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The evaluation of airline service quality by fuzzy MCDM

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Abstract

This study applies the fuzzy set theory to evaluate the service quality of airline. Service quality is a composite of various attributes, among them many intangible attributes are difficult to measure. This characteristic introduces the obstacles for respondent in replying to the survey. In order to overcome the issue, we invite fuzzy set theory into the measurement of performance. By applying AHP in obtaining criteria weight and TOPSIS in ranking, we found the most concerned aspects of service quality are tangible and the least is empathy. The most concerned attribute is courtesy, safety and comfort.

Keywords: AHP; Fuzzy MCDM; TOPSIS; Airline; Service quality

1. Introduction

In Taiwan, the air travel market, both domestic and international, have been experiencing great competition in recent years due to both the deregulation and the increasing of customers awareness of service quality. Under the circumstance, airlines not only attempt to establish more convenient routes, but also introduce more promotional incentives, including mileage rewards, frequent flyer membership program, sweepstakes, and so on. Airlines hope to consolidate the market share and enhance profitability. However, the marginal benefits of marketing strategies gradually reduce because most of the airlines act similarly. Recognizing this limitation of the marketing strategies, some of air carriers now tend to focus on the commitment of improving customer service quality.

The air carriers provide a range of services to customers including ticket reservation, purchase, airport ground service, on-board service and the service at the destination. Airline service also consists of the assistance associated with disruptions such as lost-baggage handling and service for delayed passengers.

Service quality can be regarded as a composite of various attributes. It not only consists of tangible attributes, but also intangible/subjective attributes such as safety, comfort, which are difficult to measure accurately. Different individual usually has wide range of perceptions toward quality service, depending on their preference structures and roles in process (service providers/receivers). To measure service quality, conventional measurement tools are devised on cardinal or ordinal scales. Most of the criticism about scale based on measurement is that scores do not necessarily represent user preference. This is because respondents have to internally convert preference to scores and the conversion may introduce distortion of the preference being captured.

Since service industry contains intangibility, perishability, inseparability and heterogeneity, it makes peoples more difficult to measure service quality. To explore the past related research document, most of the methods for evaluating airline service quality employs statistics method. 5-point of Likert Scales is the major way to evaluate service quality in the past. Nowadays, the fuzzy set theory has been applied to the field of management science, like decision making (Hutchinson, 1998; Viswanathan, 1999; Xia et al., 2000), however, it is scarcely used in the field of service quality.

Lingual expressions, for example, satisfied, fair, dissatisfied, are regarded as the natural representation of the preference or judgement. These characteristics

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indicate the applicability of fuzzy set theory in capturing the decision makers' preference structure fuzzy set theory aids in measuring the ambiguity of concepts that are associated with human being's subjective judgment. Since the evaluation is resulted from the different evaluator's view of linguistic variables, its evaluation must therefore be conducted in an uncertain, fuzzy environment. During the process of evaluators are imprecise with too large an allowance for error. Therefore, this study includes Fuzzy Multiple Criteria Decision-Making (MCDM) theory to strengthen the comprehensiveness and reasonableness of the decision-making process.

The rest of this study is structured as follows: The first part describes important aspects for the assessment of service quality of airline and presents the evaluation framework and methodology. Next part discusses the procedure and results of empirical study. The final results of the empirical study are presented and discussed in the final section.

2. Evaluation framework and methods of airline service quality

The evaluation procedure of this study consists of several steps as shown in Fig. 1. First, we identify the service quality aspects and attributes that customers consider the most important. After constructing the evaluation criteria hierarchy, we calculate the criteria weights by applying Analytic Hierarchy Process (AHP) method. The measurement of performance corresponding to each criterion is conducted under the setting of fuzzy set theory. Finally, we conduct Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) to achieve the final ranking results. The detailed descriptions of each step are elaborated in each of the following sub-section.

