

Providing a Framework for Evaluating the Quality of Health Care Services Using the HealthQual Model and Multi-Attribute Decision-Making Under Imperfect Knowledge of Data

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Abstract. Due to the increasing importance of evaluating the quality of health care services using the patient-centred approach, this study aimed to propose a novel framework by combining the SERVQUAL model and multi-attribute decision-making (MADM) methods using interval-valued triangular fuzzy numbers (IVTFN). In this study, after an initial overview of related work and expert opinions, a list of the most important dimensions and indicators for measuring the quality of health care services was extracted and localized. Then, to determine the importance of each of the identified factors, one of MADM's acceptable methods called step-wise weight assessment ratio analysis (SWARA) was used. Then, in order to use the developed framework for comparing different health centres and ranking them, after collecting evaluation data in the form of linguistic variables, another practical method in the field of MADM has been used, namely, Additive Ratio Assessment (ARAS) method. The dimensions and sub-dimensions identified are, on the one hand, appropriate to the conditions of the case study and, on the other hand, the findings from the implementation show that among the dimensions of health service quality, responsiveness and then reliability has the highest rank in this case. Also, the use of IVTFN, on the one hand, eliminates the problems related to the use of Likert scale in other quality assessment methods and, on the other hand, reduces the possibility of facing imperfect knowledge of data which is a common problem in the field of qualitative evaluations. Utilizing the results of this study can significantly help decision makers in their choice of strategies to improve service quality. Furthermore, improving the quality of services can play an important role in promoting the competitiveness and performance of health care providers by increasing patient satisfaction with the services received. Also, as a side effect, the developed framework can be used to compare the performance of different hospitals and health centres, as well as their ranking.

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Key words: service quality, health care, HealthQual, interval-valued triangular fuzzy numbers (IVTFN), step-wise weight assessment ratio analysis (SWARA), additive ratio assessment (ARAS).

1. Introduction

Today, the health care industry, as one of world's largest and fastest-growing service industries, (Behdioğlu *et al.*, 2019) is facing fundamental changes (Chen and Yeh, 2015). Financial and economic crises, on the one hand (Ferreira and Marques, 2016), the converging pressures of patients' quickly changing expectations and preferences, regarding the health care services, as well as increasing competition among health care providers (Meesala and Paul, 2018) have led to alterations in the health care system in recent years, and without a doubt these alterations will continue on a larger scale in the future (Ginter *et al.*, 2018). Novel diagnostic and therapeutic technologies and techniques, information technology and the emergence of a new generation of consumers of health care services have led to the development of a patient-centred culture that provide opportunities for customers to participate in cocreation activities to respond to demand for personalized high quality health care services (Sharma and Conduit, 2016).

Accordingly, the patient-centred approach has become a key component in promoting health services (Rahim *et al.*, 2021). Today, the adoption a patient-centred approach in health care services is more often (Buawangpong *et al.*, 2020) due to the benefits it has to patients, managers of service organizations, third-parties and administrative departments (Liao *et al.*, 2020). The quality of health care services can lead to a sustainable competitive advantage and the continuity of business profitability, and at the same time it can increase patient satisfaction (Meesala and Paul, 2018; Altuntas and Kansu, 2019). Although in many previous studies, satisfaction and service quality have been used as two synonymous concepts, some new approaches have emphasized the differences between the two. According to Ferreira *et al.* (2018), patient's satisfaction and overall quality of provided health care can be different for various reasons such as emotional evaluation of quality of health services by patients, the effects of non-health related items on patients' satisfaction and the effects of individual characteristics of patients (such as personality, attitudes, interests and expectations) on their evaluations. But, the weakness of some of mentioned variables in the relationship with satisfaction may be the reason why most of the researches only focus on service quality attributes. However, a review of the results of some studies shows that in the current situation, many patients are not satisfied with the quality of services received (Chen and Yeh, 2015). This dissatisfaction may disrupt their treatment process due to unwillingness to follow medical advice after discharge (Carlucci *et al.*, 2013). Due to various service features such as intangibility, inseparability, heterogeneity, and un restorable nature, it is difficult to measure service quality (Akdag *et al.*, 2014). Also, in order to achieve the health of patients and to satisfy the beneficiaries, different aspects of services should be considered.

Lee (2017) considered the different measurement items used to evaluate health care service quality in different contexts based on the researcher viewpoints. Among the studies

conducted, the SERVQUAL model proposed by Parasuraman *et al.* (1985, 1988) to measure service quality has been widely endorsed by other researchers (Aydin and Pakdil, 2008). Today, new and different applications of SERVQUAL model have been presented in various service areas (Beheshtinia and Omid, 2017). In the health care industry, this model has been used in many research studies in the last decade as HealthQual, hospital service quality (HSQ) or similar names (Singh and Prasher, 2019; Singh *et al.*, 2020; Yucesan and Gul, 2020; Li and He, 2020; Singh, 2019; Lee, 2017; Behdioğlu *et al.*, 2017). Service quality based on HealthQual and HSQ refers to patient's attitude towards the service offered by a health care service provider resulting from a comparison of patient's expectations and patient's perceptions. Donabedian (1988) triangular service quality model referred three dimensions to assess quality of health care services, namely, structure, process and result. Structure quality includes the physical, financial, and structural tools and resources of health care providers. The process-related quality of health care services depends on how the service provider and recipient interact. This is the dimension that Grönroos (1988) called functional quality. Result-related quality reflects the patients' perception of the quality of services after the medical act. According to Boller *et al.* (2003), the "results" dimension is the output of service quality and not a part of it, so in measuring service quality the focus should be on the dimensions of "structure" and "process". Also, due to the long time between the moment the service is provided and when the results are obtained, the majority of studies such as the present study, have been centralized on evaluation of patients' satisfaction with the quality of services received from the first two dimensions, i.e. structure and process (Choi *et al.*, 2005).

In addition to how to identify, select and use items that affect the quality of health care services, as an important part of the focus of researchers, the next challenge is how to measure the quality of health care services. The multifaceted and complex nature of health care service quality metrics (La Fata *et al.*, 2019; Ampaw *et al.*, 2020) has led to a variety of methodologies in addition to a variety of models and patterns of service quality. A review of past research works on health care quality shows that most of them have been based on statistical approaches. However, these approaches are usually inefficient in calculating the importance of criteria, as well as in the final aggregation of evaluation scores of different alternatives (hospitals and health care centres) and their final ranking (Afkham *et al.*, 2012). For this reason, the multi-attribute decision-making (MADM) approach has recently received special attention (Li and He, 2020). The logic of this method is based on the fact that customers' desires for service are calculated based on the evaluation of different aspects of services in terms of the importance assigned to them (Lupo, 2016).

Also, most researchers in recent years have tried to use the Likert scale to measure the quality of health care and to summarize the opinions of a large number of people in the form of a definite number. However, it is not appropriate to use the Likert scale and perform calculations based on it in order to measure the quality of health care (Ferreira *et al.*, 2021). Accordingly, in the field of MADM methods, linguistic variables are generally used in the form of pairwise comparisons. Although linguistic variables have been criticized by researchers due to the influence of factors such as subjectivism, judgments, selection and priority of evaluators on the final results in the field of quality evaluation of health care services (Afkham *et al.*, 2012; Lupo, 2016; Li and He, 2020).

Even though Likert scale linguistic variables are often described as an imprecise tool that has a high level of imperfect knowledge of data, Singh and Prasher (2019), Zadeh (1965) proposed the theory of fuzzy number sets in order to be used in decision making process based on vague and ambiguous information (Boltürk and Kahraman, 2022). Fuzzy numbers make it possible to include uncertainty and imperfect knowledge of data in the decision-making process of experts and can be well applied to perform calculations in cases where linguistic variables have been used (Akdag et al., 2014). This ability of fuzzy numbers caused (Büyüközkan et al., 2011) to use a fuzzy approach to measure the quality of services for the first time in 2011 (Li and He, 2020). However, compared to studies based on quality assessment models (such as SERVQUAL, HealthQual, etc.), limited research has indicated the use of MADM methods and fuzzy numbers to evaluate the quality of health care services (Yucesan and Gul, 2020). One of the weaknesses of fuzzy numbers is in determining the exact value of the upper and lower bound of the membership function. Gorzałczany (1987) has tried to solve it by using IVTFN numbers (Dahooie et al., 2020). Accordingly, the current study proposed a novel methodology for evaluating and prioritizing the dimensions of health care service quality and ranking of service providers based on the combined MADM methods with interval-valued triangular fuzzy numbers (IVTFN). For this purpose, Step-wise weight assessment ratio analysis (SWARA) and Additive ratio assessment (ARAS) have been used to increase the efficiency of the framework compared to similar approaches. In addition to the privileges that these two methods have in terms of mathematical logic, due to advantages such as user-friendliness, less complexity, and less implementation time, these two methods have attracted the attention of many researchers to use them in different areas of decision-making.

In the second part of the article, the theoretical background on the quality of services in the field of health care has been reviewed. The third section introduces the research case study. The fourth describes the research steps. The fifth section presents research data and findings based on the views of decision makers in this field. In the sixth section, the findings are discussed and compared with the results of previous researches, and finally in the seventh section, while summarizing, the research innovations are explained and practical recommendations and future research suggestions are presented.

2. Theoretical Background

2.1. Health Care Service Quality

The measurement of the quality of health care services can be important from the perspective of different stakeholders: the view of service providers with goals such as promoting profitability, the viewpoint of social health insurance aiming to minimize costs and the patient-oriented view with the main focus on health service recipients with goals such as satisfaction with the services received and improving health. But it seems that high quality services can cover the goals of all stakeholders at the same time. Providing appropriate and high-quality health care services prevents unnecessary patient referrals and consequently

additional costs (Sharifi *et al.*, 2021). Also, previous studies have confirmed the direct relationship between the quality of health care services with increasing profitability and market share of service providers in a competitive environment (Naidu, 2009; Meesala and Paul, 2018; Altuntas and Kansu, 2019).

An organization providing health care services (such as a hospital) needs accurate knowledge of patient satisfaction as an integral part of the quality of health care services (Pekkaya *et al.*, 2019; Altuntas and Kansu, 2019). This is because increasing patients' satisfaction with health care services by increasing the quality of services received, leads to several achievements such as improving their loyalty (Fatima *et al.*, 2018; Meesala and Paul, 2018) and competitiveness of hospitals, etc. (Chen and Yeh, 2015).

Understanding what factors can affect patients' perceptions of the quality of services they receive is of considerable importance not only to patients; but also, to service providers, governments, and other stakeholders (Li and He, 2020). As health care providers prepare themselves to face the challenges of the Industrial Revolution 4.0, patient oriented, value driven, health care quality management plans should include efforts to identify and satisfy patients' needs and preferences (Rahim *et al.*, 2021).

Due to this importance, one of the issues of previous research has been to identify and determine the factors affecting the quality of health care services in order to be able to consider the appropriate criteria for determining, controlling and improving the quality of services. However, there have been limited studies in the field of patients' perceptions of service quality dimensions (Gill and White, 2009).

2.2. Health Care Service Quality Dimensions

Given the importance of health care quality, to date we have seen numerous studies and researches that have sought to introduce dimensions and indicators affecting the quality of health care services (Li and He, 2020). In general, health care quality assessment items are used and studied differently according to the views of researchers because there are no standard measurement items (Lee, 2017). Vouri (1982) introduced efficiency, effectiveness, accuracy and quality improvement of scientific-technical competencies as important factors in the quality of health care services (Lee, 2017). Donabedian (1988) introduces the dimensions affecting the quality of healthcare services including structure, process and results. According to the model of Grönroos (1984), patients evaluate the quality of health care services based on two dimensions: technical quality (result of received services) and functional quality (manner and process of received services). Carman (1990) presented tangibles, reliability, safety, empathy, convenience, and cost as items to measure health care service quality. Scobie *et al.* (2006) also presented health care service quality in the following six dimensions: tangibles, accessibility, timeliness, efficient costs, values, policy, and implementation to improve quality, understanding the expected value of patients, and capabilities of the service provider. Otani *et al.* (2009) considered the dimensions affecting the quality of health care services as admission process, staff care, nursing care, physician care, food and room. Lee (2017), by focusing on health care processes and results, attempted to measure health care service quality through tangibles,

empathy, efficiency, safety, and degree of improvements of health care service. Li and He (2020) categorized the health care service quality assessment into six main dimensions including tangibles, responsiveness, professional competence, professional capability, reliability, and administrative policy.

However, over the years, the most famous and practical model of health care service quality on which other models have been presented is the service quality gap model called SERVQUAL, proposed by Parasuraman *et al.* (1985, 1988), an instrument with 5 main dimensions for measuring the quality of services from the customer's perspective. It should be noted that its dimensions have been various in different models and it has been used mostly in the form of four-dimensional, five-dimensional and six-dimensional categories (Li and He, 2020). This model has been extensively studied in recent years in various service areas such as the quality of health care services. This has led to the formation of a version of the SERVQUAL model called HealthQual. HealthQual is a multidimensional scale that measures the quality of health care services from the patient's point of view (Sharifi *et al.*, 2021; Asiamah *et al.*, 2021; Nemati *et al.*, 2020; Ampaw *et al.*, 2020; Lee, 2017).

