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Evaluating the service quality of airports in Thailand using fuzzy multi-criteria decision making method

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1. Introduction

Increasing wealth is driving the growth of demand of air travel both globally and regionally. However this growth has created its own challenges especially to the passenger experience, which has suffered because of uneven growth parity between infrastructure and number of passenger. This infrastructure bottleneck often compromises the values that airport delivers to its passengers and airlines. The growth of air travel has also increased the demand for airport services and mandated for more efficient process of service deliveries to its customer. It has also catalyzed the competition among airport operators to improve value proposition to its customer. The airlines seek to make their operations hub at the airport operating efficiently in order to reduce their costs and increase the quality of services rendered to their passengers (Oum et al., 2003). Efficiency and service quality are key performance indicators for the operation of airport, which needs to be trade off to optimize the performance.

Efficiency evaluation of airport is widely used and applied in management of airport, which are mostly based on comparative analysis of airport's economic or operational performance, employing Data Envelopment Analysis (DEA) and Total Factor Productivity (TFP) (ATRS, 2004; Park, 2003). Although the efficiency evaluation of airport indicates the improvement areas however it fails to give managers, a quality perspective on the services provided, which may compromise sustainable development (Fernandes and Pacheco, 2002; Pacheco and Fernandes, 2003).

With the advent of commercialization, marketization and competition in airport business arena, the philosophy of airport management is undergoing transformation where customer service quality and customer delight are emphasized. For instance, in 2015, 300 airports across 80 countries participated in Airport Service Quality (ASQ) survey organized by Airport Council International (ACI) (Airport Council International, 2016). Hence evaluating and improving the quality of service are main concerns of modern airport business. Many studies are conducted on evaluation of the quality of airline services but only few literature in this context are available for airport. Hence the changing nature of airport business has necessitated for research in this context.

Most of the researches conducted on airport service quality are based on SERVQUAL method. However the SERVQUAL model is based on assumption that all the criteria used to gauge the quality are rated equally important (Chou, 2009a). In order to address this limitation (Chou, 2009c) proposed a Multi Criteria Decision Making (MCDM) method to gauge the service quality of airlines. Later Chou, 2009b proposed fuzzy weighted SERVQUAL method for the evaluation of airline service quality. As Tsaur et al. (2002) observed it is difficult explain and measure the service quality of airlines due to heterogeneity, intangibility and inseparability. Hence it is not easy for passengers to express their satisfaction and importance of criteria using an exact numerical value, therefore it is more realistic to use linguistic terms to describe the perception value and importance of evaluation criteria (Chien-Chang, 2012).

This article attempts to evaluate the service quality of the two busiest airports operated by Airport of Thailand and identify the scope of improvement keeping in view the changing consumer needs. The service quality of airport was investigated using the Fuzzy Multi Criteria Decision Making Analysis (MCDM). It also employs Improvement Performance Analysis using fuzzy expert system to explore the enhancement of services at the airports.

2. Literature review

2.1. Need of measuring airport service quality

Service is an experience and strictly associated with customer satisfaction (Bezerra and Gomes, 2015). Service quality can be

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defined as the whole of the explicit and tacit components on which complete satisfaction of customer needs depends (Laura and Gabriella, 2009). Customer satisfaction is a measure of company performances as per the specific need of customer (Hill et al., 2003). The measure of customer satisfaction provides the service quality measure (Laura and Gabriella, 2009). As the perceived level of quality is an antecedent of customer satisfaction, hence the measuring of airport service quality may guide the organization's effort to address the specific needs of customer (Cronin et al., 2000; Falk et al., 2010; Wilson et al., 2012). The key measure of effective airport management is the opinion of passengers to airport services (Lubbe et al., 2011).

Many research has been conducted related to Airport service quality (ASQ). In 1980's few studies related to ASQ sought to examine the level of service in the passenger terminal (e.g. Bennets et al., 1975; Mumayiz and Ashford, 1986; Omer and Khan, 1988; Tosic and Babic, 1984). In 1990s few research were conducted on exploring the passengers' needs and their perception towards services and facilities provided in airport terminals. (e.g. Hackett and Foxall, 1997; Lemer, 1992; Muller and Gosling, 1991; Mumayiz, 1991; Park, 1999; Seneviratne and Martel, 1991, 1994; Yen, 1995).

With the increasing traffic volume, the airport has to optimize the existing infrastructure while adopting a customer oriented service performance (Fodness and Murray, 2007; Halpren and Graham, 2013). Airports are expected to operate as self-sufficient service organizations providing efficient and high quality services to a variety of customers (Bezerra and Gomes, 2016). Apart from it, large international hub airports are in intense competition to maximize their share in the increasing non aeronautical revenues, which has mandated them to enhance their respective perceived service quality and customer satisfaction to lure their customers and maintain competitive advantage (Merkert and George, 2015; Pantouvakis and Renzi, 2016). Thus it presents the need for airports to measure their service quality and to continuously improve their service performance in constantly changing business environment.

