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Quality risk assessment model for airline services concerning Taiwanese airlines

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ABSTRACT

Whereas most studies have focused on elevating the service quality of airlines, few have explored quality risks from the viewpoint of customer dissatisfaction caused by poor service. For this study, we designed a quality risk assessment model that measures quality risk for airline services by integrating the Kano model, degrees of importance and satisfaction, and the failure mode and effects analysis. Data were collected for Taiwanese airlines through a questionnaire. The application of the proposed quality risk assessment model revealed several high-risk services, such as employee service attitudes, the ability of employees to manage customer complaints, the comfort of airplane seats, in-flight snack services, and flight punctuality. Finally, this study presents a discussion on the managerial implications and recommends directions for future research.

1. Introduction

While managing numerous challenges, airlines face strong competition from competing carriers (Dolnicar et al., 2011). Various antecedents may influence passengers' choice in the airline, including flight schedules, convenience, the frequency of flights, fares, punctuality, frequent flyer programs, perceived image, and service quality (Nako, 1992; Singh, 2015). The service process for airline services has always been considered a primary influence on service quality and customer satisfaction (Goodwin and Ross, 1992). However, in a service process that begins with the ticket booking process and involves onboard services, various factors may result in service failure (Bejou and Palmer, 1998). When the service quality does not meet the expectations of passengers, they become dissatisfied (Kau and Loh, 2006). This generates losses for the airline, and is regarded as a negative influence, which is the reason it is crucial to discuss the service quality of airline services.

Most studies on service quality have applied a positive-influence perspective to investigate the methods of improving service quality (Chen and Chang, 2005; Curry and Gao, 2012; Park et al., 2006; Robledo, 2001; Saha and Theingi, 2009). When the service quality does not meet customer expectations, passengers become dissatisfied, and may choose another airline in the future (Pérez et al., 2007). This negative assessment is based on a negative-influence perspective that can be used when discussing the service quality of airlines. Because of the relevance of the negative-influence perspective, the Airline Quality Rating (AQR) index was developed in 1991 (Bowen and Headley, 2015). The index is a weighted average of the elements that are relevant to consumers when assessing the quality of airline services. The weight of an element reflects its priority in consumer decision-making, and its sign reflects the direction of impact that the element should have when a consumer rates the airline service quality (Bowen and Headley, 2015). Although the AQR index has included several indices concerning the occurring rate of negative service attributes (e.g., on-time percentage, number of lost baggage reports as well as instances of denied boarding), the concept of quality risk has not been considered in its entirety. Airlines should consider the influence of service quality attributes as well as the requirement of failure prevention for all service attributes (Chang and Sun, 2009). This study regarded service quality management as an implement for controlling quality risks.

Risk is defined as uncertainty caused by a potential loss or injury, and may be avoided through preemptive action. Therefore, risk management aims to minimize losses associated with an event (Cleary and Malleret, 2007; Fragnière and Sullivan, 2006; Rejda,

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2011; Skipper, 2008). Recent applications of risk management have expanded to include the concept of quality; this topic is called quality risk management (QRM) (Claycamp, 2007). QRM is applied to ensure the quality of a product or service through systematic planning. This planning involves the four procedures of risk assessment, risk control, risk communication, and risk review (Mire-Sluis et al., 2010). Risk assessment is the first critical task in QRM. Failure mode and effects analysis (FMEA) is commonly applied for this purpose because it is related to risk assessment. Because FMEA focuses on exploring all types of potential mistakes in an operation system, it evaluates the degree of risk by analyzing error types, the probability of failure, the severity of faults, and the degree of hazards. This methodology is also commonly used for preventing service failures (Chang and Sun, 2009). When applied to service quality, FMEA can identify various service failures by measuring risk factors, and then assessing the probability of service failure (Shahin, 2004). Establishing an improvement method by using FMEA for a service process may help eliminate potential errors (Greenall et al., 2007; McDermott et al., 2008; Ookalkar et al., 2009). However, research applying FMEA to assess the service quality risk of airlines remains scant.

