



USING MULTI CRITERIA DECISION MAKING APPROACHES FOR EVALUATING AND SELECTING WEBSITE: A LITERATURE REVIEW

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ABSTRACT

The number of publications dedicated to website service quality evaluation and selection problem studies has been increased in recent years. Various decision making techniques and service quality factors have been proposed to solve the problem. Increasing usage of the Website for commercial purposes, an increase in customer expectations and competition for the assessment of changes in the web site rather than a single factor made it necessary to focus on many factors. This paper reviews the literature of the multi criteria decision making approaches for evaluating and selecting website. Related papers appearing in the international journals and papers presented at conferences 2005-2016. The paper thus provides a review of articles and papers about the factors used in evaluating the quality of website services and used in the selection of website reveals the multi-criteria decision-making approach. This research helps the researchers and decision makers in applying the approaches effectively.

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INTRODUCTION

Nowadays, the internet is the most widely used and an effective tool for organizations/firms to reach their customers by their websites. The decision makers at e-business companies have continued to make vast investments in developing websites for e-business without having clear knowledge of what factors contribute to developing a high quality website and how to measure the effects on e-business success. Extensive multi-criteria decision making approaches have been proposed for web site quality evaluation, such as the analytic hierarchy process (AHP), analytic network process (ANP), case-based reasoning (CBR), data envelopment analysis (DEA), fuzzy set theory, genetic algorithm (GA), mathematical programming, simple multi-attribute rating technique (SMART), VIKOR, Electre I, Electre II, Grey relational analysis (GRA) and their hybrids.

There is no journal article reviewing the literature regarding Website service quality evaluation and selection models. We decided to focus our study on articles published in journals and papers presented at conferences, not therefore including sources such as books, book reviews. We searched the Academic Search Complete (Ebscohost), Business Source Complete (Ebscohost), Emerald, IEE Xplore, Ingenta, JSTOR, MetaPress, ProQuest, Sage Journals Online, Science Direct, Springer Link, Taylor and Francis and Wiley Online Library databases for articles with the terms analytic hierarchy

process (AHP), analytic network process (ANP), case-based reasoning (CBR), data envelopment analysis (DEA), fuzzy set theory, genetic algorithm (GA), mathematical programming, simple multi-attribute rating technique (SMART), VIKOR, Electre, Grey relational analysis (GRA), without limiting the search date in their abstracts or keywords or full text. We obtained a total initial sample of 265 English papers, a hundred and fifty-nine of which were removed from the study because of being large sample size. A total of 106 papers therefore retained in the final sample; these were read carefully. Our aim was to analyse the multi criteria decision making approaches for evaluating and selecting website literature to answer the questions such as: what decision making methods are most commonly used? What web site quality topics decision making methods are treated the most often in the literature? What is the scope of these studies? Which countries stand out in the research about the phenomenon?

The paper is organized as follows: Sections 2 and 3 describe the individual approaches and integrated approaches. Section 4 analyses the most extensively used approaches, discusses the most prominent evaluating criteria. Section 5 suggests for future work. Section 6 concludes the paper.

Individual Approaches

Analytic Hierarchy Process (AHP)

Twenty six out of one hundred and six articles (25%) applied AHP in the website evaluation and selection process. Guo and

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Shao (2005) proposed the analytic hierarchy process (AHP) to measure the web sites of Chongqing Foreign Trade Enterprises focuses on three categories: site content, functional service and construct quality. Lee and Kozar (2006) investigated website quality factors, their relative importance in selecting the most preferred website, and the relationship between website preference and financial performance applying an analytic hierarchy process. The model consists of four major website quality factors including information quality, service quality, systems quality, and vendor-specific quality.

Colace, De Santo and Pietrosanto (2006) proposed a model for describing, characterizing and selecting E-Learning platform using the Analytic Hierarchy Process (AHP). Wang, Yeh and Jiang (2006) proposed that different weights on these nine fundamental concerns are assigned by different lifestyle individuals. This study indicated that privacy, safety, and product quality were the most critical concerns of on-line consumers. Wang and Liu (2007) described the usability and usability evaluation of B2C Web site. A comprehensive set of usability guidelines developed by Microsoft (MUG) was revised and utilized. The weights of each indexes and sub indexes were decided by AHP (Analytical Hierarchy Process). Godse, Sonar and Mulik (2008) proposed analytical hierarchy process (AHP) approach for prioritizing web service features. Security of service, Quality of service, Business agreement factors and 12 attributes evaluated by authors. Tran, Tsuji and Masuda (2009) proposed a novel approach for designing and developing a QoS ontology and its QoS-based ranking algorithm for evaluating Web services using Analytic Hierarchy Process (AHP).

