Using fuzzy number for measuring quality of service in the hotel industry

Juan Manuel Beníteza, Juan Carlos Martínb,*, Concepción Románb

aDepartamento de Economía y Dirección de Empresas. Universidad de Las Palmas de Gran Canaria, 35017 Las Palmas G.C., Spain
bDepartamento de Análisis Económico Aplicado. Universidad de Las Palmas de Gran Canaria, 35017 Las Palmas G.C., Spain

Received 4 June 2003; accepted 6 March 2004

Abstract

This paper presents a fuzzy multi-attribute decision-making approach for evaluating dynamically the service quality of three hotels of an important corporation in Gran Canaria island via surveys. Service quality is a composite of various attributes, among them many attributes are intangible and difficult to measure. Fuzzy numbers (FN) are based on triangular fuzzy numbers and fuzzy set theory as a new method to overcome some linguistic problems. In other words, fuzzy numbers try to resolve the ambiguity of concepts that are associated with human beings’ subjective judgments vaguely measured with linguistic terms. Based on the concept of the degree of optimality, we develop through TOPSIS an overall service performance index for each pair hotel-date of survey. This index will help hotel managers to understand their relative ranking position, and provide an adequate alternative to performance evaluation of hotel services which usually involve subjective judgments of qualitative attributes.

Keywords: Fuzzy numbers; Service quality; Hotel industry; TOPSIS

1. Introduction

The hotel industry in Canary Islands has been experiencing a great competition during the past recent years due to tour operators’ pressures and the appearance of other important tourism competitor markets. Under these circumstances, hotel corporations not only attempt to establish more adequate services, but also introduce more promotional incentives to attract consumers. Hotels would like to consolidate their market shares and enhance profitability. However, the marginal benefits of marketing strategies are beginning to shrink because most of the actors have similar plans. Having in mind this limitation, some of the hotels now tend to focus on the commitment of improving customer services.

Hotels provide an ample range of services to customers, including lodging services, reception, meals, room service, tennis courts, beach nearby location, swimming pools and gardens, among others. Service quality can be regarded as a composite measure of various attributes. It not only consists of tangible attributes but also intangible/subjective attributes such as safety, quietness, which are difficult to measure accurately and usually studied throughout linguistic information.

The evaluation of service quality in the hotel industry is an on-going process that requires continuous monitoring to maintain high levels of service quality across a number of different service areas (attributes). The evaluation should be based on a comparative process that allows managers to identify areas of service improvement or deterioration below some standard of performance that had been previously established. Thus, the evaluation results can be used by managers as a tool to benchmark the different service areas. Dubé and Renaghan (1999a) compared frequent travelers’ opinions about the importance of the lodging-industry’s functional best practices with those of hotels managers and operators. They focused on those practices that are perceived by consumers as the most important hotel attributes (and thus create consumer value and loyalty). Consumer rated the relative importance of specific attributes related to different functional areas.
They found that (1) the quality and variety of on-site hotel services; (2) the quality of hotel staff; (3) the quality of guest-room design and amenities; (4) a strong brand name and positive reputation; and (5) perceived value were the most important areas that generate top performance. Dubé and Renaghan (1999b) showed that most hotels accommodate guests from different market segments and each group assigns different importance to distinct service areas. Travelers usually seek a functional and comfortable hotel. Leisure travelers place their emphasis on comfort, while business and convention travelers are more concerned with staff and management processes. Convention participants value most a convenient place to stay, while comfort was far ahead of convenience for transit business guests.

When solving real-life service-quality engineering problems, linguistic information usually appears as an important output of the process. This information is frankly more difficult to measure throughout a classical mathematical function. In this sense, it is very easy to measure the temperature of a room in Celsius degrees; however, it is not easy to measure whether the temperature of a room is adequate or not. Twenty-two Celsius degrees can obtain different answers about the adequacy of the temperature of a room in a seven-point Likert scale (1 totally disagree, 7 totally agree). This value depends greatly on the environment and the preferences of different consumers.

Linguistic information represents subjective knowledge and is usually overlooked by analysts when forming mathematical models that represent “real world phenomena”. However, attributes measuring service quality are characterized by uncertainty, subjectivity, imprecision and ambiguity. When consumers make decisions, they usually employ this subjective knowledge and linguistic information.

Lewis and Booms (1983) defined service quality as a measure of how well the service delivered matches customers’ expectations. Parasuraman, Zeithaml, and Berry (1985) developed a service quality conceptual model between consumers and firms in some industries, and proposed five gaps in which the fifth is defined as “the quality that a consumer perceives in a service is a function of the magnitude and direction of the gap between expected service and perceived service” (p. 46). In their model, expected service describes consumers’ expectations about what service a firm should provide and perceived service reveals consumers’ feelings about what service delivery consumers actually received from a firm.

In marketing research, most questionnaires use Likert scales to measure respondents’ attitude, which is linguistic. In the past, some statistical methods have been employed to analyze the quality of services in the lodging industry, using some n-point Likert scale to weight the importance of different attributes. In this paper, we are going to use the fuzzy set theory, that has been applied in the field of management science (Hutchinson, 1998; Viswanathan, 1999; Xia, Wang, & Gao, 2000), and it is beginning to gain acceptance in the field of service quality (Tsaur, Chang, & Yen, 2002; Yeh & Kuo, 2003).

