5
Vakıflar Bankasi	0.0565	0.0073	0.0632	96.33	6
Akbank	0.0528	0.0073	0.0595	90.68	9
Alternatif Bank	0.0461	0.0069	0.0532	80.98	14
Anadolubank	0.0435	0.0069	0.0505	77.00	15
Sekerbank	0.0489	0.0059	0.0572	87.19	11
Tekstil Bankasi	0.0436	0.0073	0.0503	76.59	16
Turkish Bank	0.0428	0.0069	0.0499	76.02	17
TEB	0.0577	0.0065	0.0653	99.41	2
Garanti Bankasi	0.0590	0.0073	0.0657	100.00	1
Is Bankasi	0.0571	0.0071	0.0640	97.52	4
Yapı ve Kredi	0.0532	0.0073	0.0599	91.20	8
Denizbank	0.0561	0.0075	0.0626	95.41	7
Finans Bank	0.0506	0.0077	0.0569	86.73	12
HSBC	0.0494	0.0073	0.0561	85.47	13
ING	0.0497	0.0065	0.0573	87.22	10

As shown in Table 8, Garanti Bankasi with a utility degree of 100% had the best website regardless of quality in Turkey. TEB with a utility degree of 99.41% had the second most quality bank website. Ziraat Bankasi with a utility degree of 98.16% was the third ranking bank website. Finally, Is Bankasi and Halk Bankasi with utility degrees of 97.52% and 97.27%, respectively, were selected as the fourth and fifth choices for websites. However, Anadolubank, Tekstil Bankasi, and Turkish Bank with utility degrees of 77%, 76.59% and 76.02%, respectively, had the worst websites.

Conclusions

There are justifiable reasons to evaluate a bank's website quality. For example, a bank's success is more related to the quality of its website. For every bank site, its competitor is only a link away. Hence, a high quality bank website is one that meets its owner's and users' needs.

However, selecting the best quality bank website is a difficult task since this problem is complex with multiple criteria. Hence, this study proposed a hybrid model for evaluating and selecting the best quality bank website. The hybrid model integrates the AHP method

and the COPRAS-G method. First, the AHP method was used to determine the weights of the website evaluation criteria in this study. Next, the COPRAS-G method was used to rank and select the most quality bank website. Moreover, a real-world case study was presented and demonstrated the applicability of the hybrid model.

The present study investigated factors affecting bank website quality and showed remarkable results. According to the findings, respondents considered information quality as the most important factor. Relevance and richness were highly ranked, indicating that banks should expend more effort to make the website more relevant and rich. Second important factor with regard to the respondents is system quality. Navigability and response time were highly ranked, indicating that banks should expend more effort to make the website more navigable and fast. Interestingly, the relative unimportance of service quality could be a surprising finding. A possible reason is that respondents have experienced poor bank web service. However, this does not mean service quality is less important. Instead, banks might use high service quality as a strategic tool for differentiation from other competitors. Additionally, according to the results of this study, Garanti Bankasi, TEB, and Ziraat Bankasi were the three best bank websites and that Anadolubank, Tekstil Bankasi, and Turkish Bank were the three worst bank websites in Turkey. Therefore, this paper's results had practical implications for the bank managers and owners. By discovering a website's strengths and weaknesses and comparing these to competitors, they can make resource allocation decisions about how to achieve high quality websites.

Finally, the proposed hybrid model has the following advantages: structured and systematic with step-by-step and well-defined procedures; transparent with a comprehensive computation process; logical and rational with a sound mathematical foundation; informative with a scalar value that identifies both the best and the worst bank website simultaneously; and flexibility with the ability to be applied to other MCDM problems.

In sum, the main contribution of this study is to offer bank managers and owners not only investigating factors affecting bank website quality, but also a practical decision tool for assessing website quality. Furthermore, despite this study relates to the banking sector, the hybrid model can also be applied to other sectors to handle any assessment problem. Concerning future research, it would be beneficial to extend this study to a fuzzy environment.