Guo and Zhao (2009) applied an analytic hierarchy process (AHP) approach to evaluate the information service quality of ten primary high-tech industry information center web portals in China. Authors proposed a modified evaluation criteria model consists of five major criteria to measuring the information service quality of HIIC web portals, including the usefulness of content, adequacy of information, specialization, easy of use and interaction. Ku and Fan (2009) proposed the analytic hierarchy process (AHP) method based on the customer-value perspective, this study focused on exploring the relative weights of the nine proposed fundamental purchasing travel products from an Internet perspective. The results showed privacy, safety, and product quality were the three most important factors influencing customer purchases of room products on the internet.

Delice and Gungör (2009) presented the usability problems of web sites. Heuristic Evaluation (HE) was used to identify the usability problems, and Analytic Hierarchy Process (AHP) was used to rate their severity. Yuan and Yuan (2009) established the model of integrated assessment of e-government website based on the basic principle of the Analytic Hierarchy Process (AHP). Authors established the index system of assessing e-government website, this is the index system of hierarchical structure and these indexes are divided three layers; Aim layer has one criteria, second layer has five criterias and third layer has nineteen criterias. Sanga and Venter (2009) presented the analytical hierarchy process algorithm is suitable for the evaluation of software by the evaluators with little information Technology experience. The scope of the research was the evaluation of two free and open source e-learning systems at the Open University of Tanzania

using 33 stakeholders with diverse levels of Information Technology experience. Model included three main indicator systems (Usability, maintainability, deployability) and Functionality, Reliability, Efficiency, Portability, Maintainability), eighteen sub criterias and thirty eight attributes. Wang and LiaoNing (2010) aimed the actual situation of China government websites construction in view of user and references on other research result of government websites performance evaluation using AHP to evaluate the transparency of information, the site infrastructure, online services, public participation.

Yao, Yao and Feng (2010) proposed an e-government public satisfaction measurement index system and evaluated the usage of government portal sites in Chongqing. Zhao (2010) investigated the satisfaction of college students on the existing C2C E-Commerce web sites through the scientific methods of AHP. Dumitrache (2010) presented the cycle of development of e-Commerce applications. Author presented the criteria for e-Commerce applications which are grouped into 4 main categories: information quality, service quality, systems quality, and vendor specific quality. Yu (2010) constructed e-commerce service quality (ESQ) index system using an analytic hierarchy process (AHP) approach to measure the service quality in e-commerce environments. The criteria in this study include information quality, website design and responsiveness.

Liu, Wang and Xie (2010) established e-government web site evaluation index system using analytic hierarchy approach process. The model has content, function, technology and other criterias. Kumar and Zayaraz (2011) proposed a web service selection model using the Analytic Hierarchy Process which was used to select the best web service based on QoS Constraints. Authors described response time, throughput, reliability, availability and cost parameters which will be optimized and ranked by the Analytic Hierarchy Process. Abdellatief et al. (2011) proposed a new technique to evaluate e-learning website quality from developer's view using AHP technique and the result of trial evaluation for validation of author's technique. Authors proposed four quality characteristics named Service Content, System Functionality, Information Technology and System Reliability.

Zhao (2011) established B2C e-commerce site evaluation system Based on the principle of AHP. Author proposed the Web site product factors, price factors, service factors, and credibility factors as the first indicators to evaluate B2C e-commerce web sites. Kargar (2011) adapted the AHP methodology to the measurement of the selected 18 information quality criteria priorities. The results showed that there are significant differences for priorities in Blog context in compare of common Websites. Yeh and Lin (2012) presented a hierarchical model constructs four dimensions of Curriculum, Instruction, Interaction, and System based on the concept of e-learning. Xiao, Jun and Yibo (2012) applied the analytic hierarchy process to evaluate the education of the content of the web site and function of the assessment. Authors put forward a set of applicable index system, and there are 6 indicators in Level 1, such as navigation design, retrieval function, etc. There are about 19 indicators in Level 2, such as link quality, link quantity, retrieval method etc. Kurt and Atrek (2012) classified and assessed the importance levels of the quality attributes of E-S-QUAL measurement scale based on the analytical hierarchy process (AHP). The

results showed Privacy dimension was found to be a high value-added attribute, whereas the least important attributes were found to be within the efficiency dimension. None of the quality attributes of E-S-QUAL were regarded as attractive attributes.

Garg *et al.* (2012) the analytic hierarchy process (AHP) was used in order to evaluate the identified 14 critical factors of CE and to find their priorities for success in banking organizations.

Data Envelopment Analysis (DEA)

There are eleven (10 %) out of 106 journal articles proposing DEA to deal with the website evaluation and selection problem.

Kamis and Davern (2005) applied to DEA to measure Novice Category, Purchase Involvement, Perceived Time Pressure, perceived ease of use, Perceived Usefulness, Decision Quality constructs. Jiang and Talaga (2006) explored the relationship between satisfying customers and building a customer base using the data envelopment analysis (DEA). Authors analyzed e-retailing industry related to the input variables (e.g. customers' ratings on a set of e-store attributes) and output variables (e.g. a proxy measure of "customer base").