2.2. Existing methodologies to measure airport service quality

Due to complexity of the airport service environment, an effective process of measuring and analyzing passenger perceptions of ASQ is not easily achieved (Bezerra and Gomes, 2016). Overtime varied methodologies has been developed to measure and evaluate ASQ. Broadly these methodologies can be segregated in three categories: Stated Importance Methods (SIMs); Derived Importance Method (DIMs) and Multi-Criteria Decision-Making Method (MCDM). In SIMs the perception and expectation of passenger is measured on liguistic-numerical likert type scales, which is simple to apply however it requires a significant increase in length of survey and can sometimes give insufficient difference in rating of the service dimensions (Lupo, 2015). Because of these reason DIMs is widely applied in recent past where expectation rating on service dimensions are statistically derived keeping in view the relationships among performance on service aspects and overall passenger satisfaction (Humphreys and Francis, 2000, 2002; Adler and Berechman, 2001; Barros and Diseke, 2007; Correia et al., 2008; Chaudha et al., 2011; Lubbe et al., 2011; Lupo, 2015).

Both SIMs and DIMs are based on liguistic numerical likert type scale rating which can give imprecise result as judgement provided by linguistic numerical evaluation scales are subject to uncertainties deriving from incompleteness due to partial ignorance (Lupo, 2015; Chou et al., 2011). To overcome the stated weakness, MCDM method was later utilized by many researcher to gauge the passenger's perception about the service quality expectations and performance. The MCDM was employed to assess service quality as the assumption of Fishbein's attitude model and Multi criteria value model coincide which states the attitude of a customer towards a given service is based on the assessment of service criteria weighted by importance assigned to these criteria. It resulted in utilization of varied MCDM methods such as AHP (Saaty, 2008); TOPSIS (Hwang and Yoon, 1981a); VIKOR (Opricovic, 1998; Opricovic and Tzeng, 2004) PROMTHEE (Brans and Vincke, 1985) etc. Specifically in area of measurement of ASQ some studies utilized deterministic MCDM process (Chen and Tzeng, 2004; Correia et al., 2008; Liou et al., 2011). While other have taken into account the imprecise numeric values of decision data (Liang, 1999; Chen, 2000); (Ding and Liang, 2005; Iraj et al., 2008; Wang et al., 2009).

Since the subjective evaluation of service quality is difficult to be expressed in number, there is existence of uncertainty (fuzziness) (Chien-Chang, 2012). Hence the use of Fuzzy MCDM model can be more realistic in assessing service quality as perception of passengers can be expressed in linguistic term. Fernandes and Pacheco (2010) evaluated the ASQ using Fuzzy multi-criteria analysis and alpha cut concept. The author applied these methods on six airports in Brazil and rendered strategic framework for management of airport. Lupo (2015) utilized ELECTRE III method to comparatively evaluate quality of airport service alternative, however the outranking approach of ELECTRE method is not able to directly gauge and verify the strength and weaknesses of alternatives (Velasquez and Hester, 2013; Konidari and Mavrakis, 2007). Also the process and outcomes of ELECTRE method is complex to employ (Velasquez and Hester, 2013). Chien-Chang (2012) also employed Fuzzy MCDM method to gauge the service quality of two airports in Taiwan and gave strategic solution to improve the service quality performance of airport by employing fuzzy expert system in which the service quality performance is fuzzified using graded mean integration approach and defuzzified using Inverse Arithmetic representation method; while Importance Performance Analysis is conducted on the principle of approximate reasoning by employing fuzzy IF-THEN Rule based expert system which is relatively easy and reliable to gauge airport service quality. In line with Chien-Chang (2012), this research attempts to fill the methodological gap in literature by employing Fuzzy MCDM to measure the service quality of the airports.

2.3. Scale for measurement of airport service quality

As airport has complex setting, hence generic scales for gauging the service quality may omit the specific features pertaining to services and facilities (George et al., 2013; Pantouvakis, 2010). The functional aspect of airport terminal consists of three major areas: access interface, processing area and flight interface (Horonjeff et al., 2010). The processing area refers to all areas where the passenger are processed such as ticketing, check-in, security inspection, boarding etc. (Bezerra and Gomes, 2015). Pantouvakis and Renzi (2016) identifies four major dimensions in measuring ASQ namely Servicescape, Signage, Service and Image. Servicescape refers to airport facilities, circulation planning attributes, cleanliness, lighting, and congestion; the second dimension signage refers to level and quality of Information and guidance available at the airport; service refers to experience of passenger while actually utilizing the facilities and provisions of the airport and image refers to holistic way the airport is depicted in customers mind (Pantouvakis and Renzi, 2016).

There are two main categories of functions performed at airport terminal, passenger process activities and discretionary activities (Popovic et al., 2009; Caves and Pickard, 2000). Process activities refer to passenger flow from check-in to security screening till boarding where as discretionary activities refers to what passengers are able to do with their slack time such as shopping, eating, entertainment etc. (Bezerra and Gomes, 2015). In connection to processing activities, the perception of passengers about quality of service are generally indicating towards the efficiency of process time, short waiting time and courtesy of staff (Caves and Pickard, 2000; Fodness and Murray, 2007; Rhoades et al., 2000). For measurement of service quality associated with discretionary activities a variety of aspects need to be inculcated in measurement scale such as leisure alternatives and airport servicescape (Bitner, 1992; Bogicevic et al., 2013; Mari and Poggesi, 2011).

Fodness and Murray (2007) conducted an empirical study for evaluation of service quality of airport in which it was concluded that passenger's expectation to ASQ depends on three key dimensions: interaction, function and diversion. Lubbe et al. (2011) conducted an empirical study based on Fodness and Murray (2007) measures of ASQ and identified the difference in opinion of corporate and leisure travellers on expectation on service quality of airport. For assessing the service quality of airports, Chou et al. (2011) developed scale based on SERVQUAL methodology, the traditional approach of measuring service. Erdil and Yıldız (2011) also evaluated the service quality of airport based on SERVQUAL approach with 22 service criteria. Liou et al. (2011) employed a new method- dominance based rough set approach (DRSA) to assess the service quality of airport in which passengers evaluated the level of airport services by ranking varied sets of service criteria. DRSA method was useful for the purpose of development of strategies to improve service quality.

