Service Quality Analysis with Using a Fuzzy AHP Methodology: A case study in Veterinary Hospital in Turkey

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Abstract

The purpose of this study is to present a novel fuzzy evaluation framework to analyze service quality in a veterinary hospital in Turkey. Since the veterinary hospital service quality has been studied rarely in the literature, we aim to introduce a new aspect for this topic. A novel fuzzy Analytic Hierarchy Process (AHP) method is developed to determine the service quality expectations in the veterinary hospital. In this study, fuzzy search methodology is applied in order to address the linguistic evaluation scales to tackle with the uncertainty and subjectivity of the evaluation process of the service quality. Service quality performance indicators used in this study are determined based on the SERVQUAL (service quality) dimensions.

Keywords
Service Quality, Analytic Hierarchy Process, Multi-criteria decision-making, Fuzzy, and Veterinary Healthcare

1. Introduction

Quality is a concept that is shaping with determination of customer requests and expectations. In order to maintain product or service quality, products and services need to be produce according to these requests and expectations. The concept of quality can be defined in a differential manner, according to the manufacturer's product/service or the customer's perspective. With the globalization firms need to produce customer specified products or services to gain a competitive advantage in the market. In today's conditions when there is intensive competition, among a variety of alternatives, customers choose the products or the services, which are designed according to their requirements. Therefore, potential customer's quality perception has become crucial. When products are the case, after determining the customer requirements, companies can design products according to this request then produce the product and they offer them to the customers. In this process, products can be evaluated in terms of quality. Services unlike tangible products are produced and consumed at the same time in the presence of the customer and the service producer. Service quality is composed of different specialties in which intangible properties take place such as comfort, ability, and trustiness. Measurement of intangible features is related with subjective opinions and because of that it is hard to measure these intangible features (Akdağ et al., 2014). In addition, the service quality definition is a relative term, which is mostly associated with personal opinion. In the service industry there is need to carry out detailed studies on customer service quality requirements. For this mentioned reasons, it is more difficult to maintain service quality (Ramseook-Munhurrun, et al., 2010).

In the last years, service quality measurement in health care industry has started getting more attention in the literature. Numerous firms that offer the service in the health sector are working with the aim to assess the customer perception about the services. A wealth of knowledge and experience in enhancing the quality of health care has accumulated globally over many decades (Bengoga, et al., 2006). An accurate assessment of healthcare service quality is necessary to enhance quality of care and perform a strategic service quality management. Service quality concept is usually studied in human healthcare industry; however service quality concept in a veterinary hospital is rarely studied in the literature. Therefore, we aim to introduce a new aspect for this topic and determine the criteria, which have an effect on service quality in a veterinary hospital.

Since, veterinarian practice service quality has gained more importance with the growing pet ownership in Turkey, veterinary hospitals need to improve their healthcare service quality to gain a competitive advantage in this increased market competition. Veterinarians are trained about animal healthcare and committed to excellence in the diagnosis, treatment of animal health. However, a veterinary hospital is one of the complex business firms, which is composed of a variety of interrelated job processes. Since veterinarians are not trained as business people, the process management in the veterinary hospital can be challenging. Thus, it is important to determine and prioritize relevant criteria to maintain a successful service quality.

Service process quality can be measured by using service quality dimensions. SERVQUAL is a well-known and discussed scale for measuring service quality. It is firstly developed by Parasuraman et al. (1995). It is an efficient model in helping an organization to improve service quality. Service quality dimensions are grouped in five main criteria (tangibles, reliability, responsiveness, assurance and empathy) in SERVQUAL. Rahman et al. (2007) and Chakraborty & Majumdar (2013) consider the five dimensions of SERVQUAL analysis in healthcare industry. Devebakan and Aksaraylı (2003) indicate that in the literature a standard SERVQUAL model is used to evaluate service quality in healthcare industry. Chakraborty & Majumdar (2011) conclude that SERVQUAL analysis is very popular and useful method when measuring service quality in healthcare industry additionally to the other proposed methods in the literature. Based on the literature, it is concluded that SERVQUAL dimensions are suitable for service quality evaluation in healthcare industry. Additionally to this, all veterinarians are expected to adhere to ethical principles additionally to customer satisfaction when they are providing service to their patients. Therefore, in this study, the ethical dimension is added to the basic five dimensions of SERVQUAL when determining critical criteria for service quality evaluation in veterinary hospital. The fuzzy AHP is used to tackle with the uncertainty and vagueness of service and to take in to consideration of the decision maker's subjective judgments. A good many paper in literature consider the fuzzy AHP to determine the priority of critical criteria, which are qualify the service quality.

