Journal of Air Transport Management 76 (2019) 67–77

Contents lists available at ScienceDirect

Journal of Air Transport Management

journal homepage: www.elsevier.com/locate/jairtraman

FIPIA with information entropy: A new hybrid method to assess airline service quality

Kumru Didem Atalay, Buket Atalay, Feride Bahar Isin*

Baskent University, Turkey

ARTICLE INFO

Keywords:
Information entropy
Triangular fuzzy number
FIPIA
Airline service quality
Resource allocation

ABSTRACT

This study proposes "FIPIA with information entropy" as a new, hybrid method to assess airline service quality by identifying the most important priorities for airline passengers and producing recommendations to airline management for optimal resource allocation to improve service quality and customer satisfaction. The proposed method is an improvement over IPA, IPIA and FIPA methods, through the introduction of information entropy and fuzzy logic to the analysis of importance, performance and impact dimensions of airline service quality to improve interpretability and actionability of analysis results. This study also offers airline managers a list of what they should improve in resource allocation in order to increase service quality considering customer satisfaction and create value by managing the relational capital more effectively. The new hybrid method was field-tested by administering a 26-item questionnaire to passengers of a major airline operator, analyzing the responses using the Importance-Performance-Impact Analysis (IPIA) method, fuzzy logic and information entropy. The analysis revealed four main dimensions of airline service quality, namely reliability, assurance, tangibles, empathy and responsiveness with 17 constituent attributes. The case study revealed that (1) resource allocation was adequate only on four attributes; (2) seven service quality attributes were identified as needing further management focus on resource allocation; (3) six service quality attributes received more resources than necessary which should be shifted to other attributes; (4) dimensions of reliability and tangibles needed more focus than others. The proposed hybrid method of FIPIA with information entropy can be employed for any industry where service quality depends on multiple attributes.

1. Introduction

Service industry providers operating in a rapidly changing environment are well aware of the need to deliver high quality (Nadiri et al., 2008). As competition in the airline industry increases, providing high quality services and value creation have become all the more necessary (Chen et al., 2011). Today, value creation relies mostly on intellectual capital that cannot be recognized in financial statements under the current accounting standards or financial reporting framework (Gokten and Gokten, 2017; Atalay et al., 2018). A main component of the intellectual capital is relational capital that refers to customer loyalty and satisfaction. Relational capital increases profitability by enhancing service quality and customer satisfaction. As Liou et al. (2011) points out, there is no universally agreed definition of service quality. Service quality is a context-dependent construct that can be evaluated through various aspects for various industries. Conventional opinion holds that customer satisfaction increases as perceived service quality increases. However, recent studies indicate the existence of a non-linear pattern between the dimensions of service quality and customer satisfaction (Basfirinci and Mitra, 2015). For this reason, it is necessary to identify the relative importance of service quality dimensions.

An airline operator is expected to satisfy the passengers on each attribute if it wishes to be the preferred operator (Li et al., 2017; Medina-Muñoz et al., 2018). Studies show that customer expectations and perceptions of airline services have not fully been understood (Chow, 2015; Waguespack and Rhoades, 2008). Besides, many airline operators fail to correctly allocate their resources (Curtis et al., 2012). Market shares of airline operators are driven by customer perceptions of service quality (Zhu, 2016). Passengers make their airline choices based on service quality, and rank airline operators accordingly (Prayag, 2007; Wen and Yeh, 2010). Learning customer expectations and needs is a critical factor to ensure sustainability in the airline industry (Chen and Chang, 2005; Tsafarakis et al., 2018; Zhu, 2016). It is necessary for airline operators to prioritize service characteristics that have greater impact on important customer expectations and needs, and accordingly

* Corresponding author.
E-mail address: bahar@baskent.edu.tr (F.B. Isin).

https://doi.org/10.1016/j.jairtraman.2019.02.004
Received 28 July 2018; Received in revised form 26 December 2018; Accepted 9 February 2019
Available online 25 February 2019

manage their resources so as to appropriately meet customer expectations (Liou et al., 2011; Chow, 2015). Global financial environment demands targeted and well-projected resource management (Tsafarakis et al., 2018).

This study proposes a new hybrid method to identify highest priorities for airline passengers and accordingly optimize resource allocation, combining the Importance-Performance-Impact Analysis (IPIA) method introduced by Lin and Vlachos (2018), fuzzy logic and information entropy. The IPIA method aims to identify the most critical attributes for customers using importance, performance and impact dimensions and to propose efficient and effective resource allocation for managers. It attempts to overcome the shortcomings of the Importance-Performance Analysis (IPA) method (Martilla and James, 1977) by enhancing the reliability and usefulness of resource allocation decisions for managers with the addition of impact dimension (Lin and Vlachos, 2018). Thus, it is to date study that provides airline managers with information on customer expectations, level of fulfillment of these expectations and impact of these expectations on the resource capacity and allocation of airline operators. In the new hybrid approach proposed in this study, fuzzy logic is used to reduce the uncertainty created by the fuzzy nature of subjective human perceptions. The fuzzy set theory is appropriate to evaluate service quality (Benitez et al., 2007; Chon et al., 2008; Tsaur et al., 2002; Wang, 2004). This study also introduces information entropy to the analysis in an attempt to remove decision-maker bias. Consequently, the new hybrid model enhances the reliability and usefulness of resource allocation decisions by taking the impact dimension into account, reduces uncertainty, considers the fuzzy nature of subjective human perceptions through fuzzy logic, and removes decision-maker bias. There are a few studies in the literature discussing the Fuzzy Importance-Performance Analysis (FIPA) method and one discussing the IPIA method. This is the first ever study that combines information entropy and the Fuzzy Importance-Performance-Impact Analysis (FIPIA) method into a hybrid approach.

In the following sections, the concept, dimensions and attributes of airline service quality are discussed. Then, IPA and IPIA methods are outlined, followed by an introduction to fuzzy logic and information entropy to build the proposed hybrid method. Then, a field study is presented which has employed the proposed hybrid model to identify air passengers' perceptions on dimensions and attributes of airline service quality, and analyze responses to produce recommendations to airline managers for better resource allocation. The final section consists of a discussion of the findings, conclusions, limitations of this present study and suggestions for further research.

2. Studies on airline service quality

While there are many studies on the measurement of airline service quality, there is no consensus on what criteria are important in attracting and satisfying airline customers, their preference for an airline operator or flight over another, or assessing service quality (Chen and Chao, 2015; Gupta, 2018; Han, 2013; Kim and Park, 2017; Medina-Muñoz et al., 2018). A preferred scale for determining airline service quality attributes is the "servqual scale" developed by Parasuraman et al. (1991). Reliability, assurance, tangibles, empathy and responsiveness were emphasized as four important dimensions of airline service quality in various studies (Bruning et al., 2009; Chang and Yeh, 2002; Correia et al., 2008; Gilbert and Wong, 2003; Mohamed et al., 2008; Tiernan et al., 2008; Zhu, 2016; Zeglat et al., 2008).

In addition to these main dimensions, other criteria were offered in various studies. Medina-Muñoz et al. (2018) indicated that 'safety and punctuality', 'ticket price', and 'attention and service during journey' were the most important criteria in determining airline attractiveness. Cabin crew's professional knowledge, emergency handling abilities and flight schedule were highlighted by Kim and Park (2017) as core components of airline service quality. Pangow et al. (2017), Al-Medabesh and Ali (2014), Munusamy et al. (2011) and Mikulić and Prebežac, 2012 emphasized cabin crew's service quality. Kurtulmuşoğlu et al. (2016) and Chen and Chao (2015) pointed out the importance of punctuality in assessing airline service quality. Chiang Leong (2008) drew attention to check-in service, in-flight entertainment and convenience. Tsantoulis and Palmer (2008) named cabin comfort, in-flight amenities, and the attitude of ground and flight crews in service delivery as the most important criteria for passenger satisfaction. Surovitskikh and Lubbe (2008) drew attention to the significant effect of on-time performance on the consistency of service quality. Chen and Chang (2005) highlighted the importance of punctuality and scheduling criteria for passenger satisfaction. Vink et al. (2005) noted comfort during flight experience. Gilbert and Wong (2003) offered the dimensions of reliability, assurance, facilities, employees, flight patterns, customization, and responsiveness as the components of airline service quality. Chang and Yeh (2002) emphasized the importance of reservation and ticketing processes in assessing airline service quality. Jin (1998) put forward safety record, ticket price, cabin food/beverage and possible delay time as service quality criteria effective in airline selection. Elliott and Roach (1993) used on-time performance, baggage handling, food quality, seat comfort, check-in service, and in-flight service to define airline service quality.

3. IPA approach

The Importance-Performance Analysis (IPA) suggested by Martilla and James (1977) is a method that identifies the most important service attributes and priorities to be improved and helps managers increase customer satisfaction and develop strategies (Hansen and Bush, 1999; Matzler et al., 2004). IPA is among the methods widely used to evaluate the quality of service in public transportation (Chen and Chang, 2005; Chou et al., 2011; Freitas, 2013; Weinstein, 2000).