Magri and Alves (2005) employed the Airport Council International (ACI) framework of 36 criteria to measure the service quality of airport but overall service quality was not aggregated in their study which gave fragmented results. The ACI (2000) developed a scale for measurement of service quality of airport based on opinion of 512 airport members in which 13 Objective criteria and 38 subjective criteria are used. Later the scale was revised and is employed in the current research for measuring the service quality which has turn out to be systematic practice within airport industry (ACI, 2012; IATA, 2015).

3. Methodology

The study being empirical in nature has taken fuzzy logic tool to investigate the research questions and its respective implementation. The study has incorporated following steps: designing of questionnaire, collection of data, fuzzification of scores for service criteria and their respective weightage, analysis and interpretation of service criteria scores obtained, fuzzification for Importance Performance Analysis (IPA) and finally its defuzzification and interpretation which is depicted in Fig. 1.

The next section of the paper gives an overview of Fuzzy set theory and principles which are utilized to meet the objective of the current research. Subsequently the main steps of the research process are detailed.

3.1. Fuzzy set theory and linguistic-fuzzy evaluation scales

Service quality articulates passenger's perception and expectation. It is being measured very often on the basis of numerical linguistic variable which often results in incomplete, inconsistent, vague and imprecise results (Lupo, 2015). On the contrary it would be preferable to furnish interval value judgments rather than crisp value judgment (Chan and Kumar, 2007). Since measurement of service quality encompasses with intrinsic complexity related to nature of service, hence Fuzzy set theory render an effective approach to measure perception and expectation based on interval based linguistic variable (Lupo, 2015).

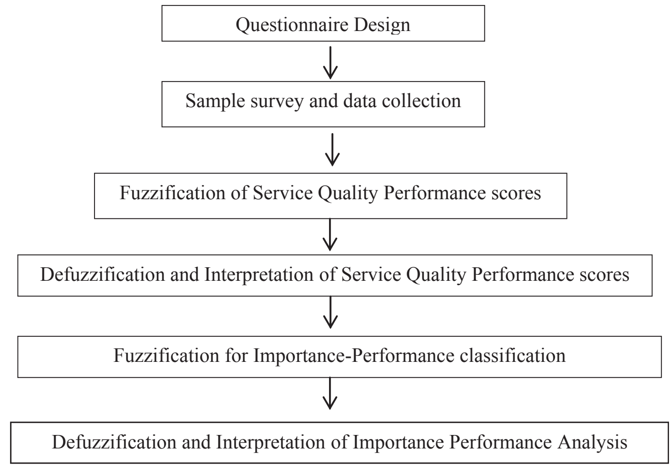

Fig. 1. Research process of fuzzy MCDM.

The concept of fuzzy set was propounded by Zadeh (1973) with the purpose to measure the human judgments or preferences more pragmatically by the help of linguistic terms. As the preferences expressed by human cannot be estimated with an exact numerical value, hence interval based linguistic term are used to describe the desired value (Zadeh, 1973; Bellman and Zadeh, 1970; Zadeh, 1975; Hwang and Yoon, 1981a,b; Liang and Wang, 1991; Hsu and Chen, 1997; Chiadamrong, 1999; Chien and Tsaia, 2000; Chen, 2001; Enrique, 2004). Fuzzy set theory provides a strict mathematical framework in which vague conceptual phenomena can be precisely and rigorously studied (Zimmermann, 2001). Fodor and Roubens (1994) derived mathematical details of Fuzzy MCDM analysis. Altrock (1995) applied fuzzy logic to describe the 30 case studies emphasizing wide application as decision making tool.

A fuzzy set is a set without a crisp, clearly defined boundary and contains elements with only a partial degree of membership (Mathworks, 2012). Mathworks (2012) defines a membership function (MF) as a curve that explains how each point in the input space is mapped to a membership value (or degree of membership) between 0 and 1. The concepts of linguistic variable can be quantified by fuzzy numbers using suitable membership functions.

In the current research linguistic variable were used to represent the passenger's assessment of the service criteria and positive triangular fuzzy numbers were employed to gauge the linguistic variable as depicted in Table 1. Similarly for importance of service criteria the fuzzy linguistic scale was utilized and their respective ratings are specified in Table 2.

The previous literature has already established the basic arithmetic operations on fuzzy numbers. If $A_1 = (l_1, m_1, u_1)$ and $A_2 = (l_2, m_2, u_2)$ are representing two distinct triangular fuzzy numbers then their algebraic multiplication operations can be expressed by equation (1).

$$A1 \otimes A2 = (l1, m1, u1) \otimes (l2, m2, u2) = (l1l2, m1m2, u1u2) \quad \text{Equation 1}$$

Table 1
Linguistic variables for service quality perception.

Poor	(0.0, 1.0, 2.0)
Fair	(1.0, 2.0, 3.0)
Good	(2.0, 3.0, 4.0)
Very Good	(3.0, 4.0, 5.0)
Excellent	(4.5, 5.0, 5.0)

Table 2
Linguistic variables for importance of service criteria.