Consumers’ judgments towards a service depend basically on the strength of their beliefs or expectations about various features or attributes associated with the service and the weight of attributes (Engel, Blackwell, & Miniard, 1995). Consumers’ beliefs typically involve perceived associations between the service and its associated attributes, stemming from their direct experiences with the service and past experiences with other services of analogous nature. The weight of attributes is usually related with the relative importance that consumers confer to each attribute. This implies that the attributes for measuring service performance depend highly on the context and should be selected to reflect the evaluation problem and the service environment investigated.

In this sense, many models have been formulated to evaluate quality of service as a weighted sum of beliefs about the service attributes, taking into consideration the relative importance of these attributes. These methods resemble some multi-attribute decision making (MADM) models based on multi-attribute value (or utility) theory (MAVT) (Keeney & Raiffa, 1993). MAVT or MADM models have been widely used to rank a finite number of decision alternatives characterized by multiple, usually conflicting attributes (Dyer, Fishburn, Steuer, Wallenius, & Zionts, 1992; Stewart, 1992; Yeh, Deng, & Pan, 1999). These models are particularly suited to decision problems where it is really important and necessary to obtain a cardinal preference or ranking of the alternatives. In our case, we will evaluate three hotels of a corporation and obtain an overall service performance index in each period for each of them.

For evaluating quality of services in the hotel industry using the MADM approach, we first need to identify a number of idiosyncratic service attributes that are under the control of hotel managers. The quality of services perceived by its customers can then be represented and measured by these attributes. To this end, we are going to employ the questionnaire survey that is conducted by the corporation on a regular basis. The questionnaire comprises 13 service attributes given in Table 1. This questionnaire was developed by the department of marketing of the corporation. To stay competitive, the hotels of the corporation need to offer “the best value for money”. To this end, managers of the hotels, guided by the department of marketing, conduct the surveys asking their clients to poll for the hotels’ overall performance based on those 13 attributes. The 13 attributes included in the questionnaire are rather standard in the studies of service quality within the hotel industry. These attributes are suitable for use as the evaluation criteria in our methodology and reflect some of the major concerns of international and domestic customers lodged in the hotels. These attributes represent the performance measures that are under the control of hotel management and correspond to the performance of hotel services, known as the functional
quality. The functional quality is concerned with the service delivery process, thus reflecting customers’ experiences of hotel services. Some manifest that the functional quality plays the most critical role in customers’ overall quality perception and that managers’ success depend on the continuous improvement of the functional quality of hotel services.

The degree of the functional quality of hotel services perceived by customers has been assessed subjectively via a survey process on a regular basis since the beginning of the year 2002. In total, we have 25,402 respondents of 59 different surveys (corresponding to different dates) that were conducted in the three hotels of the group. The sample represents 37% of the total number of clients of the three surveys (corresponding to different dates) that were conducted in the three hotels of the group. The sample represents 37% of the total number of clients of the corresponding hotels during these specific dates. This subjective assessment process is intrinsically imprecise, due to the characteristics of hotel services and the method that has been employed to obtain a weighted sum of overall performance.

In the survey process, one set of linguistic terms (‘poor, fair, good, very good’) is used for assessing the quality of each dimension respectively. Each respondent assesses the performance rating of each service attribute by using one of the linguistic terms defined in the corresponding term set. It is important to remark that each of the linguistic terms is linked to some graphical expression of the human face that appears at the beginning of the questionnaire, and that the respondent needs to tick off below one of the expressions of the faces for each dimension.

### 2. Fuzzy numbers

Linguistic terms, satisfaction degree and importance degree are often vague. For example, lingual expressions, such as satisfied, fair, dissatisfied, are usually regarded as

natural representations of consumers’ preferences or judgments. This vagueness is the origin of the applicability of fuzzy set theory in capturing decision makers’ preference structure. Fuzzy set theory aids in measuring the ambiguity of concepts that are associated with human beings’ subjective judgments. During the process of evaluation, consumers are often imprecise and important errors can be present in the analysis. Therefore, fuzzy set theory is a valuable tool to strengthen the comprehensiveness and reasonableness of the decision-making process.

Modeling using fuzzy sets has proven to be an effective way for formulating decision problems where the information available is subjective and imprecise (Zimmermann, 1996). The subjectivity and imprecision involved in the survey process to reflect the assessments made by the respondents are better embodied as fuzzy sets. Herrera and Herrera-Viedma (2000) sustained that linguistic terms are intuitively easier to use when decision makers express the subjectivity and imprecision of their assessments, and for this reason fuzzy set theory is becoming a very popular method in the field of the evaluation of the performance of service quality.