The biggest advantage of IPA is to simultaneously reflect the identified attributes and strategic suggestions (Deng, 2008). IPA defines customer satisfaction as a function of two components. While the performance of attributes is depicted on the X-axis, the importance customers attach to attributes is depicted on the Y-axis. The first quadrant includes low performance attributes with high importance. The second quadrant includes high performance attributes with high importance. The third quadrant includes low performance attributes with low importance and the fourth quadrant includes high performance attributes with low importance. Those in the first quadrant constitute the attributes that managers must concentrate on. Sustaining the strategies existing for the attributes included in the second quadrant is appropriate (Keep Up the Good Work). The attributes included in the third quadrant constitute low priority attributes (Low Priority). The attributes included in the fourth quadrant refer to those over-cared by managers (Possible Overkill). Despite all the advantages of the method, there are still some drawbacks with respect to the sufficiency and reliability of resource allocation decisions (Bacon, 2012; Matzler et al., 2004; Oh, 2001). The main deficiencies of IPA highlighted in the literature include erroneous assumptions of linear relationships between attribute performance and customer satisfaction (Geng and Chu, 2012; Oh, 2001), inadequate measures of attribute importance (Matzler et al., 2004), assuming independence of individual attributes while they are strongly correlated (Geng and Chu, 2012; Matzler et al., 2004; Oh, 2001), low construct validity of 'importance' dimension and reliability of 'performance' dimension, inability to delimit the thresholds of IPA quadrants (Matzler and Sauerwein, 2002; Oh, 2001; Sever, 2015). The IPIA method developed by Lin and Vlachos (2018) is an improvement over the IPA method, removing the latter's limitations. The IPIA method improves the reliability and validity of resource allocation over IPA by adding the impact dimension as a third dimension. "Impact" can be defined as the effect of customer attributes on resource allocation (Lin and Vlachos, 2018: 188). The IPIA method remedies the conceptual and methodological deficiencies of the IPA method by taking the impact dimension into account. The IPIA method also provides more reliable propositions to managers by using advanced analytical tools and overcoming limitations of data. Moreover, it enables managers to get more opinions while deciding how to allocate resources in order to achieve the optimum level of customer satisfaction (Lin and Vlachos, 2018: 186). Taking no account of impact dimension would cause managers to make suboptimal resource allocation decisions. The impact dimension indicates the direction and impact magnitude of the attributes on resource allocation (Lin and Vlachos, 2018: 188). In this study, the IPIA method is applied in this study to prioritize resources and make efficient decisions on resource allocation especially for intellectual capital management. Managing the intellectual capital efficiently provides competitive advantage to companies operating in sectors with intense competition. In this sense, a company's competitive advantage depends on its creation of superior value for its customers, and the capacity to do so relies on its resources (Radjenović and Krstić, 2017: 128).

4. Information entropy

Entropy measuring the prospective information content of a given message has a benignant meaning within the scope of information theory. Thus, this concept has become a significant one in social sciences (Capocelli and De Luca, 1973; Nijkamp, 1977). Entropy is used as a measure for the information amount exemplified by a discrete probability distribution, p_1, ..., p_k, and points out that a distribution with small variations among the p_i's includes less information than does a distribution with large variations (Hwang and Yoon, 1981; Jaynes, 1957). In theory, this criterion for information was defined by Shannon and Weaver (1947) as given below, where $\phi\_k = 1/ln(k)$ is a positive constant (Chan et al., 1999) and k means the attribute numbers.

$$E(p_1, \ldots, p_k) = -\phi_k \sum_{i=1}^{k} p_i ln p_i \tag{1}$$

The method of entropy weight was first applied from thermodynamics to information systems (Shannon, 2001). Information entropy refers to the fuzziness of signals in the processes of communication. The weight decreases as the information entropy increases (Ji et al., 2015).

5. Fuzzy logic

In many cases, it is not easy to precisely transform the opinions of people into quantitative values because of the subjective nature and uncertainty of their preferences (Hsu et al., 2010; Kannan et al., 2014; Lin, 2017; Tseng et al., 2015). Perceptions of customer service are described by ambiguity and fuzziness. Perceptions and attitudes of human beings are subjective and uncertain. Moreover, differences in individual perceptions and personality result in that the same words used by two persons may demonstrate completely different perceptions (Chiou et al., 2005). As a consequence, using binary logic and crisp numbers in order to identify the perceptions and attitudes of human beings fails to deal with fuzziness (Zadeh, 1965). Zadeh (1965) remarked that the fuzzy set theory can cope with problems including ambiguity and fuzziness. A fuzzy number is regarded as more suitable than a crisp number to stand for the linguistic term scale concerning the customer's perception of service delivered (Chien and Tsai, 2000; Wu et al., 2004). The fuzzy set theory transforms qualitative data into quantitative depending on membership functions. Fuzzy mathematics is frequently implemented to objectively represent the uncertainty in human judgment, to reflect vague and missing information, to include non-quantifiable and partial realities in decision-making (Cheng et al., 2016).

Fuzzy membership function and triangular fuzzy numbers (TFNs) definitions are defined below (see Fig. 1).

Definition 1. Let X denote a universal set. Then a fuzzy subset $\tilde{A}$ of X is defined by its membership function

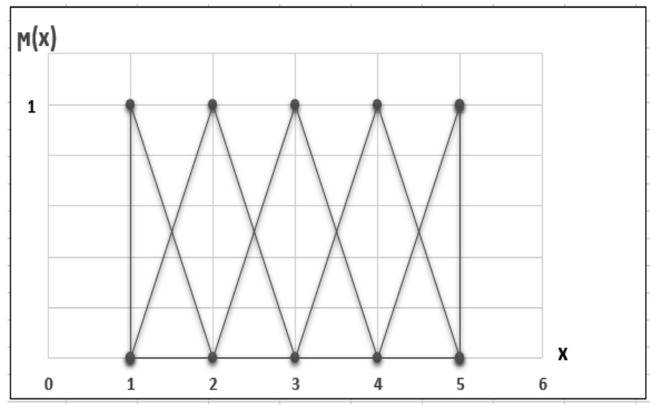

Fig. 1. Triangular membership function.

$$\mu_{\tilde{A}} = X \rightarrow [0,1] \tag{2}$$

which assigns a real number $\mu_{\tilde{A}}(x)$ in the interval [0,1] to each element $x\varepsilon$X, where $\mu_{\tilde{A}}(x)$ represents the grade of membership of x in $\tilde{A}$. A fuzzy subset $\tilde{A}$ can be characterized as a set of ordered pairs of elements x and its grade $\mu_{\tilde{A}}(x)$ and is often written as

$$\tilde{A} = \{(x, \mu_{\tilde{A}}(x))x\varepsilon X\} \tag{3}$$

Definition 2. The triangular fuzzy numbers can be denoted as $A = (a_1, a_2, a_3)$ and where a_2 is the central values, a_1 and a_3 are the left and right spreads. The triangular membership function shown in Eq. (4).

$$\mu_{\tilde{A}}(x) = \begin{cases} 0, & x \le a_1 \\ (x - a_1)/(a_2 - a_1), & a_1 \le x \le a_2 \\ (a_3 - x)/(a_3 - a_2), & a_2 \le x \le a_3 \\ 0, & x \ge a_3 \end{cases} \tag{4}$$

Fuzzy arithmetic is basically applied to fuzzy numbers and refers to a direct method of the extension principle (Dubois and Prade, 1980; Zadeh, 1975; Baser et al., 2017). Further information on Fuzzy arithmetic can be found in Chen and Hwang (1992).

6. FIPA approach

Deng (2008) used the FIPA method instead of the IPA method to determine critical service attributes that should be improved to achieve customer satisfaction in the airline industry and concluded that the set of service characteristics identified were almost completely different from those obtained by the IPA method.

Lin (2017) used the FIPA method in the education sector to examine the perceived importance and performance of the learning courses for school administrator candidates on the instructional targets; Wang and Tseng (2011) used this method to determine the dynamics that allowed foreign students to continue higher education in Taiwan; and Cheng et al. (2016) used FIPA in the education sector to determine critical features in e-learning system measurements. Similarly, Chen et al. (2016) used the FIPA method to explore the strategies that boosted the competitive power of Taiwan's free trade ports, and Tseng and Bui (2017) did so to determine the basic eco-innovation attributes to enhance industrial symbiosis performance. Chen (2016) applied the FIPA method to assess how Taiwan could create a niche in Asia's travel tourism industry; Qiao et al. (2014) to determine the public perception of the importance and performance of the environmental service quality of the park located in the Xinxiang Economic Development Zone; Cheng et al. (2016) to determine the effects of various features on visitor satisfaction. Islam et al. (2018) used the FIPA method to determine critical green supply chain practices according to importance and performance levels based on language preferences; and Akomeah et al.

