A hybrid multi-criteria decision making technique to improve the quality of hotel industry services in Mashhad City

Ali Mohaghar
Faculty of Management,
University of Tehran,
Tehran, Iran
Email: amohaghar@ut.ac.ir

Roya Eghbal
Department of Business Administration and MBA,
Payame Noor University,
P.O. Box 19395-3697, Karaj, Iran
Email: roya.eghbal@yahoo.com

Seyed Hojjat Bazazzadeh*
Young Researchers and Elite Club,
West Tehran Branch,
Islamic Azad University,
Tehran, Iran
Email: Seyed hb@gmail.com
*Corresponding author

Abstract: Service industry is one of the most lucrative industries in the 21st century. To survive and succeed in competitive markets, service organisations pay special attention to the quality of their services. In between, hotel industry, as one of the most important parts of booming tourism industry in each country, has always been considered. The goal of conducting this study is to identify and rank the factors affecting the improvement of the quality of hotel industry services. For this purpose, 21 components were identified reviewing research literature and experts’ views; and finally, two FUZZY ANP and FUZZY TOPSIS methods prioritised using combination method. The conclusion showed that having new and up-to-date hotel equipments, having professional staff for hoteling services and respecting customers are the first priorities. Therefore, regarding the above factors, it is suggested to hotel managers, to work on advancing services quality presented by this industry.

Keywords: service quality; hotel industry; MCDM; F ANP; F TOPSIS.

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1 Introduction

Today for survival, all organisations need to compete in different areas such as services. Therefore, providing high quality services is necessary and leads an organisation to a sustainable competitive advantage. Experiences clearly indicate that service delivery improvement would lead to customer satisfaction (Yaya et al., 2014), and customer satisfaction results in increasing his/her loyalty (Izogo and Ogbia, 2015) that the result of which will be more profitable for an organisation (Sattar et al., 2014). Service quality is an enduring construct that encompasses quality performance in all activities undertaken by management and employees (Soñ et al., 2016). Service quality is a function of the difference between service expected and customers’ perceptions of the actual service delivered (Hapsari et al., 2016). The discussion of service quality in residential places is considered as one of the important and essential discussions. Lack of the specified standards for service quality in the field of residential industry has taken the possibility of exact definition for standard service quality from the owners and managers in this industry (Borkar and Koranne, 2014). Obviously, what causes to maintain and survive the hotel industry is lack of gaps and contradictions between the expectations of customers and the delivered services (Prince and Khaleq, 2013). Effective customer management is a vital issue for the success of hotel industry (Prakash et al., 2016). Since, the goal of all hotels is a thriving business in the current competitive conditions, the most successful hotels can attract permanent or so-called loyal customers and this will not be achieved except by keeping the customers satisfied which needs to provide high quality services (Siddiqi, 2011). The best way to provide high quality services in hotels is to recognise customers’ needs, demands and interests; and awareness of their ideas, suggestions and criticisms (Amritharaj and Vembar, 2014). Iran with a history of 7,000 years and having potential tourism capacities has always been considered by tourism industry managers. According to the statistics of Universal Tourism Organization (UNWTO); by attracting
5.3 million foreign tourists in 2013, Iran has been placed at the fourth rank in the Middle East. In between, historical cities of Shiraz, Isfahan, Yazd and Mashhad have been the destinations of most foreign tourists. After Tehran city, Mashhad is the second metropolis of Iran. Because of the existence of the shrine of Imam Ali ibn Musa al-Reza, the eighth Imam of Shiites in the world, this city annually has more than 30 million domestic and more than 1 million foreign pilgrims (Alizadeh, 2011). According to the selection of Mashhad as a research scope of this study, the discussion about providing services in residential places especially hotels plays an important role in attracting more tourists and development of tourism industry in this city. This study has been conducted on foreign passengers in four and five-star hotels that have travelled during March 2015 to visit holy, pilgrimage and tourism places of Mashhad city. As mentioned before, in this study we are looking for identification and prioritisation of the factors affecting service quality improvement using MADM techniques. Multi-attribute decision making model (MADM) is a scientific analytical model to evaluate and prioritise a set of options based on multiple criteria (Peng and Tzeng, 2013). So, in the second part of this study, the best service quality improvement model of hotel industry is recognised by reviewing research literature and help of experts and specialists in hotel industry. In the third part, namely research methodology, the algorithms of FUZZY ANP and FUSSY TOPSIS methods are described. The fourth part is related to data analysis. In this part, the weight of each criterion is obtained using FUZZY ANP method and the priority of each parameter achieved using FUSSY TOPSIS method. In the fifth part, conclusion will be stated and suggestions offered.