Fuzzy numbers are an extremely suitable methodology that embraces adequately subjective knowledge and objective knowledge. Zadeh (1965) stated some basic results linked to the development of fuzzy sets. Many sets encountered in reality do not have precisely defined bounds that separate the elements within the set from those outside the set. In our case, it might be said that a certain check-in counter has a “long” waiting time. If we denote by W the set of “long waiting time at a check-in counter”, the question logically arises as to the bounds of such a defined set. Does a waiting time of 5 min belong to this set? What about 10 min or 15 min? The answers to these questions are always logical and there exists some positive probability of finding a consumer that answers these questions positively.

On the other hand, it is intuitively clear that a waiting time of 10 min belongs “more likely” or “stronger” to the set W “long waiting time at a check-in counter”, than a time of 5 min. In other words, there is more truth in the statement that a waiting time of 10 min is a “long waiting time at a check-in counter” than in the statement that a waiting time of 5 min is a “long waiting time at a check-in counter”. Within this context, we can fully appreciate that “everything is a matter of degree”, so all waiting times at a check-in counter can be treated as long. If now we introduce a set called “short waiting time at a check-in counter”, and proceed analogously, we see that we can treat all the waiting times as short. Finally, we can ask ourselves whether a waiting time of 5 min is long, short or perhaps medium. The answer is very simple. A waiting time of 5 min is long, short and medium, all at the same time. In other words, a waiting time of 5 min belongs to the sets “long waiting time at a check-in counter”, “short waiting time at a check-in counter” and “medium waiting time at a check-in counter” with different intensity of membership.

---

1. We do not have a profile of the respondent as the questionnaire does not contemplate this issue. However, we are now investigating more attributes studying the relationship of these service quality variables with some socioeconomic characteristics of the customers.
Zadeh (1975) and Mandami and Assilian (1975) developed fuzzy logic, introducing a concept of approximate reasoning, and showed that vague logical statements enable the formation of algorithms that can use vague data to derive vague inferences. Many fields have benefited from this approach, but above all the study of complex systems has seen the formation of algorithms that can use vague data to derive vague inferences. Many fields have benefited from this approach, but above all the study of complex systems has seen the formation of algorithms that can use vague data to derive vague inferences.

Let the universe of discourse $X$ be the subset of real numbers $R$, $X = \{x_1, x_2, x_3, \ldots, x_n\}$. A fuzzy set $A = \{(x, \mu_A(x))|x \in X\}$ in $X$ is a set of ordered pairs, where $\mu_A(x)$ is called a membership function and $\mu_A(x): X \to [0, 1]$. The membership function for fuzzy sets can take any value from the closed interval $[0, 1]$. The greater $\mu_A(x)$ is, the greater the truth of the statement that element $x$ belongs to set $A$ is.

In this paper, we are going to parameterize a triangular fuzzy number $A$ by a triplet $(a_1, a_2, a_3)$. The membership function $\mu_A(x)$ is defined below and its graph is shown in Fig. 1.

$$\mu_A(x) = \begin{cases} \frac{x-a_1}{a_2-a_1}, & a_1 \leq x \leq a_2, \\ \frac{x-a_2}{a_3-a_2}, & a_2 \leq x \leq a_3, \\ 0, & \text{otherwise}. \end{cases}$$ (1)

Each linguistic term was characterized by a triangular fuzzy number for representing its approximate value range between 0 and 100, and denoted as $(a_1, a_2, a_3)$, where $0 \leq a_1 \leq a_2 \leq a_3 \leq 100$. $a_2$ is the most likely value of the linguistic term, and $a_1$ and $a_3$ are the lower and upper bounds used, respectively, to reflect the fuzziness of the term.

We could not reflect the fact that respondents may have different perceptions of these linguistic terms, but hopefully this caveat is not very important because we have used some representative default values to reflect the preferences that have been previously employed. The default values of the linguistic terms are shown in Table 2, and the membership functions can be calculated according to the Eq. (1). The asymmetry of these fuzzy numbers is well explained by the asymmetry of the linguistic terms.

In this paper, we intend to compare the evaluation of hotel service quality as a fuzzy MADM problem that requires cardinal ranking. The problem involves a set of $m$ alternatives, each one corresponding to some date in some of the three hotels where a survey has been carried out. The alternatives have been evaluated based on a set of 13 service attributes or criteria, as given in Table 1. The objective of the problem is to rank all the hotels/dates by giving each observation an overall service performance index with respect to all service attributes.

Vagueness of linguistic terms about satisfaction degree has already been set up. So in order to provide more objective information for hotel managers, we have fuzzified satisfaction degree as triangular fuzzy numbers and aggregated group opinions of consumers according to the average fuzzy number of $n$ triangular numbers $\hat{A}_i = (a_1^{(i)}, a_2^{(i)}, a_3^{(i)})$, where $i = 1, 2, 3, \ldots, n$, as follows:

$$\hat{A} = (a_1, a_2, a_3) = \frac{1}{n} \cdot (\hat{A}_1 \oplus \hat{A}_2 \oplus \cdots \hat{A}_n)$$

$$= \left(\frac{\sum_{i=1}^{n} a_1^{(i)} + \sum_{i=1}^{n} a_2^{(i)} + \sum_{i=1}^{n} a_3^{(i)}}{n}\right),$$ (2)

where $\oplus$ is the multiplication of a scalar and a fuzzy number, and $+$ is the add operation of fuzzy numbers, so $\hat{A}$ is the overall average performance valuation of some hotel/date (observation) under some attribute over $n$ interviewed consumers. Eq. (2) shows that the average performance can be represented by a new triangular fuzzy number (Buckley, 1985).

