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Review

APPLICATION OF MULTIPLE-CRITERIA DECISION-MAKING TECHNIQUES AND APPROACHES TO EVALUATING OF SERVICE QUALITY: A SYSTEMATIC REVIEW OF THE LITERATURE

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Abstract. The main purpose of this paper is to present a systematic review of multiple-criteria decision-making (MCDM) techniques used in the assessment of service quality. This study reviewed a total of 79 articles from 51 journals, published from 2001 to 2015. Articles were classified into 10 application areas and scopes. Furthermore, articles were categorised based on an author, year, application area, the nationality of the author, technique, a number of criteria, research purpose, gap and research problem, results and outcome. The best criteria were determined in each article. The results of this study revealed that more papers on MCDM were published in 2011 than in any other year. Integrated techniques, analytic hierarchy process (AHP) and fuzzy AHP methods, were ranked as first and second methods in use, respectively. Finally, the airline industry was ranked as the first application area, in which previous studies applied MCDM techniques for the evaluation of the service quality. This research contributes to the existing literature on the service quality and MCDM. The research outputs are valuable to academics scholars and leaders of organisations and industries in the field of service quality evaluation.

Keywords: AHP, airline industry, decision making, literature review, multiple-criteria decision making, service quality, TOPSIS.

JEL Classification C44, L25, M1, M10, M11.

Introduction

The steadily growing amount of literature on service quality covers a variety of interpretations and implementations. At the time of decision making, decision makers attempt to select the best solution. Indeed, a truly best solution can be obtained from a single criterion, which is taken into consideration. In most actual decision-making

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procedures, it is insufficient to make a decision based on one criterion only; rather, a number of inconsistent and non-commensurable objectives must be taken into account. MCDM is applied in situations, which have contradictory criteria to help individuals make decisions in accordance with their preference (Bogetoft, Pruzan 1997). MCDM is associated with the division of a complicated difficulty into smaller parts. Once decisions are made, and issues related to smaller parts of the problem are considered, the parts of the problem are reconstructed to represent an inclusive view of the decision makers (DMs) (Dodgson *et al.* 2009). Meanwhile, the issue of service quality can be measured according to different qualitative and quantitative criteria; the MCDM techniques are appropriate for the assessment of expected service quality. There are many ways to measure the service quality, such as statistical approaches, analysis of multicriteria satisfaction for benchmarking, AHP, VIKOR (VIsekriterijumska optimizacija i KOmpromisno Resenje), fuzzy AHP, Preference Ranking Organisation Method for Enrichment Evaluation (PROMETHEE), and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS).

This literature review identified a substantial body of literature on the application of MCDM techniques and approaches used to address service quality problems. During this review, we attempted to outline a number of major MCDM approaches and techniques offered throughout the years and ways various approaches and techniques have been used for service quality problems in various industries such as the airline industry, the tourism industry, the healthcare industry, etc. The examples were selected to give an extensive overview of all approaches and techniques that have been applied to service quality problems. This article also evaluates the most important advantages of various approaches and techniques and the difficulties they might face. Furthermore, this article attempts to review those selected articles based on various perspectives, such as an author, year, application area, the nationality of the author, technique and approach, a number of criteria, scope, research purpose, gap and research problem, results and outcomes. The best criteria are determined in each article. Finally, this study argues that MCDM is practical for solving problems related to the service quality and involving multiple resources; however, this type of problems has not yet been examined in any MCDM review study.

1. Literature review

1.2. Service quality, MCDM and its application areas

Delivering, building, understanding and maintaining better service quality are the major concerns of every industry today. Service quality expectation was used to describe service predictions, an ideal standard, an attribute of importance, and customer evaluation of the service quality (Tseng 2009a). The main purpose of evaluating the service quality is to measure service performance, diagnose service problems, manage service delivery, and provide the optimal service for all customers (Li 1997). Many methods can be used to study the service quality. MCDM techniques have been formulated to evaluate the service quality in various application areas such as the airline industry, websites and

Internet services, tourism and the hospitality industry, the healthcare industry, other transportation industries, the manufacturing industry, the banking sector, the education sector and service organisations. MCDM techniques were extensively applied in ranking a limited amount of decision alternatives characterised through multiple, typically conflicting attributes; those techniques are mainly suitable for the decision problems where it is actually more significant and necessary to attain a cardinal preference or ranking of the substitutes in service quality issues. In this section of the paper, we attempted to show the important role of MCDM techniques in 10 areas of application for the service quality. In recent years, MCDM techniques were used in different application areas by other scholars for the evaluation of the service quality issue.

1.2.1. Airline industry and service quality

The airline industry plays an important role for the service sector itself as well as contributes significantly to other industries through the ability to transport passengers to their required locations all over the globe (Rhoades, Waguespack Jr 2008). Generally, competitive policies of airlines focus on the price, service matters, and service quality. The level and quality of service can affect the competitive advantage of an airline through client support, and with this comes a market portion and, eventually, effectiveness (Ozment, Morash 1994). The service quality of airline companies can be influenced by the concerns and gratification of customers and relates to a number of important issues concerning charges and productivity of the companies. Generally, the decision-making procedure for the assessment of the service quality is considered one of the several necessities with indefinite circumstances and should be considered concurrently. Several precision-based MCDM approaches for assessing the service quality in aircraft manufacturing, and choosing substitutions were improved, with most of the substitutes associated with the synthesized rankings. These investigations were related to the doubt and/or imprecise numeric values of decision data and the subjectiveness of human behaviour. According to findings of Table 1, 18 of previous studies used MCDM techniques in the airline industry. Other information details, such as the number of criteria, resarch purpose, gap and research problem, results and outcome and the best criteria for this category, are presented in Table 1.

1.2.2. Websites and Internet services, MCDM and the service quality

The rise of the Internet has changed the decision-making behaviour of consumers, and information sharing in social media has become an important reference for consumers making purchasing decisions (Elzinga *et al.* 2009). In recent years, social media and other types of Internet communities have become mainstream all over the world, with increasing numbers of individuals and businesses getting involved in social media activities (Edelman 2010). Therefore, Internet service quality must also be considered. MCDM is capable of dealing with multiple dimensions of evaluation problems and is a rapidly developing area of operational research and management science (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.

Table 1. Distribution of articles on the airline industry, MCDM and the service quality

Author (s)	Technique and approach	Number of criteria	Research purpose	Gap and research problem	Results and outcome	Best criteria
(Kuo, Liang 2011)	VIKOR with GRA	7	Provide an effective method for the assessment of the SQ of international airports of Northeast Asia.	Evaluation of service levels of each service item of international airport services has become an important issue for airport management.	The study results showed that this approach is effective means for tackling MCDM problems involving subjective assessments of qualitative attributes in a fuzzy environment.	Information visibility
(Liou *et al.* 2011b)	VIKOR	28	Enhancement of the SQ in domestic airlines of Taiwan.	In a competitive environment, delivery of a high-quality service is important; however, since the global economic downturn of 2008, airlines have been struggling just to survive.	Findings isolated important factors that airlines may wish to focus on and those in which airlines have already done well and can reduce their efforts without affecting the overall service level.	Cabin service except for the variety of newspapers and magazines
(Kuo 2011)	Fuzzy VIKOR with GRA	14	Evaluate the quality of service in Chinese cross-strait passenger airlines.	Authors of this paper argued that previous articles did not show service levels and did not measure effectively services provided to an air travel passenger.	Results of this study indicated that flight security and safety are important criteria.	Flight security and safety
(Tsaur *et al.* 2002)	Fuzzy TOPSIS and AHP	15	Evaluation of the SQ of an airline industry.	The need to identify the evaluation criteria for the SQ of an airline.	The study found that the most concerned aspects of the SQ are tangible and the least one is empathy.	Courtesy of attendants
(Liou, Tzeng 2007)	AHP, GRA and SAW	10	Assessment and enhancement of the SQ of the airline industry.	Authors of this paper believed that the evaluation of the service quality of a website was not correct based on conventional additive measures.	Results indicated that safety and reliability emerges as the critical factors of the service quality.	Safety
(Tsai *et al.* 2011)	VIKOR and AHP	12	Improving the SQ of an airport.	There is a gap between passenger perceptions (perceived service quality) and their expectations (expected service quality) in relation to an airport.	Empirical results were from the analysis of the airport in Taiwan and culture as a significant influence in marketing management; the results may not be generalized broadly.	On-time departure of flights, information board.