For the above mentioned reasons, we aim to develop and fuzzy AHP method to present an evaluation framework for veterinary healthcare service quality. In this study, the SERVQUAL quality dimensions (tangibles, assurance, reliability, responsiveness, empathy) and ethics have been considered and evaluated. The purpose of the paper is to provide a practical reference for veterinary service quality management and examine the relative importance of critical service quality criteria for the veterinary hospitals of Turkey.

The remainder of the paper is organized as follows. In section 2, solution methodology is presented and fuzzy AHP is explained. In section 3, the application of fuzzy AHP methodology in veterinary healthcare service quality is demonstrated. Finally, the conclusion is discussed in section 4, followed by the references.

2. Solution Methodology

AHP is one of the popular MCDM methods, which is developed by Saaty (1980). Since then, it used to solve different kind of problems in the literature. It is applicable to complicated real life problems since it incorporates expert comments to the solution. Thanks to this feature of the method, the qualitative or intangible attributes can be evaluated by using pair-wise comparisons along with expert judgments (Chai et al., 2013). The conventional AHP can be not suitable for dealing with the uncertainty and vagueness of linguistic assessment. Since service quality contains intangibility and vagueness in its nature, fuzzy AHP method is used to tackle with this situation. The fuzzy set theory is firstly developed by Zadeh (1965). According to fuzzy theory the key elements in human thinking are not numbers but linguistic terms and they can be quantify by using fuzzy set labels (Srichetta and Thurachon, 2012). Fuzzy analytic hierarchy process (AHP), which is the extension of the Saaty's theory, has been studied extensively since 1983. FAHP is applied to solve decision problems from different industries. Especially, it has been widely used in the evaluation of service quality of many sectors like banking, logistics, fast-food industry, hospitality industry, and retail industry, since FAHP is able to model linguistic expressions. In fuzzy AHP, well-known linguistic statements are used in the pair-wise comparison, which can be represented by fuzzy numbers. In the literature, triangular fuzzy numbers (TFNs) are generally used for the sake of its simplicity. There have been many TFNs are developed in the literature. One of the appropriate TFNs that have been used to convert the preferences scale of the crisp AHP is considered in this study. Table 1 summarized the corresponding TFNs.

Table 1. The aggregated fuzzy pair-wise comparison matrix

Linguistic Scale	TFNs	Reciprocal TFNs
Equally important	(1,1,1)	(1,1,1)
Weakly more important	(2/3, 1, 3/2)	(2/3, 1, 3/2)
Strong more important	(3/2, 2, 5/2)	(2/5, 1/2, 2/3)
Very strong more important	(5/2, 3, 7/2)	(2/7, 1/3, 2/5)
Absolutely more important	(7/2, 4, 9/2)	(2/9, 1/4, 2/7)

Triangular fuzzy numbers can be denoted as (l ,m ,u). The parameters l, m, and u respectively represent the smallest possible value, the most promising value, and the largest possible value that describe a fuzzy event. A triangular fuzzy number $\widetilde{M}$ is shown in Fig. 1 (Deng, 1999).