To justify whether a hotel attribute is weak or strong, we need to defuzzify the information obtained above. The result of fuzzy synthetic information of each observation is a fuzzy number. Therefore, it is necessary to employ some nonfuzzy ranking method for fuzzy numbers during service quality comparison for each observation. In other words, Defuzzification is a technique to convert the fuzzy number into crisp real numbers. The procedure of defuzzification is to locate the Best Nonfuzzy Performance (BNP) value. This purpose can be attained by several available methods. Mean-of-Maximum, Center-of-Area, and $\alpha$-cut Method (Zhao & Govind, 1991) are some of the most common approaches. In this paper, we compare the performance of two triangular fuzzy numbers using $v_3$ defined as follows, $v_3 = (a_1 + 2a_2 + a_3)/4$ for the triplet $(a_1, a_2, a_3)$ of a triangular fuzzy number $A$. This method (Chen, 1996) has been chosen due to its simplicity and the lack of requirement of analyst’s personal judgment. The method is based on Kaufmann and Gupta’s (1988) method to compare fuzzy numbers and its logic is underpinned in the definition of the removal of a fuzzy number.

In the following sections, we calculate $v_3$ to rank two fuzzy numbers for clarifying the performance of the three hotels of the corporation for each date and attribute.
obtaining in this way a crisp performance matrix for each alternative (hotel-date).

Now we need to resolve the multi-attribute evaluation problem characterized by the crisp performance matrix. There are many alternatives that can be applied, but our method is based on the concept of the degree of optimality rooted in a best virtual alternative formed by different alternatives where multiple attributes characterize their achievement and the notion of the best (Zeleny, 1982). In this paper, we are going to employ a method based in the TOPSIS approach. Hwang and Yoon (1981) proposed the following logic of TOPSIS, defining the ideal solution and the negative ideal solution. The positive ideal solution is the solution that maximizes the benefit criteria and minimizes the cost criteria; whereas the negative ideal solution has got the opposite logic, i.e. maximizes the cost criteria and minimizes the benefit criteria. The optimal observation is the one, which is closest to the ideal solution and farthest from the negative ideal solution. The ranking of alternatives in TOPSIS is based on “the relative similarity to the ideal solution”, which avoids from the situation of having same similarity to both ideal and negative ideal solutions.

To sum up, an ideal solution is composed of all best values attainable of criteria, whereas a negative ideal solution is made up of all worst values attainable of criteria. During the processes of selection of observation, the best alternative would be the one that is nearest to the positive ideal solution and farthest from the negative ideal solution. Take the objective space of the two criteria as positive ideal solution and farthest from the negative ideal solution. The best alternative would be the one that is nearest to the criteria. During the processes of selection of observation, the best alternative would be the one that is nearest to the positive ideal solution and farthest from the negative ideal solution.

Fig. 2. Distance between ideal solution and negative ideal solution for each observation: two criteria example.

where $J$ and $J'$ form a partition of the different criteria according to their benefit or cost characteristic.

After the determination of ideal solutions, we calculate the Euclidean distance between ideal solution and negative ideal solution for each observation as

$$S_i^+ = \text{dist}(V_i, A^+) = \left( \sum_{j=1}^{n} (V_{ij} - A_{j}^+) \right)^{1/2}, \quad i = 1, 2, \ldots, m,$$

(5)

$$S_i^- = \text{dist}(V_i, A^-) = \left( \sum_{j=1}^{n} (V_{ij} - A_{j}^-) \right)^{1/2}, \quad i = 1, 2, \ldots, m.$$  

(6)

Then we calculate the relative closeness to the positive ideal solution of each observation, such as

$$C_i = \frac{S_i^-}{S_i^+ + S_i^-}, \quad i = 1, 2, \ldots, m,$$

(7)

where $0 \leq C_i \leq 1$. An observation is closer to an ideal solution as $C_i$ approaches to 1. A set of alternatives can be sorted according to the descending order of $C_i$. This approach has been widely used in different decision contexts (e.g. Athanassopoulos & Podinovski, 1997; Chang & Yeh, 2001; Chen & Hwang, 1991; Yeh, Deng, & Chang, 2000; Zeleny, 1998). This is mainly due to its applicability

<table>
<thead>
<tr>
<th>Table 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Triangular fuzzy numbers</td>
</tr>
<tr>
<td>Linguistic terms</td>
</tr>
<tr>
<td>Fuzzy number</td>
</tr>
</tbody>
</table>

Default values of linguistic terms.
in solving different scenarios of human decision problems, and its mathematical simplicity measuring the relative performance of the alternatives.