Continue of Table 1

Author (s)	Technique and approach	Number of criteria	Research purpose	Gap and research problem	Results and outcome	Best criteria
(Toosi, Kohanali 2011)	fuzzy AHP and fuzzy TOPSIS	44	Assessing the SQ of Iranian airlines.	There is a lack of evaluation of the SQ of airlines of Iran.	Results show that the important criteria are comfort flight safety, knowledgeable employees able to answer customer questions, flights without delays, comfortable air-conditioning on the plane, rapid announcement of scheduled flights and the option to cancel or delay flights.	Comfort of a flight, safety
(Wang *et al.* 2011)	Fuzzy DEMATEL	19	Assessment of customer perceptions based on the SQ of the airline industry.	The need to evaluate consumer perceptions in the airline industry.	Results of this study indicated that, it is important to provide committed services, professional training of flight attendants and accuracy of various operations.	Truly providing committed services, professional training of flight attendants
(Wang 2014)	DEMATEL	19	Evaluation of the service quality in the airline industry.	In practical industrial operations with limited resources, there is an urgent need to delve into the assessment guidelines that have an impact on customers when they choose an airline, which can be used as a basis for improving customer satisfaction.	Results show that aviation safety and consumer feelings of comfort during the flight have become the most important evaluation criteria that affect the quality of airline services.	Aviation safety
(Liou *et al.* 2011a)	GRA and TOPSIS	28	Modified GRA to examine the SQ of four major domestic Taiwan airlines.	It is necessary for managers of an airline to control customer requirements.	Results indicate that the factor of cabin service except for the variety of newspapers and magazines is a significant factor.	Cabin service except for the variety of newspapers and magazines.
(Y. Kazançoğlu, İ. Kazançoğlu 2013)	Fuzzy TOPSIS	23	Finding the SQ criteria of Turkish domestic airlines.	In a highly competitive environment, where all airline companies have comparable fares and similar frequent flyer programs, airlines are forced to seek for competitive advantage in the field of the service quality.	Among the twenty-three service sub-criteria, the most important attributes are 'personnel attention to passengers', 'cleanliness of restrooms', 'safety of aircraft' and 'friendliness and helpfulness of flight crew toward passengers'.	Personal quality

End of Table 1

Author (s)	Technique and approach	Number of criteria	Research purpose	Gap and research problem	Results and outcome	Best criteria
(Nejati *et al.* 2009)	Fuzzy TOPSIS	22	Ranking the SQ criteria of the airline industry.	The need to identify and prioritise Iranian customer needs and expectations for airlines in the current competitive market.	The results show that "flight safety", "good appearance of flight crew" and "offering highest possible quality services to customers 24 hours a day" are the most important factors of the service quality of an airline in the eyes of Iranian customers.	Flight safety
(Liou 2011)	Dominance-based Rough Set Approach	28	Used Dominance-based Rough Set model for evaluation of service strategies in the airline industry by collecting decision roles.	The need to study the evaluation of service quality by using Dominance-based Rough Set model.	Findings of this paper indicated that an airline can be improved providing more convenience and information, although, an airline can enhance more by good information on the check-in process and baggage handling.	Information
(Lupo 2015)	Fuzzy ELECTRE III	20	Assessment of the service quality of international airports.	Authors of this paper believed the assessment and accuracy are important for the quality of passenger service.	Outcomes of this study indicate that some aspects of the service quality are the main contributors to the quality of airport service.	Safety and security
(Chien-Chang 2012)	Fuzzy MCDM	20	Assessment of the quality of an airport service.	The need to evaluate the quality of an airport service.	Results show that efforts to improve the Kaohsiung International Airport and the Taoyuan International Airport should be concentrated on seven and five specific service items, respectively.	Availability of information displays with flight information
(Chou *et al.* 2011)	Fuzzy AHP	33	Evaluate the quality of service of the international air travel transportation industry.	There are few previous studies, which assess the quality of service in the airline industry based on the weighted SERVQUAL measurement.	Results of this paper indicated that reliability, assurance and responsiveness are important dimensions of the service quality and safety is the most important criteria.	Safety
(Chang, Yeh 2002)	Multicriteria analysis	15	Evaluation of all customers on SQ levels.	The need to understand how customers view their services in comparison to those of competitors.	These evaluation results would help airlines to better manage their competitive advantages and provide an incentive for the improvement of quality levels of specific services also provided by their competitors.	Security related accidents
(Cheng *et al.* 2005)	Fuzzy OWA	15	Present a novel aggregation model for the SQ evaluation.	There is a lack in evaluation of the SQ by using an aggregation model.	Results of this paper found that courtesy is an important factor of the service quality.	Courtesy

In order to obtain the evaluation criteria and preference structure, such as the quality of Internet service, hierarchical analysis must be carried out (Shee, Wang 2008). Over the past decades, there has been a large number of refined MCDM methods developed for the evaluation of service quality and Internet service 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). Based on findings provided in Table 2, 16 researchers applied MCDM techniques for the evaluation of the quality of services offered on websites and Internet. Other information, such as the number of criteria, research purpose, gap and research problem, results and outcome, and the best criteria for this category, is presented in Table 2.

1.2.3. Tourism and hospitality industry, MCDM and the service quality

The assessment of the service quality in the hotel industry is considered an on-going procedure, which needs constant monitoring for maintaining high stages of the service quality through several service areas (qualities). The assessment must be founded on a comparative procedure, which permits managers to recognise areas of service development or deterioration below some previously set standard of performance. Therefore, the assessment consequences might be applied by CEOs as means for benchmarking of several service areas. Identifying the most insignificant factors that impact on service quality is considered important. It can help CEOs of hotels focus on issues having the maximum weight and find the best strategy for the development of the hotel efficiency. The question is how to assess the relative significance of these factors. They may be measured as a multiple-attribute decision-making problem. At present, many MCDM methods for assessing the quality of hotels are promoted by public authorities and private companies. Previous studies used the MCDM technique for evaluation of the service quality in the tourism and hospitality industry. Based on outcomes of Table 3, 13 previous studies used MCDM techniques for the assessment of the service quality in the tourism and hospitality industry. Other information, such as the number of criteria, the research purpose, gap and research problem, results and outcome, and the best criteria for this category are presented in Table 3.

1.2.4. Healthcare industry, MCDM and the service quality

In the healthcare industry, the service quality dates back to the mid-19th century. Faced with continuous competitive pressure, a growing number of medical providers have realised that being able to provide good healthcare service quality is the most important factor in ensuring the future success (Min *et al.* 1997). For patients, quality and effectiveness of hospitals are two major concerns when seeking for healthcare services. If patients are not satisfied with the service quality provided by a hospital, they will seek for healthcare services elsewhere. Hospitals, therefore, have to enhance their healthcare quality and efficiency in order to retain their existing patients and attract new ones (Chang *et al.* 2011). To manage the challenges of globalisation and intensive competition successfully, hospital managers must pay more attention to the expectation of the service quality.