Based on the HealthQual model for health care service quality evaluation, patients measure their satisfaction with the quality of services received, based on 5 main dimensions. Empathy (refers to understanding patients' problems by staff and trying to meet them, paying attention to each patients, assurance (is concerned with reassuring and polite behaviour of hospital staff towards patients, existence of staff with the necessary ability and qualification to answer patients' questions, safe hospital equipment), responsiveness (entails willingness of hospital staff to help patients, respond to their requests, informing them of the methods of complaining about the services received and providing fast services), reliability (is concerned with provision of accurate and error-free services by hospitals to patients at the promised time), and tangibles (encompasses physical facilities, equipment and appearance of hospital staffs).

The results of the majority of previous studies confirm the validity of HealthQual model for evaluating the quality of health care services (Sharifi *et al.*, 2021; Asiamah *et al.*, 2021). In addition, a look at the quality standards of health care services in developed countries shows that in the service quality indicators of these countries, the dimensions of the HealthQual model have been significantly emphasized and this has increased the acceptance of this model. The dimensions of empathy, reliability and tangible factors are in accordance with the American JCI standard, reliability and tangible factors are in accordance with the Australian ACHSI standard and tangible factors are in accordance with the Canadian ACI standard (Lee, 2017).

Despite all the advantages and practicality of the SERVQUAL model in evaluating service quality in previous research, some researchers have criticized it both conceptually and paradigmatically (Coulthard, 2004). According to the three-dimensional model of Donabedian (1988), the quality of health care services should be evaluated taking into account three aspects: structure, process and result. In SERVQUAL model, the focus is more on the structure and process of providing service instead of service quality results. Other issues that have been expressed in the critique of this model are concerns about

how customers evaluate the quality of service in terms of expectations and perceptions, as well as the dimensions and universality of the five dimensions of SERVQUAL (Buttle, 1996). Lucadamo *et al.* (2021) argued that assessing health care patients' expectations is a challenging issue; SERVQUAL is not appropriate and should be modified.

2.3. Measuring Health Care Service Quality

The provision of high-quality health care is an important issue, since its direct consequences are relief to suffering and improved health status in humans (Bowers and Kiefe, 2002). For the success of health care institutions and hospitals, accurate assessment of health care service quality is as important as understanding the constitution of the service delivery system (Büyüközkan *et al.*, 2011).

Based on the literature, a number of methods have been developed to evaluate the quality of health care services. Fundamentally, they can be categorized into two basic groups: Stated Importance Methods (SIMs) and Derived Importance Methods (DIMs) (Grigoroudis and Spyridaki, 2003). In the first approach (SIM), customers are asked to complete detailed questionnaires (both expectations and perceptions on the key aspects of service quality) (Lupo, 2016). In SIMs, the perception and expectation of a customer is measured based on linguistic-numerical Likert type scales, which are simple to use, but need a significant enhance in the length of survey and can sometimes make an inadequate difference in ranks of the service dimensions (Tsai *et al.*, 2011; Lupo, 2015; Pamucar *et al.*, 2021). As a result, the customers' self-expressed importance does not sufficiently measure the true relative importance of attributes (Deng and Pei, 2009).

In the DIM approach, relatively simple questionnaires are provided to customers and they only have to provide perceptions on service quality aspects along with the overall satisfaction degree of quality (Lupo, 2016). With this approach, the rating of expectations on service dimensions is statistically obtained by considering the relationships between performance in service aspects and overall customer satisfaction (Pandey, 2016). After conducting such surveys, there are several alternatives to examine satisfaction. These alternatives can be considered as structural equation modelling, factor analysis, multiple/logistic regressions, and the so-called Multicriteria Satisfaction Analysis (MUSA) (Deng and Pei, 2009; Ferreira *et al.*, 2021). DIMs allow the recognition of underlying dimensions of quality and their relationship to overall distinguished quality or customer satisfaction, however they depend on a set of restrictions-normal data, linear relationships, multi-co-linearity, which diminishes the guarantee of generalization (Tsai *et al.*, 2011). Hence, the implicit importance values of attributes determined through statistical approaches are biased and misleading (Deng and Pei, 2009).

Lately, multi-criteria decision making (MCDM) models are growingly considered in the literature to address these weaknesses (Tsai *et al.*, 2011; Lupo, 2016; Pandey, 2016). MCDM methods are on the basis of some general principle that customers' attitudes toward certain services depend on their evaluation of service aspects based on the importance given to them (Lupo, 2016). In this method, on the one hand, there is no need to use the Likert scale to calculate weights, and instead, pairwise comparison approaches or

standard scales are used, and on the other hand, there is no necessity to use large volumes of data and observe common assumptions in statistical methods. Due to these advantages, these methods have been considered in the field of evaluating the quality of hospitals and health services by some researchers in recent years. Table 1 shows the most important studies conducted in this area.

Based on the information provided in this table, the following points can be summarized.

First, review of the literature indicates that several dimensions and criteria affect the quality of health care services, and this has made the issue of measuring their quality a complex and multi-criteria issue (La Fata *et al.*, 2019).

The differences in the dimensions and criteria considered in different researches indicate the need to localize the health care service quality measurement model in accordance with the studied conditions and related features. However, the framework that is appropriate for Iran and, in particular, the case under study was not determined.

Second, in most researches, the weight/importance is calculated using common multi-criteria decision-making methods such as AHP and ANP and based on pairwise comparisons between service aspects from customers' point of view. These pairwise comparisons, on the one hand, allow the calculation of actual relative importance of attributes, and on the other hand, due to the use of standard scales, eliminate the problems related to Likert scale and ordinal data. However, one of the main problems of these two methods is the need for a high number of pairwise comparisons; so that if there are n criteria, the number of pairwise comparisons should be $n(n - 1)/2$ (Rezaie, 2015). Since the number of dimensions and criteria used in the field of quality assessment of health services is generally high, the time consumption and the possibility of inconsistencies in the evaluation process reduce the possibility of implementing these methods. The SWARA method presented by Keršuliene *et al.* (2010) uses the advantages of pairwise comparisons between factors. Also, because after ranking the criteria, each criterion is only compared with the previous criterion, fewer comparisons are required, and therefore this method is more efficient and effective in practice (Dahooie *et al.*, 2020).

Third, a review of previous research trends shows that the use of definite numbers has gradually diminished in this area (Mardani *et al.*, 2019). In most researches, evaluations related to assessment of service aspects have been done in the form of linguistic variables and then using theories such as fuzzy, these variables have been converted into interval-valued information that have their own special computational operators. The reason for this should be sought in the fact that most researchers have used the linguistic variables or Likert scale to measure the quality of health care services and summarize the opinions of a large number of people and then convert them into definite numbers. However, linguistic variables have been criticized by researchers due to the influence of factors such as subjectivism, judgments, selection and priority of evaluators on the final results in the field of quality evaluation of health care services (Afkham *et al.*, 2012; Lupo, 2016; Li and He, 2020). In other words, the linguistic variables are imprecise and have imperfect knowledge of data and fuzziness (Singh and Prasher, 2019). Fuzzy number theory, on the other hand, makes it possible to take uncertainty and imperfect knowledge of data into account

Table 1
Some research conducted with multi-attribute decision making approach.

Author(s)	Country	Dimension(s)	Weighting method	Ranking method
Wu <i>et al.</i> (2004)	Taiwan	Tangibles (physical facilities, equipment, and appearance of contact personnel), Reliability (ability to perform the promised service reliably and accurately), Responsiveness (willingness to help customers and provide prompt service), Assurance (knowledge and courtesy of employees and their ability to inspire trust) and Empathy (provision of caring, individualized attention to consumers)		Fuzzy AHP
Büyükoçkan <i>et al.</i> (2011)	Turkey	Tangibles (Building layout, Equipment, Hygiene), Reliability (Accuracy, Expertise, Image, Security/privacy), Responsiveness (Timeliness, Completeness, Willingness), Assurance (Cost, Courtesy, Compensation), Empathy (Caring, Manner, Communication), Professionalism (Skill, Experience, Innovation)	Fuzzy AHP –	
Afkham <i>et al.</i> (2012)	Iran	Tangibles (13 questions), Reliability (4 questions), Responsiveness (12 questions), Assurance (9 questions) and Empathy (11 questions).	Fuzzy AHP TOPSIS	
Altuntas <i>et al.</i> (2012)	Turkey	Tangibles (up-to-date equipment, visual appeal of facilities), Reliability (sympathetic and reassuring employees, services provided at the time promised to do so), Responsiveness (employees’ willingness, employees’ quickness), Assurance (feeling of safety by patients in interactions with hospital employees, knowledge of employees) and Empathy (careful and attentive acts of employees).		AHP and ANP
Akdag <i>et al.</i> (2014)	Turkey	Tangibles (19 questions), Reliability (4 questions), Responsiveness (8 questions), Assurance (8 questions) and Empathy (7 questions).	Fuzzy AHP	Fuzzy TOPSIS and Yager’s min–max
Chen and Yeh (2015)	Taiwan	Q1: Hospital has modern medical equipment. Q2: Medical staff is passionate about helping patients to solve their problems, Q3: Medical staff is not too busy and does not neglect patients, Q4: Prompt management of emergency patients by the medical staff. Q5: Medical staff listens to patients’ needs, Q6: Doctors can offer detailed explanations of patient status, Q7: Doctors have good professional skills, Q8: Hospital will initiate a follow-up of patients’ recovery.	AHP	–
Lupo (2016)	Italy	Healthcare staff (Ability of doctors to understand patient needs, Capacity to work as a team, Staff reliability, Staff availability), Responsiveness (Swiftness of registration and admission procedures, Administrative quality, Waiting time for tests results, Waiting time for medical records), Relationships (Confidentiality between doctor and patient, Confidentiality between all healthcare staff, Cooperation and helpfulness of administrative staff, Humanization of relationships) and Support services (Quality of food & beverage for patients, Security within hospital, Cleanliness of facilities and premises)		Fuzzy AHP

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Table 1
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Author(s)	Country	Dimension(s)	Weighting method	Ranking method
Singh and Prasher (2019) Singh (2019)	India	Tangibles (Equipment, Infrastructure, Hygiene, Appearance, Space, Parking), Reliability (Consistency, Skills, Knowledge, Image, Confidentiality), Responsiveness (Quickness, Completeness, Promptness, Procedure, Waiting), Assurance (Cost, Confidence, Guarantee, Ignorance, Consideration), Empathy (Politeness, Grievances, Concern, Interaction, Understanding) and Trustworthiness (Honesty, Relevance, Non-manipulation, Non-overcharging).	Fuzzy AHP Fuzzy AHP	– ELECTRE-I
Yucesan and Gul (2020)	Turkey	Hospital equipment (4 criteria), Service attitude (8 criteria), Pharmacy and medical treatment (5 criteria), Professional competence (3 criteria), Administrative policies (6 criteria) and Cleaning of hospital facility (6 criteria)	Pythagorean fuzzy AHP	Fuzzy TOPSIS
Karasan et al. (2022)	Turkey	Tangibles (Infrastructure, Healthcare staff, Support services, Accessibility, Hospital environment, Service attitude), Reliability (Credibility, Security, Education and research, Targets), Responsiveness (Information quality, Professional capability, Administrative policy, Process of clinical care, Information to patient), Assurance (Courtesy, Competence, Performance monitoring, Communication), Empathy (Relationships, Social responsibility, Perceived waiting time, Perceived service costs, Patient satisfaction)	Equal weights	Pythagorean Fuzzy TOPSIS and FIS
Analytical hierarchy process (AHP)		Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS)		
Analytic network process (ANP)		ELimination and Choice Expressing REality (ELECTRE)		
Fuzzy inference system (FIS)				

in the decision-making process of experts and can be well applied to perform calculations in cases where linguistic variables are used (Akdag et al., 2014).

Despite the mentioned features, literature review shows the low share of fuzzy MADM methods in the studies based on service quality evaluation models (Yucesan and Gul, 2020). Also, few decision-making methods have been used by researchers in this field (Mardani et al., 2019). However, new methods have been proposed in the field of MADM methods, each of which has its own advantages and features (Dahooie et al., 2019). Numerous studies in the field of fuzzy numbers also show that this set of numbers also has several shortcomings under real-world conditions. This has led to developments such as type-n fuzzy sets, hesitant fuzzy numbers, etc. (Dahooie et al., 2020). One of these most important shortcomings occurs in determining the exact value of the upper and lower bounds of the membership function in a set of traditional fuzzy numbers which led to the introduction of interval-valued fuzzy numbers by Gorzałczany (1987). This challenge is especially important in cases where the evaluation is done qualitatively and in the form of linguistic variables (Gorzałczany, 1987). Therefore, in view of what has been described before, special attention should be paid in the field of service quality evaluation.

3. Research Case Study

This study has chosen Iran as a case study. Iran is a vast country with attractive demographic and economic characteristics. It has a population of about 80 million which is expected to reach 88 million by 2030. According to www.ilna.news, estimates show that the turnover of the Iranian health market is 25 to 28 billion dollars, and based on this, this industry can be a very important source of employment and income for the country. Iran also spends only 7.5% of its gross domestic product (GDP) on the health system. On the other hand, the share of health expenditures in government expenditures in Iran is 17%, which is about 50% for the United States (Burns, 2014).

During the last 4 decades, the Iranian health care system has designed several major health reforms to improve the quality of health (Ranjbar *et al.*, 2021), most of which have limited achievements for various reasons, such as insufficient attention to its implementation (Mahdavi *et al.*, 2018; Dehnavieh *et al.*, 2018).