Previous studies have identified a positive, linear relationship between quality and satisfaction; that is, customer satisfaction increases with quality. Kano et al. (1984) developed a "two-dimensional quality" model, and asserted that the relationship between customer satisfaction and the performance of quality attributes is not entirely linear. The attributes then can be divided into five types of quality elements: attractive quality, 1D quality, must-be quality, indifference quality, and reverse quality. Hu and Lee (2011) then designed the improvement effort index (IEI) by combining the Kano model and degrees of importance and satisfaction to create a 2D matrix that provides information for a quality improvement strategy. Shahin (2004) combined the Kano model and FMEA into one index and applied it to a case study of travel agents. However, studies that apply the Kano model to explore QRM for airline services are scant. In addition, the literature lacks a specific methodology for applying FMEA and the Kano model to an assessment of quality risks associated with airline services. These shortcomings provided the motivation to develop a relatively more comprehensive model.

In summary, when service quality fails to meet a customer's expectations or needs, it is had a negative influence on future purchase decisions. The possibility of this negative influence is referred to as quality risk. Improving service quality can then be viewed as a managerial method for controlling quality risks. Previous studies on airline service quality have primarily focused on the attributes of service quality or have evaluated it, whereas few have explored quality risk assessment. For this study, we thus developed an integrated quality risk assessment model for use by airline services, and then applied it to Taiwanese airlines. Data collected using a questionnaire and subsequent analysis can facilitate evaluating quality risk. An evaluation of quality risk can be quantified and used to prioritize improvements to airline service quality.

2. Literature review

2.1. Airline service quality

Many scholars have treated service quality as a subjective customer perception (Levitt, 1984; Wakefield, 2001). Parasuraman et al. (1985) defined service quality as the gap between customer expectations and perceptions of the service received. Many researchers have examined various dimensions of service quality (Dabholkar et al., 1996; Juran, 1974; Lehtinet and Lehtinen, 1982; Sasser et al., 1978). The five dimensions of the SERVQUAL model are tangible, assurance, reliability, responsiveness, and responsiveness (Parasuraman et al., 1988). This model is widely used for measuring service quality in different service industries (Landrum et al., 2008; Quader, 2009; Tate and Evermann, 2010; Turner et al., 2010; Zaimrr et al., 2010). Brady and Cronin (2001) identified a multidimensional, hierarchical model with three primary dimensions of service quality (interaction, environment, and outcome) and nine subdimensions based on studies by Parasuraman et al. (1988), Rust and Oliver (1994), and Dabholka et al. (1994). Their model conflated multiple service quality conceptualizations into a single comprehensive multidimensional framework with a strong theoretical grounding.

Certain studies that have addressed service quality topics in the airline industry have explored and measured service attributes, including studies by Robledo (2001), Park et al. (2004, 2006), Chen and Chang (2005), and An and Noh (2009). Rhoades and Waguespack Jr. (2008) reviewed the conceptual foundations for service quality as it applied to the airline industry, and used data from the Air Travel Consumer Report to investigate airline quality performance regarding such key indicators as on-time arrivals, customer complaints, denials of boarding, and occurrences of mishandled baggage to characterize trends in airline service performance over the last two decades. Saha and Theingi (2009) indicated that, regarding order of priority, the dimensions of service quality, in descending order, are flight schedules, flight attendants, tangibles, and ground staff. Curry and Gao (2012) examined relationships among service quality, service satisfaction, and customer loyalty in a budget airline. Tsaur et al. (2002), Nejati et al. (2009), and Torlak et al. (2011) have used the fuzzy or TOPSIS approach to assess airline performance. Although many studies have investigated airline services, few have examined quality risk in relation to airline services.

2.2. Kano model and improvement effort index

In the past, customer satisfaction has been perceived as a 1D construct: customer satisfaction increases with the fulfillment of desired attributes (Yang, 2005). In other words, if the attribute quality is sufficient, customers can be satisfied; otherwise, they cannot. However, certain studies have shown that not every fulfillment of an attribute results in a high level of customer satisfaction (Matzler and Hinterhuber, 1998). Moreover, certain attributes may only result in nonsatisfaction or a neutral feeling for a customer, rather than increase or reduce satisfaction (Chen and Lee, 2006). Based on the results obtained by Herzberg (1959), Kano and Takahashi (1979) developed the concept of a 2D quality. Kano et al. (1984) applied two dimensions of any quality attribute: the fulfillment of quality and customer-perceived satisfaction. Each of these dimensions have five categories of quality attributes, each of which has different impacts on customer satisfaction and customer dissatisfaction (Kano et al., 1984; Löfgren and Witell, 2005; Yang, 2005). Many previous studies have applied the Kano model to measure customer satisfaction (Chen and Chuang, 2008; Chen and Lee, 2006; Matzler et al., 1996, 2004; Matzler and Hinterhuber, 1998; Rivière et al., 2006; Tan et al., 2004; Wassenaar et al., 2005).