Hsu, Chen and Wang (2009) investigated the efficiency and satisfaction of electronic records management systems (ERMS), which has been of interest to archivists and records managers, in electronic government (e-government) agencies in Taiwan. The Study applied dataenvelopment analysis to measure the relative efficiency and satisfaction in different types of e-government agencies. This investigation employed the IS success standard to efficiency assessment based on four different categories: System quality, Information quality, Service quality, user satisfaction. Storto (2009) proposed an approach based on the adoption of a distributed cognition framework and a non parametric multicriteria evaluation methodology (DEA) designed specifically to compare e-commerce websites from the consumer/user viewpoint. In total, 9 variables are measured, classified in a set of 3 website macro-dimensions (user experience, site navigability and structure). Nine evaluating factors were considered in the model, in which six inputs and three outputs.

Zheng, Jianbiao and Xiaoyi (2009) The method for website efficiency analysis, DEA, proposed in this paper, avoids the defect that focusing on output while ignoring input, emphasizing on the choose of index while neglecting the objectivity of weight, enriches the method and theory of the website efficiency analysis, and promotes the development of the wholewebsite service level and quality. Twelve evaluating factors were considered in the model, in which seven inputs and five outputs.

Huang and Fu (2009) proposed a parsimonious and effective multidimensional evaluation tool: a max–min approach to combine the hygiene–motivation factors and thereby provide a strategy to compare the competitive position of different web sites. Four hygiene factors (navigation, information display, ease of learning and response time) and five motivation factors (interaction with people, screen complexity, user empowerment, visual appearance and achievement) are measured. Authors segmented web sites into

three 'zones' based on their effectiveness scores. Lee, Lee and Yoon (2010) proposed a website development strategy for e-Commerce success by not only investigating website quality factors, their relative importance in choosing preferred website, but also finding which quality factors should be modified and enhanced for e-Commerce Success. Authors presented a methodological contribution by demonstrating the use of data envelopment analysis (DEA), a linear programming methodology to measure the efficiency of multiple decision making units, to IS research. Liu (2012) DEA was adopted to evaluate the quality of E-commerce website and a quality diagnosis method was proposed based on DEA. Product list page, Promotion page, Product page, Shopping cart page, Order process pages, Checkout pages were considered as inputs, whereas Basket Size was used as output. Luna *et al.* (2012) applied DEA to calculate an efficiency score based on some portal characteristics (outputs) such as information, interaction, transaction, integration, and participation, and some organizational, institutional and contextual factors (inputs) such as government capacity, potential demand, and operation cost. model has six input variables and five output variables.

Hsieh, Huang and Yen (2013) applied DEA to measure the effectiveness and efficiency of Taiwan's established, city- and county-level (25 cities and counties, and 1411 governmental units) governments' websites. The study compares the governments' levels of effective performance by using a geographical map to display Taiwan's four geographical regions: North, Center, South, and East (including off-shore islands). The authors used five criteria: Information Richness, Information Diversity, Design for Audience, Privacy and Security policy claims, Interactivity. Storto (2013) presented an integrative framework to evaluate e-commerce website efficiency from the user viewpoint using Data Envelopment Analysis (DEA). The proposed framework was inspired by the concepts driven from the theories of information processing and cognition and considers the website efficiency as a measure of its quality and performance. 9 variables were measured, classified in a set of 3 website macro-dimensions (user experience, site navigability and structure).

Mathematical programming

Six papers (6 %) formulated the website evaluation and selection problem as various types of mathematical programming models.

Linear programming

Saddik and Liu (2009) proposed a web service selection framework by introducing a QoS-based cost function concept to choose a few web services from a given service community according to their cost function. Then, authors composed them together to find the optimal composite service. Xiong, Fan, and Zhou (2009) presented a service functional configuration net based on Petri nets for the web service presentation and automatic assembly. The configuration specifications for the module and component services were described through the structure of disassembly Petri nets. The graph structure and algebraic properties of the model were analyzed in detail to show that a basis solution of a state-shift equation of the Petri net model corresponds to a realizable

configuration process. The proposed approach in this paper lacked such features as concurrency and synchronization.

Integer linear programming

Ardagna and Pernici (2007) introduced a new modeling approach to the Web service selection problem that is particularly effective for large processes and when QoS constraints were severe. In the model, the Web service selection problem was formalized as a mixed integer linear programming problem, loops peeling was adopted in the optimization, and constraints posed by stateful Web services were considered. Authors presented an optimization approach for the composition of Web services using the dynamic service selection which allows specifying constraints on quality requirements for the user both at local and global level, and to fulfill constraints at runtime through the adaptive reoptimization under variable QoS characteristics of Web services. Huang, Li and Wei (2008) proposed an efficient approach for multi-QoS constrained Web Services selection. Authors considered multiple QoS attributes such as price, duration and reliability, taking into account the global constraints, and use the integer linear programming method to solve the service selection problem, which is too complex for run time decisions.