Since May 5, 2014, in order to achieve the vision of 2025, Iranian Ministry of Health and Medical Education has implemented a comprehensive transformation plan (which is still in progress), the so called health transformation plan (HTP), which strives to improve the operational management of health service delivery in Iran (Mahdavi *et al.*, 2018; Ranjbar *et al.*, 2021).

As a result of HTP, many changes have taken place in the Iranian health system. Government spending on health increased significantly, health insurance coverage was extended to a larger population, and medical tariffs were revised. Also, many hospitals and public health centres were renovated, the number of hospital beds increased, new hospitals and public health facilities were established in deprived areas, and more doctors and nurses were hired in remote areas (Ranjbar *et al.*, 2021). The HTP has various goals, especially improving the quality of health care services to patients (Bahadori *et al.*, 2015).

However, since the launch of HTP, a variety of research and studies have been conducted, both in terms of content and implementation issues (Mahdavi *et al.*, 2018). A significant portion of the research examined the effects of HTP on various aspects of the health system such as out-of-pocket payments (Doshmangir *et al.*, 2019), and hospital performance from various aspects such as patient health services utilization and medical resources efficiency (Ranjbar *et al.*, 2021; Rezaei *et al.*, 2016). A look at these studies shows that although various aspects of the quality of health care services have been considered, we still need to conduct more extensive research on the results of this program on the quality of services provided to patients.

Also, a comprehensive view on the issue of service quality requires the design and application of multifaceted methodology and models that can help to get a true picture of the effects of this transformation program on the quality of services provided to patients. This research has been done to meet this need.

4. Research Methodology

The purpose of this paper is to provide an evaluation framework to measure the quality of health care services from the patient's point of view using a combination of MADM met-

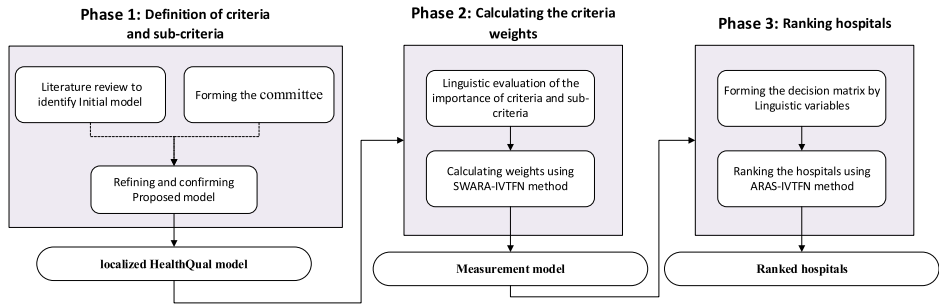


Fig. 1. Steps of the proposed framework.

hods with IVTFN. This combined approach helps to overcome the limitations mentioned before and provides the possibility of determining the importance of each criterion from the perspective of different stakeholders, calculating the scores of alternatives (hospitals, medical centres, etc.) and finally ranking them.

As Fig. 1 shows, in order to shape this framework, an initial model was first developed based on a review of the models developed to assess the quality of health care services. Since this study is designated to evaluate and rank hospitals and health care centres related to personnel working in the Iranian oil industry, a committee was formed to conduct this evaluation.

The members of this committee consist of the planning manager of the company's headquarters (with more than 20 years of experience and academic education in the field of health services planning), 6 evaluators of this management (all of whom have more than 15 years of executive experience in the field of health services of subsidiaries, also responsible for evaluations for more than 5 years as a quality assessor of health services in the company's headquarters). This committee is structurally a subset of the company's planning management and is responsible for evaluating the quality of health care services in hospitals and health centres under the supervision of the National Iranian Oil Company.

In this research, as in similar cases, it is very important to create a consensus between experts regarding the final model (Liu *et al.*, 2022). So, the initial model was provided to the members of this team in the form of Delphi method and after four rounds, the model agreed on by the committee members was created. Of course, at this stage, in order to achieve the final model of quality evaluation, in addition to the committee members, 2 university professors participated in the process. They are working in the field of health and medical services with extensive experience in related research projects. In order to conduct a comprehensive evaluation of all identified criteria, the selected evaluators were divided into three executive teams (each team includes two evaluators) and finally the results of the three teams were combined to prevent errors in the evaluations as much as possible. With the aim of designing the health service quality evaluation model, each team was first asked to determine the importance and weight of each criterion in the form of SWARA-IVTFN method steps. Finally, the opinions of these teams were combined and the relative importance of each criterion was determined. Then, the auditors evaluated each of the hospitals based on the identified criteria by different methods such as observation,

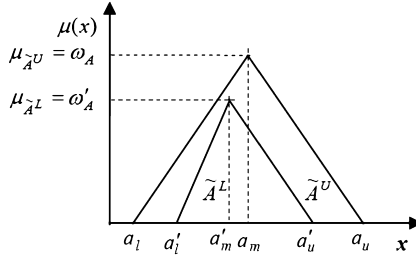


Fig. 2. Representation of an interval-valued triangular fuzzy number (IVTFN).

interviewing patients and staff and studying existing documents. Finally, according to the importance calculated in the previous step and the results of the evaluation, ten hospitals and medical centres of the oil industry were prioritized using the ARAS-IVTFN method. Finally, the results of calculating the weight of the criteria as well as the ranking results were provided to the committee members and approved by them.

4.1. Interval-Valued Triangular Fuzzy Number (IVTFN)

Fuzzy number set theory was first proposed by Zadeh (1965) to deal with vague and ambiguous information in the decision-making process (Liu *et al.*, 2021). Type-1 fuzzy set developed by Zadeh (1965) considers a crisp number in the range of 0 to 1 for the membership value. The exact membership function of a fuzzy set is not easily obtained in some conditions. In these cases, type-1 fuzzy sets do not work efficiently for linguistic assessment (Ghorabae *et al.*, 2016). This led to several developments in this theory and the formation of type-n fuzzy sets, hesitant fuzzy numbers, etc. (Dahooie *et al.*, 2020). The interval-valued fuzzy numbers introduced by Gorzalczany (1987) have eliminated the shortcomings of the traditional fuzzy approach in determining the exact value of the upper and lower bounds of the membership function (Vahdani *et al.*, 2014). This is especially important in cases where assessment is conducted qualitatively and in terms of linguistic variables (Gorzalczany, 1987).

Like other types of generalized fuzzy numbers, interval-valued fuzzy numbers can be triangular or trapezoidal numbers. Interval-valued triangular fuzzy numbers (\tilde{A}) (IVTFN) in general are represented as follows (Fig. 2):

$$\tilde{A} = [\tilde{A}^L, \tilde{A}^U] = [(a'_i, a'_m, a'_u; \omega'_A), (a_i, a_m, a_u; \omega_A)]. \tag{1}$$

In the above relation, \tilde{A}^L and \tilde{A}^U represent the lower and upper triangular fuzzy numbers, respectively, $\tilde{A}^L \subset \tilde{A}^U$; $\mu_{\tilde{A}}(x)$ is the membership function and represents the degree to which an event may be a member of \tilde{A} ; $\mu_{\tilde{A}^L}(x) = \omega'_A$ and $\mu_{\tilde{A}^U}(x) = \omega_A$, which are lower and upper membership functions, respectively. In a special case if $\omega'_A = \omega_A = 1$, then these numbers are converted into normalized interval-valued triangular fuzzy numbers (Fig. 3) and are represented as the following relation:

$$\tilde{A} = [\tilde{A}^L, \tilde{A}^U] = [(a_i, a'_i), a_m, (a'_u, a_u)]. \tag{2}$$

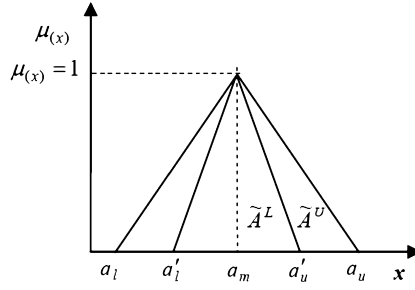


Fig. 3. Representation of a normalized interval-valued triangular fuzzy numbers.

Further details on these numbers and their related algebraic operations are provided in Dahooie *et al.* (2020), Mohammadian *et al.* (2021).

4.2. SWARA-IVTFN

In the context of MADM approaches, various methods have been provided to determine the criteria weights (Liu and Li, 2021). However, many of them are not only complicated, they are also not accurate enough. Hence, Keršulienė *et al.* (2010), introduced the SWARA method, a relatively less complex approach (Karabasevic *et al.*, 2016). This method is user-friendly, less complicated and less time consuming. It also gives decision makers the opportunity to choose and assess the criteria and set their weights, while enabling experts to use their knowledge and experience in the research area (Hashemkhani Zolfani *et al.*, 2018; Kumar *et al.*, 2022). The initial version of this method was not efficient in the face of situations where decision makers' information is unreliable and incomplete. Stević *et al.* (2022) discussed the use of the fuzzy SWARA method and proposed an improved approach to address the criticisms of this method. Considering the points raised about IVTFN numbers (eliminating the shortcomings of the traditional fuzzy approach in determining the exact value of the upper and lower bounds of the membership function), the development of this method based on this IVTFN numbers has been considered in this research. Details on how to calculate are provided in Dahooie *et al.* (2020, 2022), so here is just a summary of the steps.

- Prioritizing the criteria based on importance (in descending order);
- Determining the relative importance of each criterion (\tilde{S}_j);
- Calculation of Relative Importance Function (coefficient \tilde{K}_j) based on equation (3):

$$\tilde{k}_j = \begin{cases} \tilde{1}, & j = 1, \\ \tilde{s}_j + \tilde{1}, & j > 1; \end{cases} \quad (3)$$

- Calculation of the initial weight of the criteria (\tilde{q}_j) based on equation (4):

$$\tilde{q}_j = \begin{cases} \tilde{1}, & j = 1, \\ \frac{\tilde{q}_{j-1}}{\tilde{K}_j}, & j > 1; \end{cases} \quad (4)$$

Table 2
Linguistic variables used to calculate the weight of criteria
(Stanujkic, 2015).

Linguistic variables	Interval-valued triangular fuzzy number
Equally important	[(0.75, 0.8); 0.9; (0.9, 0.9)]
Moderately less important	[(0.55, 0.6); 0.7; (0.8, 0.85)]
Less important	[(0.35, 0.4); 0.5; (0.6, 0.65)]
Very less important	[(0.15, 0.2); 0.3; (0.4, 0.45)]
Much less important	[(0.1, 0.1); 0.1; (0.2, 0.25)]

- Determining the normalized final weight (\tilde{w}_j) based on equation (5):

$$\tilde{w}_j = \frac{\tilde{q}_j}{\sum_{k=1}^n \tilde{q}_k}; \tag{5}$$

- Defuzzification of the final weight based on equation (6):

$$BNP(\tilde{B}) = \frac{a_l + a'_l + a_m + a'_u + a_u}{5}. \tag{6}$$

The scale of linguistic variables used in this study to calculate the weight of the criteria is presented in Table 2.

4.3. ARAS-IVTFN

Among the MADM methods that have been developed with the aim of ranking and evaluating the alternatives, the ARAS (Additive Ratio Assessment) method (Zavadskas and Turskis, 2010) has had a growing trend since 2010 due to advantages such as ease of implementation and comprehensibility, the possibility of determining the utility degree of each alternative compared to the optimal alternative (Pareto optimal solution) and rank reversal resistant (Liu and Xu, 2021). Given the benefits of IVTFNs, an extended version of ARAS-IVTFN is considered in this study. A summary of the steps is provided below (read more in Dahooie *et al.*, 2018, 2022).