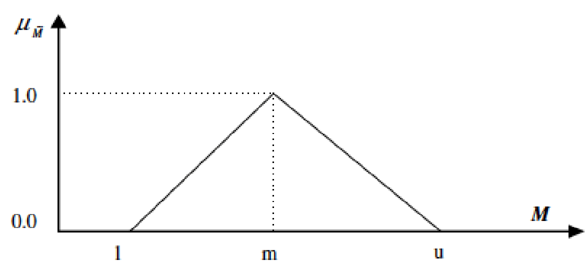

Figure 1. Triangular fuzzy number, $\widetilde{\boldsymbol{M}}$

A fuzzy number $\widetilde{M}$ is a convex normalized fuzzy set $\widetilde{M}$ of the real line R such that (Zimmermann, 1992):
It exists such that one $x_0 \in R$ with $\mu_{\widetilde{M}}(x_0) = 1$
where, x_0 is called mean value of $\widetilde{M}$ and $\mu_{\widetilde{M}}(x)$ is piecewise continuous.

In this study three operations on triangular fuzzy number are conducted. These operations are illustrated as follows. If we suppose $M_1 = (l_1, m_1, u_1)$ and $M_2 = (l_2, m_2, u_2)$ are two triangular fuzzy numbers then:

$$M_1 \oplus M_2 = (l_1 + l_2, m_1 + m_2, u_1 + u_2) \tag{1}$$

$$M_1 \otimes M_2 = (l_1 * l_2, m_1 * m_2, u_1 * u_2) \tag{2}$$

$$M_1{}^{-1} = (l_1, m_1, u_1)^{-1} \approx (\frac{1}{u_1}, \frac{1}{m_1}, \frac{1}{l_1}) \tag{3}$$

In the literature, a variety of different FAHP approaches are presented by various researchers. In this study, we used the extent FAHP developed by Chang (1996), in which the synthetic extent value S_i of pairwise comparison is used. Steps of the FAHP proposed by Chang (1996) can be given as below:

Step 1: The value of fuzzy synthetic extent with respect to the i^{th} element is computed as:

$$S_i = \sum_{j=1}^{m} M_{gi}^{j} \otimes \left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^{j}\right]^{-1} \tag{4}$$

Where, the fuzzy addition operation of m extent analysis values for a particular matrix to derive $\sum_{j=1}^{m} M_{gi}^{j}$ is defined as

$$\sum_{j=1}^{m} M_{gi}^{j} = \left(\sum_{j=1}^{m} l_j,\ \sum_{j=1}^{m} m_{j,} \sum_{j=1}^{m} u_j\right) \tag{5}$$

and the fuzzy addition operation of $M_{gi}^{j}(j = 1,2, \dots, m)$ values is performed to maintain $\left[\sum_{j=1}^{n} \sum_{j=1}^{m} M_{gi}^{j}\right]^{-1}$

$$\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^{j} = \left(\sum_{i=1}^{n} l_i, \sum_{i=1}^{n} m_i, \sum_{i=1}^{n} u_i\right) \tag{6}$$

$$\left[\sum_{j=1}^{n} \sum_{j=1}^{m} M_{gi}^{j}\right]^{-1} = \left(\frac{1}{\sum_{i=1}^{n} u_i}, \frac{1}{\sum_{i=1}^{n} m_i}, \frac{1}{\sum_{i=1}^{n} l_i}\right) \tag{7}$$

Step 2: While, $M_1 = (l_1, m_1, u_1)\ and\ M_2 = (l_2, m_2, u_2)$ are two triangular fuzzy numbers, the degree of possibility of $M_2 = (l_2, m_2, u_2) \geq M_1 = (l_1, m_1, u_1)$ is determined as

$$V(M_2 \geq M_1) = \begin{cases} 1 & , if\ m_2 \geq m_1 \\ 0 & , if\ l_1 \geq u_2 \\ \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} & , otherwise \end{cases} \tag{8}$$

where d is the ordinate of the highest intersection between μ_{M1} and μ_{M2}. So, it can be represented as $V(M_2 \geq M_1) = hight\ (M_1 \cap M_2) = \mu_{M1}(d)$. (9)

Additionally to this, the both values of $V(M_2 \geq M_1)$ and $V(M_1 \geq M_2)$ are needed to compare M_1 and M_2.