Not at all important	(0.0, 1.0, 2.0)
Slightly Important	(1.0, 2.0, 3.0)
Moderately Important	(2.0, 3.0, 4.0)
Very Important	(3.0, 4.0, 5.0)
Extremely Important	(4.5, 5.0, 5.0)

The three main steps below shall describe the proposed method to conduct the current study:

Step 1: Questionnaire Design and Sampling Framework

A questionnaire was designed in line with the ASQ survey of ACI (2012) which contains seven Dimension and 33 service criteria which are detailed in Fig. 2. The passenger's service quality perception of each service criteria is gauged using the linguistic variable scale which were labeled as ‘very poor’, ‘poor’, fair, good and very good and their respective rating are indicated in Table 1.

The data was collected from the departing passengers at Suvaranabhumi and Don Mueang airports in Thailand. The survey was conducted throughout the month of February 2016 by employing simple random sampling without replacement method. A sample of 320 passengers for Suvarnabhumi and 305 Don Mueang airport respectively were taken for the study which is corollary to Iacobucci and Churchill (2010) sample size estimation when population standard deviation is unknown and it estimates sample size of 300 and 284 for Suvarnabhumi and DonMueang airport respectively. 500 questionnaires were distributed in survey for which response rate obtained at Suvarnabhumi and Don Mueang airport was 64% and 57% respectively.

Step 2: Method Utilized for Fuzzification and Defuzzification of Service Quality Performance Score

For ranking of fuzzy numbers graded mean integration representation method was explored by Chen and Hesieh (1998). Further Chou (2003) identified canonical representation of multiplication operation on two triangular fuzzy numbers by graded multiple integration representation method. Chou (2006) applied inverse function arithmetic representation for multiplication operation of multiple trapezoidal fuzzy numbers and the framework was employed to solve MCDM problem by Chou (2007). Chien-Chang (2012) developed a fuzzy MCDM model for evaluation the service quality of the airports where the service quality criteria and importance weight both were transformed into triangular fuzzy number.

This paper constructs fuzzy MCDM model for evaluation the ASQ using canonical representation of TFN based on graded mean integration method which is in line with study of Chien-Chang

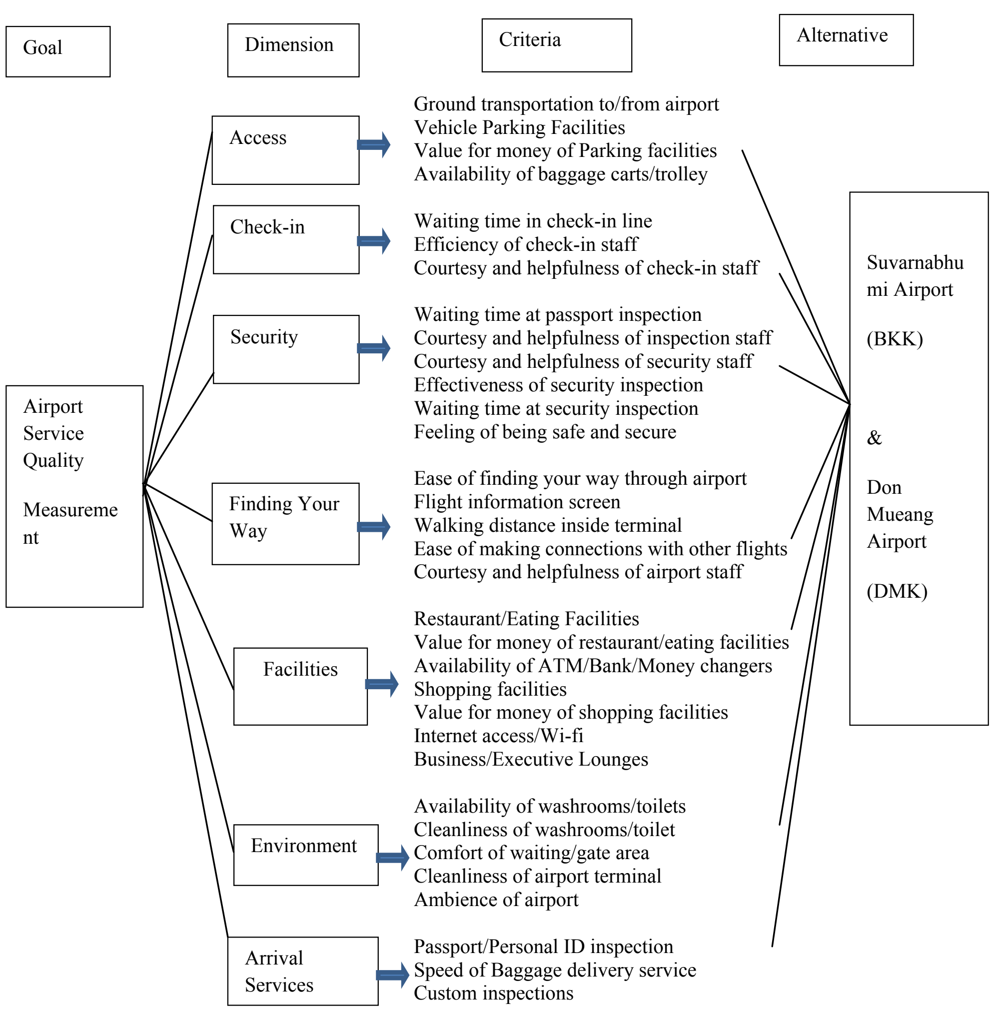

Fig. 2. Hierarchical analysis structure for evaluation of the quality of airport service of high importance.