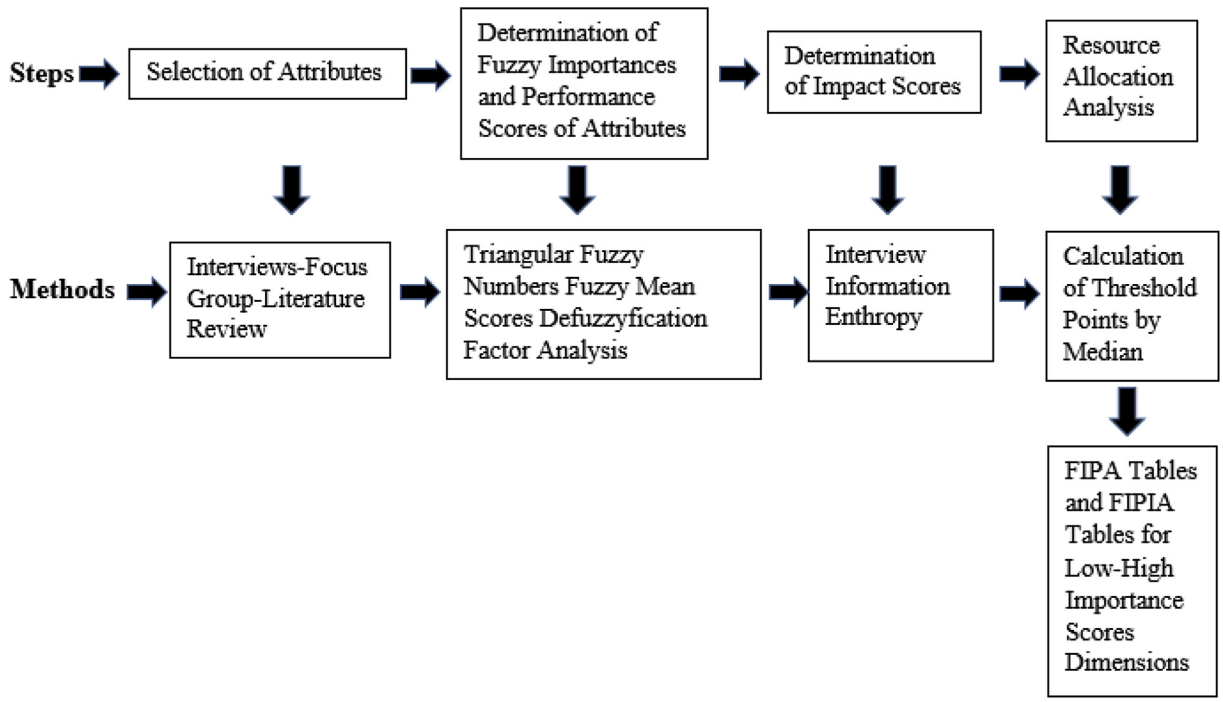

Fig. 2. Hybrid information entropy and FIPIA.

(2017) to discuss the diversity of bank choices of illiterate bank customers.

7. Hybrid method of FIPIA with entropy

The hybrid method of FIPIA with entropy consists of 4 basic steps (see Fig. 2).

Attributes are determined in the first step, using the approach by Churchill (1979). First, a literature review study was conducted to examine the service quality attributes in previous studies. Then, the attributes so identified were evaluated by the interview method. The list of most important attributes obtained as a result of these interviews were examined in a focus group study guided by a moderator. Accordingly, attributes were created. In the second step, importance and performance values for passengers were captured through a questionnaire administered to airline passengers. In this step, a fuzzy scale expressed as triangular fuzzy number was used to extract important attributes from responses and increase the reliability of performance dimension by obtaining a more reliable measurement. Thus, it became possible to convert people's opinion into quantitative values, overcoming the earlier inability to do so due to the subjective nature and uncertainty of respondents' preferences.

Fuzzy performance mean scores for each attribute were calculated by using the performance measurement values by respondents. Defuzzification was performed to each attribute value obtained with triangular fuzzy numbers by using respondents' importance measurement values on which a factor analysis was applied. The factor loads were preferred as the importance values in the IPA analysis. Thus, the validity of the importance scores was increased by solving the problem of inadequacy of the direct measure of the importance scores and removing the inability to measure importance in numerical scores. The preferred way to determine performance and importance scores also delivered a solution to the problem of linearity among importance performance assumption. In the third step, impact scores included in the model in order to remove deficiencies in resource allocation decisions were determined since performance measurements were only determined by importance attributes. For this purpose, decision makers were asked to evaluate the impact scores of attributes from the least significant to the most on a 5-point scale. Information entropy for each attribute was calculated using these evaluations, and the calculated values were used as the impact scores of attributes. Entropy knowledge was used to remove the negative effects of the factors that prevented decision maker not to be biased and accurately reflect the truth (Abramson, 1963).

In the fourth step, the IPA diagram was drawn with the X-axis denoting importance and the Y-axis denoting performance scores. In this diagram, the intersection points of the axes were found by separately calculating the medians of the importance and performance of the measurements in the calculation of the threshold value. The reason why median was used in this step was to reduce the probability of possible measurement errors, and accordingly outliers' effect according to the properties of score set (Bacon, 2003).

In the FIPA graph, high and low importance attributes were examined separately. Performance impact graphs of high and low importance attributes were drawn handling them separately. Thus, the impact and performance levels of attributes that passengers identified as having low importance and those that passengers identified as having high importance differed because in both cases, the performance and impact median values calculated for the threshold point were different from the median values in the FIPA table.

The algorithm for the relevant method is given below.

Step 1: n $(i = 1, \ldots, n)$ respondents who responded to the survey, in which the number of questions (attributes) is represented by $(j = 1, \ldots, m)$.
Step 2: $\tilde{a}_{ij}$ denotes ith respondent for jth attribute. $\tilde{a}_{ij}^{imp}$ is a triangular fuzzy number given by

$$\tilde{a}_{ij}^{imp} = (l_{ij}, m_{ij}, u_{ij})^{imp} \tag{5}$$

$$\tilde{a}_{ij}^{perf} = (l_{ij}, m_{ij}, u_{ij})^{perf} \tag{6}$$

Step 3: Calculate a_{ij}^{imp}; (importance score) by Exploratory Factor Analysis (EFA).

Defuzzification is made for each of a_{ij}^{imp} values by using Eq (7)

$$def\ \tilde{a}_{ij}^{imp} = \frac{lij + 2mij + uij}{4} = a_j \quad (7)$$

a_j is obtained for $j = 1, \ldots, m$ by using Eq (7). EFAs are conducted for a_j values ($j = 1, \ldots, m$) obtained for each attribute. These are taken as importance scores.

Step 4: Calculate a_{ij} performance score by fuzzy means.

Defuzzification is made for each of a_j values by using Eq (9).

$$\overline{\tilde{a}}_j^{perf} = (\overline{l_j}, \overline{m_j}, \overline{u_j}) = \frac{\sum_{i=1}^{n} \tilde{a}_{ij}^{perf}}{n} \quad j = 1, \ldots, m \quad (8)$$

$$def\tilde{a}_j^{perf} = \frac{\overline{l_j} + 2\overline{m_j} + \overline{u_j}}{4} = PERF_j \quad j = 1, \ldots, m \quad (9)$$

Step 5: Calculate E_j information entropy for impact score. Select t decision makers. ($k = 1, \ldots, t$)

$DM_1, DM_2, \ldots, DM_k$

Request the decision makers to evaluate each of attributes using 1-to-5-point scale, with 1 least effective to 5 most effective.

Assume that the score of j th question obtained by the k th decision maker equals to x_{kj}.

Normalize the scores of decision makers.

$$P_{kj} = \frac{x_{kj}}{\sum_{k=1}^{t} (x_{kj})} \quad j = 1, \ldots, m \quad k = 1, \ldots, t \quad (10)$$

Calculate the information entropy measure by using Eq (11).

$$E_j = -\frac{1}{\ln(t)} \sum_{k=1}^{t} (P_{kj} \ln P_{kj}) \quad j = 1, \ldots, m \quad (11)$$

$$IMPACT_j = \frac{E_j}{\sum_{j=1}^{m} E_j} \quad j = 1, \ldots, m \quad (12)$$

8. A case study using the hybrid FIPIA method with information entropy for airline service quality

The first step in the FIPIA model is the identification of important attributes. First, a literature review study was conducted to examine the airline service quality attributes of passengers in previous studies. Later, the attributes so identified were evaluated by five airline managers interviewed and asked to evaluate the airline service quality attributes which they thought the passengers viewed as most important. These managers were presented a list of attributes obtained from literature reviews and also asked to express other attributes they deemed important. Three of these managers were male, with ages ranging from 45 to 60. Each had over 10 years of experience in the airline industry particularly in the customer-related areas.

The most important attributes captured in these interviews were examined in a focus group study guided by a moderator. The focus group participants included 3 airline managers, 2 passengers traveling frequently as being loyal to a certain airline, an academician who was an expert on the field of airline service quality, and an academician who was an expert on the methodology. Three focus group discussions were conducted until reaching a consensus, which when reached. The number of attributes on which consensus was reached was 17 (see Table 1).

In the study, a survey questionnaire was prepared and administered 'face-to-face' to passengers to express the importance levels of service quality attributes. The questionnaire consisted of three main parts, the first capturing respondents' demographic characteristics such as age, gender, income and educational status. The second part captured respondents' opinion on the importance levels of 17 airline service quality attributes. The third part elicited respondents' evaluations of the performance of a certain airline operator on these airline service quality attributes. As various airline operators assess service quality in various ways, one airline operator has been chosen to ensure consistency through the assessments, thus removing any bias that might arise from airline variation. The selected airline operator is the biggest in the country with the highest number of domestic routes and flights, and a member of the Star Alliance running international flights. A triangular fuzzy number was used to stand for the linguistic term of respondent's opinion on the importance and performance of service quality. Moreover, the linguistic terms from among which respondents selected to indicate importance and performance evaluation for service were "very unimportant," to "very important" and "very poor" to "very good" (see Table 2).

Table 1
Attributes of service quality.

1. Cabin equipment amenities
2. Seating comfort
3. Interior cabin in general
4. The cleanliness of aircraft
5. In flight food and beverage services
6. Direct or connecting flight
7. On-time performance
8. Ease of reservation and ticketing with internet
9. Charge for buggage
10. Baggage handling service
11. Politeness of cabin crew
12. Convenience of flight schedule
13. Frequent flyer program
14. Clear in flight passenger announcement
15. Knowledge and experience of cabin crew
16. Waiting time for luggage
17. Convenience in making reservation

The draft questionnaire was pilot-tested to evaluate the validity of questions and examine whether questions were misunderstood or not understood. Of 25 pilot respondents in total, 15 of male, and 10 were female. All were university graduates, ages ranging from 30 to 55 years, flying at least 5 times a year. The questionnaire was finalized based on the responses in the pilot administration. To administer the actual questionnaire, passengers waiting at the largest airport in the country were asked whether they would participate in the survey and were informed that the results would be used for an academic study. The questionnaire was administered for two consecutive weekends. A total of 395 passengers responded to the questionnaire. The sample size was identified as 370 to stand for the population (more than 10,000 passengers annually), with a 95% confidence level and a 5% error margin (DeVaus, 2000). The demographic characteristics of the participants are given in Table 3.