Mixed integer linear programming

Jang, Shin and Lee (2006) presented a fast method for quality driven composite Web services selection based on a workflow partition strategy. The proposed method partitions an abstract workflow into two sub-workflows to decrease the number of candidate services that should be considered. A mixed integer linear programming was utilized for solving the service selection problem. Experimental results showed that the partition strategy performed faster than the optimal strategy. Also, the qualities of the selected composite Web services were not significantly different from the optimal one.

Goal programming

Kattepur, Georgantas and Issarny (2013) proposed goal programming approach to choose Pareto optimal solutions with respect to diverse QoS domains.

Fuzzy Set Theory

Five papers (5 %) proposed fuzzy set theory in the website evaluation and selection process. Davoli, Mazzoni and Corradini (2005) presented EQT4Web, a quantitative inspector-based methodology for Web site evaluation, with a hierarchical structure. The proposed approach, based on fuzzy operators, permits a sophisticated aggregation of measured atomic quality values, using linguistic criteria to express human experts' evaluations.

Choi *et al.* (2007) proposed a new approach for evaluating the mobile service quality. the proposed approach is based on the fuzzy set theory. Abbaci *et al.* (2011) proposed a novel approach for service retrieval that taken into account the service process model and relied both on preference satisfiability and structural similarity. User query and target process models were represented as annotated graphs, where user preferences on QoS attributes were modelled by means of fuzzy sets. Sumetanupap and Senivongse (2011) applied a concept of interpersonal trust, especially trusting beliefs, to devise a quality of provider model based on competence, benevolence, and integrity of service providers, and trust

score can be computed using the fuzzy set theory. Stanujkic *et al.*, (2015) proposed an approach which is based on the use of a smaller number of criteria that are evaluated using Atanassov fuzzy sets. Also, in order to create a model which as simple as possible, based on Atanassov fuzzy sets, this approach uses the Singleton Intuitionistic Fuzzy Numbers. The proposed approach can be successfully applied to the tourism and hotels industry, as well as to other areas, with the aim of determining the quality of the websites from the first-time visitors' point of view.

Analytic Network Process (ANP)

Among 106 journal articles, three papers (3 %) utilized ANP to evaluate and select website. Godse, Sonar and Mulik (2008) proposed a network model with clusters of elements relevant for web services and solve it as an illustrative case for ANP based web service selection. Calisir *et al.* (2010) The Analytical Network Process (ANP) was used to analyse the relative importance of the usability and functionality factors online auction and shopping web sites by examining two Turkish online-auction and shopping web sites. Hu, Wang and Hung (2012) Analytic Network Process (ANP) approach was chosen as the major analytic tool to discuss and analyse the key aspects and the key criteria.

Integrated Approaches

Integrated Fuzzy and AHP

Fourteen out of one hundred and five articles (14 %) applied integrated AHP and Fuzzy Set Theory to evaluate and select website. Kong and Liu (2005) aimed to find out the key factors that affect success in E-commerce using fuzzy AHP, and give an evaluation method for E-commerce in order to help researches and managers to determine the drawbacks and opportunities. Trust, System quality, Content quality, Online service, Use criterias used to evaluate E-commerce web site.

Liu, Kwon and Kang (2007) a fuzzy analytic hierarchy process (FAHP) approach was used to evaluating e-commerce websites, which can tolerate the vagueness and uncertainty of judgment. Authors divided into a website's quality four aspects as follows: Website basic technique, Web page design, Website information/content, Website function/service.

Deng and Wang (2008) analyzed the characters of E-commerce information system, and built up a evaluation indices. which can be divided into 3 levels, 4 aspects, includes 20 detail indices After that, it chose AHP and fuzzy evaluation method, carried out a integrative evaluation. Ellatif and Saleh (2008) developed an assessment method to evaluate the critical success factors of E-bank portals using Fuzzy AHP & VBA, and give an evaluation method to analyse five quality dimensions: access, web site interface, trust, attention and credibility. Jun and Yu (2008) presented fuzzy analytic hierarchy process model to measure the e-commerce web sites' performance. The study has investigated three web sites the relative importance of site quality, information quality, transaction capability. Fei and Yu (2009) presented a fuzzy multiple-criteria decision making method-Fuzzy Analytic Hierarchy Process based on the trapezoidal fuzzy numbers as the evaluation method to evaluate public satisfaction of e-government. Li and Chen (2009) proposed fuzzy analytical hierarchy process (FAHP) approach to evaluate online bookstores. Research consists of five major criteria that are

identified to achieve the overall goal. Specifically, the five major criteria are price, reputation, website features, service and quality.

Lin (2010) developed an evolution model that integrates the triangular fuzzy numbers and analytic hierarchy process to develop a fuzzy evaluation model which prioritized the relative weights of course website quality factors. Firstly, author conducted a review of the literature on course website quality to generate 16 sub-criteria along with four criteria used to measure course website quality. Secondly, a fuzzy AHP approach was adopted to determine the relative weights linking the above criteria between high and low online learning experience groups. Li and Chen (2010) introduced an AHP-Fuzzy method. Six top B-to-B commercial websites were selected as models of evaluation. Authors set up an indicator system which included three main indicator systems and 10 sub-indicators. Wang, Li and Tian (2010) established an evaluation index system of food enterprise websites from the perspective of user's experience based on the website localization and the current literature, and used the analytic hierarchy process to determine the weight of each level index, and established the fuzzy comprehensive evaluation model of enterprise websites, and carried out a case study with the evaluation index system.