Table 2. Distribution of articles on services offered on websites and Internet, MCDM and the service quality

Author (s)	Technique and approach	Number of criteria	Research purpose	Gap and research problem	Results and outcome	Best criteria
(Lin 2010)	Fuzzy AHP	20	Assessment of a website course quality.	There is a need to investigate the website quality and experiences of different groups taking an online course.	Findings of this paper demonstrated that the assessment of the quality of a website course resulted in differences and similarities between lowly and highly evaluated experiences.	Information quality
(Chiang *et al.* 2009)	Fuzzy AHP	15	Evaluate of the SQ of a portal website.	Authors of this paper believed that the evaluation of the service quality of a website was not correct if based on crisp data and conventional additive measures.	The results indicate the need to improve the service quality of a website to satisfy customers.	Site features
(Lee *et al.* 2011)	Fuzzy AHP	17	Determine the SQ measurement.	The need to present an SQ model for a travel website.	Results indicate that the three most important aspects are privacy, efficiency, and reliability.	Efficiency
(Wang, Pang 2011)	Fuzzy VIKOR	23	Evaluation of the SQ of an online auction.	There is a lack of a model that evaluates the quality and the need to upgrade an online auction.	Results indicate the most concerned dimension of SQ is Transaction Safety Mechanism and the least is Charge Item.	Transaction Safety Mechanism
(Wu *et al.* 2014)	Fuzzy AHP and VIKOR	5	Use of the e-SQ dimensions for the evaluation of the SQ in social media.	There are no electronic SQ (e-SQ) criteria for this new phenomenon in the Internet environment.	Findings demonstrate not only the dimensions of e-SQ that Facebook users prefer and which brands are 'liked' by them but also highlight the opportunity for developing new e-SQ criteria of social commerce.	Security
(Büyüközkan, Çifçi 2012)	Fuzzy AHP and fuzzy TOPSIS	20	Investigate the e-SQ concept and find the key factors of e-SQ.	There is a need to monitor and enhance the e-service quality in a hospital website.	Findings of this paper indicate that hospitals should focus on the accuracy, interactivity and the specialization as sub-criteria, and responsiveness and reliability as main criteria to achieve qualified web service and customer satisfaction.	Specialization
(Chou, Cheng 2012)	FANP and Fuzzy VIKOR	12	Assessing website quality of the top-four CPA firms.	The need to measure the level of website quality for resource allocation.	The results show that richness is na important criterion for a portal website.	Richness
(Kaya 2010)	Fuzzy AHP and fuzzy TOPSIS	9	Present a multi-attribute evaluation of the quality of an e-business website.	Measuring the quality of a website is a crucial step for any type of an organisation in building a successful website.	Results indicated that a study can successfully handle the problem of the evaluation of a website quality, which contains complexity and imprecision.	Awareness

End of Table 2

Author (s)	Technique and approach	Number of criteria	Research purpose	Gap and research problem	Results and outcome	Best criteria
(Ecer 2014)	AHP AND COPRAS-G	10	Evaluate the quality of bank websites.	Choosing the best quality bank website is a difficult task since this problem is complex and has multiple criteria.	Empirical findings show that banks in Turkey utilize the Internet to its full potential to improve their websites.	Information quality
(Seo *et al.* 2005)	PROMETHEE, AHP and MAUT	13	A selection of the best Web Service.	Current studies fail to address the critical problem of selecting the right service instances based on a service level and customer preferences.	The results show that the proposed approach effectively selects high quality web service (i.e., web service, which have a higher overall QoS).	Response time
(Chung *et al.* 2015)	Fuzzy AHP and fuzzy VIKOR	21	Assessment of Portal Website based on SQ dimensions.	The need to measure intangible attributes of the SQ.	Results found that the top four evaluation criteria are system stability, credit card payment security, data transmission security and shopping information security.	System stability
(Aydin, Kahraman 2012)	Fuzzy AHP and fuzzy VIKOR	23	Assessment of the quality of an e-commerce website.	There is a lack of an evaluation model that could be used to measure the quality of a website.	Findings indicate that the methodology proposed in this study can handle the evaluation of the website quality effectively and efficiently.	Quick response to customer demands
(Bueyuekoezka, Ruan 2007)	Fuzzy AHP and fuzzy TOPSIS	15	Measurement of the performance of governmental websites.	The need to help and create relationships between the public and the government.	Findings concluded that the security and information richness of governmental websites are important quality criteria.	Security
(Hsu *et al.* 2012a)	Fuzzy ANP	14	Assessment of the quality of an electronic service.	Previous research ignored the interdependence perspective of the criteria and sub-criteria for evaluation of e-SQ.	The results indicated that the interdependence perspective among criteria and sub-criteria should be taken into consideration by practitioners looking to improve their e-SQ.	Website Design
(Hsu *et al.* 2012b)	ANP	14	Evaluate multiple criteria and sub-criteria of e-SQ.	The need to discover the interdependence perspective of criteria and sub-criteria for e-SQ evaluation.	Findings indicate that the interdependence perspective among criteria and sub-criteria should be taken into consideration, and the authors remind practitioners of the need to implement overall improvements instead of independently addressing each criterion or sub-criterion of e-SQ individually.	Easy to find desired information
(Tu, Chao 2010)	ANP	12	Evaluation of the SQ of the E-Marketplace.	There is a need to call for better performance measurement for evaluation of the e-marketplace SQ.	Results of the analysis show that seller-oriented e-marketplace has the best criteria, followed by buyer-oriented and neutral ones.	Innovation and learning

Table 3. Distribution of articles based on the tourism and hospitality industry, MCDM and the service quality

Author (s)	Technique and approach	Number of criteria	Research purpose	Gap and research problem	Results and outcome	Best criteria
(Lin *et al.* 2009a)	Fuzzy AHP	33	Evaluate the service performance of a travel intermediary.	In order to overcome linguistic problems encountered in previous studies, this paper used the FMCDM technique.	Results represent that most customers of travel businesses are mainly concerned with DTO pre-tour information offers and hotel arrangements.	Complete information
(Shahin *et al.* 2014)	Fuzzy AHP	20	Evaluating and ranking hotels based on the electronic SQ.	Few articles refer to customer evaluation of the online service quality.	Outcomes of this study indicate that in terms of the electronic service quality, quality information has the best ranking, followed by dimensions of usability and service interaction.	Quality of information
(Hsieh *et al.* 2008)	ANP and AHP	23	Measurement architecture of the SQ in the hotel industry.	There is a need to identify customer preferences for the service quality of hotels.	Results indicate that decision-making problems become more complex with more factors involved; one should not neglect the interdependent and feedback relationships among the evaluation criteria.	The quick problem-solving abilities by the service personnel
(Tseng 2011)	DEMATEL, fuzzy set and TOPSIS	22	Evaluate the service quality expectations in hot springs hotels.	The need to evaluate the SQ based on customer expectations.	Results show that hot springs hotel S2 is the best selection in terms of a set of criteria.	service information to customers
(Wu, Wang 2014)	Fuzzy DEMATEL	17	Evaluate the quality of Chinese tourist service.	Very few researches were conducted to examine the mutual relationships and cause-effect relations among the variables.	Results confirmed that the tourism service quality is more likely to enhance customer satisfaction than the environmental quality in our study.	Safety
(Lin *et al.* 2009b)	Fuzzy DEMATEL	22	Evaluation of SQ factors applicable to the Leisure Farm.	The need to rebuild the SQ evaluation framework to address the Leisure Farm challenges.	Trustworthy is an important criterion for the service quality framework in the Leisure Farm.	Employees are trustworthy, believable, and honest
(Benitez *et al.* 2007)	Fuzzy TOPSIS	13	Measurement of the SQ in the hotel industry.	The need to identify attributes of idiosyncratic service in hotels.	The main restaurant dinner service was the significant attribute in the hotel industry.	Main restaurant dinner service