To calculate the performance values, the fuzzy means values of each attribute were calculated using Eq (8). Performance scores were calculated by making obtained fuzzy triangular numbers defuzzyficated using Eq (9) (see Table 4).

In order to calculate the importance values, defuzzification was made to each attribute value obtained from each passenger by using Eq (7), and importance attributes values were made crispy (see Table 5).

Explanatory factor analysis was applied to these data. A principal

Table 2
Triangular fuzzy number to represent to linguistic terms for performance and importance.

Linguistic terms for importance	Linguistic terms for performance	Triangular fuzzy number (TFN)
Very unimportant	Very poor	(1, 1, 2)
unimportant	poor	(1, 2, 3)
medium	medium	(2, 3, 4)
important	good	(3, 4, 5)
Very important	Very good	(4, 5, 5)

Table 3
Profile information on the survey respondents.

		Frequency (***n*** = 395)	%
Age	18–30	270	68.4
	31–43	61	15.4
	44–56	53	13.4
	> 57	11	2.8
Highest education level	Primary school	15	3.8
	High School	54	13.7
	University	240	60.8
	Postgraduate	86	21.8
Gender	Male	216	54.7
	Female	179	45.3
Marital status	Married	250	63.29
	Single	145	36.71
Income	500-1000	209	52.9
	1001-2000	128	32.4
	> 2001$	58	14.7

component analysis with varimax rotation was used in the analysis. To identify the reliability of the scales, the coefficients of the Kaiser–Meyer–Olkin (KMO) test (0.854 > 0.5) and Bartlett's test of sphericity (p = 0.000 < 0.01) are analyzed in this study. These results indicate that the data is normally distributed, which is appropriate for factor analysis. The eigenvalues were equal to or greater than l, and maximum variance rotation was used in this study. Consequently, four factors were extracted from the expectation data set, namely ‘reliability, assurance, tangible, empathy and responsiveness” for service quality evaluations of passengers. In terms of reliability analysis, Cronbach's alpha was found to be 0.838 for questionnaire items. Factor loadings and internal consistency values for each dimension are given in Table 6. The factors loadings of importance attributes were used to determine the importance scores of passengers.

In the third step of FIPIA, information entropy was calculated for each attribute using Eq (11) in order to determine impact values. In this step, three mid-level executives working in the airline industry were asked to assign impact values for attributes. All three executives had more than 15 years of experience in the sector. For this purpose, the decision makers were requested to evaluate the impact scores of attributes on a 1-to-5-point scale, 1 being least significant and 5 being most significant. Information entropy for each attribute was calculated using these evaluations (see Table 7). Information entropy values were used as impact scores of attributes.

In the final step, the FIPA diagram was drawn with the X-axis denoting performance and the Y-axis denoting importance scores (see Fig. 3).

In this diagram, the threshold values of the axes were identified by calculating the medians of the importance and performance of the measurements separately for the calculation of the threshold value.

Two separate FIPIA diagrams were created (see Figs. 4 and 5) pointing out the performance and impact values of attributes with low and high importance values determined on the basis of this diagram, and resource allocation analysis was made (see Table 8).

Seven service quality attributes were identified as those that should be focused on the resource allocation dimension. There was an efficient and effective resource allocation for only four service quality attributes. For the remaining six service quality attributes, it seems that other priorities should be concentrated on in terms of resource allocation. The attributes that should be concentrated on were included in the

Table 4
Triangular fuzzy number (TFN) for performance.

	Attribute 1 (***j*** = 1)	Attribute 2 (***j*** = 2)	Attribute 3 (***j*** = 3)	Attribute 4 (***j*** = 4)		Attribute 17 (***j*** = 17)
	$\tilde{a}_{i1}^{perf}$	$\tilde{a}_{i2}^{perf}$	$\tilde{a}_{i3}^{perf}$	$\tilde{a}_{i4}^{perf}$	⋯	$\tilde{a}_{i17}^{perf}$
1	(3, 4, 5)	(3, 4, 5)	(3, 4, 5)	(3, 4, 5)	⋯	(3, 4, 5)
2	(3, 4, 5)	(3, 4, 5)	(4, 5, 5)	(3, 4, 5)	⋯	(2, 3, 4)
3	(3, 4, 5)	(3, 4, 5)	(3, 4, 5)	(3, 4, 5)	⋯	(3, 4, 5)
4	(2, 3, 4)	(3, 4, 5)	(4, 5, 5)	(4, 5, 5)	⋯	(1, 2, 3)
5	(3, 4, 5)	(3, 4, 5)	(3, 4, 5)	(3, 4, 5)	⋯	(2, 3, 4)
6	(2, 3, 4)	(3, 4, 5)	(4, 5, 5)	(4, 5, 5)	⋯	(1, 2, 3)
7	(4, 5, 5)	(2, 3, 4)	(3, 4, 5)	(3, 4, 5)	⋯	(3, 4, 5)
8	(2, 3, 4)	(1, 2, 3)	(3, 4, 5)	(3, 4, 5)	⋯	(2, 3, 4)
9	(2, 3, 4)	(1, 2, 3)	(3, 4, 5)	(3, 4, 5)	⋯	(1, 2, 3)
10	(2, 3, 4)	(1, 2, 3)	(3, 4, 5)	(3, 4, 5)	⋯	(1, 2, 3)
11	(2, 3, 4)	(2, 3, 4)	(3, 4, 5)	(3, 4, 5)	⋯	(1, 2, 3)
12	(4, 5, 5)	(4, 5, 5)	(4, 5, 5)	(4, 5, 5)	⋯	(4, 5, 5)
13	(4, 5, 5)	(4, 5, 5)	(4, 5, 5)	(4, 5, 5)	⋯	(4, 5, 5)
14	(2, 3, 4)	(3, 4, 5)	(4, 5, 5)	(4, 5, 5)	⋯	(1, 2, 3)
15	(3, 4, 5)	(3, 4, 5)	(3, 4, 5)	(3, 4, 5)	⋯	(3, 4, 5)
16	(3, 4, 5)	(2, 3, 4)	(3, 4, 5)	(3, 4, 5)	⋯	(2, 3, 4)
17	(2, 3, 4)	(3, 4, 5)	(4, 5, 5)	(4, 5, 5)	⋯	(1, 2, 3)
18	(3, 4, 5)	(3, 4, 5)	(3, 4, 5)	(3, 4, 5)	⋯	(2, 3, 4)
19	(2, 3, 4)	(2, 3, 4)	(3, 4, 5)	(3, 4, 5)	⋯	(3, 4, 5)
20	(2, 3, 4)	(2, 3, 4)	(3, 4, 5)	(3, 4, 5)	⋯	(3, 4, 5)
21	(3, 4, 5)	(4, 5, 5)	(3, 4, 5)	(4, 5, 5)	⋯	(2, 3, 4)
22	(3, 4, 5)	(3, 4, 5)	(3, 4, 5)	(3, 4, 5)	⋯	(3, 4, 5)
23	(4, 5, 5)	(3, 4, 5)	(4, 5, 5)	(3, 4, 5)	⋯	(3, 4, 5)
24	(3, 4, 5)	(2, 3, 4)	(3, 4, 5)	(3, 4, 5)	⋯	(2, 3, 4)
25	(3, 4, 5)	(4, 5, 5)	(4, 5, 5)	(3, 4, 5)	⋯	(4, 5, 5)
26	(3, 4, 5)	(2, 3, 4)	(3, 4, 5)	(3, 4, 5)	⋯	(2, 3, 4)
27	(3, 4, 5)	(4, 5, 5)	(4, 5, 5)	(3, 4, 5)	⋯	(4, 5, 5)
28	(3, 4, 5)	(2, 3, 4)	(3, 4, 5)	(2, 3, 4)	⋯	(2, 3, 4)
	⋮	⋮	⋮	⋮	⋯	⋮
395	(4, 5, 5)	(3, 4, 5)	(2, 3, 4)	(3, 4, 5)	⋯	(2, 3, 4)
	(2.77, 3.77, 4.53)	(2.80, 3.80, 4.58)	(3.08, 4.08, 4.82)	(3.19, 4.18, 4.84)	⋯	(2.52, 3.48, 4.31)
	3.71	3.75	4.01	4.10		3.45