2 Research literature

2.1 Service quality

Since 1980, in addition to production sector, the discussion of quality has been considered in all parts and activities of an organisation such as service delivery (Gummesson et al., 2012). Quality measurement is easily done in tangible products and goods but measurement of this item in relation to services is somewhat vague and complex (Parasuraman et al., 1985). Service properties usually become clear in a dual relation between staff and customers in a place that the service would be presented (Lun et al., 2016; Paul et al., 2016). Service quality as a source for creating competitive advantage has attracted a lot of attentions (Nejati et al., 2009); it is an important and significant issue for trade organisations all over the world (Haksever et al., 2015). Moreover, it plays an important role in promotion of comprehensive quality management (Yu et al., 2015). In fact, service quality is customers’ judgments based on their total experiences about a company; this judgment is achieved as a result of comparing customers’ expectations with the performance conceived by them (Dubé, 2015) and has a strong and direct impact on customers’ confidence toward the considered organisation (Karjaluoto et al., 2015). Organisations can take steps towards customer orientation by training, socialisation and accountability (Whedon et al., 2016). In the recent years, great efforts have been made by experts to define and measure the quality of service conceived by customers (Babakus and Inhofe, 2015) and many researchers have studied the factors affecting the quality of service and as a result consumers’ satisfaction (Bojanic, 2015; Cronin Jr. and Taylor, 1992). Bansal and Taylor (2015a) consider the delivered service
quality as an important potential factor for customers’ satisfaction, Aniley and Negi (2015) state that there is a significant statistical relationship between customers’ satisfaction and service quality; and generally, service quality is obtained through satisfaction. Thus, service quality is very important to create and enhance customer’s satisfaction and understanding; it generates a friendly relationship between purchaser and seller (Dedeoglu et al., 2015). Hopkins et al. (2015) state that, the attraction and attitude of seller are among the factors affecting customers’ perception of service quality. Guesalaga and Pitta (2014) has stated that, although, there is a relationship between service quality and key outcomes of it such as customer’s satisfaction and performance; but, people’s perceptions of service quality is different among various cultures. The results of Dubé’s (2015) studies indicate that service quality improvement of a company marginally impacts on customers’ satisfaction; therefore, it can be cited as a key factor in competitive advantage (Yang et al., 2011). Dabholkar (2015) surveys the direct and indirect impacts of customer’s participation in service quality delivery; and suggests that increasing customer’s participation for special service delivery will lead to higher quality of the perceived service. Caruana et al. (2015b) emphasise on the existence of a significant relationship between service quality and customer’s loyalty and believe that managers and marketers should examine the dimensions of service quality in relation to their customers and meet customers’ expectations (Jayawardhena, 2015). However, many customer-based firms have problem in the process of recognition and evaluation of customers’ preferences and have often a false perception of customers’ demands and expectations (Cronin et al., 2000). Parasuraman, that is one of the most famous marketing faces specially in the field of service quality (Bansal and Taylor, 2015b); mentions the five main dimensions of tangibility, reliability, responsiveness, assurance and empathy as the most important measurement criteria of service quality improvement (Gremler, 2011).

2.2 Service quality in the hotel industry and the factors affecting on it

The studies indicate that one of the factors influencing on thriving tourism industry is to consider accommodation services and hoteling for foreign travellers (Ye et al., 2014). Presenting good services to the costumers is one of most important factors of differentiation between hotels in a competitive atmosphere (Chang et al., 2016). Kozak and Gürel (2015) in their studies concluded that the quality of service delivery in the hotels has always been very important. In this respect, hoteliers are always looking for identification of effective factors of high quality service delivery to maintain its competitive advantage (Molina-Azorín et al., 2015; Nasution, 2016). Dhar (2015) in his research stresses on the existence of a strong and effective relationship between education of hotel employees and the delivered service quality. High quality service delivery is considered as an important factor for returning passengers to the hotel (Rauch et al., 2015). The results of Al-Refaie’s (2015) researches indicate that use of modern methods of human resources management and creating satisfaction and loyalty in the hotel staffs will result in delivery of high quality service to customers. Siavoshani et al. (2014) in a research that was conducted in a hotel in Mashhad City concluded that the quality of service has a positive effect on reputation of name of a hotel. Hanzae and Mirvaisi (2013) have mentioned the positive effect of staffs’ job satisfaction on delivery of high quality service to customers. Managers and staffs tendency to deliver high quality service is one of the factors affecting customers’ satisfaction (Vala, 2014; Rahimi and Kozak, 2016). Sorayaei et al. (2014) in their research have mentioned the committed and
competent staffs in delivery of high quality service. Varesi et al. (2012) in a research on the situation of service delivery in the hotels of Isfahan concluded that the most important weakness of these hotels is lack of effective facilities and trained and skilled staffs (Chen et al., 2011). Liat et al. (2014) mentioned that the factors such as creating positive image in customer mind as well as his/her satisfaction and loyalty is important to improve the quality of service in the hotel industry. Attractiveness of physical facilities as well as the tranquility dominant on hotel environment has a deep impact on passengers’ satisfaction (Mueller and Kaufmann, 2001). Modernity of hotel facilities along with its apparent attractiveness is another factor affecting the improvement of hotel service quality (Lin, 2014). On the other side, delivery of high quality service and goods appropriate with the culture of passengers from different countries and also the performance of hotel staffs help to create a friendly space and distinguish this hotel from other hotels (Huei and Easvaralingam, 2011). Markovic et al. (2013) in their study mentioned the modernity of hotel facilities, the cleanliness of hotel, dress up of staffs and personnel’s interest in solving guests’ problems as outstanding cases. Dress up of staffs is important to create positive attitude in passengers (Pijls and Groen, 2012; Wang et al., 2013). Therefore, it should be tried to dress up hotel staffs; because, this attracts more attention to passengers and guests (Reichel et al., 2014). Ali and Amin (2014) considered a good and attractive physical environment as a factor for frequent travels to a hotel. Full performance of their obligations to passengers is of other factors effective on the improvement of hotel service quality (Zientara et al., 2015). Lin (2014) considered staffs’ tendency to deliver service to customers and the existence of modern facilities in a hotel among the factors of services quality delivered to passengers that influence their satisfaction. Sohrabi et al. (2012) considered the quantity and quality of service facilities in a hotel, geographical location of a hotel, for example, being in a good climate region, proper delivery of service by staffs and finally courteous staffs of hotel among the factors affecting passengers’ satisfaction. Mohsin and Lengler (2015) consider climate conditions of an area where the hotel is located as well as comparison of cost against services that deliver to customers effective on selecting a hotel by passengers. Arrival of passengers to clean rooms with beautiful landscapes impacts on their positive evaluation of a hotel (Walker, 1995). Restaurant also must be ready for favourable entertainment of guests (Borkar and Koranne, 2014). And also, hotel should provide various services for passengers’ entertainment (Blešić et al., 2011). Ariffin and Maghzi (2012) considered smile and warm meeting of staffs, staffs efforts in solving passengers’ problems and finally staffs treatment with respect effective on attracting passengers to a hotel. Anca and Andreea (2013) mentioned the cleanliness of hotel, staffs’ tendency to deliver services to customers and respect to customers’ character as the most important factors affecting the improvement of service quality. Another significant problem is that a balance should be considered between number of staffs and their responsibilities in the hotels (Chen et al., 2014). Rao (2014) states that staffs’ tendency to deliver timely and accurate services are critical in the success of hotel. Among the factors affecting customers’ satisfaction and return them to a hotel are interest in solving their problems, focus on customers’ demands and respect to their character (Chadha, 2015). Also, the confidence of customers to the staffs and feeling that they are interested in solving passengers’ problems and do their duties with utmost courtesy and respect are other factors that effect on the improvement of service quality (Minh et al., 2015). The results of Rhee and Yang’s (2015) studies indicate that the location of hotel, service and facilities of rooms, residential pricing per night and the capability of staffs for rapid delivery service to passengers are among the
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reasons for customers’ satisfaction or dissatisfaction of a hotel. Attallah (2015) stresses on staffs’ politeness when meeting passengers and their full knowledge and awareness in responding to probable questions. Dortyol et al. (2014) mentioned the factors such as creating confident in passengers, ability and communication skills of employees, attractive design and physical environment, staffs’ empathy with the passengers and also the quality of food as the most important factors of improving service quality in a hotel. Martinez and del Bosque (2013) considered staffs’ interest and tendency in solving customers’ problems as the most important factor of creating satisfaction and loyalty. Deng and Zuo (2014) and Sitawati and Mia (2015) have stated that rapid delivery service to passengers is important. Wang et al. (2012) believed that hotels should consider current and potential needs of passengers to maintain their competitive advantage. Security of passengers is another important factor that should be on the agenda of hoteliers. Because feeling of security leads to a longer stay in the hotel (Tsai et al., 2015; Li et al., 2015b). Based on the review of research literature and using the views of university professors and experts in the hotel industry, the most important criteria and factors affecting the improvement of hotel service quality were identified according to Table 1.