Li and Pang (2011) proposed an AHP-based multi-level fuzzy comprehensive evaluation model for business website assessment. Effectiveness of business, Information of business, Design of business, Availability of system, efficiency of system as the first indexes in the study. Chen (2011) explored the digital capital measures of automated cargo clearance business website. The content analysis and fuzzy analytic hierarchy process were used while collecting and analyzing the data. The research subject was TradeVan, a semi-government controlled web-based service provider. This study has identified four dimensions to measure the digital capital of business website that is Internet relational capital, Internet customer capital, Internet innovative capital, and Internet service capital.

Ip, Law and Lee (2012) adopted a sophisticated approach that analyzes the weights of hotel website functionality. This approach involved triangular fuzzy numbers and an analytic hierarchy process to develop a fuzzy analytic hierarchy process (AHP) model which prioritizes the relative importance of hotel website functionality criteria. A fuzzy AHP approach was used to examine the relative importance of the criteria and sub-criteria of hotel website functionality evaluation. Wang, Chou and Pang (2012) applied fuzzy AHP to evaluate the service quality of online auction. Authors invited fuzzy set theory into the measurement of performance and used AHP in obtaining criteria.

Fuzzy, AHP and TOPSIS

Sixteen papers (15 %) proposed integrated Fuzzy Set Theory, AHP and TOPSIS approaches to deal with the website evaluation and selection problem. Zhang (2008) presented the consumer-oriented criteria for mobile commerce website evaluation and developed a model, including four dimensions: mobile web site quality, enjoyable shopping experience, service quality, and trading risk. Authors utilized an evaluation approach based on fuzzy set theory and TOPSIS to

determine overall performance value and rank of the mobile commerce websites, using triangular fuzzy numbers. Fasanghari and Samimi (2009) presented a m-government performance assessment model by using fuzzy AHP and fuzzy TOPSIS method. Sun and Lin (2009) explored how shopping websites to establish their competitive advantages through technology acceptance factors, website service quality and specific holdup cost factors. Authors adopted the fuzzy TOPSIS as the analytical tool that determined the weights of each criterion by using the fuzzy TOPSIS method based on fuzzy sets in solving MCDM problems. research result showed that the security and trust were the most important factors for improving the competitive advantage of shopping website.

Kaya (2010) proposed a multi-attribute e-business website quality evaluation methodology based on a modified fuzzy TOPSIS approach. The proposed TOPSIS-AHP methodology has nine sub-criteria under four main categories. Fasanghari, Amalnick and Khatibi (2010) proposed the framework of m-government development assessment. The proposed assessment method combined fuzzy AHP and fuzzy TOPSIS. Büyüközkan and Çiftçi (2010) combined fuzzy AHP and fuzzy TOPSIS to evaluate a set of hospital web site alternatives in order to reach to the best qualified alternative that satisfies the expectations of customers. Büyüközkan, Ertek and Arsenyan (2010) an axiomatic design based approach for fuzzy group decision making is adopted to evaluate the quality of e-learning web sites. Another multi-criteria decision making technique, namely fuzzy TOPSIS, was applied in order to validate the outcome. Seyedi *et al.* (2011) proposed a web site quality model according to three main aspects as follows information quality, service quality, system quality, vendor specific quality. The model designed based on fuzzy AHP and fuzzy TOPSIS.

Chen, Tseng and Lin (2011) proposed a recommendation system to provide product selection and negotiation service in the e-store. The proposed system was designed based on FAHP and TOPSIS, and it was helpful to the customers' shopping on the e-stores. Kabir and Hasin (2012) discussed the major factors for travel agency websites quality from the viewpoint of users' perception and explored the use of multiple-attribute decision making (MADM) approaches for the evaluation of TWSQ. A comparative analysis of Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) and Fuzzy TOPSIS methods were illustrated through a practical application from the websites of five travel agencies. Kabir and Hasin (2012) used the fuzzy analytic hierarchy process (FAHP) approach to support a generic on-line retail benchmarking process. on-line retail service provider was benchmarked along with four other on-line service providers using TOPSIS method. Büyüközkan and Çiftçi (2012) proposed e-sq framework which was illustrated with a web service performance example of healthcare sector in Turkey by using a combined multiple criteria decision making (MCDM) methodology containing fuzzy analytic hierarchy process (AHP) and fuzzy technique for order performance by similarity to ideal solution (TOPSIS). Nilashi *et al.* (2012) Proposed a framework, which has three key dimensions service quality, information quality and system quality for online shopping website. Web sites ranked normal TOPSIS and fuzzy- TOPSIS approaches. The

results showed that trust, response time, reliability, responsiveness, empathy, timeliness, accuracy of information, navigation and accessibility are the nine first important parameters in online website quality.