Table 5
Triangular fuzzy number (TFN) for importance and deffuzzyfication

	Attribute 1 (j = 1)		Attribute 2 (j = 2)		Attribute 3 (j = 3)			Attribute 17 (j = 17)	
i	$\tilde{a}_{i1}^{imp}$	$def\tilde{a}_{i1}^{imp}$	$\tilde{a}_{i2}^{imp}$	$def\tilde{a}_{i2}^{imp}$	$\tilde{a}_{i3}^{imp}$	$def\tilde{a}_{i3}^{imp}$		$\tilde{a}_{i17}^{imp}$	$def\tilde{a}_{i17}^{imp}$
1	(3, 4, 5)	4,00	(3, 4, 5)	4,00	(4, 5, 5)	4,75	⋯	(4, 5, 5)	4,75
2	(3, 4, 5)	4,00	(3, 4, 5)	4,00	(3, 4, 5)	4,00	⋯	(3, 4, 5)	4,00
3	(2, 3, 4)	3,00	(3, 4, 5)	4,00	(3, 4, 5)	4,00	⋯	(3, 4, 5)	4,00
4	(2, 3, 4)	3,00	(4, 5, 5)	4,75	(4, 5, 5)	4,75	⋯	(4, 5, 5)	4,75
5	(1, 2, 3)	2,00	(3, 4, 5)	4,00	(3, 4, 5)	4,00	⋯	(4, 5, 5)	4,75
6	(3, 4, 5)	4,00	(3, 4, 5)	4,00	(3, 4, 5)	4,00	⋯	(4, 5, 5)	4,75
7	(3, 4, 5)	4,00	(4, 5, 5)	4,75	(4, 5, 5)	4,75	⋯	(4, 5, 5)	4,75
8	(3, 4, 5)	4,00	(3, 4, 5)	4,00	(4, 5, 5)	4,75	⋯	(3, 4, 5)	4,00
9	(3, 4, 5)	4,00	(3, 4, 5)	4,00	(4, 5, 5)	4,75	⋯	(3, 4, 5)	4,00
10	(3, 4, 5)	4,00	(3, 4, 5)	4,00	(4, 5, 5)	4,75	⋯	(3, 4, 5)	4,00
11	(3, 4, 5)	4,00	(4, 5, 5)	4,75	(3, 4, 5)	4,00	⋯	(4, 5, 5)	4,75
12	(3, 4, 5)	4,00	(4, 5, 5)	4,75	(4, 5, 5)	4,75	⋯	(3, 4, 5)	4,00
13	(3, 4, 5)	4,00	(4, 5, 5)	4,75	(4, 5, 5)	4,75	⋯	(4, 5, 5)	4,75
14	(2, 3, 4)	3,00	(3, 4, 5)	4,00	(4, 5, 5)	4,75	⋯	(4, 5, 5)	4,75
15	(3, 4, 5)	4,00	(3, 4, 5)	4,00	(3, 4, 5)	4,00	⋯	(4, 5, 5)	4,75
16	(3, 4, 5)	4,00	(4, 5, 5)	4,75	(4, 5, 5)	4,75	⋯	(4, 5, 5)	4,75
17	(2, 3, 4)	3,00	(4, 5, 5)	4,75	(4, 5, 5)	4,75	⋯	(4, 5, 5)	4,75
18	(4, 5, 5)	4,75	(4, 5, 5)	4,75	(4, 5, 5)	4,75	⋯	(4, 5, 5)	4,75
19	(3, 4, 5)	4,00	(3, 4, 5)	4,00	(4, 5, 5)	4,75	⋯	(4, 5, 5)	4,75
20	(3, 4, 5)	4,00	(3, 4, 5)	4,00	(4, 5, 5)	4,75	⋯	(4, 5, 5)	4,75
21	(3, 4, 5)	4,00	(3, 4, 5)	4,00	(3, 4, 5)	4,00	⋯	(3, 4, 5)	4,00
22	(1, 2, 3)	2,00	(3, 4, 5)	4,00	(3, 4, 5)	4,00	⋯	(4, 5, 5)	4,75
23	(4, 5, 5)	4,75	(3, 4, 5)	4,00	(4, 5, 5)	4,75	⋯	(4, 5, 5)	4,75
24	(3, 4, 5)	4,00	(4, 5, 5)	4,75	(4, 5, 5)	4,75	⋯	(4, 5, 5)	4,75
25	(3, 4, 5)	4,00	(3, 4, 5)	4,00	(4, 5, 5)	4,75	⋯	(3, 4, 5)	4,00
26	(3, 4, 5)	4,00	(4, 5, 5)	4,75	(4, 5, 5)	4,75	⋯	(4, 5, 5)	4,75
27	(3, 4, 5)	4,00	(3, 4, 5)	4,00	(4, 5, 5)	4,75	⋯	(3, 4, 5)	4,00
28	(3, 4, 5)	4,00	(4, 5, 5)	4,75	(3, 4, 5)	4,00	⋯	(4, 5, 5)	4,75
	⋮	⋮	⋮	⋮	⋮	⋮	⋯	⋮	⋮
395	(1, 1, 2)	1,25	(3, 4, 5)	4,00	(3, 4, 5)	4,00	⋯	(4, 5, 5)	4,75

Table 6
Result of EFA (n = 395).

	SERVICE QUALITY ATTRIBUTES	Internal Consistency (Cronbach's α)	Factor scores
RELIABILITY	Ease of reservation and ticketing with internet	0.679	0.716
	On-time performance		0,645
	Baggage handling service		0.609
	Charge for buggage		0,485
ASSURANCE	Convenience of flight schedule	0.674	0.715
	Frequent flyer program		0.658
	Waiting time for luggage		0.580
	Convenience in making reservation		0.521
TANGIBLE	Seating comfort	0.647	0.702
	The cleanliness of aircraft		0.628
	Cabin equipment amenities		0.622
	In flight food and beverage services		0.579
	Interior cabin in general		0.569
EMPATHY AND RESPONSIVENESS	Clear in flight passenger announcement	0.667	0.751
	Direct or connecting flight		0.577
	Knowledge and experience of cabin crew		0.524
	Politeness of cabin crew		0.507

dimensions of reliability and tangibles.

9. Discussion and conclusion

This study identified 17 attributes clustered variously around the four dimensions of airline service quality i.e. “reliability, assurance, tangibles, empathy and responsiveness”, and captured the relative importance, performance and impact of those attributes using the proposed new hybrid method of FIPIA with information entropy.

Frequently highlighted in previous research, the “tangibles” dimension as analytically captured in this included cabin equipment amenities (Han, 2013; Kim and Park, 2017), seating comfort (Chen and Chao, 2015; Forgas et al., 2010; Han, 2013; Kim and Park, 2017; Carlos Martín et al., 2008; Mason and Gray, 1995; Park et al., 2004, 2009; Wen and Lai, 2010), cleanliness of aircraft (Chen and Chao, 2015; Kim and Park, 2017), clear in-flight passenger announcement (Kim and Park, 2017; Mason and Gray, 1995) and interior cabin in general. The attributes discussed in this dimension are generally related to the fixed characteristics of services offered by airline operators by (Chang et al., 2003), on which airline managers should concentrate when making resource allocation decisions.

Another dimension also frequently highlighted in previous research

Table 7
Importance, performance and impact scores.

Attribute	Importance	Performance	Impact
Cabin equipment amenities	0.6220	3.7139	0.0575
Seating comfort	0.7020	3.7462	0.0597
Interior cabin in general	0.5690	4.0120	0.0583
The cleanliness of aircraft	0.6280	4.0975	0.0597
In flight food and beverage services	0.5790	3.9139	0.0529
Direct or connecting flight	0.5770	3.8937	0.0559
On-time performance	0.6450	3.6791	0.0605
Ease of reservation and ticketing with internet	0.7160	3.8924	0.0608
Charge for buggage	0.4850	3.5152	0.0605
Baggage handling service	0.6090	3.6677	0.0603
Politeness of cabin crew	0.5070	4.0456	0.0575
Convenience of flight schedule	0.7150	3.9253	0.0604
Frequent flyer program	0.6580	3.7614	0.0594
Clear in flight passenger announcement	0.7510	3.7354	0.0583
Knowledge and experience of cabin crew	0.5240	3.9234	0.0575
Waiting time for luggage	0.5800	3.4557	0.0602
Convenience in making reservation	0.5210	3.4475	0.0608

was "reliability" which included the analyzed attributes of on time performance (Bruning et al., 2009; Chen and Chao, 2015; Forgas et al., 2010; Kim and Park, 2017; Carlos Martín et al., 2008; Mason and Gray, 1995; Park et al., 2004, 2009; Rose et al., 2012; Teichert et al., 2008; Wen and Lai, 2010), baggage handling service (Chao et al., 2013; Chen and Chao, 2015; Forgas et al., 2010; Kim and Park, 2017; Park et al., 2004, 2009), ease of reservation and ticketing with internet (Chao et al., 2013; Chen and Chao, 2015; Mason and Gray, 1995; Park et al., 2004, 2009) and charge for baggage. Airline managers should also concentrate on these attributes for better resource allocation.

On time performance is seen as a core dimension of service quality, and its importance for service consistency has been emphasized (Surovitskikh and Lubbe, 2008). But, due to the resource allocation, even concentration on these attributes fails to satisfy customer expectations and causes dissatisfaction. In cases when delays cannot be controlled by operation management, they can be controlled by perception management (Katz et al., 1991).

The need is obvious for the preferred airline operators to provide passengers with consistent and desirable service quality in baggage handling, a part of service usually outsourced. That is why it is important for airline operators to monitor and control the outsourced services as well. Online reservation and ticketing offer passengers benefits of time and location while enabling airline operators to capitalize on opportunities to access new markets and reduce costs (Hanke and Teo, 2003). Online services increase efficiency and productivity and create new and convenient channels for customers (Zeithaml and Gilly, 1987; Meuter et al., 2003; Bitner et al., 2002). These results are also important for the airline operators' human resources units. Care should be taken to improve the training programs for personnel in direct contact with passengers.

This study revealed that there is an efficient and effective resource allocation for only four service quality attributes, whereas six service quality attributes needed management attention on account of passengers' evaluations suggesting that resource allocation was inadequate. Therefore, it is obvious that managers should carefully review these criteria and direct resources to higher priority service quality dimensions. Considering scarce resources and increasingly fierce competition in the market today as well as airline customers with increased awareness and more choices, any operator's survival and sustainability hinge on its efficient resource allocation.