(2012). Later the defuzzification of the scores is done using Inverse Arithmetic representation method.

All the service criteria indicated in Fig. 2, are assessed using a linguistic scale and TFN were considered to measure the customer's feedback. The fuzzy linguistic evaluation scale utilized is reported in Table 1. By employing the graded mean integration method a TFN $Y_1 = (c_1, a_1, b_1)$ is represented utilizing Equation (2). The same representation is employed on all service criteria for service performance and importance scores obtained from passengers respectively.

$$P(Y1) = \frac{1}{6}(c1 + 4a1 + b1) \qquad \text{Equation 2}$$

On the obtained score defuzzification was further executed by utilizing the formula indicated in equations (3) and (4) which is inverse function representation of multiplication operation of two triangular fuzzy numbers and is in line with study of Chien-Chang (2012) and Chou (2006).

The service performance and importance scores of ith service criterion (i = 1,2,…….w) which is rated by nth passenger (n = 1,2,…….n) for kth airport (k = 1,2,……m) are denoted by TFNs' respectively and are fuzzified utilizing the graded mean method explained above. The service performance score is represented by S_{ikn} which depicts the service quality performance score of ith service criterion rated by nth passenger for kth airport. The importance score is represented by w_{in} which indicates the importance score given by nth passenger for ith service criterion.

For defuzzification, the first step followed is to calculate the ratio AW_{ik} which is obtained using the formula indicated by equation (3).

$$AWik = \frac{\sum_{n=1}^{N} win}{\sum_{i=1}^{I}\sum_{n=1}^{N} win} \qquad \text{Equation 3}$$

The average score of the service quality performance for the K^{th} airport (TS_k), is obtained by utilizing the formula in equation (4) which is based on inverse function arithmetic representation method in which product of two TFN i.e. Percentage of importance weight criteria (AW_{ik}) and Service Performance Score (S_{ikn}) are aggregated and averaged for the respective airports.

$$TS_k = \frac{1}{N}\sum_{i=1}^{I}\sum_{n=1}^{N} AWik \otimes Sikn \qquad \text{Equation 4}$$

Step 3: Method Utilized for Fuzzification and Defuzzification of Importance-Performance Analysis (IPA)

IPA is conducted by employing the fuzzy rule based expert system. For IPA the scores of service quality performance and importance are fuzzified using graded mean integration representation method explained earlier and indicated in equation (2) and then defuzzification is conducted using fuzzy rule based expert system in which IF-THEN Rule are employed to solve the classification problem (Klose, 2002). The discussed fuzzy expert system is based on process of approximated reasoning which is the generalized modus ponens (Zadeh, 1978, 1979).

Implication: IF $X = U_x$ THEN $Y = U_y$
Premise: $X = U_x$
Conclusion: $Y = U_y$

Following four IF-THEN rules describe all possible implications in the fuzzy system with evaluation criteria 'Average score of importance' (AS_i) and 'Average score of Performance' (AS_p) are applied to the pertaining for defuzzification and segregation of coordinates in four quadrants:

$$IF\ S(i) > AS(i) AND\ S(p) < AS(p)\ THEN\ Quadrant\ I \qquad (1)$$

$$IF\ S(i) > AS(i) AND\ S(p) > AS(p)\ THEN\ Quadrant\ II \qquad (2)$$

$$IF\ S(i) < AS(i) AND\ S(p) < AS(p)\ THEN\ Quadrant\ III \qquad (3)$$

$$IF\ S(i) < AS(i) AND\ S(p) > AS(p)\ THEN\ Quadrant\ IV \qquad (4)$$

where $S_{(i)}$ stands for average score of importance for ith criteria, $AS_{(i)}$ stands for overall average score of importance across all criteria, $S_{(p)}$ indicates the average score of performance for pth criteria and $AS_{(p)}$ indicated overall average score of performance.

The IPA grid has two axes; horizontal axis represents importance of attribute while vertical axis depicts performance of service criteria. There are four quadrants in IPA, where quadrant I represents 'concentrate here', quadrant II indicates 'keep up good work', quadrant III symbolizes 'low priority' and quadrant IV characterizes 'possible overkill' (Chen and Chang, 2005). On the basis of above IF-THEN rules the coordinates are designated in appropriate quadrants for ith service criterion (i = 1, 2, ……….w) and Kth airport (K = 1,2,3,….m).

4. Findings

The average score of overall service quality performance of Suvarnabhumi and Don Mueang Airports are 3.97 and 3.61 respectively and overall service quality expectations for BKK and DMK are 3.75 and 3.39 respectively demonstrating that at both airports actual benefit received by passengers for overall service quality is higher that perceived benefits and is indicating that passengers at both airports are satisfied of the service quality. The scores of service quality performance and expectations scores for each service criterion are listed in Table 3 for the studied airports.

It is found that at BKK airport, the performance and expectation scores for the service criteria, value for money of shopping is 4.10 and 2.83, ambience of airport is 4.11 and 3.18 and effectiveness of security inspection 4.05 and 3.16 respectively; and are top three performing criteria from passenger satisfaction per se. However BKK airport needs to improve on the service criteria, waiting time in check-in line, waiting time at security inspection, ease of finding way through airport, cleanliness of washrooms and speed of baggage delivery service where the score of performance is lower than expectation of passengers as indicated in Table 3.