References

Agarwal, R.; Venkatesh, V. 2002. Assessing a firm's web presence: a heuristic evaluation procedure for the measurement of usability, *Information Systems Research* 13(2): 168–186. http://dx.doi.org/10.1287/isre.13.2.168.84

Aghdaie, M. H.; Hashemkhani Zolfani, S.; Zavadskas, E. K. 2013. Market segment evaluation and selection based on application of fuzzy AHP and COPRAS-G methods, *Journal of Business Economics and Management* 14(1): 213–233. http://dx.doi.org/10.3846/16111699.2012.721392

Ahn, T.; Ryu, S.; Han, I. 2007. The impact of Web quality and playfulness on user acceptance of online retailing, *Information & Management* 44(3): 263–275. http://dx.doi.org/10.1016/j.im.2006.12.008

Aladwani, A. M.; Palvia, P. C. 2002. Developing and validating an instrument for measuring user-perceived Web quality, *Information & Management* 39(6): 467–476. http://dx.doi.org/10.1016/S0378-7206(01)00113-6

Bai, B.; Law, R.; Wen, I. 2008. The impact of website quality on customer satisfaction and purchase intentions: evidence from Chinese online visitors, *International Journal of Hospitality Management* 27(3): 391–402. http://dx.doi.org/10.1016/j.ijhm.2007.10.008

Baloglu, S.; Pekcan, Y. A. 2006. The website design and internet site marketing practices of upscale and luxury hotels in Turkey, *Tourism Management* 27(1): 171–176. http://dx.doi.org/10.1016/j.tourman.2004.07.003

Banaitiene, N.; Banaitis, A.; Kaklauskas, A.; Zavadskas, E. K. 2008. Evaluating the life cycle of a building: a multivariant and multiple criteria approach, *Omega: The International Journal of Management Science* 36: 429–441.

Barker, T. J.; Zabinsky, Z. B. 2011. A multicriteria decision making model for reverse logistics using analytical hierarchy process, *Omega: The International Journal of Management Science* 39(5): 558–573. http://dx.doi.org/ 10.1016/j.omega.2010.12.002

Barnes, S. J.; Vidgen, R. 2006. Data triangulation and web quality metrics: a case study in e-government, *Information & Management* 43(6): 767–777. http://dx.doi.org/10.1016/j.im.2006.06.001

Barnes, S. J.; Vidgen, R. 2001. An evaluation of cyber-bookshops: the webQual method, *International Journal of Electronic Commerce* 6: 11–30.

Bauer, H. H.; Hammerschmidt, M.; Falk, T. 2005. Measuring the quality of e-banking portals, *International Journal of Bank Marketing* 23(2): 153–175. http://dx.doi.org/10.1108/02652320510584395

Bilsel, R. U.; Büyüközkan, G.; Ruan, D. 2006. A fuzzy preference-ranking model for a quality evaluation of hospital web sites, *International Journal of Intelligent Systems* 21(11): 1181–1197. http://dx.doi.org/10.1002/int.20177

Bindu Madhuri, C.; Anand Chandulal, J.; Padmaja, M. 2010. Selection of best web site by applying COPRAS-G method, *International Journal of Computer Science and Information Technologies* 1(2): 138–146.

Bitarafan, M.; Hashemkhani Zolfani, S.; Arefi, S. L.; Zavadskas, E. K. 2012. Evaluating the construction methods of cold-formed steel structures in reconstructing the areas damaged in natural crises, using the methods AHP and COPRAS-G, *Archives of Civil and Mechanical Engineering* 12(3): 360–367. http://dx.doi.org/10.1016/j.acme.2012.06.015

Büyüközkan, G.; Ruan, D. 2007. Evaluating government websites based on a fuzzy multiple criteria decision-making approach, *International Journal of Uncertainty, Fuzziness and Knowledge-Based Systems* 15(3): 321–343. http://dx.doi.org/10.1142/S0218488507004704

Büyüközkan, G.; Ruan, D.; Feyzioglu, O. 2007. Evaluating e-learning web site quality in fuzzy environment, *International Journal of Intelligent Systems* 22(5): 567–586. http://dx.doi.org/10.1002/int.20214

Cai, L.; Card, J. A.; Cole, S. T. 2004. Content delivery performance of world wide web sites of US tour operators focusing on destinations in China, *Tourism Management* 25(2): 219–227. http://dx.doi.org/10.1016/S0261-5177(03)00095-5

Cao, M.; Zhang, Q.; Seydel, J. 2005. B2C e-commerce web site quality: an empirical examination, *Industrial Management & Data Systems* 105(5): 645–661. http://dx.doi.org/10.1108/02635570510600000

Carr, R. 2003. Marketing your web site to increase business, *The National Public Accountant*, September, 11–12.