Table 1 The factors affecting the improvement of service quality in the hotel industry

<table>
<thead>
<tr>
<th>Criteria</th>
<th>No</th>
<th>Factors</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
<td>Attractiveness of physical facilities in the hotel</td>
<td>Mueller and Kaufmann (2001), Lin (2014), Ali and Amin (2014) and Dortyol et al. (2014)</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Dress up of staffs</td>
<td>Pijls and Groen (2012), Sohrabi et al. (2012), Markovic et al. (2013), Wang et al. (2013) and Reichel et al. (2014)</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Locating hotel in a good climate region</td>
<td>Sohrabi et al. (2012), Mohsin and Lengler (2015) and Rhee and Yang (2015)</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>A balance between number of staffs and their responsibilities in the hotels</td>
<td>Chen et al. (2014)</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>The cleanliness of hotel environment</td>
<td>Walker (1995), Anca and Andreea (2013) and Markovic et al. (2013)</td>
</tr>
<tr>
<td>Confidence</td>
<td>7</td>
<td>Full performance of obligations</td>
<td>Zientara et al. (2015)</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Proper delivery of service by staffs</td>
<td>Huei and Easvaralingam (2011), Sohrabi et al. (2012) and Dortyol et al. (2014)</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Delivery of high quality service at the time promised</td>
<td>Rao (2014)</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>Security of passengers</td>
<td>Tsai et al. (2015) and Li et al. (2015b)</td>
</tr>
</tbody>
</table>
Table 1 The factors affecting the improvement of service quality in the hotel industry (continued)

<table>
<thead>
<tr>
<th>Criteria</th>
<th>No</th>
<th>Factors</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responding</td>
<td>11</td>
<td>Staffs’ tendency in providing fast and reliable services to customers</td>
<td>Lin (2014), Anca and Andreea (2013), Rao (2014) and Minh et al. (2015)</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>Staffs’ tendency in solving customers’ problems</td>
<td>Ariffin and Maghzi (2012), Markovic et al. (2013), Chadha (2015) and Minh et al. (2015)</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>Staffs’ focus on addressing the needs and demands of customers</td>
<td>Chadha (2015)</td>
</tr>
<tr>
<td>Warranty services</td>
<td>15</td>
<td>The ability and credibility of hotel in providing reliable and good services</td>
<td>Minh et al. (2015) and Attallah (2015)</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>Having the qualified and skilled staffs for hotel service delivery</td>
<td>Varesi et al. (2012), Attallah (2015) and Dhar (2015)</td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>Customers’ trust in the hotel staffs</td>
<td>Martínez and del Bosque (2013) and Minh et al. (2015)</td>
</tr>
<tr>
<td>Respect for human values and empathy</td>
<td>18</td>
<td>Staffs’ respect to customers’ character</td>
<td>Ariffin and Maghzi (2012), Anca and Andreea (2013) and Chadha (2015)</td>
</tr>
<tr>
<td></td>
<td>19</td>
<td>Particular attention of staffs to cultural differences of customers</td>
<td>Huei and Easvaralingam (2011)</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>Understanding customers’ needs by hotel staffs</td>
<td>Wang et al. (2012) and Ren et al. (2015)</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>Politeness and humility of the hotel staffs</td>
<td>Sohrabi et al. (2012), Attallah (2015) and Minh et al. (2015)</td>
</tr>
</tbody>
</table>