- Formation of a decision matrix including the evaluation results of each alternative as well as the optimal alternative (Eq. (7)):

$$\tilde{X} = \begin{bmatrix} \tilde{x}_{01} & \cdots & \tilde{x}_{0j} & \cdots & \tilde{x}_{0n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ \tilde{x}_{i1} & \cdots & \tilde{x}_{ij} & \cdots & \tilde{x}_{in} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ \tilde{x}_{m1} & \cdots & \tilde{x}_{mj} & \cdots & \tilde{x}_{mn} \end{bmatrix}, \quad i = 0, 1, \dots, m, \quad j = 1, 2, \dots, n. \tag{7}$$

Suppose there are m alternatives and n criteria, then \tilde{x}_{ij} represents the performance of the i -th alternative based on the j -th criterion in the form of the IVTFN values,

and \tilde{x}_{0j} represents the optimal value of the j -th criterion, which is calculated based on equation (8) (Ω_{\max} stands for profit criteria and Ω_{\min} stands for cost criteria):

$$\tilde{x}_{0j} = [(l_{0j}, l'_{0j}), m_{0j}, (u'_{0j}, u_{0j})], \quad (8)$$

$$l_{0j} = \begin{cases} \max_i l_{ij}, & j \in \Omega_{\max}, \\ \min_i l_{ij}, & j \in \Omega_{\min}, \end{cases}$$

$$l'_{0j} = \begin{cases} \max_i l'_{ij}, & j \in \Omega_{\max}, \\ \min_i l'_{ij}, & j \in \Omega_{\min}, \end{cases}$$

$$m_{0j} = \begin{cases} \max_i m_{ij}, & j \in \Omega_{\max}, \\ \min_i m_{ij}, & j \in \Omega_{\min}, \end{cases}$$

$$u'_{0j} = \begin{cases} \max_i u'_{ij}, & j \in \Omega_{\max}, \\ \min_i u'_{ij}, & j \in \Omega_{\min}, \end{cases}$$

$$u_{0j} = \begin{cases} \max_i u_{ij}, & j \in \Omega_{\max}, \\ \min_i u_{ij}, & j \in \Omega_{\min}; \end{cases}$$

- Calculation of the normalized decision matrix (\tilde{X}) based on equations (9), (10):

$$\tilde{X} = \begin{bmatrix} \tilde{x}_{01} & \cdots & \tilde{x}_{0j} & \cdots & \tilde{x}_{0n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ \tilde{x}_{i1} & \cdots & \tilde{x}_{ij} & \cdots & \tilde{x}_{in} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ \tilde{x}_{m1} & \cdots & \tilde{x}_{mj} & \cdots & \tilde{x}_{mn} \end{bmatrix}, \quad i = 0, 1, \dots, m, \quad j = 1, 2, \dots, n, \quad (9)$$

$$\tilde{x}_{ij} = \begin{cases} \left[\left(\frac{a_{ij}}{c_j^+}, \frac{a'_{ij}}{c_j^+} \right), \frac{b_{ij}}{c_j^+}, \left(\frac{c'_{ij}}{c_j^+}, \frac{c_{ij}}{c_j^+} \right) \right], & j \in \Omega_{\max}, \\ \left[\left(\frac{1}{a_j^-}, \frac{1}{a'_{ij}} \right), \frac{1}{a_j^-}, \left(\frac{1}{c_j^-}, \frac{1}{c'_{ij}} \right) \right], & j \in \Omega_{\min}, \end{cases} \quad (10)$$

$$a_j^- = \sum_{i=0}^m \frac{1}{a_{ij}}, \quad c_j^+ = \sum_{i=0}^m c_{ij}, \quad i = 0, 1, \dots, m;$$

- Calculation of the interval-valued weighted normalized decision matrix (\tilde{X}) based on equations (11), (12):

$$\tilde{X} = \begin{bmatrix} \tilde{x}_{01} & \cdots & \tilde{x}_{0j} & \cdots & \tilde{x}_{0n} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ \tilde{x}_{i1} & \cdots & \tilde{x}_{ij} & \cdots & \tilde{x}_{in} \\ \vdots & \ddots & \vdots & \ddots & \vdots \\ \tilde{x}_{m1} & \cdots & \tilde{x}_{mj} & \cdots & \tilde{x}_{mn} \end{bmatrix}, \quad i = 0, 1, \dots, m, \quad j = 1, 2, \dots, n, \quad (11)$$

Table 3
Linguistic variables used to score alternatives and rank them
(Stanujkic, 2015).

Linguistic variables	Interval-valued triangular fuzzy number
Very High (VH)	[(0.75, 0.8); 0.9; (0.9, 0.9)]
High (H)	[(0.55, 0.6); 0.7; (0.8, 0.85)]
Medium (M)	[(0.35, 0.4); 0.5; (0.6, 0.65)]
Low (L)	[(0.15, 0.2); 0.3; (0.4, 0.45)]
Very Low (VL)	[(0.1, 0.1); 0.1; (0.2, 0.25)]

$$\tilde{x}_{ij} = \tilde{w}_j \cdot \tilde{x}_{ij}, \quad i = 0, 1, \dots, m; \tag{12}$$

- Calculation of the overall performance index for each alternative (\tilde{S}_i) based on equation (13):

$$\tilde{S}_i = \sum_{j=1}^n \tilde{x}_{ij}, \quad i = 0, 1, \dots, m; \tag{13}$$

- Defuzzification of the overall performance index of each alternative (S_i) based on Eq. (14) and calculation of the utility degree of each alternative (K_i) based on Eq. (15):

$$S_i = \frac{(1 - \lambda)S_{il} + \lambda S_{il'} + S_{im} + \lambda S_{iu'} + (1 - \lambda)S_{iu}}{5}, \quad \lambda \in [0, 1], \tag{14}$$

$$K_i = \frac{S_i}{S_0}, \quad i = 0, 1, \dots, m, \tag{15}$$

λ is a coefficient between zero and one that by changing its value, the parameters $S_{il'}$ and $S_{iu'}$ can be given more importance than the parameters S_{il} and S_{iu} , and vice versa. S_0 is also the defuzzified value of the optimal index. It should be noted that K_i has a value in the range of [0, 1];

- Ranking the alternatives based on K_i values and selecting the most effective alternative.

The scale of the linguistic variables used in this study for scoring alternatives and final ranking is presented in Table 3.

5. Research Findings

In order to verify the validity of the proposed framework, the steps of this framework were applied to evaluate and rank the hospitals and medical centres of the Iranian oil industry in terms of health care quality. The following are the main findings based on the steps described in the methodology section.

5.1. Identification of Dimensions and Sub-dimension for HealthQual Model

As described in the previous sections, in this study, first, the standard SERVEQUAL model was considered as the basis of the work. Thus, the 5 main dimensions presented by Parasuraman *et al.* (1985, 1988) were selected which have been considered in most articles. Then, based on the standard definitions of these dimensions and considering the articles that used this model in the field of health services, an attempt was made to determine the initial list of sub-dimensions. At the end, the list was provided to committee members and two experienced professors in the form of Delphi process. Finally, after four rounds, this model was localized in the form of 5 main dimensions and 23 sub-dimension. The final dimensions and sub-criteria are shown in Table 4.

5.2. Calculating the Criteria Weights for HealthQual Model

As mentioned in the research steps section, in the first step, the importance and weight of each of the criteria and sub-criteria of the HealthQual model have been calculated using the SWARA-IVTFN method. For this purpose, first the weights of the main criteria and then the weights of the sub-criteria were calculated and then the weight of the criteria was multiplied by the weight of the sub-criteria to obtain the final weight of each of the sub-criteria. The results of the developed SWARA method based on interval-valued triangular fuzzy numbers for the first team are shown in Table 5. As shown in the third column of this table, the team representative is asked to sort the criteria in descending order of importance. In the following, calculations have been made based on the steps of the developed SWARA-IVTFN method. The results of the second, third (equation (3)), fourth (equation (4)) and fifth (equation (5)) step are given in the next columns of this table, respectively.

Then, in order to calculate the final weight of the criteria, the geometric means of the weights for all three teams were obtained and then normalized. The final results are shown in Table 6. In this table, the first column shows the final weights of the first team, which is presented in the last column of Table 5. Note, however, that the data in Table 5 are entered based on the priority of the criteria, and therefore some values have been substituted with each other to transfer to Table 6. The next two columns are the results of the weights for the other two teams (which are not presented in the text due to space constraints). The final column is the weights obtained from the geometric average weight of three different teams.

In order to create a suitable basis for display and analysis, the final values of the weights were calculated based on equation (6), the results of which are presented in Fig. 4.

Finally, the results of calculating the weight of the criteria were provided to the committee members and approved by them.

5.3. Results of Additive Ratio Assessment Based on ARAS-IVTFN

As mentioned, although the main purpose of this article is to provide a framework for evaluating the quality of health services, it can also be used to rank hospitals and health

Table 4
Definition of dimensions and sub-criteria of localized HealthQual model.

Dimensions	Sub-dimension	References
<i>Empathy (EM)</i>	<i>EM1 = Perception of patients' special needs by hospital staff</i>	Lim and Tang (2000), Mostafa (2005), Yeşilada and Direktör (2010), Ranjbar et al. (2012), Kalepu (2014), Asiamah et al. (2021), Sharifi et al. (2021)
	<i>EM2 = Special attention of personnel to patients</i>	
	<i>EM3 = Dedication of all staff efforts to the needs of patients</i>	
<i>Assurance (AS)</i>	<i>AS1 = Personnel with knowledge and experience</i>	Babakus and Boller (1992), Youssef et al. (1996), Lim and Tang (2000), Scobie et al. (2006), Yeşilada and Direktör (2010), Asiamah et al. (2021), Sharifi et al. (2021)
	<i>AS2 = Kind and polite staff</i>	
	<i>AS3 = Full explanation of the patient's medical condition by personnel</i>	
	<i>AS4 = Safe medical equipment</i>	
<i>Responsive-ness (RES)</i>	<i>RES1 = Providing 24-hour services</i>	Babakus and Boller (1992), Youssef et al. (1996), Jun et al. (1998), Lim and Tang (2000), Ranjbar et al. (2012), Kalepu (2014), Asiamah et al. (2021), Sharifi et al. (2021)
	<i>RES2 = Internal willingness of staff to meet the needs of patients</i>	
	<i>RES3 = Appropriate response of hospital staff to patients' questions</i>	
	<i>RES4 = Ability of hospital staff to quickly understand the needs of patients</i>	
	<i>RES5 = Ability of hospital staff to deal quickly and effectively with sudden events</i>	
	<i>RES6 = Easy and accessible ways for patients to complain about the services they receive</i>	
	<i>RES7 = Providing fast and immediate service to patients by hospital staff</i>	
<i>Reliability (REL)</i>	<i>REL1 = Proper organization in providing services to patients</i>	Babakus and Boller (1992), Youssef et al. (1996), Lim and Tang (2000), Ranjbar et al. (2012), Yeşilada and Direktör (2010), Kalepu (2014), Asiamah et al. (2021), Sharifi et al. (2021)
	<i>REL2 = High reliability in providing services to patients</i>	
	<i>REL3 = Providing promised services to patients</i>	
	<i>REL4 = Providing error-free services to patients</i>	
<i>Tangibles (TA)</i>	<i>TA1 = Friendly and comfortable hospital environment</i>	Babakus and Boller (1992), Youssef et al. (1996), Lim and Tang (2000), Ranjbar et al. (2012), Kalepu (2014), Asiamah et al. (2021), Sharifi et al. (2021)
	<i>TA2 = Cleaning inside and outside of the hospital</i>	
	<i>TA3 = Newness and completeness of hospital equipment and facilities</i>	
	<i>TA4 = Clean and comfortable rooms of the hospital</i>	
	<i>TA5 = Appropriate appearance and cleanliness of hospital staff</i>	

centres. To show how it works in this area, an attempt was made to prioritize ten hospitals using the ARAS-IVTFN method.

According to the steps described in the research methodology, each of the selected teams presented their evaluation for each of the ten subordinate hospitals (H1–H10) based on the criteria of the final model in terms of linguistic variables presented in Table 3. Table 7 presents the evaluation of each hospital based on the identified criteria.

Then, the linguistic variables were replaced by their corresponding IVTFNs. Subsequently, in order to aggregate the opinions and compile the final evaluation table, the evaluation results of different teams were averaged. The results are presented in Appendix A.

Table 5
Calculations of criteria weights by members of the first team.