Chatterjee, P.; Athawale, V. M.; Chakraborty, S. 2011. Materials selection using complex proportional assessment and evaluation of mixed data methods, *Materials and Design* 32(2): 851–860. http://dx.doi.org/10.1016/j.matdes.2010.07.010

Chatterjee, P.; Chakraborty, S. 2012. Material selection using preferential ranking methods, *Materials and Design* 35: 384–393. http://dx.doi.org/10.1016/j.matdes.2011.09.027

Cheng, R. W.; Chin, T. L.; Pei, H. T. 2010. Evaluating business performance of wealth management banks, *European Journal of Operational Research* 207(2): 971–979. http://dx.doi.org/10.1016/j.ejor.2010.04.034

Chiou, W. C.; Lin, C. C.; Perng, C. 2010. A strategic framework for website evaluation based on a review of the literature from 1995–2006, *Information & Management* 47(5–6): 282–290. http://dx.doi.org/10.1016/j.im.2010.06.002

Chou, W. C.; Cheng, Y. P. 2012. A hybrid fuzzy MCDM approach for evaluating website quality of professional accounting firms, *Expert Systems with Applications* 39(3): 2783–2793. http://dx.doi.org/10.1016/j.eswa.2011.08.138

Datta, S.; Beriha, G. S.; Patnaik, B.; Mahapatra, S. S. 2009. Use of compromise ranking method for supervisor selection: a multi criteria decision making (MCDM) approach, *International Journal of Vocational and Technical Education* 1(1): 713.

DeLone, W. H.; McLean, E. R. 2003. The DeLone and McLean model of information systems success: a ten-year update, *Journal of Management Information Systems* (19): 9–30.

DeLone, W. H.; McLean, E. R. 2004. Measuring e-commerce success: applying the DeLone & McLean information systems success model, *International Journal of Electronic Commerce* 9(1): 31–47.

Deng, J. 1982. Control problems of grey systems, *Systems and Control Letters* 5: 288–294.

Deng, J. L. 1988. Properties of relational space for grey system, in Deng, J. L. (Ed.). *In Essential Topics on Grey System-Theory and Applications.* Beijing: China Ocean. 113 p.

Ecer, F.; Küçük, O. 2008. Tedarikçi seçiminde analitik hiyerarşi yöntemi ve bir uygulama, *Atatürk Üniversitesi Sosyal Bilimler Enstitüsü Dergisi* 11(1): 355–369.

Figueira, J.; Greco, S.; Ehrgott, M. (Eds.). 2005. *Multiple criteria decision analysis: state of the art surveys*. Boston: Springer. 1048 p.

Gao, L.; Hailu, A. 2013. Identifying preferred management options: an integrated agent-based recreational fishing simulation model with an AHP-TOPSIS evaluation method, *Ecological Modelling* 249: 7583. http://dx.doi.org/10.1016/j.ecolmodel.2012.07.002

Ginevičius, R.; Podvezko, V. 2008. Multicriteria evaluation of Lithuanian banks from the perspective of their reliability for clients, *Journal of Business Economics and Management* 9(4): 257–267. http://dx.doi.org/ 10.3846/bm.2010.133

Gregg, D. G.; Walczak, S. 2010. The relationship between website quality, trust and price premiums at online auctions, *Electronic Commerce Research* 10(1): 125. http://dx.doi.org/ 10.1007/s10660-010-9044-2

Hasan, L.; Abuelrub, E. 2011. Assessing the quality of web sites, *Applied Computing and Informatics* 9(1): 11–29. http://dx.doi.org/10.1016/j.aci.2009.03.001

Hashemkhani Zolfani, S.; Rezaeiniya, N.; Aghdaie, M. H.; Zavadskas, E. K. 2012a. Quality control manager selection based on AHP-COPRAS-G methods: a case in Iran, *Ekonomska Istrazivanja – Economic Research* 25(1): 88–104.

Hashemkhani Zolfani, S.; Chen, I. S.; Rezaeiniya, N.; Tamosaitiene, J. 2012b. A hybrid MCDM model encompassing AHP and COPRAS-G methods for selecting company supplier in Iran, *Technological and Economic Development of Economy* 18(3): 529–543. http://dx.doi.org/10.3846/20294913.2012.709472

Huang, S. J.; Chiu, N. H.; Chen, L. W. 2008. Integration of the grey relational analysis with genetic algorithm for software effort estimation, *European Journal of Operational Research* 188(3): 898–909. http://dx.doi.org/ 10.1016/j.ejor.2007.07.002

Hur, Y.; Ko, Y. J.; Valacich, J. 2011. A structural model of the relationships between sport website quality, e-satisfaction, and e-loyalty, *Journal of Sport Management* 3: 458–473.