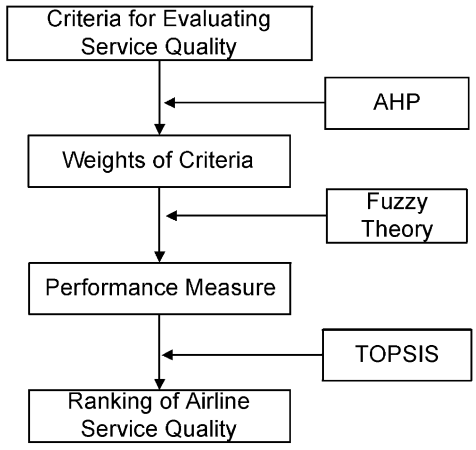

Fig. 1. Evaluation framework of airline service quality.

2.1. Evaluation aspects and criteria

The typical multiple criteria evaluation problem focuses on a set of feasible alternatives and considers more than one criterion to determine a priority ranking for alternative implementation. Keeney and Raiffa (1976) suggest that five principles to be considered when criteria are being formulated: completeness, operational, decomposable, non-redundancy, and minimum size.

There are many empirical studies concerned about service quality. Parasuraman, Zeithaml, and Berry (1985a, b) proposed ten aspects of evaluation criteria in assessing service quality. Many scholars measured the discrepancy in the perception of service quality between airline managers and passengers. Gourdin (1988) have categorized airline service quality into three items: price, safety and timelines. Elliott and Roach (1993) pointed out that timelines, the luggage transportation, the quality of F&B, the comfort of seat, the check in process and inboard service are the six guidelines for evaluating airline service quality. In Ostrowski, O'Brien, and Gordon's (1993) empirical study of service quality and customer royalty, they took timeliness, F&B quality, comfort of seat as the factors of surveying service quality. Truitt and Haynes (1994) uses the check-in process, the convenience of transit, the process of luggage, the timeliness, the clearness of seat, the F&B quality and the customer complaints handing as the standards for measuring service quality.

This study incorporates the revised five-aspect representation of service quality proposed by Parasuraman, Zeithaml, and Berry (1985a, b). The five aspects include tangibility, reliability, responsiveness, assurance and empathy. Tangibility means the physical service presentation such as on-board equipment, quality of the food and so on; reliability stands for the how credible the airline is in terms of safety and pilot navigating skills; responsiveness aspect describes how ground or on-board crew interact with customers; assurance aspect represents the certainty that airline provides for customers and the empathy aspect represents how airline deal with the customer complaints and provide thoughtful services.

Taking the structure of the five aspects as the skeleton and synthesize the other literatures as well as the practical consideration, we established these evaluation criteria include five aspects and 15 service quality evaluation criteria, the details of which can be found in Table 1.

2.2. Analytic hierarchy process (AHP)

The AHP was first proposed by Thomas L. Saaty in 1980 (Saaty, 1980). For years it has been used in tourism planning, (Ryan, 1991; Moutinho & Curry, 1994) and in several areas of social management sciences. It

Table 1
The evaluation criteria for airline service quality

Objective	Attribute
Tangibility	Comfort and cleanness of seat
	Food
	On-board entertainment
	Appearance of crew
Reliability	Professional skill of crew
	Timeliness
	Safety
Responsiveness	Courtesy of crew
	Responsiveness of crew
Assurance	Actively providing service
	Convenient departure and arrival time
	Language skill crew
Empathy	Convenient ticketing process
	Customer complaints handing
	Extended travel service

integrates opinion and evaluation of experts and devises the complex decision making system into a simple element hierarchy system. Then, evaluation method in terms of ratio scale is employed to proceed with relative importance of pairwise comparison among every criterion. This method decomposes complicated problems from higher hierarchies to lower ones. Furthermore, it also systematizes the problem by employing the subsystem perspective endowed in the system. Based on the hierarchical for the airline service quality in this way.

The AHP weighting is mainly determined by the decision-makers who conduct the pairwise comparisons, so as to reveal the comparative importance between two criteria. If there are n evaluation criteria, then while deciding the decision-making the decision-makers have to condusect $C(n, 2) = n(n-1)/2$ pairwise comparisons. Furthermore, the comparative importance derived from the pairwise comparisons allows a certain degree of inconsistency within a domain. Saaty used the principal eigenvector of the pairwise comparison matrix contrived by scaling ratio to find the comparative weight among the criteria.