Criteria code	Comparative importance of average value \bar{S}_j	Coefficient $\bar{k}_j = \bar{S}_j + 1$	Recalculated weight \bar{q}_j	Weight (\bar{w}_j)
Main	Responsiveness	[(1, 1), 1, (1, 1)]	[(1, 1), 1, (1, 1)]	[(0.327, 0.345), 0.377, (0.401, 0.412)]
	Reliability	[(0.15, 0.2), 0.3, (0.4, 0.45)]	[(1.15, 1.2), 1.3, (1.4, 1.45)]	[(0.226, 0.246), 0.29, (0.334, 0.359)]
	Assurance	[(0.75, 0.8), 0.9, (0.9, 0.9)]	[(1.75, 1.8), 1.9, (1.9, 1.9)]	[(0.363, 0.376), 0.405, (0.463, 0.497)]
	Empathy	[(0.35, 0.4), 0.5, (0.6, 0.65)]	[(1.35, 1.4), 1.5, (1.6, 1.65)]	[(0.22, 0.235), 0.27, (0.331, 0.368)]
	Tangibles	[(0.15, 0.2), 0.3, (0.4, 0.45)]	[(1.15, 1.2), 1.3, (1.4, 1.45)]	[(0.152, 0.168), 0.208, (0.276, 0.32)]
Empathy	EM3	[(1, 1), 1, (1, 1)]	[(1, 1), 1, (1, 1)]	[(0.453, 0.466), 0.49, (0.512, 0.523)]
	EM2	[(0.55, 0.6), 0.7, (0.8, 0.85)]	[(1.55, 1.6), 1.7, (1.8, 1.85)]	[(0.245, 0.259), 0.288, (0.32, 0.337)]
	EM1	[(0.15, 0.2), 0.3, (0.4, 0.45)]	[(1.15, 1.2), 1.3, (1.4, 1.45)]	[(0.373, 0.397), 0.452, (0.521, 0.561)]
Assurance	AS2	[(1, 1), 1, (1, 1)]	[(1, 1), 1, (1, 1)]	[(0.442, 0.456), 0.482, (0.493, 0.498)]
	AS1	[(0.75, 0.8), 0.9, (0.9, 0.9)]	[(1.75, 1.8), 1.9, (1.9, 1.9)]	[(0.526, 0.526), 0.526, (0.556, 0.571)]
	AS3	[(0.55, 0.6), 0.7, (0.8, 0.85)]	[(1.55, 1.6), 1.7, (1.8, 1.85)]	[(0.284, 0.292), 0.31, (0.347, 0.369)]
	AS4	[(0.15, 0.2), 0.3, (0.4, 0.45)]	[(1.15, 1.2), 1.3, (1.4, 1.45)]	[(0.196, 0.209), 0.238, (0.289, 0.321)]
Responsiveness	RES3	[(1, 1), 1, (1, 1)]	[(1, 1), 1, (1, 1)]	[(0.325, 0.344), 0.378, (0.416, 0.433)]
	RES2	[(0.55, 0.6), 0.7, (0.8, 0.85)]	[(1.55, 1.6), 1.7, (1.8, 1.85)]	[(0.541, 0.556), 0.588, (0.625, 0.645)]
	RES1	[(0.55, 0.6), 0.7, (0.8, 0.85)]	[(1.55, 1.6), 1.7, (1.8, 1.85)]	[(0.292, 0.309), 0.346, (0.391, 0.416)]
	RES4	[(0.35, 0.4), 0.5, (0.6, 0.65)]	[(1.35, 1.4), 1.5, (1.6, 1.65)]	[(0.177, 0.193), 0.231, (0.279, 0.308)]
	RES7	[(0.1, 0.1), 0.1, (0.2, 0.25)]	[(1.1, 1.1), 1.1, (1.2, 1.25)]	[(0.142, 0.161), 0.21, (0.254, 0.28)]
	RES6	[(0.15, 0.2), 0.3, (0.4, 0.45)]	[(1.15, 1.2), 1.3, (1.4, 1.45)]	[(0.098, 0.115), 0.161, (0.211, 0.244)]
	RES5	[(0.35, 0.4), 0.5, (0.6, 0.65)]	[(1.35, 1.4), 1.5, (1.6, 1.65)]	[(0.059, 0.072), 0.108, (0.151, 0.181)]
Reliability	REL3	[(1, 1), 1, (1, 1)]	[(1, 1), 1, (1, 1)]	[(0.341, 0.357), 0.387, (0.415, 0.429)]
	REL4	[(0.15, 0.2), 0.3, (0.4, 0.45)]	[(1.15, 1.2), 1.3, (1.4, 1.45)]	[(0.69, 0.714), 0.769, (0.833, 0.87)]
	REL2	[(0.35, 0.4), 0.5, (0.6, 0.65)]	[(1.35, 1.4), 1.5, (1.6, 1.65)]	[(0.418, 0.446), 0.513, (0.595, 0.644)]
	REL1	[(0.55, 0.6), 0.7, (0.8, 0.85)]	[(1.55, 1.6), 1.7, (1.8, 1.85)]	[(0.226, 0.248), 0.302, (0.372, 0.416)]
Tangibles	TA3	[(1, 1), 1, (1, 1)]	[(1, 1), 1, (1, 1)]	[(0.336, 0.351), 0.38, (0.404, 0.416)]
	TA2	[(0.15, 0.2), 0.3, (0.4, 0.45)]	[(1.15, 1.2), 1.3, (1.4, 1.45)]	[(0.69, 0.714), 0.769, (0.833, 0.87)]
	TA1	[(0.75, 0.8), 0.9, (0.9, 0.9)]	[(1.75, 1.8), 1.9, (1.9, 1.9)]	[(0.363, 0.376), 0.405, (0.463, 0.497)]
	TA4	[(0.55, 0.6), 0.7, (0.8, 0.85)]	[(1.55, 1.6), 1.7, (1.8, 1.85)]	[(0.196, 0.209), 0.238, (0.289, 0.321)]
	TA5	[(0.1, 0.1), 0.1, (0.2, 0.25)]	[(1.1, 1.1), 1.1, (1.2, 1.25)]	[(0.157, 0.174), 0.217, (0.263, 0.291)]

Table 6
Aggregation of the weights calculated by assessment teams.

Criteria code	Team 1	Team 2	Team 3	Aggregation	
Main	Responsiveness	[(0.327, 0.345), 0.377, (0.401, 0.412)]	[(0.365, 0.383), 0.416, (0.446, 0.46)]	[(0.33, 0.344), 0.372, (0.405, 0.421)]	[(0.34, 0.357), 0.388, (0.417, 0.431)]
	Reliability	[(0.226, 0.246), 0.29, (0.334, 0.359)]	[(0.197, 0.213), 0.245, (0.279, 0.297)]	[(0.2, 0.215), 0.248, (0.289, 0.312)]	[(0.207, 0.224), 0.26, (0.3, 0.321)]
	Assurance	[(0.119, 0.13), 0.153, (0.186, 0.205)]	[(0.107, 0.118), 0.144, (0.174, 0.192)]	[(0.108, 0.12), 0.146, (0.181, 0.201)]	[(0.111, 0.122), 0.147, (0.18, 0.199)]
	Empathy	[(0.072, 0.081), 0.102, (0.133, 0.152)]	[(0.074, 0.084), 0.111, (0.145, 0.167)]	[(0.086, 0.1), 0.133, (0.164, 0.183)]	[(0.077, 0.088), 0.114, (0.147, 0.167)]
Empathy	Tangibles	[(0.05, 0.058), 0.078, (0.111, 0.132)]	[(0.051, 0.06), 0.085, (0.121, 0.145)]	[(0.06, 0.071), 0.102, (0.137, 0.159)]	[(0.053, 0.063), 0.088, (0.122, 0.145)]
	EM1	[(0.169, 0.185), 0.222, (0.267, 0.293)]	[(0.154, 0.168), 0.198, (0.235, 0.256)]	[(0.387, 0.391), 0.398, (0.425, 0.438)]	[(0.216, 0.23), 0.259, (0.298, 0.32)]
	EM2	[(0.245, 0.259), 0.288, (0.32, 0.337)]	[(0.255, 0.268), 0.297, (0.328, 0.345)]	[(0.31, 0.326), 0.361, (0.386, 0.398)]	[(0.268, 0.283), 0.314, (0.344, 0.359)]
Assurance	EM3	[(0.453, 0.466), 0.49, (0.512, 0.523)]	[(0.471, 0.483), 0.505, (0.526, 0.535)]	[(0.188, 0.204), 0.241, (0.276, 0.295)]	[(0.342, 0.358), 0.391, (0.42, 0.435)]
	AS1	[(0.233, 0.526), 0.254, (0.274, 0.285)]	[(0.093, 0.741), 0.136, (0.172, 0.192)]	[(0.315, 0.326), 0.347, (0.379, 0.394)]	[(0.19, 0.503), 0.229, (0.261, 0.278)]
	AS2	[(0.442, 0.456), 0.482, (0.493, 0.498)]	[(0.172, 0.952), 0.232, (0.275, 0.298)]	[(0.094, 0.509), 0.143, (0.179, 0.201)]	[(0.193, 0.605), 0.252, (0.29, 0.31)]
	AS3	[(0.126, 0.468), 0.149, (0.171, 0.184)]	[(0.249, 0.833), 0.301, (0.329, 0.343)]	[(0.174, 0.655), 0.243, (0.287, 0.311)]	[(0.176, 0.634), 0.222, (0.253, 0.27)]
Responsiveness	AS4	[(0.087, 0.401), 0.115, (0.143, 0.16)]	[(0.312, 0.318), 0.331, (0.362, 0.377)]	[(0.218, 0.714), 0.267, (0.316, 0.342)]	[(0.181, 0.45), 0.217, (0.254, 0.274)]
	RES1	[(0.095, 0.106), 0.131, (0.162, 0.18)]	[(0.06, 0.071), 0.096, (0.129, 0.15)]	[(0.036, 0.043), 0.06, (0.085, 0.101)]	[(0.059, 0.068), 0.091, (0.121, 0.14)]
	RES2	[(0.176, 0.191), 0.223, (0.26, 0.279)]	[(0.042, 0.051), 0.074, (0.108, 0.13)]	[(0.181, 0.197), 0.229, (0.266, 0.285)]	[(0.11, 0.124), 0.156, (0.195, 0.218)]
	RES3	[(0.325, 0.344), 0.378, (0.416, 0.433)]	[(0.304, 0.327), 0.368, (0.406, 0.423)]	[(0.335, 0.354), 0.39, (0.426, 0.442)]	[(0.321, 0.341), 0.379, (0.416, 0.433)]
	RES4	[(0.058, 0.066), 0.087, (0.116, 0.134)]	[(0.1, 0.113), 0.144, (0.181, 0.202)]	[(0.059, 0.068), 0.09, (0.119, 0.136)]	[(0.07, 0.08), 0.104, (0.136, 0.154)]
	RES5	[(0.019, 0.025), 0.041, (0.063, 0.078)]	[(0.165, 0.181), 0.217, (0.254, 0.273)]	[(0.098, 0.109), 0.135, (0.166, 0.184)]	[(0.068, 0.079), 0.106, (0.138, 0.158)]
	RES6	[(0.032, 0.039), 0.061, (0.088, 0.106)]	[(0.02, 0.026), 0.044, (0.075, 0.098)]	[(0.029, 0.036), 0.054, (0.077, 0.092)]	[(0.026, 0.033), 0.053, (0.08, 0.098)]
Reliability	RES7	[(0.046, 0.055), 0.079, (0.105, 0.121)]	[(0.029, 0.036), 0.057, (0.09, 0.113)]	[(0.02, 0.025), 0.042, (0.064, 0.08)]	[(0.03, 0.037), 0.057, (0.085, 0.103)]
	REL1	[(0.077, 0.089), 0.117, (0.154, 0.178)]	[(0.323, 0.337), 0.364, (0.395, 0.409)]	[(0.351, 0.367), 0.396, (0.424, 0.437)]	[(0.206, 0.222), 0.256, (0.296, 0.317)]
	REL2	[(0.143, 0.159), 0.198, (0.247, 0.276)]	[(0.223, 0.241), 0.28, (0.329, 0.356)]	[(0.079, 0.091), 0.12, (0.158, 0.182)]	[(0.136, 0.152), 0.188, (0.234, 0.261)]
	REL3	[(0.341, 0.357), 0.387, (0.415, 0.429)]	[(0.135, 0.15), 0.187, (0.235, 0.264)]	[(0.242, 0.262), 0.305, (0.353, 0.38)]	[(0.223, 0.241), 0.28, (0.325, 0.35)]
Tangibles	REL4	[(0.235, 0.255), 0.298, (0.346, 0.373)]	[(0.108, 0.125), 0.17, (0.214, 0.24)]	[(0.131, 0.146), 0.179, (0.221, 0.245)]	[(0.149, 0.167), 0.208, (0.254, 0.28)]
	TA1	[(0.122, 0.132), 0.154, (0.187, 0.207)]	[(0.073, 0.082), 0.105, (0.142, 0.165)]	[(0.126, 0.142), 0.179, (0.228, 0.256)]	[(0.104, 0.116), 0.143, (0.182, 0.206)]
	TA2	[(0.232, 0.251), 0.293, (0.337, 0.361)]	[(0.29, 0.306), 0.338, (0.368, 0.382)]	[(0.068, 0.079), 0.106, (0.142, 0.165)]	[(0.166, 0.182), 0.219, (0.26, 0.284)]
	TA3	[(0.336, 0.351), 0.38, (0.404, 0.416)]	[(0.2, 0.219), 0.26, (0.307, 0.332)]	[(0.302, 0.319), 0.35, (0.382, 0.398)]	[(0.273, 0.29), 0.326, (0.362, 0.38)]
	TA4	[(0.066, 0.073), 0.091, (0.117, 0.133)]	[(0.138, 0.156), 0.2, (0.256, 0.289)]	[(0.209, 0.228), 0.269, (0.319, 0.346)]	[(0.124, 0.138), 0.17, (0.212, 0.237)]
	TA5	[(0.053, 0.061), 0.082, (0.106, 0.121)]	[(0.058, 0.069), 0.096, (0.129, 0.15)]	[(0.055, 0.066), 0.096, (0.129, 0.15)]	[(0.055, 0.065), 0.091, (0.121, 0.14)]

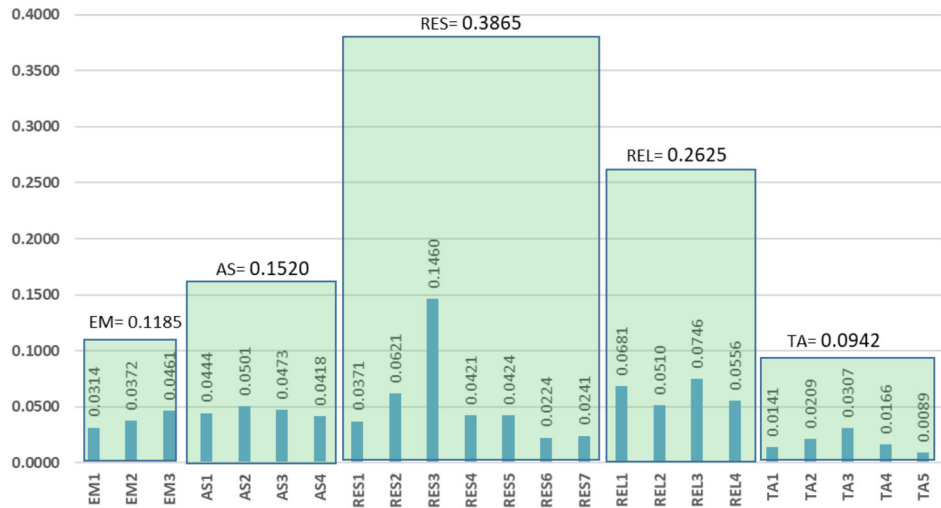


Fig. 4. The final weight of the criteria based on the results of aggregating the opinions of evaluation teams.