Based on Kano's definitions, service quality was divided into attractive quality elements (A), one-dimension quality elements (O), must-be quality elements (M), indifferent quality elements (I), and reverse quality elements (R). For the attractive (A) attribute, customer satisfaction increases superlinearly with attribute performance; for the one-dimensional (O) attribute, customer satisfaction is a linear function of the performance of a criterion; for the must-be (M) attribute, customers become dissatisfied when the performance of this criterion is low or the product attribute is absent; for the indifferent (I) attribute, customer satisfaction is unaffected, regardless of whether this quality is present; and for the reverse (R) attribute, customers are dissatisfied when this quality element is present (Löfgren and Witell, 2005).

The questionnaire of Kano's model contains pairs of items for each attribute; that is, attribute items are presented in a functional and dysfunctional form (Berger et al., 1993; Kano et al., 1984). When responding to each item, a participant can choose one of five options: "I like it that way," "I expect it to be that way," "I am neutral," "I can accept it that way," and "I dislike it that way" (Berger et al., 1993; Kano et al., 1984; Löfgren and Witell, 2008; Matzler and Hinterhuber, 1998). A quality attribute is classified using a questionnaire matrix between the functional and dysfunctional forms of the item (Table 1). A quality attribute can then be classified into the highest-percentage category. Matzler et al. (1996) provided a classification rule for when a certain quality attribute cannot be clearly assigned to the various categories; that is, "M > O > A > I".

Berger et al. (1993) developed the customer satisfaction coefficient to analyze whether satisfaction can be raised by meeting a customer requirement, or whether fulfilling this requirement merely prevents the customer from being dissatisfied. Berger et al. (1993) presented two useful indices for the customer satisfaction coefficient to facilitate calculating the average impact on satisfaction and dissatisfaction: the satisfaction increment index (SII) and the dissatisfaction decrement index (DDI):

$$SII = \frac{(A+O)}{(A+O+M+I)}$$

$$DDI = \frac{(O+M)}{(A+O+M+I)\times(-1)}.$$

These two coefficients indicate how strongly a product feature may influence customer satisfaction or, in the case of nonfulfillment, dissatisfaction (Matzler and Hinterhuber, 1998).

Hu and Lee (2011) integrated the Kano model with an importance–performance analysis to create the IEI. According to Hu and Lee (2011), when a service attribute is satisfactory, it can increase customer satisfaction and simultaneously reduce dissatisfaction. Therefore, the positive difference between the SII and DDI can be understood as the total contribution of satisfaction from a service attribute. They derived the satisfaction contribution index (SCI) as

$$SCI = \frac{SII - DDI}{\max(SII - DDI)}.$$

Based on the "quality attribute ranking" proposed by Wasserman (1993), the standardized weight (a_i) of quality attributes, which is used to prioritize the attributes regarding their contributed improvement, can be derived by integrating their degrees of importance and satisfaction. The processes used to calculate a_i in this study are as follows:

1. Rank the importance and satisfaction values of each attribute separately on a scale ranging from maximum to minimum.
2. Calculate the difference index by subtracting the satisfaction from the importance values.
3. Rank the difference index on a scale ranging from maximum to minimum. If attributes with equal difference indices exist, the attribute with the higher degree of satisfaction is assigned a higher ranking. The ranking number is called the priority weight (w_i), and it indicates the change in the number of difference index rankings caused by improvement.
4. Calculate a_i by using the normalized priority weight as $a_i = w_i/max(w_i)$.

Hu and Lee (2011) proposed the IEI to identify improvements that result from satisfying the service quality attribute. The IEI is derived as $IEI = a_i \times SCI$, and indicates the degree to which an attribute is in agreement with a customer's demand and contributes to satisfaction.

2.3. Failure mode and effects analysis

FMEA is a systematic auxiliary tool used for engineering systems. It is applied wen exploring all potential mistakes in a system: It analyzes factors while searching for error types, the probability of failure, the severity of faults, and the degree of a hazard. This helps firms prevent and correct errors, thereby avoiding failure or reducing the fault severity after a fault occurs (Chang and Sun, 2009). In addition, establishing an improvement method by applying FMEA for a service process may contribute to the elimination of potential errors (Greenall et al., 2007; McDermott et al., 2008; Ookalkar et al., 2009).