End of Table 3

Author (s)	Technique and approach	Number of criteria	Research purpose	Gap and research problem	Results and outcome	Best criteria
(Hu 2009)	Weighted average method (WAM)	12	Finding the critical factors for the evaluation of the SQ in travel websites.	The need for more attention to the service quality of travel websites based on customer decision making.	Findings of this paper indicate that airlines can improve convenience and provision of information; although, airlines can enhance even more by effective information on the check-in process and baggage handling.	Assurance/ trust
(Carrasco *et al.* 2012)	2-tuple LOWA and 2-tuple LWA	5	Achieve the overall value of the SQ hotel based on SERVQUAL measurement.	The need to propose a computational model for the generation of information to achieve some value from the SQ in a hotel.	The study concludes that the hotel "Palacio de los Patos" is the best hotel of the Hunder according to the SERVQUAL instrument.	Null
(Tseng 2009a)	Grey-fuzzy DEMATEL	21	Provide a perception method for the relationship with a real estate agent in the SQ expectation ranking with uncertainty.	There is a lack of previous studies, which did not focus on whether agents are aware of the significance of the service quality.	Findings of this study indicate that according to the final rating, the most desired agent is the CY real estate agent.	Employees are courteous, polite, and respectful
(Tseng 2009b)	Fuzzy DEMATEL	22	The assessment method for assessing SQ perceptions.	There is a lack of analysis of service quality perceptions in the hotel industry.	Findings of this study show that additional efforts undertaken by a hotel are the best criteria for service quality perceptions in the hotel industry.	The hotel provides additional service information
(Tseng *et al.* 2012)	Fuzzy DEMATEL	21	Evaluate the SQ in hot springs hotels.	The need to show how to enhance the competitiveness of hot springs in terms of a set of SQ criteria with dependent relationships between customer expectations and employee performances with subjective and objective functions.	Empirical result shows that two groups of perceptions can be combined into a visual model to further develop the strategic concerns.	The club provides additional service
(Lazim, Wahab 2010)	Average fuzzy judgment and BNP	10	Customers evaluated the service of a ferry.	The need to evaluate the operation activities of a ferry in an island tourist destination.	The outcomes of this paper showed that customers are very satisfied with the service quality of the ferry and the island tourist destination.	Service efficiency of the ferry personnel

Therefore, how to closely meet the needs of patients and how to assess the service quality of patients have become critical challenges for hospital administrators (Teng *et al.* 2007). Based on the service industry classification, a hospital is a service industry with the characteristics of contacting with people directly, communicating with people frequently, and providing customised and professional medical services (Shieh *et al.* 2010). Although the service quality of a hospital has been in development for several years, evaluating the service quality expectation is as vital as to ascertain whether hospitals are well aware of the importance of the service quality. Since the service quality of a hospital can be measured according to different qualitative and quantitative criteria, the MCDM approach is suitable for evaluating the expectation of the service quality of a hospital. There are many ways to measure the service quality, such as statistical approaches, multi-criteria satisfaction analysis for benchmarking analysis, AHP, VIKOR, fuzzy AHP, PROMETHEE, and TOPSIS. According to finding of Table 4, seven of previous papers used MCDM techniques for evaluation of the service quality in the healthcare industry. Other information, such as the number of criteria, research purpose, gap and research problem, results and outcome, and the best criteria for this category, are presented in Table 4.

1.2.5. Other transportation industries, MCDM and the service quality

The evaluation of the service quality of transportation systems is considered important for the development of productivity, gaining income and improving client gratification. This includes evaluation of several issues associated with the service quality, for instance, efficacy, reliability, safety, ease, etc. The usually applied multi-criteria decision-making methods for the evaluation of the service quality of public transit schemes are founded on weighted scoring. In multi-criteria decision-making methods, the substitute is assessed against multiple weighted standards, and an aggregate performance score is identified. If the substitute performs over a pre-defined threshold limit, the service quality is believed to be perfect. The substitute with the maximum score is selected as the best substitute. Yeh *et al.* (2000) proposed a fuzzy MCDM method for performance assessment of bus firms. Tsaur *et al.* (2002) applied the MCDM model to accomplish that the most significant qualities of air transport services are politeness, safety and ease. According to the SERVQUAL and fuzzy TOPSIS, Yedla and Shrestha (2003) offered a multi-criteria method according to the AHP to select the alternative choices for ecologically sustainable transport system in Delhi. Outcomes of Table 5 show that five of previous studies applied MCDM techniques for the evaluation of the service quality in transportation industries. Some other information, such as the number of criteria, research purpose, gap and research problem, results and outcome and the best criteria for this category, are presented in Table 5.

Table 4. Distribution of articles based on the healthcare industry, MCDM and the service quality

Author (s)	Technique and approach	Number of criteria	Research purpose	Gap and research problem	Results and outcome	Best criteria
(Akdag *et al.* 2014)	OWA, AHP and TOPSIS	46	Evaluation of the SQ of a hospital.	In general, the SQ has abstract properties, which means that the use of the previously known measurement approach is insufficient.	It is observed that deductions of the four aggregation techniques indicate that the ranking of hospitals remains unchanged; moreover, the hospital B indicates the best performance according to four methods.	The architectural congruity of the hospital's buildings
(Altuntas *et al.* 2012)	AHP and ANP	9	Measurement of the perceived SQ.	Making recommendations on the perceived SQ to governments is rather important with respect to different hospital classes.	According to patients, the most important criteria are knowledge of employees, empathy, services provided at the time promised and sympathetic and reassuring employees, the feeling of safety among patients in interactions with hospital employees.	Empathy
(Bilsel *et al.* 2006)	Fuzzy PROMETHEE and AHP	17	Quality assessment framework to measure the performance of hospital websites.	The need to evaluate the SQ in a more detailed manner.	Results indicate that important factors in terms of hospital websites are richness, privacy and relevancy.	Richness
(Shieh *et al.* 2010)	DEMATEL	22	Finding the key success factors of the hospital SQ.	Medical services in Taiwan are very competitive. Therefore, there is a need to evaluate medical service.	Results show that trusted medical staff with professional competence in healthcare is the most important criterion.	Trusted medical staff with professional competence in healthcare
(Basu, Bhola 2014)	TOPSIS	5	Ranking the service quality factors in IT enabled scalable healthcare ventures	Little understanding exists for such a study in IT-enabled Indian healthcare.	Results of this paper present a partial support for a new service venture to achieve scalability with its service offering followed by reliability, responsiveness and other issues.	IT infrastructure
(Chang 2014)	Fuzzy VIKOR	33	Evaluation of the hospital SQ.	Although hospital service quality has been in development for several years, evaluating the SQ expectation is as vital as to ascertain whether hospitals are well aware of the importance of the service quality.	Results reveal that the SQ of private hospitals is better than that of public hospitals because private hospitals are rarely subsidized by governmental agencies.	Medical staff with professional abilities
(Büyü-közkan *et al.* 2011)	Fuzzy AHP	19	Using the SERVQUAL for measure SQ.	It is essential that customer expectations are properly understood and measured under the constraints that organisations must manage.	The results showed that hospitals should focus more on empathy, professionalism and reliability to perform satisfying and qualified service.	Empathy

Table 5. Distribution of articles based on other transportation industries, MCDM and the service quality

Author (s)	Technique and approach	Number of criteria	Research purpose	Gap and research problem	Results and outcome	Best criteria
(Liou *et al.* 2014)	Fuzzy DEMATEL and ANP	12	Assessment and enhancement of the SQ of transport systems.	Improvement of the service quality of transportation is an important issue promoting the use public transportation among passengers, so it is important for governments to focus more on these systems.	Results of this study indicate that there are some significant relationships among criteria of this study.	Safety
(Awasthi *et al.* 2011)	Fuzzy TOPSIS	14	Evaluation of the transportation SQ.	There is a lack of assessment of the service quality in the transportation industry.	Results of this study indicate that there is a lack of the quantitative information and the ability to evaluate the service quality in the transportation industry.	Staff service for customer requests
(Chou, Ding 2013)	MCDM and IPA	6	Assess the service quality in three international ports.	Little attention has been given to the service gap between the expectation service from the shipping carriers and the real service delivered by ports.	Results of this paper found that the proposed model is suitable for the evaluation and analysis of the service quality in international ports.	Physical infrastructure
(Chou *et al.* 2011)	Fuzzy AHP	33	Evaluate the quality of service in the international air travel transportation industry.	A small number of studies assessed the quality of service in the airline industry based on the weighted SERVQUAL measurement.	Results of this paper indicate that the reliability, assurance and responsiveness are important dimensions of the service quality and safety is the most important criterion.	Safety
(Lupo 2013)	Fuzzy AHP	18	Analysis of the SQ and customer satisfaction.	The need to analyse the customer satisfaction in transit based on the SQ measurements.	The obtained results show that only a few service attributes play an important role in performing a quality transit service.	Route characteristics