Table 7
Evaluation of each hospital based on the final criteria.

Criteria		H1	H2	H3	H4	H5	H6	H7	H8	H9	H10	
Team 1	Empathy	EM1	H	H	H	H	H	VH	VH	M	VH	H
		EM2	H	H	H	H	VH	H	H	H	H	H
		EM3	H	H	H	H	VH	H	VH	H	H	H
	Assurance	AS1	VH	VH	H	H	VH	H	H	H	H	H
		AS2	VH	VH	H	H	VH	H	H	H	H	H
		AS3	VH	VH	H	H	VH	H	H	H	H	H
		AS4	H	H	H	H	VH	H	VH	VH	H	H
	Responsiveness	RES1	H	H	H	H	VH	H	VH	VH	VH	VH
		RES2	VH	VH	H	H	VH	H	VH	VH	H	H
		RES3	VH	VH	H	H	VH	H	VH	VH	VH	VH
		RES4	H	VH	H	H	VH	H	VH	VH	VH	VH
		RES5	H	H	H	H	VH	H	VH	VH	H	H
		RES6	VH	VH	VH	H	H	H	H	H	H	H
		RES7	VH	VH	VH	H	H	H	H	H	H	H
	Reliability	REL1	VH	VH	VH	H	H	H	H	H	H	H
REL2		VH	VH	VH	H	H	H	H	H	H	H	
REL3		VH	VH	VH	H	H	H	H	H	H	H	
REL4		VH	VH	VH	H	H	H	H	H	H	H	
Tangibles	TA1	VH	VH	VH	H	H	H	H	H	H	H	
	TA2	VH	VH	VH	M	H	H	H	M	H	H	
	TA3	VH	VH	VH	H	H	H	H	H	H	H	
	TA4	VH	VH	VH	M	H	H	H	M	H	H	
	TA5	VH	VH	VH	H	H	H	H	H	H	H	
Team 2	Empathy	EM1	H	VH	H	H	H	H	VH	H	H	VH
		EM2	H	H	H	H	H	H	H	H	H	H
		EM3	H	H	H	H	H	H	H	H	H	H

(continued on next page)

Table 7
(continued)

Criteria		H1	H2	H3	H4	H5	H6	H7	H8	H9	H10
Assurance	AS1	VH	VH	VH	H	H	H	VH	M	VH	VH
	AS2	H	VH	VH	H	H	H	VH	H	VH	VH
	AS3	M	H	H	M	M	M	H	H	H	H
	AS4	VH	VH	VH	VH	VH	VH	VH	H	VH	VH
Responsiveness	RES1	VH	VH	VH	VH	VH	VH	VH	H	VH	VH
	RES2	M	H	H	H	H	M	H	H	H	H
	RES3	M	H	H	H	M	H	H	H	H	H
	RES4	M	H	M	H	M	M	M	M	H	H
	RES5	H	H	H	H	H	H	H	M	H	H
	RES6	VH	VH	VH	H	VH	H	VH	VH	VH	VH
	RES7	VH	VH	VH	H	H	VH	VH	VH	VH	VH
Reliability	REL1	VH	VH	VH	H	H	VH	H	H	H	H
	REL2	H	H	H	H	H	H	H	H	H	H
	REL3	VH	VH	VH	H	H	H	H	H	H	H
	REL4	H	H	VH	H	H	H	H	H	H	H
Tangibles	TA1	VH	VH	VH	VH	H	H	H	M	VH	VH
	TA2	VH	VH	VH	H	VH	H	VH	M	VH	VH
	TA3	VH	VH	VH	H	VH	VH	VH	H	VH	VH
	TA4	VH	VH	VH	H	VH	H	VH	M	VH	VH
	TA5	VH	VH	VH	VH	VH	VH	VH	M	H	VH
Empathy	EM1	VH	VH	VH	H	H	VH	VH	VL	M	VH
	EM2	VH	VH	VH	H	H	VH	VH	M	M	VH
	EM3	VH	VH	VH	H	H	VH	VH	M	M	VH
Assurance	AS1	VH	VH	VH	H	H	VH	VH	M	M	VH
	AS2	VH	VH	VH	H	H	VH	VH	M	M	VH
	AS3	VH	VH	VH	H	H	VH	VH	M	M	VH
	AS4	VH	VH	VH	H	H	VH	VH	M	M	VH
Responsiveness	RES1	VH	VH	VH	H	H	VH	VH	M	M	VH
	RES2	H	H	H	M	M	H	L	L	H	H
	RES3	H	H	M	H	H	M	M	L	L	VH
	RES4	VH	VH	VH	H	H	VH	VH	M	M	VH
	RES5	VH	VH	VH	H	H	VH	VH	M	M	VH
	RES6	VH	VH	VH	H	H	VH	VH	M	M	VH
	RES7	VH	VH	VH	H	H	VH	VH	M	M	VH
Reliability	REL1	VH	VH	VH	H	H	VH	VH	M	M	VH
	REL2	VH	VH	VH	H	H	VH	VH	M	M	VH
	REL3	VH	VH	VH	H	H	VH	VH	M	M	VH
	REL4	VH	VH	VH	H	H	VH	VH	M	M	VH
Tangibles	TA1	VH	VH	VH	H	H	VH	VH	M	M	VH
	TA2	VH	VH	VH	H	H	VH	VH	M	M	VH
	TA3	VH	VH	VH	H	H	VH	VH	M	M	VH
	TA4	VH	VH	VH	H	H	VH	VH	M	M	VH
	TA5	VH	VH	VH	H	H	VH	VH	M	M	VH

After creating the aggregated decision matrix, it was normalized based on Eq. (10) and then the weighted normalized decision matrix was calculated based on Eq. (12) and using the weights obtained in the previous step. The results are shown in Appendix B.

Table 8
Final ranking results for different values of λ .

Ideal	\tilde{S}_i	$\lambda = 0$			$\lambda = 0.5$			$\lambda = 1$		
		BNP	K_i	Rank	BNP	K_i	Rank	BNP	K_i	Rank
Alternative	[(0.399, 0.64), 0.805, (1.151, 1.373)]	0.516	1.000	0	0.517	1.000	0	0.519	1.000	0
Hospital 1	[(0.361, 0.586), 0.749, (1.101, 1.331)]	0.488	0.947	3	0.488	0.943	3	0.487	0.938	3
Hospital 2	[(0.382, 0.618), 0.779, (1.133, 1.364)]	0.505	0.979	1	0.505	0.977	1	0.506	0.975	1
Hospital 3	[(0.358, 0.581), 0.744, (1.103, 1.337)]	0.488	0.946	4	0.487	0.941	4	0.486	0.935	4
Hospital 4	[(0.308, 0.5), 0.653, (1.036, 1.297)]	0.452	0.876	8	0.445	0.859	8	0.438	0.843	8
Hospital 5	[(0.32, 0.525), 0.677, (1.049, 1.3)]	0.459	0.891	7	0.455	0.879	7	0.450	0.867	7
Hospital 6	[(0.329, 0.537), 0.695, (1.063, 1.308)]	0.467	0.905	6	0.463	0.894	6	0.459	0.884	6
Hospital 7	[(0.344, 0.567), 0.722, (1.08, 1.316)]	0.476	0.924	5	0.475	0.918	5	0.474	0.912	5
Hospital 8	[(0.251, 0.422), 0.564, (0.908, 1.142)]	0.391	0.759	10	0.385	0.745	10	0.379	0.730	10
Hospital 9	[(0.272, 0.455), 0.604, (0.96, 1.201)]	0.415	0.806	9	0.410	0.792	9	0.404	0.778	9
Hospital 10	[(0.363, 0.585), 0.745, (1.109, 1.349)]	0.491	0.953	2	0.490	0.946	2	0.488	0.940	2

Table 9
Comparison of rankings of methods with the proposed approach.

Alternatives	ARAS-IVTFN	TOPSIS-IVTFN	SAW-IVTFN	VIKOR-IVTFN
Hospital 1	3	3	3	3
Hospital 2	1	1	1	1
Hospital 3	4	4	4	4
Hospital 4	8	7	8	8
Hospital 5	7	6	7	7
Hospital 6	6	8	6	6
Hospital 7	5	5	5	5
Hospital 8	10	10	10	10
Hospital 9	9	9	9	9
Hospital 10	2	2	2	2

Finally, the overall performance index for each alternative (\tilde{S}_i) was calculated based on Eq. (13) (second column of Table 8). Then, using Eq. (14), the defuzzification process was performed on different λ s, the results of which are given in the form of the next columns of Table 8.

6. Comparison and Discussion

6.1. Comparison of the Proposed Ranking Method with Previous Methods

In order to evaluate the stability of the results of the model, the results have been compared with the results of three methods: SAW-IVTFN, TOPSIS-IVTFN (Chai and Zhou, 2022) and VIKOR-IVTFN (Zhou and Xu, 2018). The final ranking based on these methods is presented in Table 9. The selection of these methods is due to their extensive use in previous studies.

As this table shows, the ranks of most alternatives are the same in different methods. The insignificant differences show that the results of the applied model have an acceptable level of stability.

6.2. Managerial Implications

Based on the current research findings, the most important dimension of quality of health care services is Responsiveness (0.3865) and among the different items of this dimension, the time allotted to answer patients' questions and ambiguities, as well as demands and the internal willingness of the staff to respond to and meet the needs of patients have been given the highest priority.

Following this dimension, Reliability (0.2625) is the next priority. Among the various items of this dimension, the credibility of the hospital shows the highest importance. Assurance is the third important dimension among the dimensions that shape the quality of services studied in this research (0.1520) and accurate description of the patient's medical condition by staff is the most important component of this dimension. Empathy is the fourth most important dimension in the evaluation of service quality by patients (0.1185) and special attention to patients by staff is the most important component of this dimension of service quality. A look at the obtained results reveals that the last priority in evaluating the quality of services was allocated to Tangibles (0.0942). In this dimension, based on the items, we can refer to modern and up-to-date equipment, which have the highest importance. A discussion of the priorities obtained for each of the dimensions shaping the quality of health care services is presented below.

Responsiveness is the highest priority among all aspects of health service quality. Responsiveness means willingness and readiness to help patients and provide services at the right time. A look at the constituent items of this dimension of the quality of health care services shows that answering patients' questions is the most important item. The importance of this indicator in evaluating the quality of health care services by patients has been emphasized in many recent studies (Singh, 2019; Otay *et al.*, 2017; AIOmari, 2020). Given the important role that health care services play in ensuring the health of patients, the ambiguity that patients usually have about the disease and the methods of treatment, is one of their most important concerns. Therefore, accurate response to these ambiguities can be one of the most important factors in increasing the quality of services provided to patients. The significance of inner desire of service personnel to respond and provide correct answers willingly and wholeheartedly as one of the important factors for the quality of health care services shown in this study is in line with previous research (AIOmari, 2020).

Reliability is another important dimension for the quality of health care services which according to the results of this study, has the next highest importance after responsiveness. Reliability means the ability of a health care provider to provide accurate and error-free services to patients. Given the importance of these services in the health and life of patients, without a doubt, providing accurate and error-free services with high organization and reliability in the promised time can play an important role in improving the quality of health care services provided to patients (Singh *et al.*, 2020).

Assurance is the third priority among SERVQUAL dimensions. The knowledge, politeness and decency of service providers are some items of this dimension, which can ensure the quality of services received by patients. In addition, safe medical equipment plays an important role in improving the assurance of services provided to patients. The service nature of health care services leads to the fact that service providers have a special importance in shaping patients' perceptions of the quality of health care services and play a significant role in satisfying patients. This finding is consistent with the findings of other previous studies that emphasize the role and importance of health care providers (Altuntas *et al.*, 2012).

Empathy involves paying special attention to patients and understanding their specific needs and striving to meet those needs as much as possible. Based on the obtained results and considering the priorities of the items of this dimension, understanding the specific needs of patients alone is not enough and the main priority is to try to meet those needs as much as possible. The importance of this item is such that in some studies this parameter has been mentioned as the most important parameter for patients in evaluating the quality of health care services (Singh *et al.*, 2020). The importance of empathy as a significant indicator in evaluating the quality of services of health organizations in Iran has been confirmed in previous studies (Afkham *et al.*, 2012).

Among all dimensions of health care services quality, the lowest priority was given to tangibles. This finding is in line with the results of Singh and Prasher (2019) and Singh *et al.* (2020), which introduced this parameter as one of the low priority parameters in weighting the factors affecting the quality of health services. In interpreting this result, one should bear in mind that low priority does not in any way mean the low importance of this parameter, but indicates a lower priority compared to other factors. The friendly, clean and comfortable environment of the hospital along with the good appearance of the staff are some factors that can affect patients' perception of tangibles in assessing the quality of services. Complete and new hospital equipment as another item of this dimension, is of the highest importance.

Findings related to the ranking of hospitals in terms of service quality performance also showed that Hospital 4 has the highest rank and the best hospital service quality among the ten hospitals, which is obviously due to the better performance of this hospital based on the service quality parameters with a higher weight. It is followed by Hospital 4, 2, 1 and 6.