According to previous research, the purpose of the implementation of FMEA is to identify the failure mode of a critical system, determine a potential failure or current degradation failure, request a design evaluation or a design review, identify a problem in quality management, in maintenance design, and in the product safety aspects of an application (Onodera, 1997). FMEA involves three steps: analyzing the damage from a failure; evaluating the result of a failure; and managing the risk of a failure. For evaluating the result of a failure, the risk priority number (RPN) is calculated by multiplying the severity (S) by occurrence (Oc), and then by detection (D): $RPN = S \times Oc \times D$.

Shahin (2004) integrated the Kano model and FMEA, and indicated that severity can be considered a function of occurrence and detection, and further assumed that$S = DOc^k$. Shahin also developed a new risk index, the correction ratio (Cr), to identify the gap between a current value and the target value, and assumed that $Cr = 1 - \frac{RPN_{Tg}}{RPN_0}$, where Tg is the target value of an attribute, and 0 is the current value of the attribute. As Cr increases, the gap between current and target value widens.

We reevaluated the integration method by Shahin (2004).

Table 1
Kano Category table.

Customer requirements		Dysfunctional form of the question				
		Like	Expect	Neutral	Accept	Dislike
Functional form of the question	Like	Q	A	A	A	O
	Expect	R	I	I	I	M
	Neutral	R	I	I	I	M
	Accept	R	I	I	I	M
	Dislike	R	R	R	R	Q

Note: attractive (A). One-dimensional (O), must-be (M), reverse (R), and indifferent (I) attributes. The letter "Q" means questionable.
Source: Matzler and Hinterhuber (1998).

According to Shahin's (2004) formula $S = DO^k$, severity increases with detection. However, the results of the formula are do always reflect the real-world conditions; that is, increased severity does not always correspond with increased detection. For instance, customers may feel dissatisfied with the service quality of a company because of a service failure, but they may not necessarily complain to the staff, and thus, detection would be low. However, because of this dissatisfaction, customers may not choose this company again, and may even publicize their negative experiences. This could further adversely affect the willingness of others to choose this company, and generate a potentially serious loss. Thus, if severity is considered a function of detection, a service failure becomes less serious because detection is low. Because this is not entirely accurate, this study proposed a novel approach to integrate Kano's model and FMEA.

3. Method

3.1. Quality risk assessment

For this study, we applied a novel conceptual framework for quality risk assessment based on the work by Hu and Lee (2011) and Shahin (2004) (Fig. 1). The framework includes three steps: The first and second steps were developed by Hu and Lee (2011), and the third combines the results of the first two steps into FMEA that was developed in this study.

In Step 1, the Kano model is used to analyze the category of airline service quality attributes. The SII and DDI can then be acquired from the analytical results, enabling the SCI to be derived (Hu and Lee, 2011). An increase in the SCI of an attribute indicates an increase in the influence of the attribute on total satisfaction caused by quality improvement, regardless of whether satisfaction is increasing or dissatisfaction is decreasing.

In Step 2, the degrees of satisfaction and the importance of airline service quality attributes are used to calculate a_i (Wasserman, 1993). The SCI and a_i are then integrated into the IEI, which provides information for a quality improvement strategy in accordance with Kano's classifications and the results of the degrees of satisfaction and importance on service quality attributes (Hu and Lee, 2011).

In Step 3, the FMEA model is applied to identify the quality risk of each service quality attribute. In this model, the IEI is incorporated into the RPN of quality risk (RPN^{QR}). As mentioned, we modified the integration method by Shahin (2004). This novel approach can be used to evaluate the quality risk of airline services. The RPN^{QR} is defined as the product of attribute contribution to satisfaction, the occurrence of quality failure, and the detection of quality failure. Thus, $RPN^{QR} = IEI \times Oc \times D$. Furthermore, the formula of the critical ratio of quality risk (Cr^{QR}) of airline service quality attributes is

$$Cr^{QR} = 1 - \frac{RPN^{QR}_{Tg}}{RPN^{QR}_{0}} = 1 - \frac{IEI_{Tg} \times Oc_{Tg} \times D_{Tg}}{IEI_0 \times Oc_0 \times D_0}$$