3 Methodology

Decision making is considered as one of the most important duties of managers of companies and organisations (Betsch and Haberstroh, 2014). In fact, decision making is selection of an option among various options to solve a problem (Tzeng and Huang, 2011; Maier et al., 2014). Looking at the decisions that are made in the real world, it can be understood that most of our decisions are the types of multiple criteria decisions (Tzeng and Huang, 2011). In multiple criteria decision making instead of a criterion for optimality measurement, two or more criteria are used to compare solutions (Wan and Li,
Multiple criteria decision making models are divided into two categories of multiple objective decision making and multiple attribute decision making (Gupta and Raman, 2014). In multiple objective decision making (MODM), the best option should be designed based on the limitations of the system, different objectives as well as optimal values considered by decision maker for these goals (Chen and Chang, 2014); while, multiple attribute decision making (MADM) is used for the selection of superior option and generally for ranking of options (Zeng et al., 2014). The set of MADM methods are considered as useful tools for making difficult decisions. Since, the criteria affecting the improvement of service quality have not equal importance and on the other side they are dependent on each other; among the set of multiple criteria decision making methods, ANP method was selected to determine the weight of criteria and TOPSIS method for final ranking of the components. But because classical management science uses precise and definitive data to analyse issues and this approach does not reflect thinking of human in the real world; so, fuzzy management science is used (Li et al., 2015a; Zadeh et al., 2014). Lotfi and Fallahnejad (2010) introduced the fuzzy set for the first time. In this set, verbal variables are used to resolve ambiguities and insert decision makers’ feelings (Salah and Moselhi, 2015). The values of verbal variables are words or sentences found in natural language, but they are not numbers (Gottwald, 2015). Verbal variables can be quantified by use of fuzzy set theory and used in calculations (Huang, 2012; Karwowski and Mital 2014).

In classical set theory, an existence may be or may not be the member of a set. Since, an existence is uncertainty in a fuzzy set, we should define the membership function, that is the fundamental of the fuzzy sets, for each existence in the set.

A fuzzy number is a particular fuzzy set $A = x, R | \mu_A(x)$, where $x$ gets its values from the real line $R; -\infty < x < +\infty$ and its membership function $\mu_A(x)$ is a successive mapping from the closed interval and to it. Triangular and trapezoidal fuzzy numbers are the most generally used fuzzy numbers. Because of easy computation and features, triangular fuzzy numbers (TFNs) are often used in applications. TFNs are applied to represent the linguistic variables in this article. A TFN can be given as $\bar{M} = (l, m, u)$, its membership function $\mu_{\bar{M}}(x): R \to [0, 1]$ is:

$$
\mu_{\bar{M}}(x) = \begin{cases} 
\frac{x-l}{m-l} & l \leq x \leq m \\
\frac{x-u}{m-u} & m \leq x \leq u \\
0 & \text{otherwise}
\end{cases}
$$

(1)

where $l$ and $u$ are symbols of the lower and upper value of the support of $\bar{M}$, respectively; and $m$ is the mid-value of $\bar{M}$. The parameters of $l$, $m$, and $u$ describe a fuzzy number and imply the smallest possible value, the most promising value and the largest possible value, respectively. In Figure 1, TFN $\bar{M}$ is shown 11 (Seçme et al., 2009).
If two positive TFNs $\tilde{A} = (l_1, m_1, u_1)$ and $\tilde{B} = (l_2, m_2, u_2)$ are defined, then we have:

$$\tilde{A} \oplus \tilde{B} = (l_1, m_1, u_1) + (l_2, m_2, u_2) = (l_1 + l_2, m_1 + m_2, u_1 + u_2)$$  \hspace{1cm} (2)

$$\tilde{A} \otimes \tilde{B} = (l_1, m_1, u_1) \times (l_2, m_2, u_2) = (l_1 \times l_2, m_1 \times m_2, u_1 \times u_2)$$  \hspace{1cm} (3)

$$\tilde{A}^{-1} = (l_1, m_1, u_1) \approx \left( \frac{1}{u_1}, \frac{1}{m_1}, \frac{1}{l_1} \right)$$  \hspace{1cm} (4)

To analyse the data of this research, three main phases were defined according to Figure 2.

**Figure 2** Analysis process of research data

As it is observed in Figure 2, reviewing research literature and using the views of university professors and experts in tourism industry; the most important criteria and factors affecting the improvement of the quality of hotel industry service were identified in phase 1. In phase 2, using paired-comparison matrix and Sevkli et al. (2012) fuzzy verbal expressions, expert survey questionnaire was provided to determine the
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In the next phase, the second questionnaire in the format of Patil and Kant (2014) fuzzy quintuple Likert was distributed among 270 passengers of four and five-star hotels in Mashhad that 244 of them were returned. It should be noted that the validity of questionnaire data were confirmed by experts and Cronbach’s alpha was calculated using SPSS software to ensure the reliability of data; the result was the number 8.0 indicating an acceptable reliability. In the third phase, MATLAB software was used; first, the weight of criteria was calculated using FUZZY ANP and next final prioritisation of components obtained using FUZZY TOPSIS. In continue the algorithm of each of FUZZY ANP and FUZZY TOPSIS methods will be described.

3.1 FANP

Due to disability of AHP method in considering the interdependencies between criteria and options, Saaty and Takizawa (1986) introduced the approach of network analysis process (Chang et al., 2015a). ANP is able to model the available correlations and feedbacks between elements affecting decision making and calculate all internal impacts of the elements affecting decision making (Chen, 2012). Although, paired-comparisons are used to prioritise the components in both AHP and ANP methods but there are differences between them. The first difference is that hierarchy analytic process is a special state of network analysis process; because, network analysis process considers the interdependence of cluster (interdependence) and middle clusters (external dependence) (Pastor-Ferrando et al., 2010).

The second difference is that the ANP has a nonlinear structure. Unlike the AHP model in which the decision maker considers a uni-directional hierarchical relationship between different levels of decisions (Aznar et al., 2010). ANP simply determines the relationships between criteria and options (Kilic et al., 2015). Figure 3 indicates the difference between AHP structure and ANP structure.