This study offers all steps necessary to capture the expectations of airline passengers in the big picture, identify the areas where service quality needs to be improved, and accordingly make resource allocation based on customer expectations. Improved resource allocation would enhance service quality and customer satisfaction of the airline operators. This should have positive impact on their relational capital, i.e. customer loyalty etc. and consequently on profitability.

Thus, this study provides executives with a list of what should be evaluated in order to manage the intellectual capital more effectively and create value. At this point, the most critical issue is the ability of airline operator identify the most important attributes for it cannot outperform others in all attributes and make resource allocation accordingly. These attributes are the ones which will make the difference.

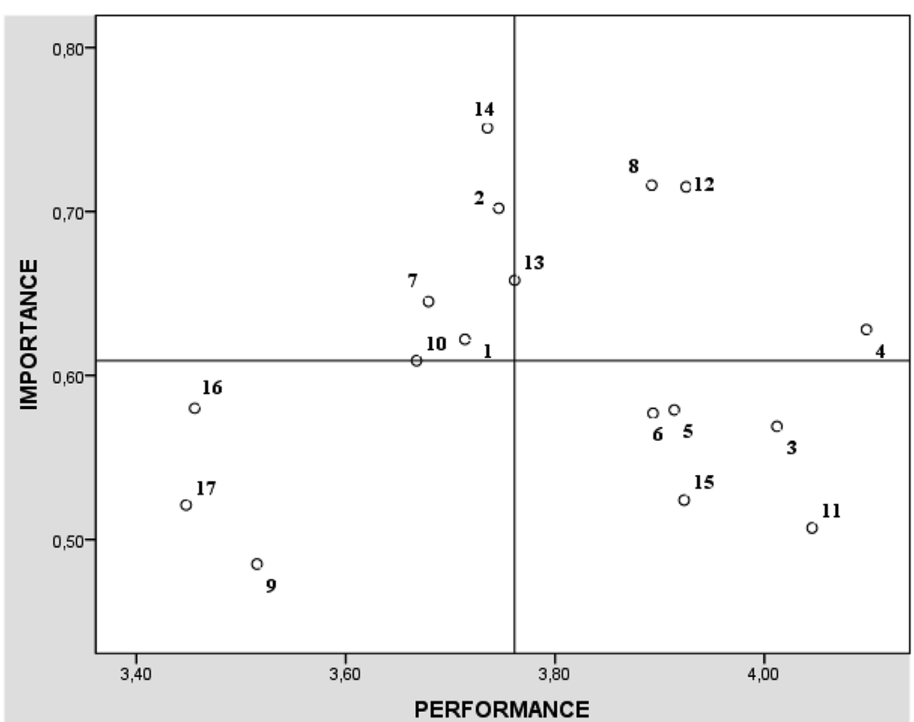

Fig. 3. FIPA.

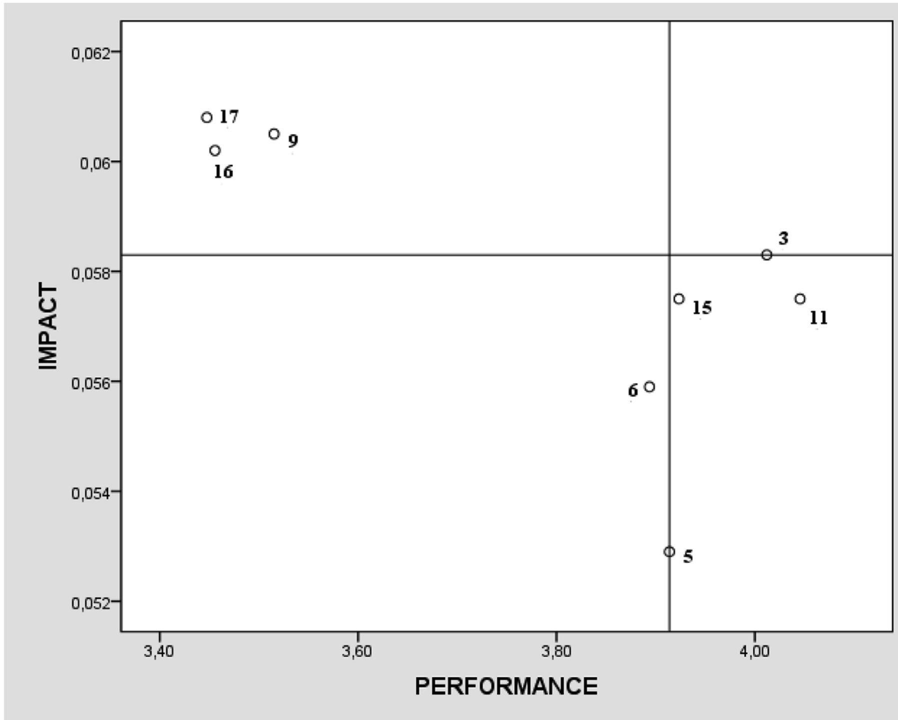

Fig. 4. Graphics of performance and impact for low importance.

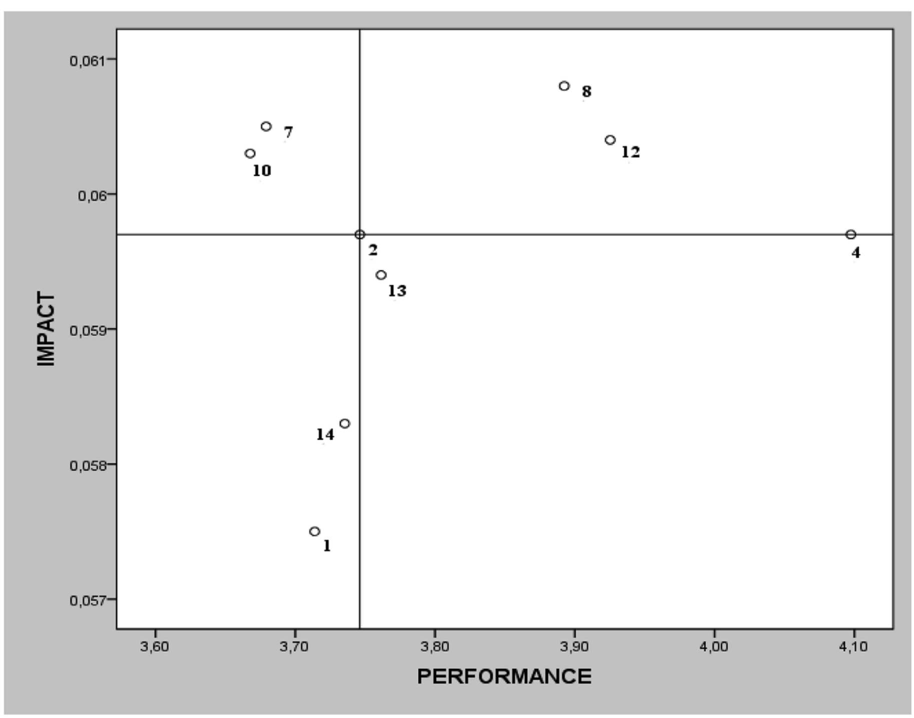

Fig. 5. Graphics of performance and impact for high importance.

As an improvement over IPA, IPIA and FIPA methods, the proposed hybrid method of "FIPIA with information entropy" can be employed for any industry where service quality depends on multiple attributes.

10. Limitations and further research

The number of service quality attributes was limited in this study to facilitate responses from passenger-respondents in the pre-flight waiting lounge. Future research may investigate a larger set of attributes, possibly inquiring the importance, and pre-flight performance through passengers who complete their travel. Similarly, in future studies, a larger sample size at multiple locations can be used to provide a more representative population.

A convenience sample was used in this study. In future, this study can be repeated according to different demographic (age, marital status, number of children), behavioral (reason for travel, flight class

Table 8
Resource allocation.

ATTRIBUTES	IMPORTANCE	PERFORMANCE	IMPACT	Management Recommendations
1	High	Low	Low	Concentrate here
2	High	Low	Low	Concentrate here
3	Low	High	Low	Recover resources to other priorities
4	High	High	Low	Concentrate here
5	Low	Low	Low	Right balance, could be improved
6	Low	Low	Low	Right balance, could be improved
7	High	Low	High	Concentrate here
8	High	High	High	Concentrate here
9	Low	Low	High	Divert attention to other priorities
10	High	Low	High	Concentrate here
11	Low	High	Low	Recover resources to other priorities
12	High	High	High	Right balance, maintain resources
13	High	High	Low	Right balance, maintain resources
14	High	Low	Low	Concentrate here
15	Low	High	Low	Recover resources to other priorities
16	Low	Low	High	Divert attention to other priorities
17	Low	Low	High	Divert attention to other priorities

preference, travel frequency) and psychographic (hedonist values, lifestyle) characteristics. Cross-cultural studies can be expected to contribute to better and more valid generality of results. Moreover, although fuzzy number was used in this study, hesitant or intuitionistic fuzzy numbers, trapezoid fuzzy numbers instead of triangular fuzzy numbers can be used in future studies.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jairtraman.2019.02.004.