1.2.6. Manufacturing industry, MCDM and the service quality

The tangible result regarding the manufacturing businesses is considered a physical product. This is a billable product that they sell. Even then, the service quality is considered significant, as it contains sensitivity to client requirements, concerning the defective product and upkeep. Likewise, adding service might be a strategic solution for companies aiming to add value for the client, and grow their business in a competitive marketplace. For companies that cannot compete on production costs alone, adding better client service has a probability of becoming a competitive advantage (Souiden, Pons 2009). According to Table 6, findings showed that five of researchers used MCDM techniques such as AHP, fuzzy AHP, etc. for evaluation of the service quality in manufacturing industries. Some other information, such as the number of criteria, research purpose, gap and research problem, results and outcome, determine the best criteria for this category, are presented in Table 6.

1.2.7. Banking sector, MCDM and the service quality

During the recent years, banks have become ever more concerned with understanding that the service related decisions of clients is not merely affected by value, but also by the service provision available after the distribution of the service (Agnihothri *et al.* 2002). The operative distribution of high-quality service may help and sustain long-term association with clients. Banking has been functioning in a comparatively steady setting for several years. However, today the businesses are intensely associated with violent and deregulated competition conditions. Each bank should understand how to enter a marketplace and preserve the competitive advantage (Zineldin 2002). These days, no enterprise can succeed without attracting sufficient clients. Based on Rust and Oliver (1993), the service quality, "is considered a subjective notion, by nature, which means that knowing how the client thinks regarding the service quality is considered vital for the operative management". It is, therefore, the client's insight into the service quality a company delivers that is dominant and eventually has competitive consequences. Lastly, bankers must focus on the service quality for pleasing customers as it is obvious that the service quality has a superior and stronger positive effect on client gratification if to compare the Islamic banks with conservative banks of Pakistan (Ahmad *et al.* 2010). Ferreira *et al.* (2012) proposed a framework for evaluating the performance in five bank branches in Portugal. Results of this study suggested that the application of cognitive maps identified some omitted criteria, which might affect possible attractiveness. Results of Table 7 represented that four of previous scholars used MCDM techniques such as fuzzy TOPSIS, Fuzzy GA-based and WAM etc. for assessing the service quality in the banking sector. Some other information, such as the number of criteria, research purpose, gap and research problem, results and outcome, and the best criteria for this category, are presented in Table 7.

Table 6. Distribution of articles based on the manufacturing industry, MCDM and the service quality

Author (s)	Technique and approach	Number of criteria	Research purpose	Gap and research problem	Results and outcome	Best criteria
(So *et al.* 2006)	AHP	5	Evaluated SQ among providers of third-party logistics service.	In order to deliver good-quality service and gain customer loyalty, 3PL service providers need to understand how customers perceive and evaluate the SQ.	The results indicate that responsiveness among five SQ dimensions is the most important factor in the perception of 3PL customers.	Responsiveness
(Çelen, Yalçın 2012)	Fuzzy AHP, TOPSIS and DEA	7	Performance evaluation by incorporation of the SQ.	The need to measure the efficiency of Turkish electricity distribution utilities by focusing specifically on the issue of the quality of electricity.	Results indicate that the reliability or continuity of electricity is considered more important than its loss and theft.	System Average Interruption Frequency Index
(Chao, Qing 2006)	Fuzzy AHP	10	Assessment of SQ framework in the of MES vendors.	The need to understand the relative position of the service quality of vendors among all the competitors, and to improve the service quality to an appropriate level to win more competitive advantages in the increasingly competitive environment.	According to the feedback of respondents, although it needs some improvement, the evaluation framework is lucid and effective, and the method and conception are straightforward and practical.	Upgrade
(Jeng 2012)	Fuzzy AHP	26	The selection of the strategy for the improvement of the internal service.	The need to select the internal SQ as the focus for the development of an assessment model to reform organisations that undertake ISQ to enhance their core competencies.	The empirical results show that employee rewards and recognition outrank other strategies with regard to improving the ISQ.	Employee rewards and recognition
(Lee, Kim 2012)	DEA	5	Utilizes DEA for benchmarking and measurement of the SQ.	There is a limitation that there is no clear guideline for determining whom to benchmark and what amount of the SQ should be improved.	This study contributes to the field of measurement and benchmarking of the SQ by overcoming the mentioned limitation.	Null

Table 7. Distribution of articles based on the banking sector, MCDM and the service quality

Author (s)	Technique and approach	Number of criteria	Research purpose	Gap and research problem	Results and outcome	Best criteria
(Muhammad Awan *et al.* 2011)	AHP	26	Examine the SQ and its relationship with customer satisfaction.	There is a lack of ranking of the SQ criteria related to the customer perspective in the banking service in the field of Islamic banking.	Results of this paper showed that good value of banking products and services are important criteria in the field of Islamic banking.	Good value of banking products and services
(Amirzadeh, Reza Shoorvarzy 2013)	Fuzzy TOPSIS	24	Examine elements of services in banks using the SERVQUAL measure.	There is a lack of quality factors in Islamic banks.	Results of this study indicated that reliable and confident staff and suitable and short queue are important factors of quality for customers of Iranian banks.	Suitable and short queue
(Hu, Liao 2011)	Fuzzy GA-based and WAM	34	Evaluation of the performance and individual attributes of an Internet bank.	The authors of this study believed that traditional Likert could not deal with uncertain evaluation based on human intuition for evaluating the service quality.	Through the relative importance of the aspects and the attributes determined by the proposed fuzzy MCDM method, we can point out the feasible direction of improving the electronic service quality of Internet banks.	Efficiency
(Laroche *et al.* 2005)	TOPSIS	25	Present and evaluate comparative approaches to measuring the SQ.	The extent, to which customers recognize and are willing to accept a variation in the service.	Findings show that the rankings obtained from different methods are statistically in agreement, suggesting that alternative approaches can provide an equally good measurement of the service quality. But they should not be used in an interchangeable manner.	Responsiveness

1.2.8. Education sector, MCDM and the service quality

Universities have understood the importance of providing high-quality education as their product and have been driven by competition to evaluate the superiority of their amenities, to redefine their product and to measure client gratification in ways, which are familiar to service marketing experts. Universities have understood that their long-term survival relies on how good their services are and that superiority sets one university apart from the rest (Aly, Akpovi 2001). Education amenities are frequently intangible and problematic to be measured, as the consequence is reproduced in the transformation of persons in their knowledge, their features, and their behaviour. Consequently, there is no universally accepted description of quality, which can be used for the development of the education sector. Consequently, businesses desiring to develop profitability are recommended to screen and make developments to improve their service quality on a constant basis (Gerrard, Cunningham 2005). Specialists and researchers are interested in precisely gauging the service quality to know its necessary subjects better and, eventually, create approaches for developing the quality to obtain competitive advantages (Lassar *et al.* 2000). As a serious measure of organisational performance, the service quality remains at the forefront of both the marketing literature in general, and the service marketing literature in particular (Jensen, Markland 1996). Based on results of Table 8, four previous studies used MCDM for the evaluation of the service quality in the education sector. Some other information, such as the number of criteria, research purpose, gap and research problem, results and outcome, and the best criteria for this category, are presented in Table 8.