For example, the evaluation hierarchy structure of airline service quality in Table 1, there were three evaluation criteria in the objective level of ''Reliability'', including ''Professional Skill'', ''Timeliness'' and ''Safety''. Then the evaluation measurement of ratio scale is employed to conduct pairwise comparison to clarity the relative importance of each attributes among above attributes. Therefore, the comparison has to make for three times. To have a further explanation of the compassion, the evaluators would make the comparison between that of the importance of ''Professional Skill'' and ''Timeliness''. Besides, the evaluators also would make the comparison between ''Professional Skill'' and ''Safety''. At last, the evaluators would make the comparison between ''Timeliness'' and ''Safety''. By means of the comparative importance derived from the pairwise comparisons allows a certain degree of inconsistency within a domain. We should be used the principal eigenvector of the pairwise comparison matrix to find the comparative weight among the criteria. The AHP method should be an exact measure of the difference of attribute preference for consumers and results of this approach are better than the others. For the reasons, this study utilizes AHP method to evaluate the preference weights of airline service attributes for customers.

2.3. Fuzzy set theory

''Not very clear'', ''probably so'', ''very likely'', these terms of expression can be heard very often in daily life, and their commonality is that they are more or less tainted with uncertainty. With different daily decision-making problems of diverse intensity, the results can be misleading if the fuzziness of human decision-making is not taken into account. However, since Zadeh (1965) was first proposed fuzzy set theory, and Bellman and Zadeh (1970) described the decision-making method in fuzzy environments, an increasing number of studies have dealt with uncertain fuzzy problems by applying fuzzy set theory. With such an idea in mind, this study includes fuzzy decision-making theory, considering the possible fuzzy subjective judgment of the evaluators during airline service quality evaluation. This method for establishing airline service quality can be made more objective. The applications of fuzzy theory in this study are elaborated as follows:

2.3.1. Fuzzy number

Fuzzy numbers are a fuzzy subset of real numbers, and they represent the expansion of the idea of confidence interval. According to the definition made by Dubois and Prade (1978), Those numbers that can satisfy these three requirements will then be called fuzzy numbers, and the following is the explanation for the features and calculation of the triangular fuzzy number.

For example, the expression ''airline service quality'' represents a linguistic variable in the context of this study. It may take on values such as ''fair'', the membership functions of expression values can be indicated by triangular fuzzy numbers (TFN) $\mu_A \times (X) = (L, M, U)$ within the scale range of 0–100, the evaluators can subjectively assume their personal range of the linguistic variable μ_A (fair) $= (20, 50, 80)$, which are as shown in Fig. 2. Comparing with the traditional investigative research, the importance degree for the serving attribute used 5-points of Likert Scale, applying TFN that the utilization of linguistic variables is rather widespread at the present time, and the linguistic values

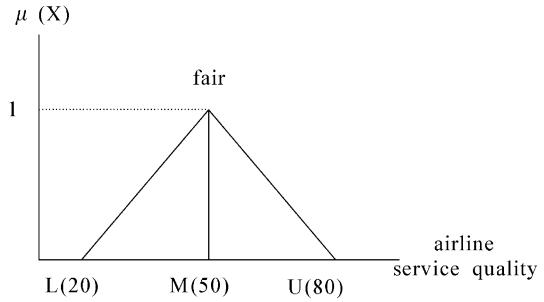

Fig. 2. Triangular membership function of fuzzy number.

found in this study are primarily used to assess the linguistic ratings given by the evaluators.

According to the nature of TFN and the extension principle put forward by Zadeh (1965), the algebraic calculation of the triangular fuzzy number.