Figure 3 The difference between hierarchical structure and network structure

<table>
<thead>
<tr>
<th>AHP structure</th>
<th>ANP structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goal</td>
<td>Goal</td>
</tr>
<tr>
<td>Criteria</td>
<td>Criteria</td>
</tr>
<tr>
<td>Sub-criteria</td>
<td>Sub-criteria</td>
</tr>
<tr>
<td>Alternatives</td>
<td>Alternatives</td>
</tr>
</tbody>
</table>

In ANP method, there is no need to strictly vertical hierarchical structure. In the networks, the elements of each class may impact on other or all elements. The
relationships are displayed in a network by arrows and where the direction of arrows is one-sided; the dependence is also one-sided (Kilic et al., 2015). The interdependence between the two classes is shown by a two-sided arrow and the interdependence between the elements of each class by ring shaped arrows (Chang et al., 2015a).

Although, experts use their own competence and capability to perform comparisons, but it should be noted that the network hierarchy analytic process may not fully reflect the style of human thinking (Tavana and Sodenkamp, 2010). According to the above descriptions, the use of fuzzy sets theory can eliminate this defect. So, in the algorithm proposed in this study, FANP method of Sevkli et al. was used for group decision making and determining the weight of each criterion. In this method, both input and output of FUZZY ANP technique are fuzzy and unlike classical fuzzy ANP, non-fuzzy structures (defuzzification) cannot be used; and paired-comparison matrix is completed between the criteria of each row, using TFNs. With this method, the values of parameters are obtained in the format of TFNs and calculated in fuzzy form. In the paired-comparison criteria, decision maker (expert) can use TFNs to determine degree of preference in options (Tadic et al., 2014). In classic ANP, the range of one to nine hours is used for paired-comparison performances. Although, this discrete spectrum is very simple and easy but does not include uncertainty and ambiguities related to an individual’s understanding and judgment on degree of preference. In other words, the decision maker may not be able to express in comparison a certain number as degree of preference (Sevkli et al., 2012). That is why a range of 19 can be used for TFNs instead of a reasonable range of one to nine hours in classic ANP that is shown in Table 2.

Table 2 Definition of TFN-linguistic scale for importance

<table>
<thead>
<tr>
<th>TFN</th>
<th>Linguistic scale for importance</th>
<th>Triangular fuzzy scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Equally preferred</td>
<td>(1, 1, 1)</td>
</tr>
<tr>
<td>2</td>
<td>Equally to moderately preferred</td>
<td>(1, 3/2, 3/2)</td>
</tr>
<tr>
<td>3</td>
<td>Moderately preferred</td>
<td>(1, 2, 2)</td>
</tr>
<tr>
<td>4</td>
<td>Moderately to strongly preferred</td>
<td>(3, 7/2, 4)</td>
</tr>
<tr>
<td>5</td>
<td>Strongly preferred</td>
<td>(3, 4, 9/2)</td>
</tr>
<tr>
<td>6</td>
<td>Strongly to very strongly preferred</td>
<td>(3, 9/2, 5)</td>
</tr>
<tr>
<td>7</td>
<td>Very strongly preferred</td>
<td>(3, 9/2, 5)</td>
</tr>
<tr>
<td>8</td>
<td>Very strongly to extremely preferred</td>
<td>(5, 6, 7)</td>
</tr>
<tr>
<td>9</td>
<td>Extremely preferred</td>
<td>(5, 7, 9)</td>
</tr>
</tbody>
</table>

In order to evaluate decision maker’s preferences, paired-comparison matrix is formed by use of TFNs \((l, m, u)\) in Table 1. TFNs matrix \((m \times n)\) can be shown as equation (5):

\[
\hat{A} = \begin{pmatrix}
(a_{11}^l, a_{11}^m, a_{11}^u) & (a_{12}^l, a_{12}^m, a_{12}^u) & \cdots & (a_{1n}^l, a_{1n}^m, a_{1n}^u) \\
(a_{21}^l, a_{21}^m, a_{21}^u) & (a_{22}^l, a_{22}^m, a_{22}^u) & \cdots & (a_{2n}^l, a_{2n}^m, a_{2n}^u) \\
\vdots & \vdots & \ddots & \vdots \\
(a_{m1}^l, a_{m1}^m, a_{m1}^u) & (a_{m2}^l, a_{m2}^m, a_{m2}^u) & \cdots & (a_{mn}^l, a_{mn}^m, a_{mn}^u)
\end{pmatrix}
\]
In this matrix, $\tilde{a}_{nm}$ indicates the importance of element in the row $m^{th}$ compared to element in the column $n^{th}$ (Ramik, 2007). If $\tilde{A}$ is a paired-comparison matrix, it is estimated that the elements of this matrix will be reversed towards the original diameter; namely, the value of $1/\tilde{a}_{nm}$ can be allocated to the element of $\tilde{a}_{mn}$ (Arif and Alam, 2014; Tung and Tang, 1998). Therefore, paired comparison matrix will be the same as equation (6):

$$
\tilde{A} = \begin{pmatrix}
(1, 1, 1) & (a_{12}^m, a_{12}^m, a_{12}^m) & \cdots & (a_{1n}^m, a_{1n}^m, a_{1n}^m) \\
\left(\frac{1}{a_{21}^m}, \frac{1}{a_{21}^m}, \frac{1}{a_{21}^m}\right) & (1, 1, 1) & \cdots & (a_{2n}^m, a_{2n}^m, a_{2n}^m) \\
\vdots & \vdots & \ddots & \vdots \\
\left(\frac{1}{a_{nm}^m}, \frac{1}{a_{nm}^m}, \frac{1}{a_{nm}^m}\right) & \left(\frac{1}{a_{nm}^m}, \frac{1}{a_{nm}^m}, \frac{1}{a_{nm}^m}\right) & \cdots & (1, 1, 1)
\end{pmatrix}
$$

(6)

In this method, fuzzy geometric mean is used to conclude experts’ views that expressed in the format of matrices $\tilde{A}$ and paired-comparisons. There are many methods to estimate fuzzy weights of $\tilde{w}_i$ based on matrix $\tilde{A}$ with approximate value of $\tilde{a}_{ij} \approx \tilde{w}_i / \tilde{w}_j$ as $\tilde{v}_i = (w_{i1}^m, w_{i2}^m, w_{i3}^m)$, $i = 1,2,\ldots,n$ (Kutlu and Ekmeckioğlu, 2012; Chen et al., 1992).