1.2.9. Service organisations, MCDM and the service quality

The service quality is usually a critical concern for most companies of the service industry. The need for high-quality service has always been an important issue for many organisations. Business growth and survival are the two important effects of customers on an enterprise because they are the fundamental construct of an enterprise, especially a customer-oriented enterprise. Therefore, main issues concerning the service industry are to improve the service quality and to satisfy customer demands in the competitive business environment. The activity of a service organisation in relation to all characteristics and scopes of the service quality can vary. Abdullah and Ling (2012) presented a new approach to the evaluation of the service quality in insurance companies by applying the interval-valued intuitionistic fuzzy entropy measure. It was found that PCF Insurance was evaluated as the best vehicle insurance company in providing the service quality to customers. Chiang and Yu (2011) improved the service quality of a real estate broker by integrating TOPSIS and AHP. Results of this study found the weights of four criteria being 0.263, 0.429, 0.119 and 0.189 for square footage of the home, the sales price, the distance to the workplace and the lot size of the property, respectively. According to Table 9, findings showed that five of earlier studies employed MCDM techniques such as AHP, fuzzy TOPSIS etc. for assessing the service quality in service organisations. Other information, such as the number of criteria, research purpose, gap and research problem, results and outcome, and the best criteria for this category, are presented in Table 9.

Table 8. Distribution of articles based on the education sector, MCDM and the service quality

Author (s)	Technique and approach	Number of criteria	Research purpose	Gap and research problem	Results and outcome	Best criteria
(Tsinidou *et al.* 2010)	AHP	40	Finding the quality determinants for education services.	The need to develop insights into comparative evaluations of quality determinants as they are perceived by students.	The findings concerning the career prospects group demonstrate that all students, irrespective of their department, consider career prospects as a top priority, followed by opportunities for postgraduate education and the links of the institution with businesses.	Communication
(Huang *et al.* 2012)	DEMATEL, GRA and ANP	6	Improve the SQ for satisfaction of customers	The need for a model that can be used to close the SQ gap, fulfil customer expectations and maximise profits.	Results found that the expertise in dynamic capacity management and new education and training should be the most important strategies for the service quality enhancement.	Scalable storage
(Jamal, Sayyadi Tooranloo 2009)	Fuzzy TOPSIS	56	Ranking of the SQ criteria of a library.	The need to identify new ways to achieve quality and to monitor its attainment are the current challenges for libraries.	The results show that there is no equal importance between library service quality indicators.	Enabling customers to find information 24 hours a day
(Tsai *et al.* 2008)	Fuzzy AHP	5	Investigate integrated SERVQUAL dimensions.	Results obtained from previous studies cannot identify the dimension, which is more important and effective for department stores.	The results of this work determined that using the fuzzy set theory method can provide the best suggestions for department store managers in enhancing the service quality.	Tangibles

Table 9. Distribution of articles based on the education sector, MCDM and the service quality

Author (s)	Technique and approach	Number of criteria	Research purpose	Gap and research problem	Results and outcome	Best criteria
(Chiang, Yu 2011)	TOPSIS and AHP	4	Improve the SQ of a real estate broker.	The need to enhance the SQ of brokers, because they play an important role in providing useful and satisfactory information to the real estate buyers.	Results found that weights of four criteria: 0.263, 0.429, 0.119 and 0.189 for square footage of the home, the sales price, the distance to the workplace and the lot size of the property, respectively.	The sales price

End of Table 9

Author (s)	Technique and approach	Number of criteria	Research purpose	Gap and research problem	Results and outcome	Best criteria
(Choi *et al.* 2007)	Fuzzy TOPSIS	6	Evaluate the mobile service quality	Due to the intrinsic subjectivity and invisibility of customer perception, conventional approaches are subjected to some shortcomings in measuring the mobile service quality.	The quality of the device was evaluated as a high quality dimension of the mobile service in Korea.	Security quality
(Chen 2001)	Fuzzy GM-CDM	5	Effective measurement of the SQ.	The need to measure the SQ dimensions based on customer views.	According to results of this paper, one can determine not only the level of the service quality but also the ranking order of all evaluation organisations.	Null
(Abdullah, Ling 2012)	Fuzzy entropy	21	Present a new approach to the evaluation of the service quality in insurance companies by applying the interval-valued intuitionistic fuzzy entropy measure.	There is a small number of studies that evaluate the service quality by using the interval-valued intuitionistic fuzzy set.	It was found that PCF Insurance was evaluated as the best vehicle insurance company in providing the service quality to customers.	Insurance

1.2.10. Other areas, MCDM and the service quality

In this section, researchers focus on some previous studies that use other techniques and approaches for the evaluation of the service quality in various and different application areas and scopes, such as the airline industry, the healthcare industry, tourism and the hospitality industry, banking and education sectors, websites and Internet services, etc. Chen *et al.* (2009) evaluated a model of service quality based on linguistic options and TOPSIS technique. Results of this paper develop an information system based on the linguistic TOPSIS method to deal with the service quality evaluation problem. Lin and Lin (2013) supposed that previous investigation has focused on the attendee viewpoint. This investigation categorised exhibitor viewpoints on the service quality of a host organisation. Results of this investigation showed that exhibition marketing was the most significant criteria to exhibitors, counting Internet exposure and inviting foreign consumers. Based on results in Table 10, three of previous studies have applied various techniques and methods for the evaluation of the service quality in different application areas and scopes. Other information details, such as the number of criteria, research purpose, gap and research problem, results and outcome, and the best criteria for this category, are presented in Table 10.

Table 10. Distribution of articles based on other areas, MCDM and the service quality

Author (s)	Technique and approach	Number of criteria	Research purpose	Gap and research problem	Results and outcome	Best criteria
(Lin 2011)	DEMATEL, ANP and VIKOR	5	Selection and evaluation of the critical factor of the SQ.	There is a problem in the decision of service quality for shopping platform services in Taiwan.	Results reveal that customers treat the "service feature and quality" and the "customer benefit and appreciation" as important aspects. "Classification and searching" and "recommendation and limited information" are not as important.	Service feature and quality
(C. T. Lin, C. W. Lin 2013)	AHP	6	Examine the quality of service provided to an exhibitor.	Prior research focused on the attendee perspective. This study classified exhibitor perspectives on the service quality of the host organisation.	Results showed that exhibition marketing was the most important criterion to exhibitors, including Internet exposure and inviting specific overseas buyers.	Internet exposure
(Chen *et al.* 2009)	TOPSIS	Null	Evaluate the Model of SQ based on linguistic options.	It is not easy to evaluate the quality of a service alternative directly. Therefore, the need exists to use a linguistic method to design a service quality evaluation system.	Develop an information system based on the linguistic TOPSIS method to deal with the problem of the evaluation of the service quality.	Null

2. Area of application and scope

In recent decades, continued research of MCDM revealed many areas, to which it can be applied. MCDM provides strong decision-making methods in domains where a selection of the best alternative is highly complex. The main purpose of this review paper is to identify various applications in and approaches to the service quality and to suggest approaches that can be used most robustly and effectively to identify the best criteria. MCDM has been applied to many domains of the service quality evaluation in various industries, organisations, companies, etc. The MCDM method helps to choose best alternatives where many criteria exist. The best alternative can be obtained by analysing different scopes and weights for the criteria and the selection of the optimum ones using any MCDM techniques. This survey shows a comprehensive view of the development of various methods of MCDM and its applications in the evaluation of the service quality. In total, 79 articles were classified into 10 application areas and scopes: (1) the airline industry, (2) websites and Internet services, (3) the tourism and hospitality industry, (4) the healthcare industry, (5) other transportation industries, (6) the manufacturing industry, (7) the banking sector, (8) the education sector, (9) service

organisations, and (10) other areas (Table 11). According to the results provided in this table, previous studies used MCDM techniques and approaches for the airlines industry, which is the focus of 18 articles; website and Internet services – 16 articles; the tourism and hospitality industry – 13 articles; the healthcare industry – 7 articles; other transportation industries – 5 articles; manufacturing industry – 5 articles; banking, education and service industries – 4 articles; and other areas – 3 articles. In the next step, based on these classifications (10 application areas and scopes), all articles are presented in tables and each area of application is summarised based on the author, year, application area, technique and approach, the number of criteria, the study purpose, gap and research problem, results and outcome, and the best criteria in each article (Tables 1–10). In the following section, the articles are distributed based on techniques and application areas (Table 12 and Fig. 1). The next section shows nationalities of authors (Table 13) and the following section provides the distribution of articles by the year of publication (Fig. 2). The last section presents articles based on the distribution by journals (Table 14).