7. Conclusions

Improving the quality of health care services has always been one of the challenges for industry managers. This challenge has been created in response to the pressure of increasing the competitiveness of health care providers that seek to raise customer awareness about the services received. Reasons that have made the development and implementation of service quality improvement strategies in the health care industry a challenging issue are the complexities of this industry due to the risky nature of services provided to patients,

the direct relationship of these services with patients' health and life and the influence of various factors such as differences in patients' conditions on the quality of perceived services. Also, the breadth of dimensions and items affecting the quality of services from the patient-centred approach is one of the key issues for health care providers in planning to improve the quality of services. Due to limited resources and lack of relevant research methods to identify and prioritize the most important aspects affecting the quality of health services, the results of this study can be of significant help to Iranian decision-makers.

Accordingly, this study tried to provide a new framework to help decision makers in identifying the most important dimensions and indicators for measuring the quality of health services from patients' view point, a method for ranking hospitals and related medical centres that can address the challenges raised in this area. This article contributes to existing knowledge of health care service quality in several important ways.

The first innovation of this article is to propose a localized model for measuring the quality of health care services in a case study (hospitals operating in selected areas of Iran). In order to calculate the weight of the criteria and evaluate each hospital based on the selected criteria, instead of using the typical Likert scale with definite numbers, linguistic variables and IVTFNs were used which overcome the mentioned limitations of fuzzy numbers, such as the limitation on determining the exact value of the upper and lower bounds of the membership function. On the other hand, based on the knowledge of the authors, this is the first attempt to calculate the weight of health service quality criteria using the SWARA-IVTFN method. In order to show the efficiency of the developed framework in comparing the performance of different hospitals and health centres, the ARAS-IVTFN method was used to calculate the score of each hospital and the final ranking of alternatives.

From a management point of view, these findings can be a basis for helping health care managers to plan service quality improvement strategies; since recognizing different aspects of quality and being aware of deviations in each dimension compared to the situation of other competitors can lead to correction and, ultimately, improvement of the quality of services. Undoubtedly, paying attention to improving the quality of services by increasing patient satisfaction with the services received can play an important role in promoting competitiveness and performance of the organizations providing health services. In this regard, it is recommended that future researchers use frameworks such as importance performance analysis (IPA) in their studies. In addition, since the identified criteria are not independent of each other, methods such as DANP can be used to model the relationships between the criteria and calculate their weights. Another important point in evaluation is the use of periodic data instead of evaluation based on findings of only one period, which can be considered as dynamic multi-attribute decision-making (DMADM) frameworks.

Appendix A. Aggregated Decision Table Based on Hospital Service Quality Evaluation Criteria

Criteria	IDEAL	H1	H2
Empathy	EM1 [(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]
	EM2 [(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]
	EM3 [(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]
Assurance	AS1 [(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.75, 0.8), 0.9, (0.9, 0.9)]
	AS2 [(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.75, 0.8), 0.9, (0.9, 0.9)]
	AS3 [(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.582, 0.635), 0.74, (0.786, 0.807)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]
	AS4 [(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]
Responsiveness	RES1 [(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]
	RES2 [(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.525, 0.577), 0.68, (0.756, 0.792)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]
	RES3 [(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.525, 0.577), 0.68, (0.756, 0.792)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]
	RES4 [(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.525, 0.577), 0.68, (0.756, 0.792)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]
	RES5 [(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]
	RES6 [(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.75, 0.8), 0.9, (0.9, 0.9)]
	RES7 [(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.75, 0.8), 0.9, (0.9, 0.9)]
Reliability	REL1 [(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.75, 0.8), 0.9, (0.9, 0.9)]
	REL2 [(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]
	REL3 [(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.75, 0.8), 0.9, (0.9, 0.9)]
	REL4 [(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]
Tangibles	TA1 [(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.75, 0.8), 0.9, (0.9, 0.9)]
	TA2 [(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.75, 0.8), 0.9, (0.9, 0.9)]
	TA3 [(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.75, 0.8), 0.9, (0.9, 0.9)]
	TA4 [(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.75, 0.8), 0.9, (0.9, 0.9)]
	TA5 [(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.75, 0.8), 0.9, (0.9, 0.9)]
Criteria	H3	H4	H5
Empathy	EM1 [(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.55, 0.6), 0.7, (0.8, 0.85)]	[(0.55, 0.6), 0.7, (0.8, 0.85)]
	EM2 [(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.55, 0.6), 0.7, (0.8, 0.85)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]
	EM3 [(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.55, 0.6), 0.7, (0.8, 0.85)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]
Assurance	AS1 [(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.55, 0.6), 0.7, (0.8, 0.85)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]
	AS2 [(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.55, 0.6), 0.7, (0.8, 0.85)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]
	AS3 [(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.473, 0.524), 0.626, (0.727, 0.777)]	[(0.525, 0.577), 0.68, (0.756, 0.792)]
	AS4 [(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]
Responsiveness	RES1 [(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]
	RES2 [(0.55, 0.6), 0.7, (0.8, 0.85)]	[(0.473, 0.524), 0.626, (0.727, 0.777)]	[(0.525, 0.577), 0.68, (0.756, 0.792)]
	RES3 [(0.473, 0.524), 0.626, (0.727, 0.777)]	[(0.55, 0.6), 0.7, (0.8, 0.85)]	[(0.525, 0.577), 0.68, (0.756, 0.792)]
	RES4 [(0.525, 0.577), 0.68, (0.756, 0.792)]	[(0.55, 0.6), 0.7, (0.8, 0.85)]	[(0.525, 0.577), 0.68, (0.756, 0.792)]
	RES5 [(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.55, 0.6), 0.7, (0.8, 0.85)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]
	RES6 [(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.55, 0.6), 0.7, (0.8, 0.85)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]
	RES7 [(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.55, 0.6), 0.7, (0.8, 0.85)]	[(0.55, 0.6), 0.7, (0.8, 0.85)]
Reliability	REL1 [(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.55, 0.6), 0.7, (0.8, 0.85)]	[(0.55, 0.6), 0.7, (0.8, 0.85)]
	REL2 [(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.55, 0.6), 0.7, (0.8, 0.85)]	[(0.55, 0.6), 0.7, (0.8, 0.85)]
	REL3 [(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.55, 0.6), 0.7, (0.8, 0.85)]	[(0.55, 0.6), 0.7, (0.8, 0.85)]
	REL4 [(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.55, 0.6), 0.7, (0.8, 0.85)]	[(0.55, 0.6), 0.7, (0.8, 0.85)]
Criteria	H6	H7	H8
Empathy	EM1 [(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.268, 0.288), 0.327, (0.458, 0.517)]
	EM2 [(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.473, 0.524), 0.626, (0.727, 0.777)]
	EM3 [(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.473, 0.524), 0.626, (0.727, 0.777)]
Assurance	AS1 [(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.407, 0.458), 0.559, (0.66, 0.711)]
	AS2 [(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.473, 0.524), 0.626, (0.727, 0.777)]
	AS3 [(0.525, 0.577), 0.68, (0.756, 0.792)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.473, 0.524), 0.626, (0.727, 0.777)]
	AS4 [(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.525, 0.577), 0.68, (0.756, 0.792)]

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Criteria	H6	H7	H8	
Responsiveness	RES1	[(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.75, 0.8), 0.9, (0.9, 0.9)]	[(0.525, 0.577), 0.68, (0.756, 0.792)]
	RES2	[(0.473, 0.524), 0.626, (0.727, 0.777)]	[(0.396, 0.458), 0.574, (0.66, 0.701)]	[(0.396, 0.458), 0.574, (0.66, 0.701)]
	RES3	[(0.473, 0.524), 0.626, (0.727, 0.777)]	[(0.525, 0.577), 0.68, (0.756, 0.792)]	[(0.396, 0.458), 0.574, (0.66, 0.701)]
	RES4	[(0.525, 0.577), 0.68, (0.756, 0.792)]	[(0.582, 0.635), 0.74, (0.786, 0.807)]	[(0.451, 0.504), 0.608, (0.687, 0.724)]
	RES5	[(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.451, 0.504), 0.608, (0.687, 0.724)]
	RES6	[(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.525, 0.577), 0.68, (0.756, 0.792)]
	RES7	[(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.525, 0.577), 0.68, (0.756, 0.792)]
Reliability	REL1	[(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.473, 0.524), 0.626, (0.727, 0.777)]
	REL2	[(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.473, 0.524), 0.626, (0.727, 0.777)]
	REL3	[(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.473, 0.524), 0.626, (0.727, 0.777)]
	REL4	[(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.473, 0.524), 0.626, (0.727, 0.777)]
Tangibles	TA1	[(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.407, 0.458), 0.559, (0.66, 0.711)]
	TA2	[(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.35, 0.4), 0.5, (0.6, 0.65)]
	TA3	[(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.473, 0.524), 0.626, (0.727, 0.777)]
	TA4	[(0.61, 0.66), 0.761, (0.832, 0.866)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.35, 0.4), 0.5, (0.6, 0.65)]
	TA5	[(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]	[(0.407, 0.458), 0.559, (0.66, 0.711)]
Criteria	H9	H10	c_j^+ / a_j^-	
Empathy	EM1	[(0.525, 0.577), 0.68, (0.756, 0.792)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]	8.291
	EM2	[(0.473, 0.524), 0.626, (0.727, 0.777)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]	8.469
	EM3	[(0.473, 0.524), 0.626, (0.727, 0.777)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]	8.486
Assurance	AS1	[(0.525, 0.577), 0.68, (0.756, 0.792)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]	8.535
	AS2	[(0.525, 0.577), 0.68, (0.756, 0.792)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]	8.584
	AS3	[(0.473, 0.524), 0.626, (0.727, 0.777)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]	8.206
	AS4	[(0.525, 0.577), 0.68, (0.756, 0.792)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]	8.649
Responsiveness	RES1	[(0.582, 0.635), 0.74, (0.786, 0.807)]	[(0.75, 0.8), 0.9, (0.9, 0.9)]	8.681
	RES2	[(0.55, 0.6), 0.7, (0.8, 0.85)]	[(0.55, 0.6), 0.7, (0.8, 0.85)]	7.957
	RES3	[(0.396, 0.458), 0.574, (0.66, 0.701)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]	7.932
	RES4	[(0.525, 0.577), 0.68, (0.756, 0.792)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]	8.109
	RES5	[(0.473, 0.524), 0.626, (0.727, 0.777)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]	8.433
	RES6	[(0.525, 0.577), 0.68, (0.756, 0.792)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]	8.633
	RES7	[(0.525, 0.577), 0.68, (0.756, 0.792)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]	8.634
Reliability	REL1	[(0.473, 0.524), 0.626, (0.727, 0.777)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]	8.57
	REL2	[(0.473, 0.524), 0.626, (0.727, 0.777)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]	8.503
	REL3	[(0.473, 0.524), 0.626, (0.727, 0.777)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]	8.554
	REL4	[(0.473, 0.524), 0.626, (0.727, 0.777)]	[(0.61, 0.66), 0.761, (0.832, 0.866)]	8.52
Tangibles	TA1	[(0.525, 0.577), 0.68, (0.756, 0.792)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]	8.535
	TA2	[(0.525, 0.577), 0.68, (0.756, 0.792)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]	8.418
	TA3	[(0.525, 0.577), 0.68, (0.756, 0.792)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]	8.635
	TA4	[(0.525, 0.577), 0.68, (0.756, 0.792)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]	8.418
	TA5	[(0.473, 0.524), 0.626, (0.727, 0.777)]	[(0.676, 0.727), 0.828, (0.865, 0.883)]	8.57

Appendix B. Weighted Normalized Decision Table

Criteria	IDEAL	H1	H2	
Empathy	EM1	[(0.012, 0.016), 0.027, (0.039, 0.048)]	[(0.01, 0.013), 0.023, (0.036, 0.046)]	[(0.011, 0.015), 0.025, (0.038, 0.047)]
	EM2	[(0.013, 0.016), 0.027, (0.042, 0.052)]	[(0.013, 0.016), 0.027, (0.042, 0.052)]	[(0.013, 0.016), 0.027, (0.042, 0.052)]
	EM3	[(0.018, 0.023), 0.037, (0.053, 0.064)]	[(0.016, 0.021), 0.034, (0.051, 0.063)]	[(0.016, 0.021), 0.034, (0.051, 0.063)]
	EM3	[(0.018, 0.023), 0.037, (0.053, 0.064)]	[(0.016, 0.021), 0.034, (0.051, 0.063)]	[(0.016, 0.021), 0.034, (0.051, 0.063)]
Assurance	AS1	[(0.016, 0.049), 0.03, (0.042, 0.05)]	[(0.016, 0.049), 0.03, (0.042, 0.05)]	[(0.016, 0.049), 0.03, (0.042, 0.05)]
	AS2	[(0.016, 0.059), 0.033, (0.047, 0.056)]	[(0.014, 0.054), 0.031, (0.045, 0.055)]	[(0.016, 0.059), 0.033, (0.047, 0.056)]
	AS3	[(0.013, 0.056), 0.027, (0.039, 0.047)]	[(0.011, 0.049), 0.024, (0.036, 0.043)]	[(0.013, 0.056), 0.027, (0.039, 0.047)]
	AS4	[(0.015, 0.044), 0.029, (0.041, 0.049)]	[(0.014, 0.04), 0.026, (0.04, 0.048)]	[(0.014, 0.04), 0.026, (0.04, 0.048)]
Responsiveness	RES1	[(0.015, 0.02), 0.032, (0.045, 0.054)]	[(0.014, 0.018), 0.029, (0.044, 0.053)]	[(0.014, 0.018), 0.029, (0.044, 0.053)]
	RES2	[(0.023, 0.029), 0.046, (0.068, 0.081)]	[(0.02, 0.025), 0.041, (0.062, 0.074)]	[(0.023, 0.029), 0.046, (0.068, 0.081)]
	RES3	[(0.074, 0.088), 0.122, (0.15, 0.165)]	[(0.057, 0.07), 0.1, (0.131, 0.148)]	[(0.067, 0.08), 0.112, (0.144, 0.161)]
	RES4	[(0.016, 0.021), 0.033, (0.049, 0.059)]	[(0.012, 0.016), 0.027, (0.043, 0.053)]	[(0.016, 0.021), 0.033, (0.049, 0.059)]
	RES5	[(0.016, 0.02), 0.034, (0.05, 0.06)]	[(0.014, 0.019), 0.031, (0.048, 0.059)]	[(0.014, 0.019), 0.031, (0.048, 0.059)]
	RES6	[(0.007, 0.009), 0.018, (0.03, 0.038)]	[(0.007, 0.009), 0.018, (0.03, 0.038)]	[(0.007, 0.009), 0.018, (0.03, 0.038)]
	RES7	[(0.008, 0.011), 0.02, (0.032, 0.04)]	[(0.008, 0.011), 0.02, (0.032, 0.04)]	[(0.008, 0.011), 0.02, (0.032, 0.04)]