In crux the passengers are satisfied with the services and facilities delivered by BKK airport however for few operational areas, dissatisfaction has been reported by passengers as enumerated below. BKK airport is reported to have bottleneck regarding waiting time at check-in and security process for which capacity addition of check in and security counter should be analyzed by airport management. The passengers at BKK are dissatisfied by cleanliness of washroom, which is a hygiene factor and needs appropriate redress by airport management. Passengers at BKK seem dissatisfied with speed of baggage delivery which needs to be diagnosed and addressed by management.

At DMK airport, courtesy and helpfulness of airport staff, effectiveness of security inspection and value for money of shopping facilities are the best three performing service criteria passenger satisfaction wise, with scores of performance and expectation of 3.79 and 2.75, 3.56 and 2.65 and 3.72 and 2.83 respectively which can be observed from Table 3.

Table 3
Service quality weight and performance score.

Dimensions	Service criteria	Suvarnabhumi airport weight score	Suvarnabhumi airport performance score	Don Mueang airport weight score	Don Mueang airport performance score
Access	Ground transportation to/from airport (I_1)	3.96	4.01	3.96	4.03
	Vehicle Parking Facilities (I_2)	3.90	3.88	3.90	3.70
	Value for money of Parking facilities (I_3)	3.67	4.04	3.67	3.51
	Availability of baggage carts/trolley (I_4)	3.76	4.01	3.76	3.49
Check-in Time	Waiting time in check-in line (I_5)	4.14	3.74	4.14	3.65
	Efficiency of check-in staff (I_6)	4.00	4.03	4.00	3.73
	Courtesy and helpfulness of check-in staff (I_7)	3.90	3.90	3.90	3.68
	Waiting time at passport inspection (I_8)	4.07	4.02	4.07	3.88
	Courtesy and helpfulness of inspection staff (I_9)	3.51	3.98	3.51	3.73
Security	Courtesy and helpfulness of security staff (I_{10})	3.67	3.89	3.35	3.65
	Effectiveness of security inspection (I_{11})	3.16	4.05	2.65	3.56
	Waiting time at security inspection (I_{12})	4.00	3.87	4.00	3.55
	Feeling of being safe and secure (I_{13})	3.72	3.94	3.38	3.62
Finding your way	Ease of finding your way through airport (I_{14})	4.17	3.90	4.17	3.90
	Flight information screen (I_{15})	3.76	4.08	3.76	3.64
	Walking distance inside terminal (I_{16})	3.85	4.04	3.00	3.59
	Ease of making connections with other flights (I_{17})	3.55	3.95	2.90	3.45
	Courtesy and helpfulness of airport staff (I_{18})	3.78	3.91	2.79	3.75
Facilities	Restaurant/Eating Facilities (I_{19})	3.50	3.89	3.18	3.64
	Value for money of restaurant/eating facilities (I_{20})	4.00	3.98	3.03	3.49
	Availability of ATM/Bank/Money changers (I_{21})	3.56	4.02	3.06	3.59
	Shopping facilities (I_{22})	3.49	4.02	3.16	3.75
	Value for money of shopping facilities (I_{23})	2.83	4.10	2.83	3.72
	Internet access/Wi-fi (I_{24})	3.72	3.95	2.89	3.54
	Business/Executive Lounges (I_{25})	3.64	4.14	2.96	3.58
Environment	Availability of washrooms/toilets (I_{26})	3.55	3.98	2.87	3.33
	Cleanliness of washrooms/toilet (I_{27})	4.11	3.90	4.11	3.47
	Comfort of waiting/gate area (I_{28})	3.68	4.03	2.83	3.47
	Cleanliness of airport terminal (I_{29})	3.77	3.79	2.10	3.45
	Ambience of airport (I_{30})	3.18	4.11	2.03	3.47
Arrival Services	Passport/Personal ID inspection (I_{31})	3.96	4.06	3.96	3.54
	Speed of Baggage delivery service (I_{32})	4.35	3.97	4.35	3.42
	Custom inspections (I_{33})	3.68	3.82	3.51	3.52
	Average	3.75	3.97	3.39	3.61

But DMK airport needs to improve on following service criteria, where the score for performance is lower than expectation as indicated in Table 3, vehicle parking facilities, value for money of parking facilities, availability of baggage carts/trolley, waiting time in check-in line, efficiency of check-in staff, courtesy and helpfulness of check-in staff, waiting time at passport inspection, Courtesy and helpfulness of inspection staff, Waiting time at security inspection, Ease of finding your way through airport, Cleanliness of washrooms/toilet, Passport/Personal ID inspection and Speed of Baggage delivery service.

In sum and substance passengers are reported to be satisfied with overall services and facilities rendered by DMK airport, however few areas of improvement have been identified in the survey results which are summarized below. DMK is reported to have passenger dissatisfaction in area of parking infrastructure and pricing which need to be addressed by airport authorities. Passenger reported their dissatisfaction regarding waiting time during check-in and passport/id clearance process which need to be examined and improved. Staff efficiency at security counter is another factor on which passengers have expressed their dissatisfaction which needs to be redressed. Apart from it passenger are reported to be dissatisfied with the cleanliness of washroom at DMK which needs attention of airport authorities.

The results of importance performance analysis are plotted graphically in Fig. 3 where the satisfaction level of service criteria is indicated on horizontal axis while the importance of criteria is indicated on vertical axis. There are four quadrants in Fig. 3 of Importance Performance Analysis, where quadrant I represents ‘concentrate here’, quadrant II indicates ‘keep up good work’, quadrant III symbolizes ‘low priority’ and quadrant IV characterizes ‘possible overkill’ (Chen and Chang, 2005).