Addition of triangular fuzzy number $\oplus$;

$$(L_1, M_1, U_1)\oplus(L_2, M_2, U_2) = (L_1 + L_2, M_1 + M_2, U_1 + U_2). \quad (1)$$

Multiplication of a triangular fuzzy number $\odot$;

A. $$(L_1, M_1, U_1)\odot(L_2, M_2, U_2) = P(L_1/L_2, M_1M_2, U_1U_2) \quad L_1 \geqslant 0,\ L_2 \geqslant 0. \quad (2)$$

B. Any real number k,

$$K \odot \mu_A(X) = (K, K, K)\odot(L, M, U) = (KL, KM, KU). \quad (3)$$

Subtraction of a triangular fuzzy number $\ominus$;

$$(L_1, M_1, U_1)(L_2, M_2, U_2) = (L_1 - L_2, M_1 - M_2, U_1 - U_2). \quad (4)$$

2.3.2. Linguistic variable

According to Zadeh (1975), it is very difficult for conventional quantification to express reasonably those situations that are overtly complex or hard to define; thus, notion of a linguistic variable is necessary in such situations. A linguistic variable is a variable with lingual expression as its values. One example for the linguistic variable is ''airline service quality''. It means the service quality that passenger experiences during the flight carried by the airline. The possible values for this variable could be: 'very dissatisfied'', ''not satisfied'', ''fair'', ''satisfied'', and ''very satisfied''. The evaluators were asked to conduct their judgments, and each linguistic variable can be indicated by a triangular fuzzy number within the scale range of 0–100. Also the evaluators can subjectively assume their personal range of the linguistic variable.

2.3.3. The overall valuation of the fuzzy judgement

The overall valuation of the fuzzy judgement copes with the fact that every respondent perceives differently toward every criterion. The subsequent valuation of the linguistic variable certainly varies among individuals. We integrate the overall fuzzy judgement by Eq. (5).

$$E_{ij} = (1/m)\odot(E_{ij}^1 \oplus E_{ij}^2, \cdots, \oplus E_{ij}^m), \quad (5)$$

where $\odot$ is the muplication of fuzzy numbers, $\oplus$ the add operation of fuzzy numbers, E_{ij} the overall average performance valuation of airline i under criterion j over m assessors.

E_{ij} as a fuzzy number can be represented by triangular membership function as Eq. (6) shows

$$E_{ij} = (LE_{ij}, ME_{ij}, UE_{ij}), \quad (6)$$

Buckley (1985) stated that the three end points can be calculated by the method proposed as:

$$LE_{ij} = \left(\sum_{k=1}^{m} LE_{ij}^k\right)\Big/m, \quad (7)$$

$$ME_{ij} = \left(\sum_{k=1}^{m} ME_{ij}^k\right)\Big/m, \quad (8)$$

$$UE_{ij} = \left(\sum_{k=1}^{m} UE_{ij}^k\right)\Big/m. \quad (9)$$

2.3.4. Defuzzification

The result of fuzzy synthetic decision of each alternative is a fuzzy number. Therefore, it is necessary that the nonfuzzy ranking method for fuzzy numbers be employed during service quality comparison for each alternative. 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. There are several available methods serve this purpose. Mean-of-Maximum, Center-of-Area, and α-cut Method (Zhao & Govind, 1991) are the most common approaches. This study utilizes the Center-of-Area method due to its simplicity and does not require analyst's personal judgement.

The defuzzified value of fuzzy number can be obtained from Eq. (10).

$$\mathrm{BNP}_{ij} = [(UE_{ij} - LE_{ij}) + (ME_{ij} - LE_{ij})]/3 + LE_{ij} \quad \forall i, j. \quad (10)$$

When we use the fuzzy approach on vague objects such as the satisfaction of airline service quality. Because the evaluation is resulted from the different evaluators view of linguistic variables, it will have the difference and ambiguity. In addition, the traditional evaluation method required the evaluators to make the choice among 'very dissatisfied'', ''not satisfied'', ''fair'', ''satisfied'', and ''very satisfied''. That would force the evaluator's to do an over-high or over-low appraisal, Consequently, it would influence the accuracy of the

evaluation. In this study, using the membership function to measure the linguistic variables to achieve the better result, which can fairly and exactly reflects the different service quality of each airline. Therefore, the fuzzy logic, thinking and results of the fuzzy approach are better than the traditional statistic approach.