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Criteria	IDEAL	H1	H2
Reliability	REL1	[(0.032, 0.04), 0.06, (0.08, 0.092)]	[(0.032, 0.04), 0.06, (0.08, 0.092)]
	REL2	[(0.019, 0.025), 0.04, (0.061, 0.074)]	[(0.019, 0.025), 0.04, (0.061, 0.074)]
	REL3	[(0.035, 0.043), 0.066, (0.088, 0.101)]	[(0.035, 0.043), 0.066, (0.088, 0.101)]
	REL4	[(0.023, 0.03), 0.049, (0.068, 0.081)]	[(0.021, 0.027), 0.045, (0.066, 0.079)]
Tangibles	TA1	[(0.004, 0.006), 0.011, (0.02, 0.027)]	[(0.004, 0.006), 0.011, (0.02, 0.027)]
	TA2	[(0.007, 0.009), 0.017, (0.029, 0.037)]	[(0.007, 0.009), 0.017, (0.029, 0.037)]
	TA3	[(0.011, 0.015), 0.026, (0.04, 0.05)]	[(0.011, 0.015), 0.026, (0.04, 0.05)]
	TA4	[(0.005, 0.007), 0.013, (0.023, 0.031)]	[(0.005, 0.007), 0.013, (0.023, 0.031)]
	TA5	[(0.002, 0.003), 0.007, (0.013, 0.018)]	[(0.002, 0.003), 0.007, (0.013, 0.018)]
Criteria	H3	H4	H5
Empathy	EM1	[(0.01, 0.013), 0.023, (0.036, 0.046)]	[(0.009, 0.012), 0.021, (0.035, 0.045)]
	EM2	[(0.013, 0.016), 0.027, (0.042, 0.052)]	[(0.011, 0.015), 0.025, (0.04, 0.051)]
	EM3	[(0.016, 0.021), 0.034, (0.051, 0.063)]	[(0.015, 0.019), 0.031, (0.049, 0.062)]
	AS1	[(0.014, 0.045), 0.028, (0.041, 0.049)]	[(0.012, 0.037), 0.024, (0.038, 0.047)]
Assurance	AS2	[(0.014, 0.054), 0.031, (0.045, 0.055)]	[(0.012, 0.044), 0.026, (0.042, 0.053)]
	AS3	[(0.012, 0.051), 0.025, (0.038, 0.047)]	[(0.009, 0.041), 0.02, (0.033, 0.042)]
	AS4	[(0.014, 0.04), 0.026, (0.04, 0.048)]	[(0.012, 0.036), 0.024, (0.038, 0.047)]
	RES1	[(0.014, 0.018), 0.029, (0.044, 0.053)]	[(0.012, 0.016), 0.027, (0.042, 0.052)]
Responsiveness	RES2	[(0.021, 0.027), 0.042, (0.065, 0.08)]	[(0.018, 0.023), 0.038, (0.059, 0.073)]
	RES3	[(0.052, 0.064), 0.092, (0.126, 0.145)]	[(0.06, 0.073), 0.103, (0.139, 0.158)]
	RES4	[(0.012, 0.016), 0.027, (0.043, 0.053)]	[(0.013, 0.017), 0.028, (0.045, 0.057)]
	RES5	[(0.014, 0.019), 0.031, (0.048, 0.059)]	[(0.013, 0.017), 0.029, (0.046, 0.058)]
	RES6	[(0.007, 0.009), 0.018, (0.03, 0.038)]	[(0.005, 0.007), 0.014, (0.027, 0.036)]
	RES7	[(0.008, 0.011), 0.02, (0.032, 0.04)]	[(0.006, 0.008), 0.016, (0.028, 0.038)]
	REL1	[(0.032, 0.04), 0.06, (0.08, 0.092)]	[(0.023, 0.03), 0.047, (0.071, 0.087)]
Reliability	REL2	[(0.019, 0.025), 0.04, (0.061, 0.074)]	[(0.016, 0.02), 0.034, (0.056, 0.071)]
	REL3	[(0.035, 0.043), 0.066, (0.088, 0.101)]	[(0.025, 0.032), 0.051, (0.078, 0.096)]
	REL4	[(0.023, 0.03), 0.049, (0.068, 0.081)]	[(0.017, 0.022), 0.038, (0.061, 0.076)]
	TA1	[(0.004, 0.006), 0.011, (0.02, 0.027)]	[(0.003, 0.005), 0.01, (0.019, 0.026)]
Tangibles	TA2	[(0.007, 0.009), 0.017, (0.029, 0.037)]	[(0.004, 0.006), 0.012, (0.023, 0.032)]
	TA3	[(0.011, 0.015), 0.026, (0.04, 0.05)]	[(0.008, 0.011), 0.02, (0.035, 0.047)]
	TA4	[(0.005, 0.007), 0.013, (0.023, 0.031)]	[(0.003, 0.005), 0.009, (0.019, 0.027)]
	TA5	[(0.002, 0.003), 0.007, (0.013, 0.018)]	[(0.002, 0.003), 0.006, (0.012, 0.018)]
	Criteria	H6	H7
Empathy	EM1	[(0.011, 0.015), 0.025, (0.038, 0.047)]	[(0.012, 0.016), 0.027, (0.039, 0.048)]
	EM2	[(0.013, 0.016), 0.027, (0.042, 0.052)]	[(0.013, 0.016), 0.027, (0.042, 0.052)]
	EM3	[(0.016, 0.021), 0.034, (0.051, 0.063)]	[(0.018, 0.023), 0.037, (0.053, 0.064)]
	AS1	[(0.013, 0.041), 0.026, (0.039, 0.048)]	[(0.014, 0.045), 0.028, (0.041, 0.049)]
Assurance	AS2	[(0.013, 0.049), 0.028, (0.043, 0.054)]	[(0.014, 0.054), 0.031, (0.045, 0.055)]
	AS3	[(0.01, 0.045), 0.022, (0.034, 0.043)]	[(0.012, 0.051), 0.025, (0.038, 0.047)]
	AS4	[(0.014, 0.04), 0.026, (0.04, 0.048)]	[(0.015, 0.044), 0.029, (0.041, 0.049)]
	RES1	[(0.014, 0.018), 0.029, (0.044, 0.053)]	[(0.015, 0.02), 0.032, (0.045, 0.054)]
Responsiveness	RES2	[(0.018, 0.023), 0.038, (0.059, 0.073)]	[(0.015, 0.02), 0.035, (0.054, 0.066)]
	RES3	[(0.052, 0.064), 0.092, (0.126, 0.145)]	[(0.057, 0.07), 0.1, (0.131, 0.148)]
	RES4	[(0.012, 0.016), 0.027, (0.043, 0.053)]	[(0.014, 0.018), 0.03, (0.044, 0.054)]
	RES5	[(0.014, 0.019), 0.031, (0.048, 0.059)]	[(0.016, 0.02), 0.034, (0.05, 0.06)]
	RES6	[(0.005, 0.008), 0.016, (0.028, 0.037)]	[(0.006, 0.009), 0.017, (0.029, 0.037)]
	RES7	[(0.007, 0.01), 0.018, (0.031, 0.039)]	[(0.007, 0.01), 0.018, (0.031, 0.039)]
	REL1	[(0.029, 0.036), 0.055, (0.077, 0.09)]	[(0.026, 0.033), 0.051, (0.074, 0.088)]
Reliability	REL2	[(0.017, 0.022), 0.037, (0.058, 0.073)]	[(0.017, 0.022), 0.037, (0.058, 0.073)]
	REL3	[(0.028, 0.036), 0.055, (0.081, 0.098)]	[(0.028, 0.036), 0.055, (0.081, 0.098)]
	REL4	[(0.019, 0.025), 0.041, (0.063, 0.078)]	[(0.019, 0.025), 0.041, (0.063, 0.078)]
	TA1	[(0.003, 0.005), 0.01, (0.019, 0.026)]	[(0.003, 0.005), 0.01, (0.019, 0.026)]
Tangibles	TA2	[(0.005, 0.008), 0.015, (0.027, 0.036)]	[(0.006, 0.008), 0.016, (0.028, 0.036)]
	TA3	[(0.01, 0.013), 0.024, (0.038, 0.049)]	[(0.01, 0.013), 0.024, (0.038, 0.049)]
	TA4	[(0.004, 0.006), 0.011, (0.022, 0.03)]	[(0.004, 0.006), 0.012, (0.022, 0.03)]
	TA5	[(0.002, 0.003), 0.007, (0.013, 0.018)]	[(0.002, 0.003), 0.007, (0.013, 0.018)]
	Criteria	H9	H10
Empathy	EM1	[(0.009, 0.012), 0.02, (0.033, 0.042)]	[(0.011, 0.015), 0.025, (0.038, 0.047)]
	EM2	[(0.01, 0.013), 0.022, (0.037, 0.047)]	[(0.013, 0.016), 0.027, (0.042, 0.052)]
	EM3	[(0.012, 0.016), 0.028, (0.045, 0.056)]	[(0.016, 0.021), 0.034, (0.051, 0.063)]

(continued on next page)

Criteria	H9	H10
Assurance	AS1	[(0.011, 0.035), 0.023, (0.036, 0.044)] [(0.014, 0.045), 0.028, (0.041, 0.049)]
	AS2	[(0.011, 0.043), 0.025, (0.039, 0.049)] [(0.014, 0.054), 0.031, (0.045, 0.055)]
	AS3	[(0.009, 0.041), 0.02, (0.033, 0.042)] [(0.012, 0.051), 0.025, (0.038, 0.047)]
	AS4	[(0.011, 0.032), 0.022, (0.035, 0.043)] [(0.014, 0.04), 0.026, (0.04, 0.048)]
Responsiveness	RES1	[(0.012, 0.016), 0.026, (0.04, 0.049)] [(0.015, 0.02), 0.032, (0.045, 0.054)]
	RES2	[(0.021, 0.027), 0.042, (0.065, 0.08)] [(0.021, 0.027), 0.042, (0.065, 0.08)]
	RES3	[(0.043, 0.056), 0.084, (0.114, 0.131)] [(0.074, 0.088), 0.122, (0.15, 0.165)]
	RES4	[(0.012, 0.016), 0.027, (0.043, 0.053)] [(0.016, 0.021), 0.033, (0.049, 0.059)]
	RES5	[(0.011, 0.015), 0.026, (0.042, 0.053)] [(0.014, 0.019), 0.031, (0.048, 0.059)]
	RES6	[(0.005, 0.007), 0.014, (0.025, 0.034)] [(0.006, 0.009), 0.017, (0.029, 0.037)]
	RES7	[(0.005, 0.008), 0.015, (0.027, 0.035)] [(0.007, 0.01), 0.018, (0.031, 0.039)]
Reliability	REL1	[(0.02, 0.026), 0.042, (0.064, 0.079)] [(0.026, 0.033), 0.051, (0.074, 0.088)]
	REL2	[(0.013, 0.018), 0.031, (0.051, 0.065)] [(0.017, 0.022), 0.037, (0.058, 0.073)]
	REL3	[(0.022, 0.028), 0.046, (0.071, 0.087)] [(0.028, 0.036), 0.055, (0.081, 0.098)]
	REL4	[(0.015, 0.02), 0.034, (0.055, 0.07)] [(0.019, 0.025), 0.041, (0.063, 0.078)]
Tangibles	TA1	[(0.003, 0.004), 0.009, (0.017, 0.024)] [(0.004, 0.005), 0.01, (0.019, 0.026)]
	TA2	[(0.005, 0.007), 0.013, (0.024, 0.033)] [(0.006, 0.008), 0.016, (0.028, 0.036)]
	TA3	[(0.008, 0.011), 0.02, (0.033, 0.044)] [(0.01, 0.013), 0.024, (0.038, 0.049)]
	TA4	[(0.003, 0.005), 0.01, (0.02, 0.027)] [(0.004, 0.006), 0.012, (0.022, 0.03)]
	TA5	[(0.001, 0.002), 0.005, (0.011, 0.016)] [(0.002, 0.003), 0.007, (0.013, 0.018)]

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