The rationale behind (7) is that a better performance of a pair hotel–date should be captured by a higher degree of similarity to the positive ideal solution and a lower degree of similarity to the negative ideal solution. The larger the performance index, the better the overall service quality performance of the alternative hotel–date, relative to other surveys done in the same hotel. As such, the performance index calculated is a relative concept and it indicates the relative ranking obtained dynamically for each one of the hotels evaluated in terms of the service attributes included in the survey.

3. Empirical study of hotel service quality

Some topics of tourism in island destinations, such as the development of the tourism industry, patterns of visitors and the environmental, economic and social impact of tourism, have focused the agenda of the research on island tourism (Briguglio, Butler, Harrison, & Filho, 1996; King, 1997; Lockhart & Drakalís-Smith, 1997).

Quality is considered to be an important management tool for being competitive, as positive quality affects customer satisfaction, stimulates intention to return and encourages recommending behavior. It is also well known that quality of service is an essential element of visit evaluation. Laws (1991) indicates that 77% of complaints received in UK outbound tourism is related to the quality of services and accommodations. Furthermore, the growing number of new holiday destinations has increased the competition in the European travel market, and therefore quality of accommodations is now an essential strategy for increasing the competitiveness of the resort European islands in the international tourism market. However, measurement of service quality in the island accommodations has not received much attention.4

Gran Canaria is one of the most visited islands in the European continent, but managers of the LHR chain are nowadays immerse in anticipating the problems of mature island destinations and developing alternative strategies for future development. In an effort to study the quality of service of the hotels belonging to the group, a regular survey is usually done in three hotels of the chain: Buenaventura, Catarina and Gran Hotel Costa Meloneras. In Table 3, the number of respondents for each hotel and dates of surveys can be consulted.

The questionnaire of service quality evaluation is mainly composed of 13 questions for evaluating the hotel’s performance corresponding to each criterion or attribute. As for the performance corresponding to each criteria, we used linguistic expression related to some facial expression to measure the expressed performance. Then we use the membership function associated with each linguistic expression term, according to the representative triangular fuzzy numbers. We asked respondents to specify the experiment quality of service of each attribute with linguistic expression varying from “poor”, “fair”, “good” and “very good”. These scores were later aggregated to calculate the average performance as a new triangular fuzzy number for each criterion. We have made this

---

**Table 3**

<table>
<thead>
<tr>
<th>Gran Hotel Costa Meloneras 1st wave</th>
<th>Gran Hotel Costa Meloneras 2nd wave</th>
<th>Hotel Buenaventura</th>
<th>Hotel Catarina</th>
</tr>
</thead>
<tbody>
<tr>
<td>03/01/2002 435 85.7%</td>
<td>09/07/2002 505 97.4%</td>
<td>30/06/2002 535 87.7%</td>
<td>29/06/2002 271 84.1%</td>
</tr>
<tr>
<td>15/01/2002 641 88.9%</td>
<td>18/07/2002 517 87.8%</td>
<td>08/07/2002 514 88.3%</td>
<td>07/07/2002 234 94.9%</td>
</tr>
<tr>
<td>29/01/2002 502 89.2%</td>
<td>26/07/2002 488 87.9%</td>
<td>27/07/2002 465 90.3%</td>
<td>25/07/2002 232 94.8%</td>
</tr>
<tr>
<td>12/02/2002 685 86.6%</td>
<td>08/08/2002 650 96.0%</td>
<td>09/08/2002 551 91.1%</td>
<td>10/08/2002 269 92.9%</td>
</tr>
<tr>
<td>22/02/2002 671 85.5%</td>
<td>16/08/2002 654 89.0%</td>
<td>27/08/2002 525 93.5%</td>
<td>26/08/2002 210 97.1%</td>
</tr>
<tr>
<td>12/03/2002 534 89.9%</td>
<td>28/08/2002 499 86.4%</td>
<td>09/09/2002 562 88.1%</td>
<td>10/09/2002 306 92.2%</td>
</tr>
<tr>
<td>25/03/2002 590 85.1%</td>
<td>08/09/2002 582 87.1%</td>
<td>27/09/2002 381 95.0%</td>
<td>28/09/2002 270 91.1%</td>
</tr>
<tr>
<td>06/04/2002 563 82.1%</td>
<td>17/09/2002 699 87.0%</td>
<td>11/10/2002 375 95.7%</td>
<td>12/10/2002 231 93.9%</td>
</tr>
<tr>
<td>15/04/2002 640 84.8%</td>
<td>26/09/2002 686 88.0%</td>
<td>26/10/2002 499 87.6%</td>
<td>25/10/2002 271 93.7%</td>
</tr>
<tr>
<td>30/04/2002 565 88.7%</td>
<td>10/10/2002 574 95.1%</td>
<td>08/11/2002 487 89.7%</td>
<td>09/11/2002 246 88.2%</td>
</tr>
<tr>
<td>10/05/2002 536 83.6%</td>
<td>18/10/2002 740 93.1%</td>
<td>26/11/2002 521 82.3%</td>
<td>28/11/2002 265 77.7%</td>
</tr>
<tr>
<td>23/05/2002 692 89.9%</td>
<td>27/10/2002 623 78.7%</td>
<td>06/12/2002 461 88.1%</td>
<td>07/12/2002 229 84.7%</td>
</tr>
<tr>
<td>07/06/2002 372 94.1%</td>
<td>07/11/2002 578 90.5%</td>
<td>28/12/2002 450 54.9%</td>
<td>27/12/2002 294 76.5%</td>
</tr>
<tr>
<td>17/06/2002 402 94.0%</td>
<td>19/11/2002 523 91.6%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28/06/2002 423 96.2%</td>
<td>27/11/2002 426 81.7%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29/01/2002 502 89.2%</td>
<td>08/12/2002 571 86.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17/12/2002 414 87.4%</td>
<td>26/12/2002 506 81.0%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Dates, number of questionnaires and percentage of valid questionnaires.