One of these methods is logarithm least squares method based on fuzzy weights calculation in this study. In this method, triangular fuzzy weights can be calculated for criteria, sub-criteria and options such that weights output of this method can be used in fuzzy approach to rank options (Önüt et al., 2009). To obtain the weight of the above criteria due to super matrix $w$ that can be as equation (7), the following stages were performed to calculate $w_{21}$, $w_{21}$ and the corresponding weight.

$$
w = \begin{pmatrix}
0 & 0 \\
w_{21} & w_{22}
\end{pmatrix}
$$

(7)

In matrix $w$ and $w_{21}$, geometric mean matrix of decision maker’s views is about paired-comparison of ranking indicators towards the main objective. $w_{22}$ is also calculated from geometric mean of decision makers’ views on paired-comparison of indicators towards each of other indicators (control indicator) and by use of logarithm least squares method to integrate $n$ tables of $n$ criteria (Önüt et al., 2009). Fuzzy weights logarithmic least squares method is shown as equation (8):

$$
\tilde{w}_k = (w_{k1}^m, w_{k2}^m, w_{k3}^m), k = 1,2,\ldots,n.
$$

(8)

So that:

$$
w_{kl}^s = \left\{ \frac{\prod_{j=1}^n a_{lj}^m}{\sum_{k=1}^{n} \prod_{j=1}^n a_{lj}^m} \right\}^{\frac{1}{s}}, \quad s \in \{l, m, n\}
$$

(9)
Then, matrix $w_i$ is calculated as $w_i = w_{22} \times w_{21}$ and fuzzy weight of each of priority indicators obtained using logarithm least squares method.

### 3.2 Fuzzy TOPSIS method: fuzzy techniques for order preference by similarity to idea solution

Fuzzy TOPSIS is widely used as one of MADM fuzzy techniques, due to its simplicity and programmable nature (Kutlu and Ekmeçioğlu, 2012). The basis of this technique is to determine the best option based on the concept of ideal solution. Thus, the option with the maximum distance from negative ideal and the minimum distance from positive ideal is in a higher priority (Yuen and Fung, 2014; Kannan et al., 2014). Developed method (Chen, 2000) was used in this study; it involves the following seven steps:

**Step 1** Formation of fuzzy decision making matrix, according to equation (10):

$$\hat{A}_j = \begin{bmatrix} A_1 & C_1 & C_2 & \cdots & C_n \\ x_{11} & x_{12} & \cdots & \hat{x}_{1n} \\ \vdots & \vdots & \cdots & \vdots \\ x_{n1} & x_{n2} & \cdots & \hat{x}_{nn} \\ \hat{w}_1 & \hat{w}_2 & \cdots & \hat{w}_n \end{bmatrix}$$

(10)

In this matrix, $A = \{A_i | i = 1, 2, \ldots, m\}$ are the options that should be selected by decision makers among their considered options. $C = \{C_j | j = 1, 2, \ldots, n\}$ is the criterion that the options are measured by it. $\tilde{X} = \{\tilde{x}_{ij} | i = 1, 2, \ldots, m; j = 1, 2, \ldots, n\}$ is the viewpoint of the $i^{th}$ people on the $j^{th}$ component that is calculated as fuzzy number of equation (11):

$$\tilde{x}_{ij} = (a_{ij}, b_{ij}, c_{ij})$$

(11)

And finally, $\tilde{w} = \{\tilde{w}_j | j = 1, 2, \ldots, n\}$ that includes the set of fuzzy weight of criteria is required as an input for fuzzy TOPSIS method. It should be noted that the weight of each criterion in this research was obtained using FANP method.

**Step 2** Defuzzification of decision making matrix.

At this step, fuzzy decision making matrix for evaluation of options should be converted into a normalised fuzzy matrix $\hat{R}$.

Equation (12) is used to obtain this matrix, where $m$ is the number of options and $n$ the number of experts.

$$\hat{R} = [\hat{r}_{ij}]_{m \times n} \quad i = 1, 2, \ldots, m; \quad j = 1, 2, \ldots, n,$$

(12)

If fuzzy numbers are as $(a, b, c)$ defuzzification matrix (normalised) is obtained through equation (13):

$$\bar{r}_{ij} = \left( \frac{a_{ij}}{c_j}, \frac{b_{ij}}{c_j}, \frac{c_{ij}}{c_j} \right)$$

(13)
A hybrid multi-criteria decision making technique

In equation (9), $c_j^*$ is the maximum value of $c_j$, $j^{th}$ expert among all options. Equation (13) indicates this issue.

$$c_j^* = \max_i c_{ij}$$  \hspace{1cm} (14)

**Step 3** Calculation of the weighted normalised fuzzy matrix $\tilde{V}$: at this stage, the normalised matrix of paired-comparisons is weighted by equation (15).

$$\tilde{V} = [\tilde{v}_{ij}]_{m \times n}; \quad i = 1, 2, \ldots, m; \quad j = 1, 2, \ldots, n.$$  \hspace{1cm} (15)

$$\tilde{v}_{ij} = \tilde{r}_{ij} \otimes \tilde{v}_{ij}$$  \hspace{1cm} (16)

In this equation, $\tilde{r}_{ij}$ is the normalised matrix obtained from second step.