where RPN^{QR} is the quality risk priority of airline service QRM, 0 represents the current value of each service quality attribute of an airline, and Tg is the target value among all service quality attributes of an airline. We assumed that detection is constant, and thus, $D_{Tg} = D_0$. The formula for Cr^{QR} can hence be simplified as

$$Cr^{QR} = 1 - \frac{IEI_{Tg} \times Oc_{Tg}}{IEI_0 \times Oc_0}.$$

A large Cr^{QR} value indicates a large gap between the current value and the target value, such that the quality risk of airline service quality attributes is high. Therefore, the Cr^{QR} value can provide managers with meaningful information for prioritizing improvements to airline service quality attributes. As mentioned, an attribute with a high IEI is in strong agreement with a customer's needs, and provides a strong contribution toward improving satisfaction. Conversely, an attribute with a small IEI has a low service quality risk, and would not provide a contribution that warrants justifying its improvement. Hence IEI_{Tg} should be as small as possible, and Oc_{Tg} should be as low as possible. However, airline services cannot exist without service quality risk and failure risk. Therefore, this study adopted the lowest value for IEI_{Tg}; namely, $IEI_{Tg} = \min\{IEI_i\}\ ,\quad i = 1\ldots N$. The Oc_{Tg} is the lowest current failure occurrence among all quality attributes; namely, $Oc_{Tg} = \min\{Oc_i\}\ ,\quad i = 1\ldots n$, where n is the number of service attributes.

3.2. Questionnaire design

Airline service quality was measured using 15 airline service quality measurement items (Table 2), primarily based on studies by Brady and Cronin (2001), Park et al. (2004), Chen and Chang (2005), and Erdila and Yildiz (2011). The dimensions in this study were based on the hierarchical service quality by Brady and Cronin (2001), and were “interaction quality,” “physical environmental quality,” and “outcome quality.” Because the airline service industry involves complex processes and multiple service concepts, a single comprehensive multidimensional framework with a strong theoretical foundation is required (Brady and Cronin, 2001).

Because services are inherently intangible and characterized by inseparability, the interpersonal interactions that take place during service delivery often have the greatest effect on service quality perceptions (Bitner et al., 1994; Bowen and Schneider, 1985; Hartline and Ferrell, 1996; Surprenant and Solomon, 1987). Interaction quality is determined by the factors of attitude, behavior, and expertise of service employees. Thus, the interaction quality dimension used in this study indicates the quality of the service

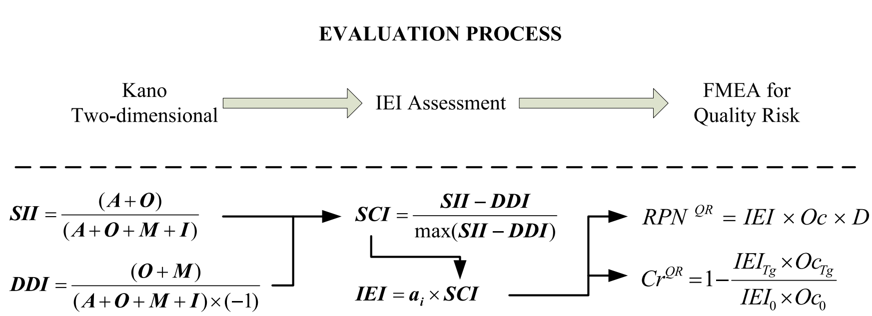

Fig. 1. Quality risk assessment model.

Table 2
Airline service quality Attributes.

Dimensions	Items
Interaction Quality	1. Service efficiency of airline employees
	2. Service attitude of airline employees
	3. Ability of airline employees to handle customer complaints
Physical Environment Quality	4. Appearance of airline employees
	5. Appearance of aircraft facilities
	6. Cleanliness of aircraft interior
	7. The in-flight entertainment of airplanes
	8. Comfort of aircraft seats
	9. In-flight snack service (items, tastes, freshness, quantity, etc.)
Outcome quality	10. Availability of in-flight duty-free sales
	11. Flight information provided by airlines
	12. Flight punctuality
	13. Convenience of reservation, ticketing and check-in service
	14. Luggage check-in service
	15. Communication channel for passenger claims or complaints

encounter, including with the ground staff and cabin crew, regarding their ability, attitude, and response with passengers.