Lee, Chiang, Chen (2012) the evaluation of travel website service quality (TWSQ) is a multiple criteria decision making (MCDM) problem. Authors proposed a hierarchical MCDM evaluation model based on the fuzzy analytic hierarchy process (FAHP) and the fuzzy technique for order preference by similarity to ideal solution (FTOPSIS) methods. Kabir and Sumi (2013) discussed the major factors for travel agency websites' quality from the viewpoint of users' perception, and explored the use of Fuzzy Technique for Order Preference by Similarity to Ideal Solution (FTOPSIS) for the evaluation of TWSQ. Nagpal *et al.*, (2015) proposed Fuzzy Analytic Hierarchy (FAHP) approach, which is extended with Fuzzy TOPSIS approach, where different decision makers (DM's) opinion was considered for ranking the website based on usability.

Fuzzy Linguistic Modelling

Eight out of one hundred articles (8 %) applied Fuzzy Linguistic Modelling to evaluate and select website. Herrera-Viedma *et al.* (2006) presented An evaluation methodology based on fuzzy computing with words aimed at measuring the information quality of Web sites containing documents. Hidalgo *et al.* (2007) presented a quality evaluation model of airline web sites which was based on a fuzzy linguistic approach. Moreno *et al.* (2008) presented a methodology for evaluating the quality of health related Web sites based on the users' perceptions and built with tools of fuzzy linguistic modelling. Herrera-Viedma, L'opez-Gij'on and Ru'iz(2010) presented a model based on a fuzzy linguistic approach to evaluate the quality of digital libraries. Cabrerizo *et al.* (2010) presented a model based on fuzzy linguistic information to evaluate the quality of digital libraries.

P'erez *et al.* (2010) presented a new application based on fuzzy linguistic approach to evaluate the quality of digital libraries, which is defined using users' perceptions on the quality of digital services provided through their Web sites. Moreno *et al.* (2010) presented a qualitative and user-oriented methodology for assessing quality of healthrelated websites based on a 2-tuple fuzzy linguistic approach. Carrasco *et al.* (2012) explored the problem of integrating semantically heterogeneous data (natural language included) from various websites with opinions about e-financial services. Authors developed an extension of the fuzzy model based on semantic translation (FMST) under the perspective of the service quality (SERVQUAL) stream of research.

Other Integrated Techniques

Many other integrated approaches (sixteen papers or 16%) were proposed. Bilsel, Büyüközkan and Ruan (2006) presented a quality evaluation model for measuring the performance of hospital Web sites using the AHP and the fuzzy PROMETHEE. The Model consists of seven major e-service quality dimensions, including tangibles, reliability, responsiveness, confidence, empathy, quality of information, and integration of communication issues of Web sites. Tsai, Leu and Chou (2009) proposed an integrated model for evaluating the airlines' websites in terms of the perspectives of "marketing mix 4Ps" and "website quality".

The DEMATEL, the ANP and the modified VIKOR methods were used for evaluating airlines' websites. Yunning and Jing (2010) built up a systematic index of the e-commerce maturity degree for construction enterprises from the view points of the management environment, technical support, the applying procedures, security and the benefits of e-commerce using the method combined grey relational analysis and the TOPSIS. Shuai and Wu (2011) applied DEA and grey entropy model to analyze the impact of Internet marketing on hotel performance. The model evaluated the hotels' websites in Taiwan from an Internet marketing perspective. Content analysis was used to analyze and compare the marketing practice on Internet. The E-marketing evaluation form consisting of 32 checkpoints. The structured form was developed to access the contents of the web sites for all international tourism hotels in Taiwan. In this study, each web site element was measured using a binary variable, representing whether or not a hotel web site has the particular marketing feature.

Wang and Pang (2011) applied fuzzy set theory and a compromised MCDM method - VIKOR method to evaluate the service quality of online auction. The results showed the most concerned dimension of service quality was Transaction Safety Mechanism and the least was Charge Item. Other criteria such as information security, accuracy and information were too vital. Tsai, Chou and Leu (2011) proposed an integrated model for evaluating airlines' websites effectiveness is. The proposed model was based on the perspectives of "marketing mix 4Ps" and "website quality", in which the DEMATEL, the ANP and the modified VIKOR methods were used for evaluating the airlines' websites effectiveness. Tseng, Lin and Chen (2011) integrated fuzzy set theory and the ANP to develop an evaluation model. The proposed model has 21 criteria and five aspects to measure e-learning system effectiveness. Alptekin and Karsak (2011) employed quality function deployment (QFD), fuzzy linear regression and optimization was presented for e-learning product selection. the proposed methodology employed fuzzy regression to determine the parameters of functional relationships between customer needs and e-learning product characteristics, and among e-learning product characteristics themselves. Kaya and Kahraman (2011) proposed an e-banking website quality assessment methodology based on an integrated fuzzy AHP-ELECTRE approach.