As displayed in Fig. 3 six criteria of DMK, speed of Baggage delivery service (I_{32}), cleanliness of washrooms (I_{27}), waiting time at security inspection (I_{12}), Passport/Personal ID inspection (I_{31}), availability of baggage carts/trolley (I_4) and value for money of parking facilities (I_3); and one service criteria of BKK, restaurant/eating facilities (I_{19}) lies in ‘concentrate here’ quadrant which means the performance results of the service criteria are reported poor although they are perceived to be important by passenger. Hence Airport management should urgently focus to redress the specific dissatisfaction in the above mentioned criteria and need to mobilize more resources to enhance satisfaction.

In ‘keep up the good work quadrant’ twenty four service criteria of BKK airport and eight criteria of DMK airport lie which are depicted in Fig. 3. The twenty four service criteria of BKK airport, lying in quadrant II are: Ease of finding your way through airport (I_{14}), waiting time in check-in line (I_5), cleanliness of washrooms/toilet (I_{27}), Waiting time at passport inspection (I_8), Efficiency of check-in staff (I_6), Value for money of restaurant/eating facilities (I_{20}), Waiting time at security inspection (I_{12}), Ground transportation to/from airport (I_1), Passport/Personal ID inspection (I_{31}), Courtesy and helpfulness of check-in staff (I_7), Vehicle Parking Facilities (I_2), Walking distance inside terminal (I_{16}), Cleanliness of airport terminal (I_{29}), Courtesy and helpfulness of airport staff (I_{18}), Availability of baggage carts/trolley (I_4), Flight information screen (I_{15}), Value for money of Parking facilities (I_3), Internet access/Wi-fi (I_{24}), Custom inspections (I_{33}), Courtesy and helpfulness of security staff (I_{10}), Value for money of Parking facilities (I_3), Business/Executive Lounges (I_{25}) and Comfort of waiting/gate area (I_{28}). And the Eight service criteria of DMK airport are waiting time in check-in

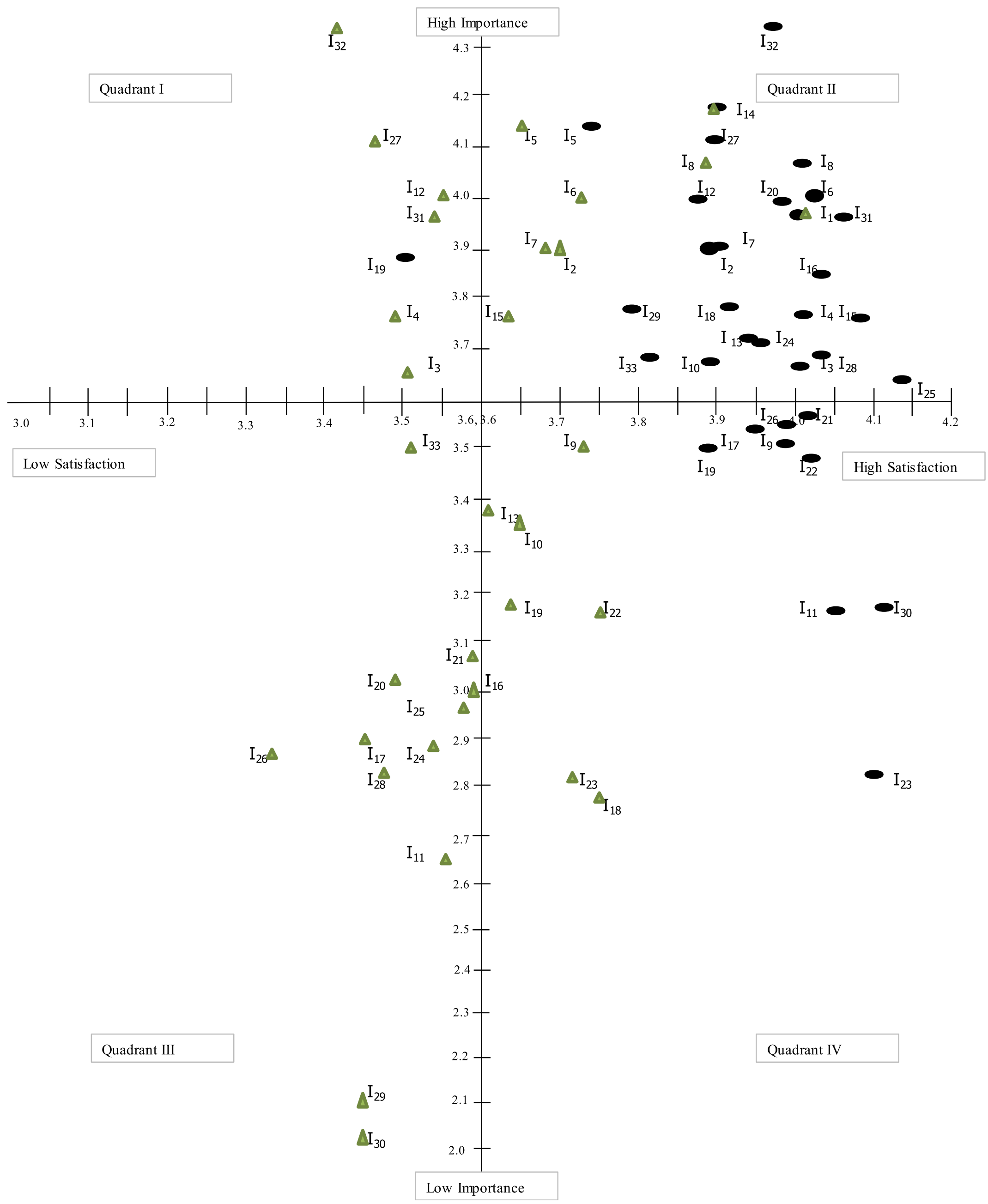

Fig. 3. Importance-performance analysis grid.