Step 3: The degree of possibility for a convex fuzzy number to be greater than k convex fuzzy $M_i\ (i = 1,2 \dots k)$ numbers can be determined by

$$V(M \geq M_1, M_2, \dots, M_k) = V[(M \geq M_1)\ and\ (M \geq M_2)\ and \dots and\ (M \geq M_k)] = \min V(M \geq M_i),\ i = 1,2,3, \dots k \tag{10}$$

Assume that $d(A_i) = \min V(S_i \geq S_k)$ for $k = 1, 2, 3, \dots, n$; $k \neq i$. Then, where, $A_i(\ i = 1,2, \dots, n)$ are n elements, the weight vector is defined by

$$W' = (d'(A_1), d'(A_2), \dots, d'(A_n))^T \tag{11}$$

Step 4: The normalized weight vectors shown as below are computed via normalization where W is a non-fuzzy number.

$$W = (d(A_1), d(A_2), \dots, d(A_n))^T \tag{12}$$

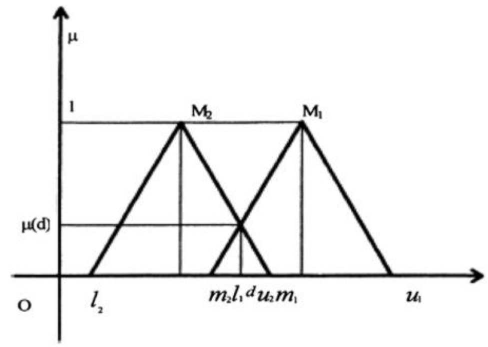

Figure 2. The intersection between M_1 and M_2

3. Case Study

In this case study, we consider service quality concept in a veterinary hospital. Application is conducted in Veterinary Teaching Hospital of Istanbul University Faculty of Veterinary Medicine, which is one of the biggest veterinary hospitals in Turkey. The veterinary hospital offers emergency, specialty and primary care services to all species including dogs, cats, exotic pets, wildlife, zoo animals, equine and farm animals. In Turkey, pet humanization has become a new trend in the last years and that affects the growth of pet care. Pet owner increasingly see their pets as member of their family, which leads them to look for the best healthcare service for their pets.

Since the decision maker in veterinary healthcare service is the owner of the animal, they interpret the service quality in a veterinary hospital. For this reason, a veterinarian shall be responsible about pet owner's service requirements. While, they provide treatment or diagnosis for an animal, they need to care about pet owner's service requirements at the same time. Therefore, providing the best possible animal healthcare service is not enough for the customer satisfaction in veterinary healthcare service. As mentioned above, all veterinarians are expected to adhere to ethical principles additionally to customer satisfaction when they are providing service to their patients. Therefore, in this study, the ethical dimension is added to the basic five dimensions of SERVQUAL when determining critical criteria for service quality evaluation in veterinary hospital. The criteria definitions are explained in Table 2.

Table 2. Criteria for Service Quality

Criteria	Definition
Tangibles	Tangibles are the appearance of physical facilities, equipment, hygiene and layout of the hospital.
Reliability	It promises accuracy and consistency of the given information (diagnosis, disease etc.).
Responsiveness	It emphasizes willingness to help customers and pro-vide prompt service accurately and consistently.
Assurance	Courtesy of personnel and their ability to inspire trust and confidence. To give guaranty to the patients in case of a problem.
Empathy	It promises personalized services, caring and understanding the patients.
Ethics	Consideration of animal welfare, providing competent veterinary medical care and appropriate patient care.

SERVQUAL analysis is one of the methods that are used to assess the perception of customer service. SERVQUAL analysis determines the customer's expectations and perceptions of the quality by using the dimensions of service quality: Tangibles, Reliability, Responsiveness, Assurance and Empathy. In this study, quality dimensions, which are used in the SERVQUAL analysis, asked to veterinarians comparing with each other. In addition to five

dimensions we also added ethics criteria in our study to the comparing. FAHP is used to tackle with the uncertainty and vagueness of service and to take in to consideration of the decision maker's subjective judgments.
The decision making group consists of the veterinarian of the Veterinary Teaching Hospital of Istanbul University Faculty of Veterinary Medicine who serves in clinics. Data are collected from eight experts who are experienced and effective on the service quality. Firstly, pairwise comparisons are conducted in linguistic and fuzzy terms. Secondly, the fuzzy comparison matrices are developed. The aggregated fuzzy pair-wise comparison matrix is computed. Table 3 illustrates the aggregated fuzzy pair-wise comparison matrix.