Hwang, C. L.; Yoon, K. 1981. Multiple attribute decision making: a state of the art survey, *Lecture Notes in Economics and Mathematical Systems*. Berlin: Springer-Verlag. 269 p. http://dx.doi.org/10.1007/978-3-642-48318-9

Islam, A.; Tsuji, K. 2011. Evaluation of usage of university websites in Bangladesh, *Journal of Library & Information Technology* 31(6): 469–479.

Iwaarden, J. V.; Wiele, T. V. D.; Ball, L.; Millen, R. 2004. Perceptions about the quality of web sites: a survey amongst students at Northeastern University and Erasmus University, *Information & Management* 41(8): 947–959. http://dx.doi.org/10.1016/j.im.2003.10.002

Jayawardhena, C. 2004. Measurement of service quality in internet banking: the development of an instrument, *Journal of Marketing Management* 20: 185–207. http://dx.doi.org/ 10.1362/026725704773041177

Jun, M.; Cai, S. 2001. The key determinants of internet banking service quality: a content analysis, *International Journal of Bank Marketing* 19(7): 276–291. http://dx.doi.org/10.1108/02652320110409825

Kaklauskas, A.; Zavadskas, E. K.; Raslanas, S.; Ginevicius, R.; Komka, A.; Malinauskas, P. 2006. Selection of low-e windows in multiple criteria methods COPRAS: a Lithuanian case, *Energy and Buildings* 38(5): 454–462. http://dx.doi.org/10.1016/j.enbuild.2005.08.005

Kasli, M.; Avcikurt, C. 2008. An investigation to evaluate the websites of tourism departments of universities in Turkey, *Journal of Hospitality, Leisure, Sport and Tourism Education* 7(2): 77–92. http://dx.doi.org/ 10.3794/johlste.72.194

Kaya, T.; Kahraman, C. 2011, A fuzzy approach to e-banking website quality assessment based on integrated AHP-ELECTRE method, *Technological and Economic Development of Economy* 17(2): 313–334. http://dx.doi.org/10.3846/20294913.2011.583727

Kim, S.; Stoel, L. 2004. Dimensional hierarchy of retail website quality, *Information & Management* 41(5): 619–633. http://dx.doi.org/10.1016/j.im.2003.07.002

Koufaris, M. 2002. Applying the technology acceptance model and flow theory to online customer behavior, *Information Systems Research* 13(2): 205–223. http://dx.doi.org/ 10.1287/isre.13.2.205.83

Law, R. 2007. A fuzzy multiple criteria decision-making model for evaluating travel websites, *Asia Pacific Journal of Tourism Research* 12(2): 147–159. http://dx.doi.org/10.1080/10941660701243372

Lee, K. C.; Chung, N. 2009. Understanding factors affecting trust in and satisfaction with mobile banking in Korea: a modified DeLone and McLean's model perspective, *Interacting with Computers* 21(5–6): 385–392. http://dx.doi.org/10.1016/j.intcom.2009.06.004

Lee, K. W.; Tsai, M. T.; Maria, C. L. L. 2011. From marketplace to marketspace: investigating the consumer switch to online banking, *Electronic Commerce Research and Applications* 10(1): 115–125. http://dx.doi.org/10.1016/j.elerap.2010.08.005

Lee, Y.; Kozar, K. 2006. Investigating the effect of website quality on e-business success: an analytic hierarchy process (AHP) approach, *Decision Support Systems* 42(3): 1383–1401. http://dx.doi.org/10.1016/j.dss.2005.11.005

Liang, C. J.; Chen, H. J. 2009. A study of the impacts of website quality on customer relationship performance, *Total Quality Management* 20(9): 971–988. http://dx.doi.org/10.1080/14783360903181784

Liu, C.; Arnett, K. P. 2000. Exploring the factors associated with web site success in the context of electronic commerce, *Information Management* 38(1): 23–33. http://dx.doi.org/10.1016/S0378-7206(00)00049-5

Loiacono, E. T.; Chen, D. Q.; Goodhue, D. L. 2002. WebQualk revisited: predicting the intent to reuse a website, in *Proc. of 8th Americas Conference on Information Systems,* August 2002, Dallas, TX, USA, 301–309.