2.4. TOPSIS

The TOPSIS was first proposed by Hwang and Yoon (1981). The underlying logic of TOPSIS is to define the ideal solution and the negative ideal solution. The ideal solution is the solution that maximizes the benefit criteria and minimizes the cost criteria; whereas the negative ideal solution maximizes the cost criteria and minimizes the benefit criteria. The optimal alternative is the one, which is closest to the ideal solution and farthest to 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, ideal solution is composed of all best values attainable of criteria, whereas negative ideal solution is made up of all worst values attainable of criteria. During the processes of alternative selection, the best alternative would be the one that is nearest to the ideal solution and farthest from the negative ideal solution. Take the objective space of the two criteria as example which is indicated in Fig. 3, A^+ and A^- are, respectively, the ideal solution and negative ideal solution, and alternation A_1 is shorter in distance in regard to the ideal solution (A^+) and negative ideal solution (A^-) than alternatives A_2. As a matter of fact, the ups and downs of these two alternatives are beyond comparison, only TOPSIS has defined such "relative closeness" so as to consider and correlate, as a whole,

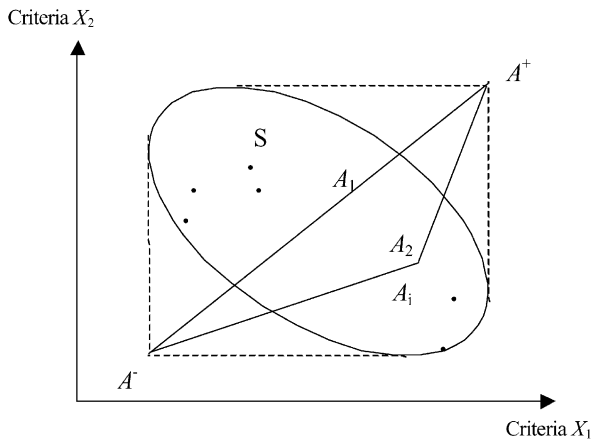

Fig. 3. The objective space of the two criteria—the distance between idea solution and negative ideal solution for each alternative.

the distance to the ideal solution and the negative ideal solution. The calculation processes of the method are as following:

2.4.1. Establish the normalized performance matrix

The purpose of normalizing the performance matrix is to unify the unit of matrix entries. Assume the original performance matrix is

$$\mathbf{X} = (X_{ij}) \quad \forall i,j, \tag{11}$$

where X_{ij} is the performance of alternative i to criterion j.

2.4.2. Create the weighted normalized performance matrix

TOPSIS defines the weighted normalized performance matrix as:

$$\mathbf{V} = (V_{ij}) \quad \forall i,j, \tag{12}$$

$$V_{ij} = w_j \times r_{ij} \quad \forall i,j,$$

where w_j is the weight of criterion j.

2.4.3. Determine the ideal solution and negative ideal solution

The ideal solution is computed based on the following equations:

$$A^* = \{(\max V_{ij} | j \in J), (\min V_{ij} | j \in J'),\ i = 1,2,\ \ldots,\ m\}, \tag{13}$$

$$A^- = \{(\min V_{ij} | j \in J), (\min V_{ij} | j \in J'),\ i = 1,2,\ \ldots,\ m\}, \tag{14}$$

where

$j = \{j = 1,2,\ \ldots,\ n | j$ belongs to benefit criteria$\}$,

$j' = \{j = 1,2,\ \ldots,\ n | j$ belongs to cost criteria$\}$.

2.4.4. Calculate the distance between idea solution and negative ideal solution for each alternative

$$S_i^* = \sqrt{\sum_{j=1}^{n} (V_{ij} - V_j^*)^2} \quad i = 1,2,\ \ldots,\ m, \tag{15}$$

$$S_i^- = \sqrt{\sum_{j=1}^{n} (V_{ij} - V_j^-)^2} \quad i = 1,2,\ \ldots,\ m. \tag{16}$$

2.4.5. Calculate the relative closeness to the ideal solution of each alternative

$$C_i^* = \frac{S_i^-}{S_i^* + S_i^-} \quad i = 1,2,\ \ldots,\ m, \tag{17}$$

where $0 \leqslant C_i^* \leqslant 1$ that is, an alternative i is closer to A^* as C_i^* approaches to 1.