The second dimension is physical environmental quality. Physical environmental quality is determined by factors such as ambient conditions, location design, and social factors. Certain studies have considered the influence of the physical or "built" environment on customer service evaluations (Brady and Cronin, 2001). Because services often require that the customer be present during the process, the surrounding environment can have a significant influence on the perceptions of the overall quality of the service encounter (Bitner, 1992). The ambient conditions and design of airline services are related to the environmental condition, appearance of service employee, and any facility or commodity used by passengers (e.g., in-flight entertainment or snack service).

The third dimension is outcome quality, which relevant because the service outcome is a type of "service product," and customers evaluate the results after service delivery (Rust and Oliver, 1994). Outcome quality is determined by the factors of tangibles, waiting time, and valence (Brady and Cronin, 2001). Providing an availability of tangible elements, such as correct flight information or in-flight duty-free sales service, is a crucial outcome of services. At present, in-flight duty-free sales provide substantial contributions to airline revenues (Mar and Young, 2001), and have become an integral part of in-flight services (Huang and Kuai, 2006). In addition, it is intuitive to infer a negative effect of waiting time on the perceptions of outcome quality. Thus, punctuality can be viewed as integral to an overall evaluation (Hui and Tse, 1996). Furthermore, valence is related to the service outcome either positively or negatively, regardless of a customer's evaluation of any other aspect of the experience. A negative experience may result in complaints. Therefore, the items of outcome quality in this study comprised the availability of in-flight duty-free sales, provision of correct information, punctuality, service convenience, luggage service, and a complaint channel.

The questionnaire comprised four parts. The first part presented questions on passenger opinions on airline service quality attributes based on the Kano model. In accordance with the Kano model, each attribute was assessed using two items: a Kano positive item (functional form) and a Kano negative item (dysfunctional form). The second part involved gathering data on passengers' perceived degrees of satisfaction and importance of service quality attributes. Respondents evaluated the service attributes of the Taiwanese carrier they used most often. A 5-point Likert scale was used to determine satisfaction and importance values, ranging from 1 (*strongly dissatisfied/unimportant*) to 5 (*strongly satisfied/important*). The third part involved collecting data on passenger perceptions of the occurrence of failures as related to service quality items. Respondents reported the frequency of service failure with their chosen airline by choosing one of the following responses: "never," "seldom," "sometimes," "usually," and "always." The fourth part involved collecting demographic information on the respondents.

3.3. Data collection

The two largest airlines that operate primarily on international routes from Taiwan were used as the investigation sample. To enhance sample validation, the data collection scheme was based on the structure of the Taiwanese airline industry. The two Taiwanese airlines serving the most passengers were chosen by referring to data from the Civil Aeronautics Administration. China Airlines and EVA Air transported 8,883,598 and 5,907,739 passengers, respectively, between January and August of 2014. To meet the effective sample size criteria and overcome limitations, quota sampling was applied for data collection. We distributed 400 questionnaires: 240 to passengers of China Airlines, and 160 to passengers of EVA Air. The questionnaires were distributed at Taoyuan International Airport, Taiwan. An investigator first asked passengers whether they had previously purchased a ticket for a flight on either airline before this trip. If the answer was "yes," he or she was selected. The respondent then filled out the questionnaire and returned it to the investigator.

The numbers of valid returned questionnaires from passengers of China Airlines and EVA AIR were 225 and 149, respectively, yielding a valid response rate of 93.5%. Of all the respondents, 50.53% (189/374) were male, and 49.46% (185/374) were female; 31.02% (116/374) were aged 16–25 years; 58.02% (217/374) had a university degree, 36.63% (137/374) were employed, and 27.01% (101/374) were students. In total, 64.17% (240/374) were flying for pleasure, whereas 20.32% (76/374) were traveling for business. Regarding travel frequency, 82.09% (307/374) of passengers flew 1–3 times per year.

Cronbach's α was applied to analyze the reliability of the importance and satisfaction constructs (Table 3). The Cronbach α

Table 3
Reliability analysis.

Dimensions	Cronbach α	
	Importance	Satisfaction
Interaction Quality	0.872	0.870
Physical Environment Quality	0.789	0.845
Outcome quality	0.816	0.822
Total	0.893	0.905

for importance and satisfaction exceeded 0.70, as well as for overall importance and satisfaction, indicating that this study had good reliability.