Loiacono, E. T.; Richard, T. W.; Dale, L. G. 2007. WebQual: an instrument for consumer evaluation of web sites, *International Journal of Electronic Commerce* 11(3): 51–87. http://dx.doi.org/10.2753/JEC1086-4415110302

Madu, C. N.; Madu, A. A. 2002. Dimensions of e-quality, *International Journal of Quality and Reliability Management* 19(3): 246–258. http://dx.doi.org/10.1108/02656710210415668

Miranda-González, F. J.; Bañegil-Palacios, T. M. 2004. Quantitative evaluation of commercial web sites: an empirical study of Spanish firms, *International Journal of Information Management* 24(4): 313–328. http://dx.doi.org/10.1016/j.ijinfomgt.2004.04.009

Mittal, H.; Sharma, M.; Mittal, J. P. 2012. Analysis and modelling of websites quality using fuzzy technique, *Second International Conference on Advanced Computing & Communication Technologies*, 7–8 January 2012, Rohtak, Haryana, 1015. http://dx.doi.org/10.1109/ACCT.2012.25

Mohanty, R. P.; Seth, D.; Mukadam, S. 2007. Quality dimensions of e-commerce and their implications, *Total Quality Management* 18(3): 219–247. http://dx.doi.org/10.1080/14783360601149992

Moustakis, V.; Tsironis, L.; Litos, C. 2006. A model of website quality assessment, *The Quality Management Journal* 13(2): 22–37.

Negash, S.; Ryan, T.; Igbaria, M. 2003. Quality and effectiveness in web-based customer support system, *Information & Management* 40(8): 757–768. http://dx.doi.org/10.1016/S0378-7206(02)00101-5

Palmer, J. W. 2002. Website usability, design and performance metrics, *Information Systems Research* 13(2): 151–167. http://dx.doi.org/ 10.1287/isre.13.2.151.88

Podvezko, V. 2011. The Comparative Analysis of MCDA Methods SAW and COPRAS, *Inzinerine Ekonomika – Engineering Economics* 22(2): 134–146. http://dx.doi.org/10.5755/j01.ee.22.2.310

Ranganathan, C.; Ganapathy, S. 2002. Key dimensions of business-to-consumer Web sites, *Information Management* 39(6): 457–465. http://dx.doi.org/10.1016/S0378-7206(01)00112-4

Rolland, S.; Freeman, I. 2010. A new measure of e-service quality in France, *International Journal of Retail & Distribution Management* 38(7): 497–517. http://dx.doi.org/10.1108/09590551011052106

Roxas, M. L.; Peek, L.; Peek, G.; Hagemann, T. 2000. A preliminary evaluation of professional accounting services: direct marketing on the Internet, *Journal of Service Marketing* 14(7): 595–606. http://dx.doi.org/10.1108/08876040010352763

Saaty, T. L. 1980. *The analytic hierarchy process*. New York: McGraw Hill. 287 p.

Sahu, N. K.; Datta, S.; Mahapatra, S. S. 2012. Establishing green supplier appraisement platform using grey concepts, *Grey Systems: Theory and Application* 2(3): 395–418.

Shee, D. Y.; Wang, Y. S. 2008. Multi-criteria evaluation of the web-based e-learning system: a methodology based on learner satisfaction and its applications, *Computers & Education* 50(3): 894–905. http://dx.doi.org/10.1016/j.compedu.2006.09.005

Smith, G. 2001. Applying evaluation criteria to New Zealand government websites, *International Journal of Information Management* 21(2): 137–149. http://dx.doi.org/10.1016/S0268-4012(01)00006-8

Sun, C. C.; Lin, G. T. R. 2009. Using fuzzy TOPSIS method for evaluating the competitive advantages of shopping websites, *Expert Systems with Applications* 36(9): 11764–11771. http://dx.doi.org/10.1016/j.eswa.2009.04.017

Swaid, S. I.; Wigand, R. T. 2009. Measuring the quality of e-service: scale development and initial validation, *Journal of Electronic Commerce Research* 10(1): 13–28.