2.4.6. Rank the preference order

A set of alternatives can be preference ranked according to the descending order of C_i^*.

3. Empirical study of airline service quality

3.1. Survey

In an effort of conducting the survey, 450 questionnaires are sent out to licensed tour guides in 29 general travel agencies. The reason of restricting the qualification of respondents was that we wished respondents had the experience of traveling with all airlines to be evaluated. The licensed tour guides were the most natural choices due to their frequent travels. Among the 450 surveys, 211 were returned for a return rate of 47%. The other demographic statistics were: 21% were at their age of 21–41; 99.05% received at least high school education; average working experience in tourism industry was 5.9 years.

The questionnaire of service quality evaluation mainly was composed of two parts: questions for evaluating the relative importance of criteria and airline's performance corresponding to each criterion. AHP method was used in obtaining the relative weight of criteria. As for the performance corresponding to criteria of every airline, we used linguistic expression to measure the expressed performance. In order to establish the membership function associated with each linguistic expression term, we asked respondents to specify the range from 1 to 100 corresponding to linguistic term 'very dissatisfied', 'dissatisfied', 'fair', 'satisfied' and 'very satisfied'. These score were later pooled to calibrate the membership functions.

We picked three major air carriers as the objects of this empirical study. Airline A, the oldest airline in Taiwan, with more than 30 years history, gains the highest market share by nearly 30%. The market share of airline B, although is only 20% currently, is rapidly growing because of the positive image and reputation. Airline C is a rather young jetliner with less than 10 years of operation history. The market share of airline C is the least out of the three airlines at about 13%.

3.2. The weights of evaluation criteria

Fig. 4 shows the relative weights of the five aspects of service quality, which are obtained by applying AHP. The weights for each of the aspect are: tangibility (0.245), reliability (0.231), responsiveness (0.189), assurance (0.170) and empathy (0.165). The weights describe in general that customer more concern the physical feature than the psychological or empathetical aspects.

Ranked by the weights, the top six evaluation criteria are: courtesy of attendants (0.105), comfort and cleanness of seat (0.09), safety (0.09), responsiveness of the attendants (0.084), on-board entertainment (0.045), extended travel service (0.044). Apparently, customers concern how well they are treated and served during the airborne time. Courteous ground or flight crew soothes the unease of air travel and makes the trip pleasant. The ranks also reflect why the new design of cabin or seat and on-board features are always welcomed by customers. Particularly for the international flight, which usually incur long airborne time, the physical comfort is