---

4Ekinci, Prokopakia, and Cobanoglu (2003) Ekinci et al. (2003) measured the service quality in Cretan accommodations, identifying characteristics of the British tourists who visit Crete and assessing their perception of service quality in the island accommodations. They found that perceptions of service quality in Cretan accommodations vary according to gender and classifications of accommodations.
exercise for each survey done in each of the hotels of the group. Table 4 lists the fuzzy performance measure for some surveys done in Gran Hotel Costa Meloneras, and similar fuzzy numbers were calculated for the rest of the hotels.

After obtaining the performance measure in terms of fuzzy numbers, we need to defuzzify the fuzzy numbers into crisp numbers in order to conduct TOPSIS ranking procedure. We used a common method to defuzzify the fuzzy numbers, and the best and the worst performance for each hotel observation were also computed. Table 5 shows the defuzzied values for the first wave of surveys, highlighting the worst and best performance (the date where the best performance and worst performance are obtained appear in bold and italic type, respectively). In general overview, it is observed that the best performances for each criterion were obtained in the most recent surveys. On the contrary, the worst performances usually appeared in the some of the oldest surveys. So, it seems that the results of the surveys are obtaining the purpose of providing employees with an incentive structure to obtain a better performance (see also Fig. 3).

Should some premiums, such as job assignments or vacation days, be part of a reward system linked with the results of the surveys? Would it be better to let the supervisors distribute some prefixed monies to the employees that attain a Figure inside some interval around the ideal solution? These ideas are very appealing. However, it is necessary to have in mind that these incentive rules could have rather detrimental effects over the overall performance of service quality, if difficult objectives about ideal solution prevail and as a consequence, losers employees predominate within the hotel. Managers need to be very flexible if some dynamic processes of comparison are going to be implemented, because after a long time ideal solutions may be really difficult to achieve. So if employees know this process in advance, it is not difficult to anticipate that the well-known ratchet effect could be present. In fear of raised standards in the future procured by ideal solutions, employees may underperform deliberately today (Freixas, Guesnerie, & Tirole, 1985; Laffont & Tirole, 1988). Job rotation and temporary laboring provide some relieves. However, managers need to balance two opposite forces in this respect. It is true that if a job is temporary, the employee can perform her task harder, because she does not need to internalize the cost of higher standards that she is imposing into the evaluation system, but some tasks are very sensitive to the service quality performance and they depend highly on the experience of employees.

In this paper, we apply triangular fuzzy numbers to assess the linguistic ratings given by the respondents in each survey. Because the evaluation is resulted from the different evaluators’ perception of linguistic variables, it will have the difference and ambiguity included in the response. In addition, the traditional evaluation method required the evaluators to make the choice among “poor”, “fair”, “good” and “very good”, and that may force the

<table>
<thead>
<tr>
<th>Table 4</th>
<th>Fuzzy performance measures of Gran Hotel Costa Meloneras for some surveys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public relations service</td>
<td>(38.73, 74.68, 91.20)</td>
</tr>
<tr>
<td>Bar service</td>
<td>(46.33, 66.94, 84.98)</td>
</tr>
<tr>
<td>Main restaurants/breakfast/food offer</td>
<td>(50.82, 73.35, 87.75)</td>
</tr>
<tr>
<td>Pool and garden area cleaning</td>
<td>(64.25, 91.60, 96.80)</td>
</tr>
<tr>
<td>Room maintenance</td>
<td>(48.66, 70.00, 86.49)</td>
</tr>
<tr>
<td>Leisure activities program</td>
<td>(46.20, 66.89, 84.54)</td>
</tr>
<tr>
<td>Room cleaning</td>
<td>(55.25, 78.68, 91.12)</td>
</tr>
<tr>
<td>Reception desk</td>
<td>(48.86, 70.47, 86.68)</td>
</tr>
<tr>
<td>Main restaurants/dinner/service</td>
<td>(49.26, 72.94, 87.86)</td>
</tr>
<tr>
<td>Dishes and cutlery cleanliness</td>
<td>(47.83, 69.37, 85.44)</td>
</tr>
<tr>
<td>General opinion of the hotel</td>
<td>(55.62, 79.38, 91.69)</td>
</tr>
</tbody>
</table>

Fifteen different surveys were done during the first semester. The rest of fuzzy numbers are omitted for simplicity.
evaluators to do an over-high or over-low appraisal. Consequently, it would influence the accuracy of the evaluation. For this reason, we use the membership function to measure the linguistic variables and approximate the different service quality of each observation reflecting adequately the vagueness of linguistic terms. When we use the fuzzy approach on vague objects such as

the satisfaction of quality of service for some hotel characteristics, we overcome some of the problems presented in the traditional statistic approaches. TOPSIS compares the relative closeness to the ideal solution in order to rank all the observations according to the hotel service quality. The results of the exercise can be seen in Table 6. Figs. 3–6 show the different behavior of TOPSIS
indicator for each survey conducted in all the hotels of the group for each of the dates when the survey was conducted.