Chou and Cheng (2012) combined the FANP and FVIKOR for evaluating website quality of the top four CPA firms in Taiwan. Chiu, Tzeng and Li (2013) proposed a new hybrid Multiple Attribute Decision Making (MADM) model, combining the Decision Making Trial and Evaluation Laboratory (DEMATEL), DEMATEL-based Analytic Network Process (DANP), and VIšekriterijumsko KOMpromisno Rangiranje (VIKOR) methods. Kardaras, Karakostas and Mamakou (2013) focused on the applicability of fuzzy logic techniques to content presentation and media adaptation. Authors applied Fuzzy Delphi Method (FDM) and Fuzzy Cognitive Maps (FCMs) in order to highlight the services features that were most preferred by the customer and to adapt presentation media and layout. Cebi (2013) an integrated multiple criteria decision making method including Delphi and DEMATEL (DEcision-MAking Trial and Evaluation Laboratory) techniques proposed for determining the importance degrees of the website design parameters.

Nilashi *et al.*, (2015) revealed the real importance level of trust factors on customers' trust and decision making in selecting the appropriate trusted website. Analytic Network Process (ANP) from the Multi-Criteria

Decision Making (MCDM) approaches and fuzzy logic from Artificial Intelligence (AI) approaches were used. Akincilar and Dagdeviren (2014) evaluated the quality of hospitality websites, or more specifically, hotel websites based on a hybrid model including two multi-criteria decision making approaches, namely the Analytic Hierarchy Process (AHP) and Preference Ranking Organisation Method for Enrichment Evaluations (PROMETHEE). Chung *et al.*, (2015) adopted the fuzzy set theory as the measurement of performance and obtain criteria's weights by using AHP. Authors ranked each performance of service quality in VIKOR. Sugiyanto *et al.*, (2016) proposed the improvement of software quality models for academic websites based on multi-perspective approach as follows prospective students, lecturers, and students.

Observations and Recommendations

In this paper, 106 papers, which appeared in the period from 2005 to 2016, solving web site service quality evaluation and selection problem using the multi-criteria decision making approaches were collected. The approaches, including individual and integrated. Some observations based on these papers are made in the following subsections.

The Most Popular Approach

The first objective of this paper is to find out the most popular approach adopted in web site service quality evaluation and selection literature. As found in the previous sections, the individual approaches (52 papers or 49%) and the integrated approaches (54 papers or 51%). The most popular individual approach is AHP, followed by DEA, mathematical programming (Linear Programming, Integer Linear Programming, Mixed Integer Linear Programming), fuzzy set theory, ANP. The Analytic hierarchy process (AHP) is one of the multi-criteria decision-making (MCDM) methods which has been widely used and first was proposed by Saaty. AHP is used as a decision-making tool for considering the priority for different strategies, with the assumption that multiple-criteria problems can be completely expressed in a hierarchical structure. AHP allows a set of complex issues, to be compared with the importance of each issue relative to its impact on the solution to the problem. Since the inception of AHP, numerous applications have been published in the literature (Jain *et al.*, 2013:36). DEA has attracted more attention mainly because of its robustness. In the past, it was used to measure the relative efficiencies of homogeneous decision making units (DMUs) based on numerical data only (Saen, 2006:1610).

There are various integrated approaches for web site service quality evaluation and selection. It was noticed that the integrated AHP approaches are more widespread. The wide applicability is due to its simplicity, ease of use, and great flexibility (Ho, 2008:211; Ho *et al.*, 2010:21; Vaidya and Kumar, 2006:1-2). AHP has been integrated with other techniques, including ANN, bi-negotiation, DEA, fuzzy set theory, GP, grey relational analysis, and multi-objective programming (Ho *et al.*, 2010:21; Jain *et al.*, 2013:35).

Relatively, the integrated Fuzzy and AHP approach is the most popular.

The Most Popular Evaluating Criterion

The second objective of this paper is to discover the most prominent criterion considered by the decision makers for evaluating and selecting the most appropriate web site service quality. Thousands of criteria were proposed. The most prominent criterion is responsiveness, followed by reliability, security, easiness, customization, service quality, navigation, layout, privacy, content, accessibility, availability, accuracy, functionality, products information, design, download speed, transaction, understandability, usability, relevance and links.