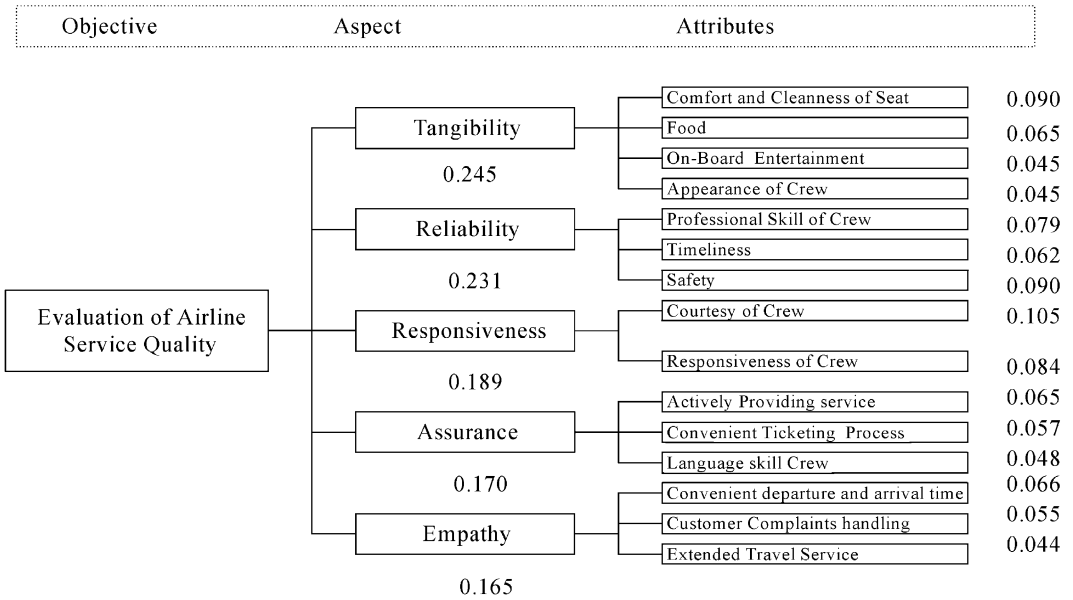

Fig. 4. Weights of the fifteen criteria.

Table 2
Fuzzy performance measures of airlines[a]

Service quality evaluation criteria	Airline A	Airline B	Airline C
Courtesy of attendants	(52.01, 61.91, 70.80)	(52.61, 62.19, 71.04)	(55.35, 65.05, 73.67)
Safety	(39.25, 48.40, 58.36)	(55.10, 67.66, 73.73)	(53.19, 63.04, 71.68)
Comfort and cleanness of seat	(51.60, 61.46, 70.23)	(53.65, 63.19, 71.74)	(56.21, 66.19, 74.85)
Responsiveness of attendants	(53.25, 62.86, 71.79)	(54.31, 63.71, 72.50)	(45.54, 54.88, 64.33)
Professional skills	(54.14, 67.94, 72.76)	(56.27, 66.04, 74.54)	(47.33, 56.75, 66.03)
Convenient departure time	(54.27, 64.05, 72.73)	(54.88, 64.10, 72.81)	(53.00, 62.64, 71.31)
Food	(52.71, 62.67, 71.21)	(51.19, 60.77, 68.96)	(51.66, 61.32, 70.09)
Actively providing service	(52.55, 58.81, 67.60)	(47.47, 59.01, 65.55)	(49.09, 58.55, 67.28)
Timeliness	(45.15, 54.93, 64.10)	(53.02, 61.91, 71.05)	(51.48, 61.09, 69.81)
Convenient ticketing process	(54.18, 63.82, 72.68)	(54.61, 64.15, 72.72)	(53.09, 62.81, 71.71)
Customer complaints handling	(44.15, 53.58, 62.95)	(46.01, 55.57, 65.02)	(45.46, 55.15, 64.56)
Language skill of airline attendant	(58.53, 68.36, 80.33)	(60.96, 68.04, 76.73)	(49.43, 58.70, 67.73)
On-board entertainment	(59.86, 69.84, 77.90)	(57.98, 70.35, 76.48)	(56.51, 66.48, 74.70)
Appearance of crew	(51.60, 61.33, 70.05)	(48.35, 57.54, 67.09)	(49.93, 59.61, 68.59)
Extended travel service	(49.58, 59.19, 67.91)	(51.45, 61.20, 69.98)	(49.32, 59.08, 68.00)

[a] Is the best performance out of the three airlines.

Table 3
Overall performance measures of airlines

Service Quality Evaluation Criteria	Airline A	Airline B	Airline C
Courtesy of attendants	61.57	61.95	64.69[a]
Safety	48.67	65.50[a]	62.64
Comfort and cleanness of seat	61.10	62.86	65.75[a]
Responsiveness of attendants	62.63	63.51[a]	54.91
Professional skills	64.95	65.61[a]	56.70
Convenient departure time	63.69	63.93[a]	62.31
Food	62.20[a]	60.30	61.02
Actively providing service	59.65[a]	57.34	58.30
Timeliness	54.73	62.00[a]	60.79
Convenient ticketing process	63.56	63.82[a]	62.54
Customer complaints handling	53.56	55.54	55.06[a]
Language skill of airline attendant	69.07[a]	68.58	58.62
On-board entertainment	69.20[a]	68.27	65.90
Appearance of crew	60.99[a]	57.66	59.38
Extended travel service	58.89	60.88[a]	58.50

[a] The final ranking results show that airline B is the best of the three airlines in terms of service quality, followed by airline C and A.