Table 6 and Figs. 3–6 can help managers understand the relative overall performance level of its service quality, analyzing dynamically the rankings obtained for each hotel. We see that the best performers are usually obtained in Gran Hotel Costa Meloneras for both waves of questionnaires. However, looking at the Figures, we can highlight that the behavior of the two waves is quite different. It seems that during the first wave, the hotel has been improving its behavior gradually, but during the second wave, it could not keep up with the great job made during the first wave. Since 26th of September, where it is observed the worst performer the overall service quality performance started gradually to be improved. These results provide a guideline for managers to correct any service quality underperformance, and to identify specific operational areas where it is necessary to improve some aspects of their basic operations. Buenaventura and Catarina present a different pattern of behavior with shorter cycles that can be explained for their long well-established staff relation managerial procedures. In this sense, it is likely that the scores obtained in the surveys provide an adequate tool for getting the staff involved in the achievement of better results for the future. Every operational area should have a procedure strategy plan that visually depicts the key components necessary for the staff to succeed and obtain better results with respect to the scores of overall service quality performance. This plan must comprise some measures that link overall service quality performance, employee attitudes and competencies, and possibly other organizational factors that directly or indirectly affect the future trend of service quality performance.

Service quality questionnaires are an important element of a comprehensive strategy, that tries to hear the voice of the customer frequently. Thus, the chain can more quickly redirect actions to fit the needs of the its customers. Operational, service and support areas can then use the scores obtained in the questionnaires to provide guidelines about how to respond more effectively to customers, how to effectively balance the tradeoffs between different attributes, how to zero in on the measures that are most effective, how to determine which areas are working well or poorly, which processes need improvement and which skills need to be enhanced.

The defuzzied value for each operational area has been calculated for each hotel and the coefficient of variation has been obtained trying to study variation with respect to service quality in relative terms. The coefficient of variation...
is useful for comparing the operational areas in the sense of whether they do present a more homogenous or heterogeneous service quality performance. Table 7 shows the six more homogenous and the six more heterogeneous operational areas. It is worth remarking that the behavior of operational areas depend highly on the hotel under study. It can be seen that the same operational area, e.g. main restaurant dinner cuisine, can belong to both groups (heterogeneous and homogeneous behavior). It also seems clear that the brand new hotel Costa Meloneras displays a more homogenous behavior in the operational areas that are related with the grandeur and magnificence of the swimming-pool, gardens and rooms. It can be seen that relative to its mean, the main restaurant dinner service in Costa Meloneras (1st wave) is more than 9 times variable than cleaning the pool and garden area. It is also necessary to highlight that different operational areas executives may have different skills or attitudes to establish operational procedures, and thus the results may contain these differences.

So far we have analyzed a single behavior from each hotel. However, a much more common operation is to compare aspects of the different hotels of the group. If we observe the box-plot of TOPSIS indicator (Fig. 7), we can conclude that every hotel of the group presents a similar behavior with respect to the average similarity to ideal solution of service quality. In fact, if we test for the equality of the means of the TOPSIS indicator for each hotel, using unpaired t-tests, we can conclude that the alternative hypothesis of true difference in means is not equal to 0 is always rejected. From these results, we are unable to say that the differences of average similarities to positive ideal solutions for each hotel are statistically significant (see Table 8).6

---

**Table 7**

<table>
<thead>
<tr>
<th>Hotel</th>
<th>Attribute</th>
<th>CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costa Meloneras (1st wave)</td>
<td>Cleaning pool and garden area</td>
<td>0.008</td>
</tr>
<tr>
<td>Buenaventura</td>
<td>Main restaurant breakfast cuisine</td>
<td>0.010</td>
</tr>
<tr>
<td>Costa Meloneras (2nd wave)</td>
<td>Cleaning pool and garden area</td>
<td>0.013</td>
</tr>
<tr>
<td>Buenaventura</td>
<td>Room maintenance</td>
<td>0.015</td>
</tr>
<tr>
<td>Costa Meloneras (2nd wave)</td>
<td>Room cleaning</td>
<td>0.015</td>
</tr>
<tr>
<td>Buenaventura</td>
<td>Main restaurant dinner cuisine</td>
<td>0.015</td>
</tr>
<tr>
<td>Costa Meloneras (2nd wave)</td>
<td>Main restaurant dinner cuisine</td>
<td>0.048</td>
</tr>
<tr>
<td>Costa Meloneras (1st wave)</td>
<td>Main restaurant dinner cuisine</td>
<td>0.049</td>
</tr>
<tr>
<td>Costa Meloneras (1st wave)</td>
<td>Reception desk</td>
<td>0.055</td>
</tr>
<tr>
<td>Costa Meloneras (1st wave)</td>
<td>Main restaurant breakfast service</td>
<td>0.065</td>
</tr>
<tr>
<td>Costa Meloneras (1st wave)</td>
<td>Main restaurant dinner service</td>
<td>0.075</td>
</tr>
</tbody>
</table>

Lower values of coefficient of variation are in italic and higher values of coefficient of variation are in bold.