4. Result

4.1. Classification of service attributes by using the Kano model

The questionnaire comprised both positive and negative statements. Therefore, a cross-comparison was performed to classify quality attributes. Table 4 lists the percentages and classification results for all service quality attributes. By summing the 15 attributes, none could be sorted as reverse quality. Two attributes were categorized as attractive, three were categorized as must-be, nine were categorized as one-dimensional, and one was categorized as indifference.

Items 7 (in-flight entertainment) and 9 (in-flight snack service) were attractive qualities (A). Thus, airlines can improve passenger satisfaction by improving both attributes. However, the absence of these two attributes does not reduce satisfaction. This can explain why certain airlines provide good in-flight entertainment or great snack service, whereas others do not. Good in-flight entertainment or a great snack service can help passengers pass the time during a flight. However, certain respondents did not care for these attributes; they cared more about economical tickets.

Items 11 (flight information provided by airlines), 12 (on-time flights), and 14 (luggage check-in service) were must-be qualities (M). Passengers regarded these three attributes as basic needs. If one was lacking, passengers were highly dissatisfied.

Items 1 (service efficiency of airline employees), 2 (service attitude of airline employees), 3 (ability of airline employees to manage customer complaints), 4 (appearance of airline employees), 5 (appearance of aircraft facilities), 6 (cleanliness of aircraft interior), 8 (comfort of aircraft seats), 13 (convenience of reservation, ticketing, and check-in service), and 15 (communication channel for passenger claims or complaints) were one-dimensional qualities (O). If an airline offered these nine attributes to a lesser degree, satisfaction would decrease, indicating that risk increases when airlines do not meet customer expectations concerning these attributes.

Finally, Item 10 (availability of in-flight duty-free sales) was an indifferent quality (I), indicating that it did not influence passenger satisfaction, and that no risk exists to airlines that fail to provide this service. The application of the Kano model is detailed in the next section for calculating the IEI proposed by Hu and Lee (2011).

4.2. Result for the improvement effort index

This study evaluated the IEI, which represents the degrees of importance and satisfaction of every service quality, as determined by the Kano model. First, the SII and DDI were calculated from the Kano model results (Berger et al., 1993). The SCI was then derived from the SII and DDI. Second, a_i was calculated from the degrees of importance and satisfaction (Wasserman, 1993). Finally, the IEI value was obtained by multiplying the SCI by a_i (Table 5).

The SII and DDI of each service quality attribute were calculated (right-hand side of Table 4). Items 2 (service attitude of airline employees), 3 (ability of airline employees to manage customer complaints), and 9 (in-flight snack service) were the three highest SIIs. By providing these services, passenger satisfaction can increase more than from other attributes. Conversely, because the DDI of Items 2 (service attitude of airline employees), 12 (flight punctuality), and 14 (luggage check-in service) were lower than other the items, enhancing these attributes can lower dissatisfaction.

Regarding importance, the attribute with the highest degree of importance was Item 12 (flight punctuality), which was also classified as a must-be attribute by the Kano model. Moreover, Items 2 (service attitude of airline employees), and 8 (comfort of aircraft seats) were ranked higher than the other attributes. The degrees of satisfaction with Items 8 (comfort of aircraft seats), 9 (in-flight snack service), and 10 (availability of in-flight duty-free sales) were lower than with other attributes. Because Item 8 (comfort of aircraft seats) had a high degree of importance and a low degree of satisfaction, this attribute had the highest a_i. By contrast, Item 4 (appearance of airline employees) had a low degree of importance and a high degree of satisfaction, resulting in the lowest a_i.

The IEI value can be obtained by considering the degrees of importance and satisfaction, and the SCI of the service quality attributes of each airline. Regarding the IEI results, Items 2 (service attitude of airline employees), 3 (ability of airline employees to manage customer complaints), 8 (comfort of aircraft seats), 9 (in-flight snack service), and 12 (flight punctuality) were the five highest-ranked attributes. These analytical results indicated that these attributes had a high degree of importance and a low degree of satisfaction. Consequently, these five attributes should be improved the most. According to Hu and Lee (2011), these types of attributes should be assigned a high priority for improvement. However, a high IEI does not signify a high rate of occurrence for

Table 4
Result of Kano model.