Table 3. The aggregated fuzzy pair-wise comparison matrix

	Tangibles (C1)	**Reliability (C2)**	**Empathy (C3)**	**Assurance (C4)**	**Responsiveness (C5)**	**Ethic (C6)**
Tangibles (C1)	(1.00,1.00,1.00)	(0.67,1.00,1.50)	(0.40,0.50,0.67)	(0.40,0.50,0.67)	(0.67,1.00,1.50)	(0.40,0.50,0.67)
Reliability (C2)	(0.67,1.00,1.50)	(1.00,1.00,1.00)	(1.50,2.00,2,50)	(1.00,1.00,1.00)	(1.50,2.00,2,50)	(0.67,1.00,1.50)
Empathy (C3)	(1.50,2.00,2,50)	(0.40,0.50,0.67)	(1.00,1.00,1.00)	(0.67,1.00,1.50)	(0.67,1.00,1.50)	(0.67,1.00,1.50)
Assurance (C4)	(1.50,2.00,2,50)	(1.00,1.00,1.00)	(0.67,1.00,1.50)	(1.00,1.00,1.00)	(2.50,3.00,3.50)	(0.67,1.00,1.50)
Responsiveness (C5)	(0.67,1.00,1.50)	(0.40,0.50,0.67)	(0.67,1.00,1.50)	(0.29,0.33,.040)	(1.00,1.00,1.00)	(0.40,0.50,0.67)
Ethics (C6)	(1.50,2.00,2,50)	(0.67,1.00,1.50)	(0.67,1.00,1.50)	(0.67,1.00,1.50)	(1.50,2.00,2,50)	(1.00,1.00,1.00)

According to Chang (1996)'s extent FAHP, firstly fuzzy synthesis values need to be calculated in order to compute weights of all criteria. The fuzzy synthesis value S_i with respect to the i^{th} criterion can be calculated with using Eq. (4). By using pair-wise comparison values in Table 3, synthesis values are calculated for each criterion. The example of fuzzy synthesis value calculation for C1 is shown as following.

$S_{C1} = (3.53{,}4.50{,}6.00) \otimes (31.52{,}40.33{,}51.90)^1 = (0.07{,}0.11{,}0.19)$

The rest of the table is calculated in a same way with S_{C1} for each criterion. All computed fuzzy synthesis values of criteria are presented in Table 4.

Table 4. The fuzzy synthesis extent value of each criterion

Criteria	**Fuzzy Synthesis Extent Value (S_i)**
C1	(0.07,0.11,0.19)
C2	(0.12,0.20,0.32)
C3	(0.09,0.16,0.28)
C4	(0.14,0.22,0.35)
C5	(0.12,0.20,0.33)

Then, the non-fuzzy values that present the relative preferences or weights of one criterion over other criteria are computed with using the fuzzy synthesis extent values. These non-fuzzy values are obtained by using Eq. (8). The example of degree of possibility for $V(S_{c1}>S_{c2})$ is calculated as following.

$V(S_{c1}>S_{c2}) = (0.12-0.19)/[(0.11-0.19)-(0.20-0.12)] = 0.44$

The relative weights of other criteria are computed and illustrated in Table 5.