line (I_5), efficiency of check-in staff (I_6), courtesy and helpfulness of check-in staff (I_7), vehicle parking facilities (I_2), Flight information screen (I_{15}), Waiting time at passport inspection (I_8), Ease of finding your way through airport (I_{14}) and Ground transportation to/from airport (I_1). These criteria are rated highly important and have received high score for performance as well. Airport management should direct the resources to maintain the performance in these areas.

The quadrant III which represents the low priority has twelve service criteria of only DMK airport. These service criteria are: Custom inspections (I_{33}), Availability of ATM/Bank/Money changers (I_{21}), Value for money of restaurant/eating facilities (I_{20}), Walking distance inside terminal (I_{16}), Business/Executive Lounges (I_{25}), Internet access/Wi-fi (I_{24}), Ease of making connections with other flights (I_{17}), Availability of washrooms/toilets (I_{26}), Comfort of waiting/gate area (I_{28}), Effectiveness of security inspection (I_{11}), Cleanliness of airport terminal (I_{29}) and Ambience of airport (I_{30}). These criteria are rated low importance by passenger and have obtained low performance score as well. The Airport Management should give low priority to mobilize resources in these areas however should try to enhance the service performance scores.

There are nine service criteria of BKK airport and seven of DMK airport lying in 'possible overkill' quadrant. The nine service criteria of BKK airport lying in quadrant IV are: Availability of washrooms (I_{26}), Availability of ATM/Bank/Money changers (I_{21}), Restaurant/Eating Facilities (I_{19}), Ease of making connections with other flights (I_{17}), Courtesy and helpfulness of inspection staff (I_9), Shopping facilities (I_{22}), Effectiveness of security inspection (I_{11}), Ambience of airport (I_{30}) and value for money of shopping facilities (I_{23}) while seven criteria of DMK are Courtesy and helpfulness of inspection staff (I_9), Feeling of being safe and secure (I_{13}), Courtesy and helpfulness of security staff (I_{10}), Shopping facilities (I_{22}), Restaurant/Eating Facilities (I_{19}), Feeling of being safe and secure (I_{13}) and Courtesy and helpfulness of airport staff (I_{18}). These criteria are having low importance but they have been rated as high performing areas by passengers. The airport management should give less importance to mobilize resources in these service criteria and should try to keep up the performance score.

5. Conclusion

This paper attempts to measure the service quality of the two gateway airports of Thailand Suvarnabhumi (BKK) and Don Mueang (DMK) by utilizing the Fuzzy MCDM Analysis and also conduct Importance Performance Analysis (IPA) using Fuzzy expert system. The paper suggests managerial implications on two fold. First it demonstrates the use of Fuzzy MCDM method to gauge the service quality of airport which is more reliable in measuring the perception. Second it exhibits the IPA using Fuzzy expert system which would be very useful to the airport management to prioritize their resource allocation for enhancement of their service weaknesses.

It was found that the service quality of both the airports is satisfactory however few avenues were identified to enhance the service quality of both airports. For BKK airport, there is need to improve on the service criteria pertaining to waiting time in check-in line, waiting time at security inspection, ease of finding way through airport, cleanliness of washrooms and speed of baggage delivery service.

DMK airport needs to improve on service criteria pertaining to vehicle parking facilities, value for money of parking facilities, availability of baggage carts/trolley, waiting time in check-in line, efficiency of check-in staff, courtesy and helpfulness of check-in staff, waiting time at passport inspection, Courtesy and helpfulness of inspection staff, Waiting time at security inspection, Ease of finding your way through airport, Cleanliness of washrooms/toilet, Passport/Personal ID inspection and Speed of Baggage delivery service.

The finding of IPA helps the airport manager to prioritize their resource allocation for enhancement of service quality. The finding suggests that the airport managers of DMK should prioritize quality enhancement of following service criteria: speed of Baggage delivery service, cleanliness of washrooms, waiting time at security inspection, Passport/Personal ID inspection, availability of baggage carts/trolley and value for money of parking facilities. The airport managers of BKK should focus on service criteria of restaurant/eating facilities.

As measuring the perception of service quality based on crisp value can often be misleading hence the use of fuzzy MCDM method can give a more realistic measurement. Since there is dearth of research measuring the service quality of airport by employing Fuzzy MCDM method; hence the paper contribute theoretically to fill the gap to above pertaining and found that the Fuzzy MCDM method is promising and pragmatic in measuring the service quality of the airports.

As to contribute as future research in this domain, different fuzzy based MCDM approach may be utilized for similar problem where results can be matched to identify the best suitable fuzzy logic approach to measure the ASQ. Since customer perception are subjective and context dependent, testing of the suitability of measuring scale may give more precise results. The time frame of data collection for the study was just a month which in further studies may be sampled throughout year to minimize the possibility of seasonal biases in the results.

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