Table 11. Distribution of articles by the area of application and scope

Area of application	Frequently	Frequently percentage
Airline industry	18	22.78%
Websites and internet services	16	20.25%
Tourism and hospitality industry	13	16.46%
Healthcare industry	7	8.86%
Other transportation industries	5	6.33%
Manufacturing industry	5	6.33%
Banking sector	4	5.06%
Education sector	4	5.06%
Service organisations	4	5.06%
Other areas	3	3.80%
Total	79	100.00%

3. Distribution of articles by techniques and approaches

Based on results presented in Table 12, a total of 79 articles used these techniques and approaches: 16 studies used AHP and fuzzy AHP in various areas of the service quality evaluation. Based on these results, 11 studies used TOPSIS and fuzzy TOPSIS, 5 studies – VIKOR and fuzzy VIKOR; integrated techniques and approaches were used in 23 articles, DEMATEL and fuzzy DEMATEL – in 8 articles, and other techniques and approaches – in 16 articles. The summary of applications of the MCDM techniques is provided in Table 12.

Table 12. Summary of articles: area of application and scope

Area of application	Frequently	Frequently percentage
Integrated techniques and approaches	23	29.11%
AHP and Fuzzy AHP	16	20.25%
Other techniques and approaches	16	20.25%
TOPSIS and Fuzzy TOPSIS	11	13.92%
DEMATEL and Fuzzy DEMATEL	8	10.13%
VIKOR and Fuzzy VIKOR	5	h6.33%
Total	79	100.00%

4. Distribution of articles by application areas and techniques

In recent decades, research on MCDM continued and many areas of application were discovered. MCDM provides strong decision-making methods in domains where selection of the best alternative is highly complex. This particular study provides a detailed review of the main streams of considerations in MCDM theory and practice. The main purpose is to identify various MCDM techniques and approaches in several fields of the service quality evaluation and to suggest approaches that could be used most robustly and effectively to identify best alternatives. The MCDM method has been applied in many domains of the service quality evaluation. The MCDM method helps to choose best alternatives where many criteria exist; the best one can be obtained by analysing different scopes and weights of the criteria, and the selection of the optimal ones can be done using MCDM techniques and approaches. This survey provides a comprehensive view of the development of various methods of MCDM for evaluation of the service quality. In total, 79 papers were classified into 10 application areas: (1) the airline industry, (2) websites and Internet services, (3) the tourism and hospitality industry, (4) the healthcare industry, (5) other transportation industries, (6) the manufacturing industry, (7) the banking sector, (8) the education sector, (9) service organisations, and (10) other application areas. Regarding the MCDM techniques and approaches, this review article classified these techniques and methods into six groups including: (1) AHP and fuzzy AHP, (2) TOPSIS and fuzzy TOPSIS, (3) VIKOR and fuzzy VIKOR, (4) integrated techniques and approaches (5) DEMATEL and fuzzy DEMATEL and (6) other techniques and approaches. Application areas and techniques are provided in Figure 1.

5. Distribution of papers by the nationality of authors

Table 13 shows that authors from 15 nationalities and countries applied MCDM for the evaluation of the service quality in various areas of application. Most of the published papers were from Taiwan (56.96%). However, findings of this paper indicate that Turkey, Republic of Korea and Iran have published papers on the service quality evaluation by using MCDM techniques and applications. Table 13 presents details regarding the nationality of authors.

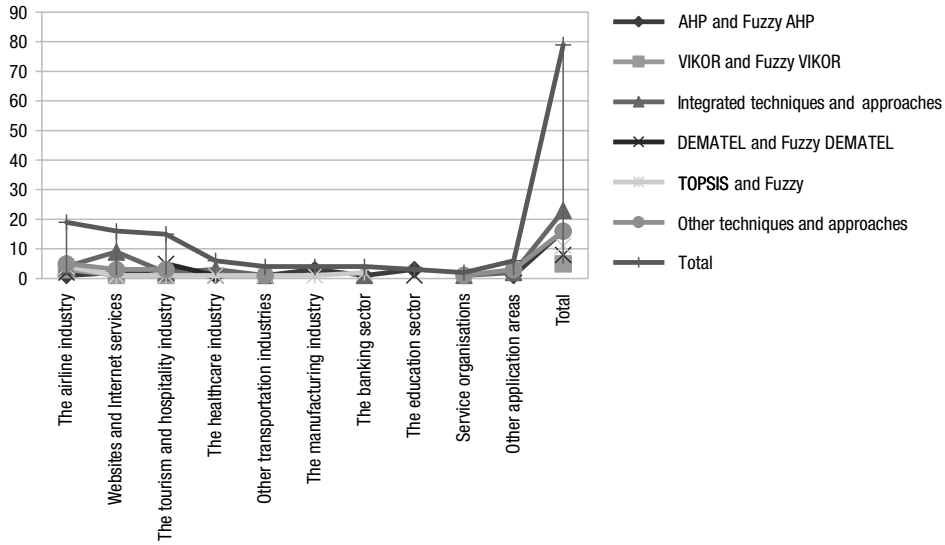

Fig. 1. Application areas and techniques

Table 13. Distribution of articles by the nationality of authors

No.	Nationality	Frequently	Frequently percentage
1	Taiwan	45	56.96%
2	Turkey	9	11.39%
3	Republic of Korea	4	5.06%
4	Iran	4	5.06%
5	Malaysia	3	3.80%
6	Spain	2	2.53%
7	Italy	2	2.53%
8	China	2	2.53%
9	USA	2	2.53%
10	France	1	1.27%
11	Canada	1	1.27%
12	Serbia	1	1.27%
13	Greece	1	1.27%
14	Pakistan	1	1.27%
15	India	1	1.27%

6. Distribution of papers by the year of publication

Figure 2 presents important evidence based on the frequency of distribution by the year of publication. The results indicate that from 2000 to 2015, information regarding the use of MCDM techniques and approaches for the evaluation of the service quality in various areas of the application has grown. According to the findings of this sec-

tion, only one paper was found to have used these techniques and approaches in 2001. The number of such papers increased to six in 2006; and to 19 and 10 papers in 2011 and 2014, respectively. It can be indicated that currently, researchers of different fields related to the service quality evaluation used the MCDM techniques and approaches. Therefore, it can be predicted that in the coming years, these numbers will grow. Results regarding the year of publication are given in Figure 2.