---

5We have used each hotel as a categorical variable or a factor to draw box-plot graphs. Box-plot graphs are really adequate to summarize a great deal of information very clearly. First, it is very good at showing extremes and/or outliers values. Clearly, this is an interesting task for the exercise we are doing. We can highlight the outliers that are present in the second wave of surveys done in Gran Hotel Costa Meloneras, so managers need to investigate further what motives can be behind this strange behavior. The vertical line inside the box shows the median response of the relative similarity to positive ideal solution. The left and right sides of the box show the 25 and 75 percentiles, respectively (i.e. it gives the location of the middle 50% of observations). The vertical marks joined to the box by the dashed line (they usually are known as whiskers) show observations of the data whose distance with the sides of the box is less than 1.5 times the interquartile range (difference between the third and first quartile). Points outside these vertical lines are outliers and are drawn as small circles. Box-plots not only show the location and spread of the data but also indicate skewness in the sizes of the left and right parts of the box.

6Unpaired t-tests have been done because we do not have the same control group of customers for each hotel. We have estimated the variance separately for each hotel because variances of different hotels were not equal, and finally Welch modification to the degrees of freedom was employed.
4. Conclusions

This study makes two major empirical contributions to the hospitality and tourism marketing literature. The first one is related to the use of fuzzy numbers as a method to measure service quality. The second one is related to the empirical measurement of service quality in three hotels located in the island of Gran Canaria of an important chain and its implications for the competitiveness of this chain in the holiday market.

The literature on service quality highlights several issues and debates. Nature of service quality dimensions and how to measure it lie at the heart of the principal concerns. The nature and dimensions of service quality go beyond the technical aspects of providing the service. They include customers’ perception of what the service should be that are based in past experiences.

Due to the rapid growth of alternative resorts worldwide, hotel managers need to make important efforts for improving their customers satisfaction. Since 2002, a survey is conducted on a regular basis in each hotel of the group considered in the study. Tourists’ evaluation of service quality in these hotels consists of 13 different dimensions. We have employed fuzzy numbers as an adequate methodology to overcome the ambiguity of concepts that are associated with human beings’ subjective judgments.

The cognitive burden of the respondents in the survey process has been reduced using linguistic terms and facial expressions for the subjective assessment, then we have represented this information as triangular fuzzy numbers. An effective algorithm has been developed to aggregate individual assessment for each pair hotel-date for each attribute by an overall fuzzy number, which explicitly attempts to accurately capture the service quality evaluation of customers. Finally, we have used TOPSIS, based on the concept of the degree of optimality, as the practical method to rank the service performance of each observation. This indicator can be used to compare all the overall service quality performance relatively, and may provide more opportunities to identify operational areas to be improved.

The findings of this study show that some dimensions of service quality are found to behave more heterogeneously, so managers should pay attention to them in order to improve the quality of services in their respective hotel. The final ranking results show that in general, Costa Meloneras seem to perform better. However, we have also shown that during the third quarter of 2002, this hotel presented a relative bad service quality performance, and Catarina and Buenaventura showed shorter cycles of ups and downs.

The identification of customers’ perceptions of service quality in hotels is essential to better tailor marketing efforts to ensure that customer needs are met. As the overall service quality indicator can be analyzed dynamically, once a lower performance level appears, managers can recognize, prioritize and improve operational areas where important weaknesses are presented. On the contrary, they can award, allocating some premium, the most effective areas, as an incentive mechanism. Thus, the results from this research may have some significant implications for managers of hotels and operational areas.

The study has two major limitations. Firstly, the survey is conducted without having in mind the treatment of fuzzy set theory methodology, and for this reason each respondent has not the option of defining a triangular fuzzy number more concordant with her/his perception. Secondly, surveys are conducted during different seasons and therefore, perception of service quality might be biased because some seasonal effect can exist. However, the sample is important and therefore the findings can be robust. Anyway, further research would be fruitful, if these considerations are taking into account and we can investigate the perceptions of the same customers visiting the hotel in different seasons.

Acknowledgments

This work is a result of a research project for measuring the quality of service in the lodging industries. We thank Manuel Luaces for his positive energy, guidance and suggestions and Katerina Bomchtein for collecting important data for this study. We have benefited from many colleagues’ comments, suggestions, discussions and assistance. We also thank comments and suggestions made by two anonymous referees. The usual disclaimer applies.
References