**Step 4** Determination of fuzzy positive ideal solution ($FPIS, A^+$) and fuzzy negative ideal ($FPIS, A^-$) solution: the basis of FTOPSIS method is to calculate the distance level of options from fuzzy positive and negative ideal solution. Therefore at this stage, fuzzy positive and negative ideal solutions are determined. Equations (17) and (18) are used to determine these solutions.

$$FPIS = \tilde{A}^+ = \left\{ \tilde{v}_{ij}^*(x), \tilde{v}_{ij}^+(x), \ldots, \tilde{v}_{ij}^*(x) \right\} = \left\{ \left( \max_j \tilde{v}_{ij}(x) \right) \left| j \in J_1 \right\}, \left( \min_j \tilde{v}_{ij}(x) \right) \left| j \in J_2 \right\} \right\} \left\{ i = 1, 2, \ldots, n \right\}$$  \hspace{1cm} (17)

$$FNIS = \tilde{A}^- = \left\{ \tilde{v}_{ij}^*(x), \tilde{v}_{ij}^-(x), \ldots, \tilde{v}_{ij}^-(x) \right\} = \left\{ \left( \min_j \tilde{v}_{ij}(x) \right) \left| j \in J_1 \right\}, \left( \max_j \tilde{v}_{ij}(x) \right) \left| j \in J_2 \right\} \right\} \left\{ i = 1, 2, \ldots, n \right\}$$  \hspace{1cm} (18)

where $J_1$ and $J_2$ are related to positive and negative criteria, respectively. It should be noted that fuzzy positive and negative ideal values introduced by Chen are used in this study. These values are:

$$v_{ij}^+ = (1, 1, 1)$$  \hspace{1cm} (19)

$$v_{ij}^- = (0, 0, 0)$$  \hspace{1cm} (20)

**Step 5** Calculating the distance level of each of options from fuzzy positive and negative ideal solutions.

If $\tilde{A}$ and $\tilde{B}$ are two fuzzy numbers as follows; then, the distance between these two fuzzy numbers is obtained by equation (21):

$$\tilde{A} = (a_1, b_1, c_1)$$

$$\tilde{B} = (a_2, b_2, c_2)$$

$$D(\tilde{A}, \tilde{B}) = \frac{1}{\sqrt{3}} \left[ \left( a_2 - a_1 \right)^2 + \left( b_2 - b_1 \right)^2 + \left( c_2 - c_1 \right)^2 \right]$$  \hspace{1cm} (21)
According to the above descriptions on the way of calculating the distance between two fuzzy numbers, the distance of each of factors from positive and negative ideals is obtained by equations (22) and (23):

\[ d_i^+ = \sum_{j=1}^{n} d\left(\tilde{v}_{ij} - v_{ij}^+\right); \quad i = 1, 2, \ldots, m. \]  

(22)

\[ d_i^- = \sum_{j=1}^{n} d\left(\tilde{v}_{ij} - v_{ij}^-\right); \quad i = 1, 2, \ldots, m. \]  

(23)

**Step 6** Calculating relative proximity of \(i^{th}\) option from ideal solution.

This relative proximity is defined as equation (24):

\[ CC_i = \frac{d_i^-}{d_i^+ + d_i^-}; \quad i = 1, 2, \ldots, n. \]  

(24)

**Step 7** Ranking of options.

The options existing in the issue can be ranked based on descending order of \(CC_i\). Each option which has a larger \(CC_i\) is a priority.

### 4 Research results

After collecting data of expert survey questionnaire; according to the conducted calculation, the weight of each of the criteria was obtained by use of fuzzy ANP method. The results are shown in the following table.

**Table 3** The weight of criteria affecting the improvement of hotel industry service quality

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Final fuzzy weight</th>
<th>Final decisive weight of dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical and tangible factors</td>
<td>(0.246, 0.314, 0.365)</td>
<td>0.311</td>
</tr>
<tr>
<td>Creating trust and confidence</td>
<td>(0.127, 0.189, 0.224)</td>
<td>0.184</td>
</tr>
<tr>
<td>Accountability</td>
<td>(0.118, 0.151, 0.2)</td>
<td>0.154</td>
</tr>
<tr>
<td>Guaranteed services</td>
<td>(0.133, 0.177, 0.225)</td>
<td>0.178</td>
</tr>
<tr>
<td>Empathy and observing Islamic values</td>
<td>(0.129, 0.168, 0.211)</td>
<td>0.169</td>
</tr>
</tbody>
</table>

As it is observed in Table 3, among different criteria of model, physical and tangible factors with the weight of 0.311, creating trust and confidence with the weight of 0.186 and guaranteed services with the weight of 0.178 were recognised as having the highest weight. In continue, by inserting the weights obtained from Table 3 in fuzzy TOPSIS method; prioritisation of the factors affecting the improvement of hotel industry service quality is achieved according to Table 4.
Table 4  Prioritisation of the factors affecting the improvement of hotel industry service quality