There are 52 papers considering the responsiveness in the website service quality evaluation and selection. Various quality related attributes have been found in the papers, such as "System quality", "Service Quality", "Performance", "Responsiveness Quality", "Response time", "Elapse time between a request And response", "Usability factors", "e-service quality", "Portal Interface Quality", "site quality", "Speed", "Customer care", "Quick connection and delivery", "minimal use of large graphics and bright color", "easy access to links", "Responding customer e-mails", "Customer service quality", "Communication", "Interaction", "Help available when problem encountered", "Provide relevant information for solving problem", "Response to customer's complain quickly", "Provide FAQ information service"

The second most prominent criterion is reliability (45 papers). Its related attributes include "Service Quality", "Runtime", "technical quality", "system quality", "Probability that a request successfully invoked the service", "information quality", "Proper website function", "Uncommon occurrence of website crash", "Provide accurate information", "Effective information delivery service", "Staff background", "Institutional information", "Availability of physicians' backgrounds", "resumes and contact information", "Comprehensive", "current, and accurate information relevant to the institution", "External recognition", "Review and awards", "hit counts", "e-quality", "Customer service quality", "security", "Usefulness of content", "Link errors", "Invalid links", "Broken links", "System Performance", "Citizens confidence", "Citizens support", "Probability, maintainability and compliance", "Transaction safety mechanism", "Proper website function", "Effective information delivery service", "Uncommon occurrence of website crash", "Provide accurate information". The third most prominent criterion is security (39 papers). Its related attributes include. "System quality", "Security of service", "quality of service", "Functionality factors", "e-service quality", "Trust", "transaction capability", "Trading risk", "assurance", "Online systems quality", "Security", "technology", "information technology", "System performance", "Website features", "Security of transaction", "Website operation effect", "Organizational business process", "website service quality", "Transaction safety mechanism". Based on the above findings, it was revealed that credibility, learnability and appearance is not the most widely adopted criterion.

Other Observation

The distribution of the 106 papers between 2005 and 2016. It is observed that there is a growth in the study of the web site service quality evaluation and selection problem using the multi-criteria decision making approaches from 2009. The first 4 years (2005-2008) to the recent 5 years (2009-2016), 61 vs. 45. It is estimated that the number will keep increasing in the coming years because of the importance of web sites.

Suggestion for Future Research

Based on the above literature analysis, we put forward the following suggestions for future research. First, pay more attention to topics related to the “Integer non-linear programming”, “Multi-objective programming”, “Case-based reasoning CBR”, “Simple Multi-Attributive Rating Technique”, “Integrated AHP and Bi-Negotiation”, “Integrated AHP and DEA”, “Integrated AHP, DEA and Artificial Neural Network”, “Integrated AHP and GP”, “Integrated AHP and Grey Relational Analysis”, “Integrated AHP and Mixed integer non-linear programming”, “Integrated AHP and multi-objective programming”, “Integrated Fuzzy, AHP, and cluster analysis”, “Integrated Fuzzy and Multi-Objective Programming”, “Integrated Fuzzy and Quality Function Deployment”, “Integrated Fuzzy and SMART”, “Integrated ANN and CBR”, “Integrated ANN and GA”, “Integrated ANP and Multi Objective Programming”, “Integrated ANP and GP”, “Integrated DEA and Multi Objective Programming”, “Integrated DEA and SMART”, “Integrated GA and Multi Objective Programming”, “Genetic algorithm”, “Fuzzy Regression”, “Max–min ant system”, “Fuzzy Grey Correlation TOPSIS”, “ahp cluster”, “Bayesian Belief Networks”, “linear weightage”, “delphi”, “gra and topsis”, “AHP Fuzzy set theory”, “Grey Situation Decision”, “Analytic Network Process and fuzzy preference relations”, “Analytic Hierarchy Process (AHP) and Partial Least Squares (PLSs)”, “AHP and K-Means Clustering”, “AHP-Entropy”, “Analytic Hierarchy Process (AHP) and the Brown–Gibson (BG)”, “the analytic hierarchy process (AHP) and quality function deployment (QFD)”, “Analytic Hierarchy Process and the Weighted Scoring Method”, “AHP and fuzzy PROMETHEE”, “Adaptive Neuro Fuzzy Inference System Approach ANFIS”, “set pair analysis and VIKOR”, “PROMETHEE I-II”, “DEMATEL”, “Fuzzy VlseKriterijumska Optimizacija I Kompromisno Resenje (FVIKOR)”. During the past several years, web site service quality evaluation and selection has focused more on AHP, DEA, Integrated Fuzzy and AHP and Fuzzy, AHP and TOPSIS.

Second, attempt to study new integrated patterns. The above mentioned possible research topics. Third, investigate the relationships and differences between the individual approaches and integrated approaches. Papers have not taken into consideration the impact of evaluating the criterias on applications.

CONCLUSION

Our analysis has shown that the study of evaluating and selecting the most appropriate web site service quality increased since 2009. This paper is based on a literature review on the multi-criteria decision making approaches for the web site service quality evaluation and selection from 2005 to 2016. First, it was found that numerous individual and integrated approaches were proposed to solve the web site

service quality evaluation and selection problem. The most prevalent individual approach is AHP, whereas the most popular integrated approach is Fuzzy, AHP and TOPSIS. Second, it was observed that credibility, learnability and appearance is not the most widely adopted criterion. Instead, the most popular criterion used for evaluating the performance of web site is responsiveness, followed by reliability, security, easiness, customization, service quality, navigation, layout, privacy, content, accessibility and so on.

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