Table 5. Non-fuzzy values for comparisons

Comparison	**Value**	**Comparison**	**Value**	**Comparison**	**Value**	**Comparison**	**Value**	**Comparison**	**Value**	**Comparison**	**Value**
$V(S_{c1}>S_{c2})$	0.44	$V(S_{c2}>S_{c1})$	1.00	$V(S_{c3}>S_{c1})$	1.00	$V(S_{c4}>S_{c1})$	1.00	$V(S_{c5}>S_{c1})$	0.96	$V(S_{c6}>S_{c1})$	1.00
$V(S_{c1}>S_{c3})$	0.65	$V(S_{c2}>S_{c3})$	1.00	$V(S_{c3}>S_{c2})$	0.80	$V(S_{c4}>S_{c2})$	1.00	$V(S_{c5}>S_{c2})$	0.40	$V(S_{c6}>S_{c2})$	1.00
$V(S_{c1}>S_{c4})$	0.31	$V(Sc_2>S_{c4})$	0.88	$V(S_{c3}>S_{c4})$	0.68	$V(S_{c4}>S_{c3})$	1.00	$V(S_{c5}>S_{c3})$	0.62	$V(S_{c6}>S_{c3})$	1.00
$V(S_{c1}>S_{c5})$	1	$V(S_{c2}>S_{c5})$	1.00	$V(S_{c3}>S_{c5})$	1.00	$V(S_{c4}>S_{c5})$	1.00	$V(S_{c5}>S_{c4})$	0.26	$V(S_{c6}>S_{c4})$	0.89
$V(S_{c1}>S_{c6})$	0.46	$V(S_{c2}>S_{c6})$	1.00	$V(S_{c3}>S_{c6})$	0.81	$V(S_{c4}>S_{c6})$	1.00	$V(S_{c5}>S_{c6})$	1.00	$V(S_{c6}>S_{c5})$	1.00

Following this, priority weights are obtained by using Eq. (10).

$d'(C_1) = \min$ (0.44,0.66,0.31,1.00,0.46) = (0.31)
$\boldsymbol{d'(C_2) = \min}$ (1.00,1.00,0.88,1.00,1.00) = (0.88)
$d'(C_3) = \min$ (1.00,0.80,0.68,1.00,0.81) = (0.68)
$d'(C_4) = \min$ (1.00,1.00,1.00,1.00,1.00) = (1.00)
$d'(C_5) = \min$ (0.96,0.40,0.62,0.26,1.00) = (0.26)
$d'(C_6) = \min$ (1.00,1.00,1.00,0.89,1.00) = (0.89)

With the normalization of these priority weights, normalized weights are computed. These normalized weights represent criteria importance priority respect to main goal. Table 6 shows the normalized weight of each criterion.

Table 6. Normalized weight values of each criterion

Criteria	**Normalized Weight**
C1	0.076
C2	0.219
C3	0.170
C4	0.249
C5	0.065
C6	0.221

From Table 6, since the criterion C4 (Assurance) has the highest priority weight with %25; we can conclude that the most important criterion in the animal healthcare service quality is assurance. The knowledge and courtesy of veterinarians and their ability to inspire trust and confidence is distinctive quality dimension in animal healthcare service quality. The criterion C6 (Ethics) is the second preferred criteria with the second highest priority weight. Consideration of animal welfare and ethical issues are also need to be considered in animal health care services to satisfy customer requirements. Furthermore, the criterion C5 (Responsiveness) has the latest importance priority weight.

4. Conclusion

Service quality concept in human health care services has been studied extensively in the literature. However, service quality management in veterinary medical health care services rarely studied. In the recent years, veterinarian practice service quality has gained more importance with the growing pet ownership in Turkey. Therefore, veterinary hospitals need to have an accurate healthcare quality assessment system and an efficient quality strategy to gain a competitive advantage in this competitive market. In this study, we aim to identify and prioritize relevant criteria to develop a sustainable service quality performance in veterinary healthcare. In order to tackle with the imprecise and vague nature of service quality, we consider fuzz AHP method to evaluate the relative priority of criteria. According to application results, the most critical criterion in the animal healthcare service quality is assurance is followed by respectively ethics, reliability, empathy, tangibles and responsiveness.
Since assurance has the most critical criterion; we can conclude that courtesy of personnel and their ability to inspire trust and confidence are precedence first in the animal healthcare service quality. In addition to this, since the computational results show that the ethics criterion is the second preferred criterion, we can conclude that the ethics is an essential dimension in the animal healthcare service quality.
For the future study, a research can be conducted to determine pet owner's service quality expectations and perceptions in animal health care service.

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Biography

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