References

Abramson, N., 1963. Information Theory and Coding. McGraw-Hill, New York, pp. 111–113.
Akomeah, M.O., Kong, Y., Hu, X., Afriyie, S.O., 2017. Banking and the illiterates miscellany in west Africa: a fuzzy importance-satisfaction approach. American Journal of Multidisciplinary Research 5 (2).
Al-Medabesh, A., Ali, M., 2014. Customer services in Saudi Arabian airlines: a case study of Jazan Province. Interdiscipl. J. Contemp. Res. Bus. 5 (9).
Atalay, B., Gokten, S., Turkcan, M., 2018. An Overview of measuring and reporting intellectual capital. In: Global Approaches in Financial Economics, Banking, and Finance. Springer, Cham, pp. 369–388.
Bacon, D.R., 2003. A comparison of approaches to importance-performance analysis. Int. J. Mark. Res. 45 (1), 1–15.
Bacon, D.R., 2012. Understanding priorities for service attribute improvement. J. Serv. Res. 15 (2), 199–214.
Baser, F., Gokten, S., Gokten, P.O., 2017. Using fuzzy c-means clustering algorithm in financial health scoring. Audit Financiar 15 (147), 385–394.
Basfirinci, C., Mitra, A., 2015. A cross cultural investigation of airlines service quality through integration of Servqual and the Kano model. J. Air Transport. Manag. 42, 239–248.
Benitez, J.M., Martín, J.C., Román, C., 2007. Using fuzzy number for measuring quality of service in the hotel industry. Tourism Manag. 28 (2), 544–555.
Bitner, M.J., Ostrom, A.L., Meuter, M.L., 2002. Implementing successful self-service technologies. Acad. Manag. Perspect. 16 (4), 96–108.
Bruning, E.R., Hu, M.Y., Hao, W., 2009. Cross-national segmentation: an application to the NAFTA airline passenger market. Eur. J. Market. 43 (11/12), 1498–1522.
Capocelli, R.M., De Luca, A., 1973. Fuzzy sets and decision theory. Inf. Control 23 (5), 446–473.
Carlos Martín, J., Román, C., Espino, R., 2008. Willingness to pay for airline service quality. Transport Rev. 28 (2), 199–217.
Chan, L.K., Kao, H.P., Wu, M.L., 1999. Rating the importance of customer needs in quality function deployment by fuzzy and entropy methods. Int. J. Prod. Res. 37 (11), 2499–2518.
Chang, Y.H., Yeh, C.H., 2002. A survey analysis of service quality for domestic airlines. Eur. J. Oper. Res. 139 (1), 166–177.
Chang, D., Kim, Y., Jeon, S., 2003. A study on the evaluation of Incheon international airport's service quality. Manag Res 32 (4), 983–999.
Chao, C.C., Lirn, T.C., Shang, K.C., 2013. Market segmentation of airline cargo transport. Serv. Ind. J. 33 (15–16), 1672–1685.
Chen, C.A., 2016. How can Taiwan create a niche in Asia's Cruise tourism industry? Tourism Manag. 55, 173–183.
Chen, F.Y., Chang, Y.H., 2005. Examining airline service quality from a process perspective. J. Air Transport. Manag. 11 (2), 79–87.
Chen, H.T., Chao, C.C., 2015. Airline choice by passengers from Taiwan and China: a case study of outgoing passengers from Kaohsiung International Airport. J. Air Transport. Manag. 49, 53–63.
Chen, S.-J., Hwang, C.-L., 1992. Fuzzy Multiple Attributes Decision Making. Springer-Verlag, Berlin, pp. 536.
Chen, Y.H., Tseng, M.L., Lin, R.J., 2011. Evaluating the customer perceptions on in-flight service quality. Afr. J. Bus. Manag. 5 (7), 2854–2864.
Chen, C.A., Chiang, Y.H., Hsu, T.K., Hsia, J.W., 2016. Strategies to increase the Competitiveness of Taiwans free trade ports based on the fuzzy importance-performance analysis. Asian Econ. Financ. Rev. 6 (11), 681.
Cheng, Q., Guo, J., Ling, S., 2016. Fuzzy importance-performance analysis of visitor satisfaction for theme park: the case of Fantawild Adventure in Taiwan, China. Curr. Issues Tourism 19 (9), 895–912.
Chiang Leong, C., 2008. An importance-performance analysis to evaluate airline service quality: the case study of a budget airline in Asia. J. Qual. Assur. Hospit. Tourism 8 (3), 39–59.
Chien, C.J., Tsai, H.H., 2000. Using fuzzy numbers to evaluate perceived service quality. Fuzzy Sets Syst. 116 (2), 289–300.
Chiou, H.K., Tzeng, G.H., Cheng, D.C., 2005. Evaluating sustainable fishing development strategies using fuzzy MCDM approach. Omega 33 (3), 223–234.
Chon, T.Y., Hsu, C.L., Chen, M.C., 2008. A fuzzy multicriteria decision method for international tourism hotels location selection. Int. J. Hosp. Manag. 27, 293–301.
Chou, J., Kim, C., Kuo, Y., Ou, N., 2011. Deploying effective service strategy in the operations stage of high-speed rail. Transport. Res. Part E 47 (4), 507–519.
Chow, C.K.W., 2015. On-time performance, passenger expectations and satisfaction in the Chinese airline industry. J. Air Transport. Manag. 47, 39–47.
Churchill Jr., G.A., 1979. A paradigm for developing better measures of marketing constructs. J. Market. Res. 64–73.
Correia, S.S., Bassani, S., Brown, T.C., Lisé, M.F., Backos, D.S., El-Husseini, A., Esteban, J.A., 2008. Motor protein–dependent transport of AMPA receptors into spines during long-term potentiation. Nat. Neurosci. 11 (4), 457.
Curtis, T., Rhoades, D.L., Waguespack Jr., B.P., 2012. Satisfaction with airline service quality: familiarity breeds contempt. Int. J. Aviat. Manag. 1 (4), 242–256.
Deng, W.J., 2008. Fuzzy importance-performance analysis for determining critical service attributes. Int. J. Serv. Ind. Manag. 19 (2), 252–270.
DeVaus, D.A., 2000. Surveys in Social Research. Routledge, London.
Dubois, D., Prade, H., 1980. Fuzzy Sets and Systems: Theory and Applications. Academic Press, New York, pp. 393.
Elliott, K.M., Roach, D.W., 1993. Service quality in the airline industry: are carriers getting an unbiased evaluation from consumers? J. Prof. Serv. Market. 9 (2), 71–82.
Forgas, S., Moliner, M.A., Sánchez, J., Palau, R., 2010. Antecedents of airline passenger loyalty: low-cost versus traditional airlines. J. Air Transport. Manag. 16 (4), 229–233.
Freitas, A.L.P., 2013. Assessing the quality of intercity road transportation of passengers: an exploratory study in Brazil. Transport. Res. Pol. Pract. 49, 379–392.
Geng, X., Chu, X., 2012. A new importance–performance analysis approach for customer satisfaction evaluation supporting PSS design. Expert Syst. Appl. 39 (1), 1492–1502.
Gilbert, D., Wong, R.K., 2003. Passenger expectations and airline services: a Hong Kong based study. Tourism Manag. 24 (5), 519–532.
Gokten, S., Gokten, P.O., 2017. Value creation reporting: Answering the question “value to Whom” according to the international integrated reporting framework. Zeszyty Teoretyczne Rachunkowości 91 (147), 145–169.
Gupta, H., 2018. Evaluating service quality of airline industry using hybrid best worst method and VIKOR. J. Air Transport. Manag. 68, 35–47.
Han, H., 2013. Effects of in-flight ambience and space/function on air travelers' decision to select a low-cost airline. Tourism Manag. 37, 125–135.
Hanke, M., Teo, T.S., 2003. Meeting the challenges in globalizing electronic commerce at United Airlines. Journal of Information Technology Case and Application Research 5 (4), 21–38.
Hansen, E., Bush, R.J., 1999. Understanding customer quality requirements: model and application. Ind. Mark. Manag. 28 (2), 119–130.