<table>
<thead>
<tr>
<th>NO</th>
<th>Factors</th>
<th>(d_i^+)</th>
<th>(d_i^-)</th>
<th>CC</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Modernity of hotel facilities</td>
<td>159.292</td>
<td>0.723</td>
<td>0.00452</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Attractiveness of physical facilities in the hotel</td>
<td>159.337</td>
<td>0.677</td>
<td>0.00423</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>Dress up of staffs</td>
<td>159.299</td>
<td>0.710</td>
<td>0.00444</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>Locating hotel in a good climate region</td>
<td>159.333</td>
<td>0.683</td>
<td>0.00427</td>
<td>18</td>
</tr>
<tr>
<td>5</td>
<td>A balance between number of staffs and their responsibilities in the hotels</td>
<td>159.310</td>
<td>0.703</td>
<td>0.00439</td>
<td>13</td>
</tr>
<tr>
<td>6</td>
<td>The cleanliness of hotel environment</td>
<td>159.320</td>
<td>0.696</td>
<td>0.00435</td>
<td>14</td>
</tr>
<tr>
<td>7</td>
<td>Full performance of obligations</td>
<td>159.307</td>
<td>0.709</td>
<td>0.00443</td>
<td>10</td>
</tr>
<tr>
<td>8</td>
<td>Proper delivery of service by staffs</td>
<td>159.293</td>
<td>0.722</td>
<td>0.00451</td>
<td>6</td>
</tr>
<tr>
<td>9</td>
<td>Delivery of high quality service at the time promised</td>
<td>159.297</td>
<td>0.719</td>
<td>0.00449</td>
<td>7</td>
</tr>
<tr>
<td>10</td>
<td>Security of passengers</td>
<td>159.301</td>
<td>0.713</td>
<td>0.00446</td>
<td>8</td>
</tr>
<tr>
<td>11</td>
<td>Staffs’ tendency in providing fast and reliable services to customers</td>
<td>159.321</td>
<td>0.695</td>
<td>0.00434</td>
<td>15</td>
</tr>
<tr>
<td>12</td>
<td>Staffs’ tendency in solving customers’ problems</td>
<td>159.308</td>
<td>0.708</td>
<td>0.00442</td>
<td>11</td>
</tr>
<tr>
<td>13</td>
<td>Appropriate response time</td>
<td>159.332</td>
<td>0.685</td>
<td>0.00428</td>
<td>17</td>
</tr>
<tr>
<td>14</td>
<td>Staffs’ focus on addressing the needs and demands of customers</td>
<td>159.332</td>
<td>0.680</td>
<td>0.00425</td>
<td>19</td>
</tr>
<tr>
<td>15</td>
<td>The ability and credibility of hotel in providing reliable and good services</td>
<td>159.284</td>
<td>0.729</td>
<td>0.00456</td>
<td>4</td>
</tr>
<tr>
<td>16</td>
<td>Having the qualified and skilled staffs for hotel service delivery</td>
<td>159.292</td>
<td>0.726</td>
<td>0.00454</td>
<td>2</td>
</tr>
<tr>
<td>17</td>
<td>Customers’ trust in the hotel staffs</td>
<td>159.284</td>
<td>0.731</td>
<td>0.00457</td>
<td>5</td>
</tr>
<tr>
<td>18</td>
<td>Staffs’ respect to customers’ character</td>
<td>159.280</td>
<td>0.735</td>
<td>0.00459</td>
<td>3</td>
</tr>
<tr>
<td>19</td>
<td>Particular attention of staffs to cultural differences of customers</td>
<td>159.310</td>
<td>0.705</td>
<td>0.00441</td>
<td>12</td>
</tr>
<tr>
<td>20</td>
<td>Understanding customers’ needs by hotel staffs</td>
<td>159.329</td>
<td>0.688</td>
<td>0.00430</td>
<td>16</td>
</tr>
<tr>
<td>21</td>
<td>Politeness and humility of the hotel staffs</td>
<td>159.332</td>
<td>0.655</td>
<td>0.00409</td>
<td>21</td>
</tr>
</tbody>
</table>

As it is observed in Table 4, among the factors of the improvement of service quality; Modernity of hotel facilities, Having the qualified and skilled staffs for hotel service delivery and Staffs’ respect to customers’ character were respectively identified as the most important factors affecting the improvement of hotel industry service quality; and on the other side, the factors Staffs’ focus on addressing the needs and demands of customers, Attractiveness of physical facilities in the hotel and Politeness and humility of the hotel staffs were placed at the lowest level of ranking.
5 Conclusions

In fact, quality is what the customer wants; in other words, a high quality product should be in compliance with customers’ needs (Prybutok, 2012). Service quality is a background for customer’s satisfaction. In today’s competitive markets, reputation and profitability of a hotel has a direct and strong correlation with level of customer’s satisfaction and customers’ satisfaction leads to increase loyalty and therefore maintaining the customer relationship (Stefano et al., 2015). Level of customers’ satisfaction; in addition to revealing the degree of success in achieving the goals of a hotel, improve the quality of services in the hotel. One of the most important actions in attracting customer’s satisfaction is to measure his/her level of satisfaction from receiving services; this level can be measured with implementation of appropriate measurement programs. The goal of conducting this study is to identify and rank the factors affecting the improvement of the quality of hotel industry services. Very few studies have been conducted in identifying and prioritising the factors affecting the improvement of the quality of hotel industry services, besides deterministic MADM methods have been commonly used in ranking the elements of the quality of services. In this work, considering the advantages of fuzzy logic in correctly reflecting the human views, we use fuzzy ANP and fuzzy TOPSIS methods, as an innovative way of ranking the quality of services. According to the results of this study, modernising and updating of hotel facilities, having professional staffs for delivery of hoteling services and staffs’ respect to customers’ character were identified as the most important factors affecting the improvement of hotel industry services. Due to the facilities of four and five-star hotels of Mashhad city, most foreign passengers who were staying at these hotels complained about poor and inefficient equipment of them. They believed that there are not professional staffs at these hotels and the majority of them were dissatisfied about the delivered service. Therefore, it is suggested that managers of these hotel pay more attention to the above factors. It is recommended to these managers that get more satisfaction of their customers, enjoying from the views of successful domestic and foreign consultants in the field of hotel service delivery. Because, if the level of passengers’ satisfaction decreases; waiting is far away to return them again to these hotels in far-coming years. Every study has its own limitation and this study is not an exception. The followings are of the limitations of this study:

- lack of scientific resources in this field
- problems in convincing the people for filling the questionnaire
- lack of some managers’ cooperation due to not believing in these types of researches.

The followings are suggested for further studies:

- It is suggested to do similar researches for other vital industries such as banking industry, insurance, etc. Because defining the best factors affecting the improvement of the quality services can increase the attraction of customers in the market.
- Considering the fact that the combination of fuzzy ANP and fuzzy TOPSIS are used in this study, it is suggested that the fuzzy AHP will be used in further researches to analyse the dependence of the elements.

References


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