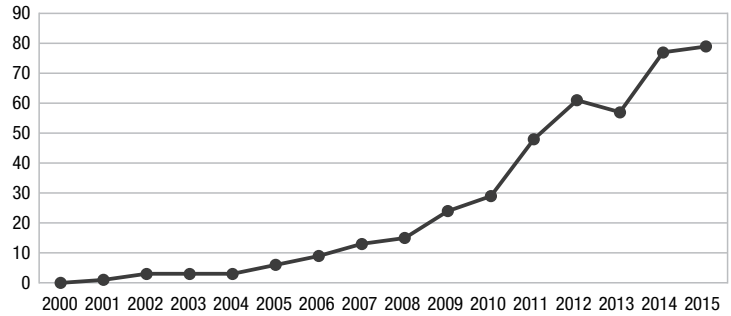

Fig. 2. Distribution of papers by the year of publication

7. Distribution of papers by the name of the journal

Table 14 provides the distribution by the name of the journal used fo this research. The papers related to the MCDM techniques and the service quality were found in 51 journals, which cover an extensive range of the "Web of Science, Scopus and Google Scholar" databases. From these 51 journals, the first and second rank were taken by the Applied Soft Computing and Expert Systems with Applications, which had seven papers. This result indicates that these two journals have a significant role in the area of MCDM issues and the evaluation of the service quality in various fields of application. IEEE journals had the third rank with six papers; in addition, the Journal of Tourism Management had four papers and was ranked the fourth. In other journal rankings, the Journal of Knowledge-Based Systems and the Journal of Air Transport Management had three papers and were ranked the fifth. The frequency of other published journals is shown in Table 14 and provides a list of journals with one used paper: the International Journal of Informatics and Communication Technology, the Journal of Islamic and Middle Eastern Finance and Management, Computers and Industrial Engineering, the Journal of Computer Science, the Journal of Information and Knowledge Management, Utilities Policy, the European Journal of Operational Research, Modeling Decisions for Artificial Intelligence, the Journal of the Chinese Institute of Industrial Engineers, the Journal of Information and Optimization Sciences, Expert Systems, Mathematical Problems in Engineering, the SIJ Transactions on Computer Science Engineering and its Applications, Technological and Economic Development of Economy, Online Information Review, Intelligent Decision Technologies, Library Management, Information and Control, Eskişehir Osmangazi Üniversitesi İktisadi ve İdari Bilimler Dergisi, Transportation Research Part E: Logistics and Transportation Review, the Journal of Services

Marketing, Management Research and Practice, the International Journal of Electronic Business Management, the Service Industries Journal, the Journal of Convention and Event Tourism, Business and Economy, Transportation Research Part A: Policy and Practice, European Transport\Trasporti Europei, the Journal of Islamic Marketing, the Journal of Quality and Reliability Management, Embedded Software and Systems, the International Journal of Business Information Systems, JISTEM-Journal of Information Systems and Technology Management, the Journal of Mathematics and Computer Science, Quality and Quantity, Quality Assurance in Education, the International Journal of Computer Science and Engineering Technology (IJCSET), Industrial Engineering and Management Systems, the International Review of Management and Business Research, Computers in Human Behavior.

Table 14. Distribution of articles by the name of the journal

No.	Journal name	Frequently
1	Applied Soft Computing	7
2	Expert Systems with Applications	7
3	IEEE	6
4	Tourism Management	4
5	Journal of Air Transport Management	3
6	Knowledge-Based Systems	3
7	Total Quality Management and Business Excellence	2
8	International Journal of Intelligent Systems	2
9	Journal of Uncertainty, Fuzziness and Knowledge-based Systems	2
10	International Journal of Computational Intelligence Systems	2
11	Procedia-Social and Behavioral Sciences	2

Conclusions

This study aimed to review papers that used the MCDM techniques and approaches for the evaluation of the service quality in 10 different areas of application and that were published from 2000 to 2015 in 51 international journals accessible in popular databases such as Scopus, Web of Science and Google Scholar. Moreover, this study attempted to categorise these papers into 10 application areas and scopes: (1) the airline industry, (2) websites and Internet services, (3) the tourism and hospitality industry, (4) the healthcare industry, (5) other transportation industries, (6) the manufacturing industry, (7) the banking sector, (8) the education sector, (9) service organisations, and (10) other application areas. Results indicated that 18 papers used fuzzy and classic MCDM techniques and approaches in the airline industry. It was found that in relation to websites and Internet services, 16 studies used fuzzy and classic MCDM techniques and application. In the tourism and hospitality industry, 13 papers used fuzzy and classic

MCDM techniques and application. While this type of study has never been conducted in the exact same way, the service quality and MCDM issues have been examined in a variety of industries over the last 10–20 years. This study only focused on those papers which have used MCDM techniques and approaches for the evaluation of the service quality in various industries and sectors such as airline, healthcare and tourism and hospitality industries, education and banking sectors, manufacturing and service industries and organisations and Internet website services. Future studies can be conducted on those articles that used other statistic's techniques and approaches, such as the Structural Equation Modeling (SEM). Results of this review article indicated that previous scholars focused more on the service quality evaluation in the airline industry rather than other industries, based on these research results, it can be observed that flight safety and security are the most important criteria.

Based on our findings, 16 studies used AHP and Fuzzy AHP. Some areas, in which previous studies used TOPSIS are airline, healthcare, tourism and hospitality industries, etc. In the distribution of journals, Applied Soft Computing and Expert Systems with Applications were given the first rank among 51 journals with seven published papers related to the MCDM issues. In the nationality-based classification, it was shown that 15 nationalities and countries applied MCDM to the evaluation of the service quality. Finally, Taiwan was shown to have the highest number of contributions to the publication of MCDM-related papers in the evaluation of the service quality. This review paper contributes to the existing literature by demonstrating the possibility of combining decision making and the evaluation of the service quality in the MCDM procedure. In an age of increasing globalisation and increasing flows of information, decision makers and scientists are trying to better understand how to construct decision-making systems to address a range of multi-level problems.

Results obtained from this review show that MCDM approaches and techniques are appropriate for the evaluation of the service quality. This study shows that a large number of MCDM approaches and techniques exists and many of these methods are applicable to the solution of problems related to the evaluation of the service quality. Each approach and technique may have some drawbacks and advantages, and it cannot be claimed that a particular approach or technique is more appropriate than the others. Various DMs generally disagree on the approach and technique, which is the most valid and suitable. The selection of an approach and technique is mostly dependent upon the preferences of DM and the analyst. The methods must be taken into consideration in terms of validity, suitability, and user-friendliness. In addition, it should be realized that employing different approaches and techniques will most likely lead to different recommendations, and it is noteworthy that there may be errors in any approach or technique. This paper provided several examples of ways, in which various MCDM approaches and techniques were applied in the evaluation of the service quality. By integrating the academic literature on the service quality and reviewing MCDM techniques and approaches in a variety of application areas, some insight into the specific results was gained, as well as a better understanding of the underlying dimensions of the service

quality. The contributions of the study results to the existing literature on the service quality and MCDM issues were addressed and results were provided to academics scholars and leaders of organisations and industries in the field of service quality evaluation enabling them to improve their service processes by identifying relevant service quality attributes and assessing their impact on the service quality.

This particular paper has some limitations and recommendations for future studies. First of all, this study categorized 79 articles into 10 application areas and scopes, i.e., the airline industry, websites and Internet services, the tourism and hospitality industry, the healthcare industry, other transportation industries, the manufacturing industry, the banking sector, the education sector, service organisations, and other areas. It is recommended for future studies to review papers in different sub-areas of these categories. Articles published in late 2014 and 2015, if any, were not included in the paper due to the limitation of reporting time. A future review can be expanded. Another limitation is that the data were collected from journals, and the documents do not include papers, textbooks, doctoral and master's dissertations and theses, and unpublished papers on MCDM issues. As a result, in a future study, data can be collected from these sources, and the obtained results can be compared to the results obtained and reported in this study. The next limitation is that all of the papers were extracted from journals in English; then, the scholarly journals published in other languages were not included in this review. However, the researchers believed that this paper comprehensively reviewed and included most of the papers, which were published in international journals. The insights provided by this paper channel the research efforts and fulfill the needs of practitioners and researchers for an easy access to the fields of healthcare and the medical industry. This paper carefully selected and summarised the available papers of several publishers in Web of Science, Scopus, and Google Scholar. Though, a number of relevant outlets might have remained beyond the scope of the current study. Therefore, future studies could review the papers that were not used in the current review. As another limitation, the paper presents the review of numerous publications, which describe the use of MCDM recently-developed methods in journals. However, this review does not cover recent methods that have been published in books.

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