Table 4
Final ranking of airlines

Rank	Airline	Similarity to ideal solution
1	B	0.8155
2	C	0.5534
3	A	0.3857

the substantial need for the customers. Safety of air travel nowadays becomes a public distress due to several serious jetliner crashes in recent years. Customers are more aware that safety is the essential requirement of any trip.

3.3. Performance measure of service quality

From the criteria weights obtained from AHP (Fig. 4), the performance of alternatives corresponding to each evaluation criterion evaluated by respondents is measured as fuzzy number with triangular membership function. The performance measure of each respondents are then calculated by Eqs. (5)–(9) to obtain the overall performance measure for each airline. Table 2 lists the fuzzy performance measure for the three airlines.

After obtaining the performance measure in terms of fuzzy number, we defuzzify the fuzzy numbers into crisp numbers so as to conduct TOPSIS ranking procedure. We used Center-of-Area method (as Eq. (10)) to defuzzify the fuzzy numbers, which are as shown in Table 3.

In general overview, airline A performs better in physical attributes, while airline B outperforms in professional aspect and airline C has better interaction with customers.

3.4. Final ranking

In this paper, we use AHP method in obtaining criteria weight, and apply TFN to assess the linguistic ratings given by the evaluators. By using TOPSIS, we aggregate the weight of evaluate criteria and the matrix of performance to evaluate the three airline service quality, the service quality evaluation results can be seen in Table 4.

4. Conclusions and implications

The concept of quality service goes beyond the technical aspects of providing the service—it includes customers' perception of what the services should be and how the services is to be conveyed.

In investigating both concerns, we establish the procedures for identifying the most important attributes of service quality for customers and capture customers' assessment of three airlines based on these attributes. The evaluation procedures consists of the following steps: (1) identify the evaluation criteria for airline service quality; (2) assess the average importance of each criterion by Analytic Hierarchical Process over all the respondents. (3) represent the performance assessment of air carriers for each criterion by fuzzy numbers, which explicitly attempts to accurately capture the real preference of assessors. Individual assessment then is aggregated as an overall assessment for each airline under each criterion. (4) Use TOPSIS as the main device in ranking the service quality of the three air carriers.

The significant findings of this study cover several perspectives. Customers are mainly concerned about the physical aspect of the service and less concerned about the empathy aspect. The finding suggests that airlines should maintain their physical features about a certain level and keep renovation necessary.

Among the fifteen service criteria, the most important attributes are 'courtesy of attendants', 'safety', 'comfort and cleanness of seat' and 'responsiveness of attendants'. These results suggest the direction for service improvement. Airline manager also should be more committed to management improvement and be alert the implication of poor management to service quality.

The final ranking results show that airline B is the best of the three airlines in terms of service quality, followed by airline C and A. It is interesting to note that assessment of the service quality is not strongly reflected in the market share. (airline A rank as the third in service quality whereas it has the largest market share). This suggests that even though customer service has an vital impact on air travel business, other factors such as fare promotion program also play the important role. Further more, customer perception of service quality is also dynamic and sensitive to some major incidents such as accidents or events, which are not necessarily promptly reflected in the market share.

In traditional investigative research, the importance degree for the serving attribute used the 5-points of Likert Scale. In this paper, we used the AHP rule and the concept of hierarchical structure to make the pairwise comparison among elements. In cases where there are many attributes, the investigation time is increased and the interviewee may feel impatient. Interactive design using the computer aid system can be used, and the above disadvantage may be improved. On other hand, we use the fuzzy approach on vague objects such as the satisfaction of airline service quality. In this study, using the membership function to measure the linguistic variables to achieve the better result, which can fairly and exactly reflects the different service quality of each airline. Therefore, the fuzzy logic, thinking and results of the fuzzy approach are better than the traditional statistic approach.

This study possess a few limitations. Firstly, our survey respondents were chosen from tour guides due to sample size limitation and response quality considerations. This may raise questions regarding representativeness of preference of a general travelers. However it may be argued that tour guides are professionals in tourism and are more sensitive to service quality because they judge on behalf of their clients. Their opinions may be treated as those of 'experts' in this field.

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