Tavana, M.; Momeni, E.; Rezaeiniya, N.; Mirhedayatian, S. M.; Rezaeiniya, H. 2013. A novel hybrid social media platform selection model using fuzzy ANP and COPRAS-G, *Expert Systems with Applications* 40(14): 5694–5702. http://dx.doi.org/10.1016/j.eswa.2013.05.015

Torkzadeh, G.; Dhillon, G. 2002. Measuring factors that influence the success of Internet commerce, *Information Systems Research* 13(2): 87–204. http://dx.doi.org/10.1287/isre.13.2.187.87

Tsai, W. H.; Chou, W. C.; Lai, C. W. 2010. An effective evaluation model and improvement analysis for national parks websites: a case study of Taiwan, *Tourism Management* 31(6): 936–952. http://dx.doi.org/10.1016/j.tourman.2010.01.016

Turskis, Z.; Zavadskas, E. K.; Peldschus, F. 2009. Multi-criteria optimization system for decision making in construction design and management, *Inzinerine Ekonomika –Engineering Economics* 1: 7–17.

Viteikiene, M.; Zavadskas, E. K. 2007. Evaluating the sustainability of Vilnius city residential areas, *Journal of Civil Engineering and Management* 13(2): 149–155. http://dx.doi.org/10.1080/13923730.2007.9636431

Wan, C. S. 2002. The web sites of international tourist hotels and tour wholesalers in Taiwan, *Tourism Management* 23(2): 155–160. http://dx.doi.org/10.1016/S0261-5177(01)00048-6

Webb, H. W.; Webb, L. A. 2004. SiteQual: an integrated measure of web site quality, *Journal of Enterprise Information Management* 17(6): 430–440. http://dx.doi.org/10.1108/17410390410566724

Wu, F.; Mahajan, V.; Balasubramanian, S. 2003. An analysis of e-business adoption and its impact on business performance, *Journal of the Academy of Marketing Science* 31(4): 425–447. http://dx.doi.org/10.1177/0092070303255379

Yang, Z.; Cai, S.; Zhou, Z.; Zhou, N. 2005. Development and validation of an instrument to measure user perceived service quality of information presenting Web portals, *Information & Management* 42(4): 575–589. http://dx.doi.org/10.1016/S0378-7206(04)00073-4

Yu, X.; Guo, S.; Guo, J.; Huang, X. 2011. Rank B2C e-commerce websites in alliance based on AHP and fuzzy TOPSIS, *Expert Systems with Applications* 38(4): 3550–3557. http://dx.doi.org/10.1016/j.eswa.2010.08.143

Zavadskas, E. K.; Kaklauskas, A.; Sarka, V. 1994. The new method of multicriteria complex proportional assessment of projects, *Technological and Economic Development of Economy* 1(3): 131–139.

Zavadskas, E. K.; Kaklauskas, A.; Turskis, Z.; Tamosaitiene, J. 2008. Selection of the effective dwelling house walls by applying attributes values determined at intervals, *Journal of Civil Engineering and Management* 14(2): 85–93. http://dx.doi.org/10.3846/1392-3730.2008.14.3

Zavadskas, E. K.; Turskis, Z. 2011. Multiple criteria decision making (MCDM) methods in economics: an overview, *Technological and Economic Development of Economy* 17(2): 397–427. http://dx.doi.org/10.3846/20294913.2011.593291

Zech, C.; Wagner, W.; West, R. 2013. The effective design of church web sites: extending the consumer evaluation of web sites to the non-profit sector, *Information Systems Management* 30(2): 92–99. http://dx.doi.org/10.1080/10580530.2013.773800

Zeithaml, V. A. 2002. Service excellence in electronic channels, *Managing Service Quality* 12(3): 135–138. http://dx.doi.org/10.1108/09604520210429187

Zhou, T.; Lu, Y.; Wang, B. 2009. The relative importance of website design quality and service quality in determining consumers' online repurchase behavior, *Information Systems Management* 26(4): 327–337. http://dx.doi.org/10.1080/10580530903245663

Zopounidis, C.; Doumpos, M. 2002. Multi-criteria decision aid in financial decision making: methodologies and literature review, *Journal of Multi-Criteria Decision Analysis* 11(4–5): 167–186. http://dx.doi.org/10.1002/mcda.333

Fatih ECER is an Assistant Professor of Operations Research in the International Trade and Finance, Faculty of Economics and Business Administrations, University of Afyon Kocatepe, Turkey. He holds a BSc in Mathematics from Dokuz Eylul University, Izmir, Turkey, and a MSc and PhD in Business Administrations from University of Afyon Kocatepe, Turkey. His work has been published, or is forthcoming, in high quality international journals. His current research interests are in the Multiple Criteria Decision Making (MCDM), optimization, Artificial Neural Networks (ANNs), and data mining.