Hsu, Y.L., Lee, C.H., Kreng, V.B., 2010. The application of Fuzzy Delphi Method and Fuzzy AHP in lubricant regenerative technology selection. Expert Syst. Appl. 37 (1), 419–425.
Hwang, C.L., Yoon, K., 1981. Methods for multiple attribute decision making. In: Multiple Attribute Decision Making. Springer, Berlin, Heidelberg, pp. 58–191.
Islam, M.S., Tseng, M.L., Karia, N., Lee, C.H., 2018. Assessing green supply chain practices in Bangladesh using fuzzy importance and performance approach. Resour. Conserv. Recycl. 131, 134–145.
Jaynes, E.T., 1957. Information theory and statistical mechanics. Phys. Rev. 106 (4), 620.
Ji, Y., Huang, G.H., Sun, W., 2015. Risk assessment of hydropower stations through an integrated fuzzy entropy-weight multiple criteria decision making method: a case study of the Xiangxi River. Expert Syst. Appl. 42 (12), 5380–5389.
Jin, L.L., 1998. The Empirical Study on Domestic Passengers' Choice Behavior of the Airlines. National Cheng Kung University, Tainan, Taiwan Unpublished doctoral dissertation).
Kannan, D., de Sousa Jabbour, A.B.L., Jabbour, C.J.C., 2014. Selecting green suppliers based on GSCM practices: using fuzzy TOPSIS applied to a Brazilian electronics company. Eur. J. Oper. Res. 233 (2), 432–447.
Katz, K.L., Larson, B.M., Larson, R.C., 1991. Prescription for the waiting-in-line blues: entertain, enlighten, and engage. MIT Sloan Manag. Rev. 32 (2), 44.
Kim, S.B., Park, J.W., 2017. A study on the importance of airline selection attributes by airline type: an emphasis on the difference of opinion in between Korean and overseas aviation experts. J. Air Transport. Manag. 60, 76–83.
Kurtulmuşoğlu, F.B., Can, G.F., Tolon, M., 2016. A voice in the skies: listening to airline passenger preferences. J. Air Transport. Manag. 57, 130–137.
Li, W., Yu, S., Pei, H., Zhao, C., Tian, B., 2017. A hybrid approach based on fuzzy AHP and 2-tuple fuzzy linguistic method for evaluation in-flight service quality. J. Air Transport. Manag. 60, 49–64.
Lin, H.C., 2017. A study of E+ C blended learning courses for school candidate principals: application of fuzzy IPA method. Int. J. Intell. Technol. Appl. Stat. 10 (3).
Lin, Z., Vlachos, I., 2018. An advanced analytical framework for improving customer satisfaction: a case of air passengers. Transport. Res. E Logist. Transport. Rev. 114, 185–195.
Liou, J.J., Hsu, C.C., Yeh, W.C., Lin, R.H., 2011. Using a modified grey relation method for improving airline service quality. Tourism Manag. 32 (6), 1381–1388.
Martilla, J.A., James, J.C., 1977. Importance-performance analysis. J. Market. 77–79.
Mason, K.J., Gray, R., 1995. Short haul business travel in the European Union: a segmentation profile. J. Air Transport. Manag. 2 (3–4), 197–205.
Matzler, K., Sauerwein, E., 2002. The factor structure of customer satisfaction: an empirical test of the importance grid and the penalty-reward-contrast analysis. Int. J. Serv. Ind. Manag. 13 (4), 314–332.
Matzler, K., Bailom, F., Hinterhuber, H.H., Renzl, B., Pichler, J., 2004. The asymmetric relationship between attribute-level performance and overall customer satisfaction: a reconsideration of the importance–performance analysis. Ind. Mark. Manag. 33 (4), 271–277.
Medina-Muñoz, D.R., Medina-Muñoz, R.D., Suárez-Cabrera, M.Á., 2018. Determining important attributes for assessing the attractiveness of airlines. J. Air Transport. Manag. 70, 45–56.
Meuter, M.L., Ostrom, A.L., Bitner, M.J., Roundtree, R., 2003. The influence of technology anxiety on consumer use and experiences with self-service technologies. J. Bus. Res. 56 (11), 899–906.
Mikulić, J., Prebežac, D., 2012. Accounting for dynamics in attribute-importance and for competitor performance to enhance reliability of BPNN-based importance–performance analysis. Expert Systems wit Mohamed, T. A., AbdelFattah, Y., & Gadallah, M. (2008). Improvement of airline industry service quality. Journal of Management & Engineering Integration 1 (1), 61 h Applications, 39(5), 5144-5153.
Mohamed, T.A., AbdelFattah, Y., Gadallah, M., 2008. Improvement of airline industry service quality. Journal of Management & Engineering Integration 1 (1), 61.
Munusamy, J., Chelliah, S., Pandian, S., 2011. Customer satisfaction delivery in airline industry in Malaysia, A case of low cost carrier. Australian Journal of Basic and Applied Sciences 5 (11), 718–723.
Nadiri, H., Hussain, K., Ekiz, H.E., Ergodan, S., 2008. An investigation on the facts, influencing passengers loyalty in the North Cyprus Airline. The TQM Journal 20 (3), 265–280.
Nijkamp, P., 1977. Theory and application of environmental economics. Studies in Regional Science and Urban Economics 1.
Oh, H., 2001. Revisiting importance–performance analysis. Tourism Manag. 22 (6), 617–627.
Pangow, V.L., Massie, J.D., Tielung, M.V., 2017. Evaluating in-flight servıce of batık air using importance and performance Analysıs. Jurnal EMBA: Jurnal Riset Ekonomi, Manajemen, Bisnis dan Akuntansi 5 (2).
Parasuraman, A., Berry, L.L., Zeithaml, V.A., 1991. Refinement and reassessment of the SERVQUAL scale. J. Retailing 67 (4), 420.
Park, J.W., Robertson, R., Wu, C.L., 2004. The effect of airline service quality on passengers' behavioural intentions: a Korean case study. J. Air Transport. Manag. 10 (6), 435–439.
Park, J.W., Robertson, R., Wu, C.L., 2009. Differences in air passengers' buying behaviour: findings from Korean and Australian international passengers. Transport. Plann. Technol. 32 (5), 441–460.
Prayag, G., 2007. Assessing international tourists' perceptions of service quality at Air Mauritius. Int. J. Qual. Reliab. Manag. 24 (5), 492–514.
Qiao, L., Liu, Y., Zhang, Y., Wang, J., 2014. Strategy for the environmental service quality assessment and improvement of the parks based on fuzzy-IPA-A case study of the park in Xinxiang economic development Zone. International Journal of Smart Home 8 (5), 87–94.
Radjenović, T., Krstić, B., 2017. Intellectual capital as the source of competitive advantage: the resource-based view. Facta Univ. – Ser. Econ. Organ. 127–137.
Rose, J.M., Hensher, D.A., Greene, W.H., Washington, S.P., 2012. Attribute exclusion strategies in airline choice: accounting for exogenous information on decision maker processing strategies in models of discrete choice. Transportmetrica 8 (5), 344–360.
Sever, I., 2015. Importance-performance analysis: a valid management tool? Tourism Manag. 48, 43–53.
Shannon, C.E., 2001. A mathematical theory of communication. ACM SIGMOB - Mob. Comput. Commun. Rev. 5 (1), 3–55.
Shannon, C.E., Weaver, W., 1947. The Math Theory of Communica. The University of Illinois Press, Urbana.
Surovitskikh, S., Lubbe, B., 2008. Positioning of selected Middle Eastern airlines in the South African business and leisure travel environment. J. Air Transport. Manag. 14 (2), 75–81.
Teichert, T., Shehu, E., Von Wartburg, I., 2008. Customer segmentation revisited: the case of the airline industry. Transport. Res. Pol. Pract. 42 (1), 227–242.
Tiernan, S., Rhoades, D.L., Waguespack Jr., B., 2008. Airline service quality: exploratory analysis of consumer perceptions and operational performance in the USA and EU. Manag. Serv. Qual.: Int. J. 18 (3), 212–224.
Tsafarakis, S., Kokotas, T., Pantouvakis, A., 2018. A multiple criteria approach for airline passenger satisfaction measurement and service quality improvement. J. Air Transport. Manag. 68, 61–75.
Tsantoulis, M., Palmer, A., 2008. Quality convergence in airline co-brand alliances. Manag. Serv. Qual.: Int. J. 18 (1), 34–64.
Tsaur, S.H., Chang, T.Y., Yen, C.H., 2002. The evaluation of airline service quality by fuzzy MCDM. Tourism Manag. 23 (2), 107–115.
Tseng, M.L., Bui, T.D., 2017. Identifying eco-innovation in industrial symbiosis under linguistic preferences: a novel hierarchical approach. J. Clean. Prod. 140, 1376–1389.
Tseng, M., Lim, M., Wong, W.P., 2015. Sustainable supply chain management: a closed-loop network hierarchical approach. Ind. Manag. Data Syst. 115 (3), 436–461.
Vink, P., Overbeeke, C.J., Desmet, P.M.A., 2005. Comfort experience. In: Vink, P. (Ed.), Comfort and Design: Principles and Good Practices. CRC Press, Boca Eaton, Fl, pp. 1–12.
Waguespack, B.P., Rhoades, D.L., 2008. Cancellations and their relationship to and impact on airline service quality. Airlines Magazine(40). http://www.aerlines.nl/issue_40/40_waguespack_cancellations.pdf, Accessed date: 24 April 2016.
Wang, C.H., 2004. Predicting tourism demand using fuzzy time series and hybrid grey theory. Tourism Manag. 25 (3), 367–374.
Wang, R., Tseng, M.L., 2011. Evaluation of international student satisfaction using fuzzy importance-performance analysis. Procedia-Social And Behavioral Sciences 25, 438–446.
Weinstein, A., 2000. Customer satisfaction among transit riders: how customers rank the relative importance of various service attributes. Transport. Res. Rec.: Journal of the Transportation Research Board (1735), 123–132.
Wen, C.H., Lai, S.C., 2010. Latent class models of international air carrier choice. Transport. Res. E Logist. Transport. Rev. 46 (2), 211–221.
Wen, C.H., Yeh, W.Y., 2010. Positioning of international air passenger carriers using multidimensional scaling and correspondence analysis. Transport. J. 7–23.
Wu, W.Y., Hsiao, S.W., Kuo, H.P., 2004. Fuzzy set theory based decision model for determining market position and developing strategy for hospital service quality. Total Qual. Manag. Bus. Excel. 15 (4), 439–456.
Zadeh, L.A., 1965. Information and control. Fuzzy sets. Inf. Control 8 (3), 338–353.
Zadeh, L.A., 1975. The concept of a linguistic variable and its application to approximate reasoning—I. Inf. Sci. 8 (3), 199–249.
Zeglat, D., Ekinci, Y., Lockwood, A., 2008. Service quality and business performance in the hospitality industry. In: Oh, H., Pizam, A. (Eds.), Handbook of Hospitality and Tourism Marketing. Elsevier, London, pp. 209–236.
Zeithaml, V.A., Gilly, M.C., 1987. Characteristics affecting the acceptance of retailing technologies: a comparison of elderly and nonelderly consumers. J. Retailing 63 (I), 49–68.
Zhu, J., 2016. Airline Service Quality Performance: A Comparison of Air China and Hainan Airlines.