Attribute	Kano quality Attributes classification percentages (%)						Classification result
	A	O	M	I	R	Q	
1. Service efficiency of airline employees	13.10	50.53	24.06	11.76	0.00	0.53	O
2. Service attitude of airline employees	10.16	57.75	21.93	9.63	0.00	0.53	O
3. Ability of airline employees to handle customer complaints	18.45	45.99	21.39	13.64	0.00	0.53	O
4. Appearance of airline employees	28.61	31.02	14.44	25.67	0.00	0.27	O
5. Appearance of aircraft facilities	19.52	41.98	21.39	16.58	0.00	0.53	O
6. Cleanliness of aircraft interior	11.23	37.17	35.83	15.24	0.00	0.53	O
7. The in-flight entertainment of airplanes	31.02	27.81	16.04	24.33	0.53	0.27	A
8. Comfort of aircraft seats	20.32	42.25	23.53	13.10	0.00	0.80	O
9. In-flight snack service (items, tastes, freshness, quantity, etc.)	35.03	28.61	15.51	20.05	0.00	0.80	A
10. Availability of in-flight duty-free sales	32.35	16.84	12.03	37.97	0.00	0.80	I
11. Flight information provided by airlines	10.43	30.75	43.32	14.97	0.00	0.53	M
12. Flight punctuality	9.63	35.03	42.51	12.30	0.00	0.53	M
13. Convenience of reservation, ticketing and check-in service	19.25	31.02	26.47	22.73	0.00	0.53	O
14. Luggage check-in service	4.55	36.10	50.00	8.82	0.00	0.53	M
15. Communication channel for passenger claims or complaints	15.51	33.42	27.54	22.99	0.00	0.53	O

Note: attractive quality (A); one-dimensional quality (O); must-be quality (M); indifference quality (I).

Table 5
Result for IEI.

Items	SII	DDI	SCI	Importance	Satisfaction	a_i	IEI
1. Service efficiency of airline employees	0.640	−0.750	0.937	4.201	3.869	0.133	0.125
2. Service attitude of airline employees	0.683	−0.801	1.000	4.377	3.864	0.667	0.667
3. Ability of airline employees to handle customer complaints	0.648	−0.677	0.893	4.273	3.746	0.800	0.714
4. Appearance of airline employees	0.598	−0.456	0.710	3.703	3.906	0.067	0.047
5. Appearance of aircraft facilities	0.618	−0.637	0.846	4.019	3.679	0.467	0.395
6. Cleanliness of aircraft interior	0.487	−0.734	0.822	4.310	3.767	0.733	0.603
7. The in-flight entertainment of airplanes	0.593	−0.442	0.698	3.824	3.567	0.333	0.233
8. Comfort of aircraft seats	0.631	−0.663	0.872	4.340	3.457	1.000	0.872
9. In-flight snack service (items, tastes, freshness, quantity, etc.)	0.642	−0.445	0.732	3.941	3.348	0.867	0.634
10. Availability of in-flight duty-free sales	0.496	−0.291	0.530	3.235	3.441	0.400	0.212
11. Flight information provided by airlines	0.414	−0.745	0.781	3.992	3.668	0.533	0.416
12. Flight punctuality	0.449	−0.780	0.828	4.492	3.693	0.933	0.773
13. Convenience of reservation, ticketing and check-in service	0.505	−0.578	0.730	4.182	3.754	0.267	0.195
14. Luggage check-in service	0.409	−0.866	0.859	4.267	3.821	0.200	0.172
15. Communication channel for passenger claims or complaints	0.492	−0.613	0.745	3.963	3.620	0.600	0.447

service attributes. Regarding QRM, managers should improve service quality attributes as determined by the IEI results, but also consider the rate of occurrence of service attributes. Thus, this study further analyzed the quality risk of these attributes by performing FMEA.

4.3. Result of failure mode and effects analysis for quality risk

As mentioned, we incorporated the concept of risk management into service quality for airlines, and proposed an assessment model that integrates the Kano model, degrees of importance and satisfaction, and FMEA. Therefore, C_r^{QR} was applied to identify the gap between the current RPN^{QR} and target RPN^{QR}. As the value of C_r^{QR} increases, the gap between the current value and target value widens, and thus, quality risk increases. Therefore, the C_r^{QR} value can be used by managers to identify the service attributes with high quality risks that should be improved. Table 6 lists the FMEA results for the two Taiwanese airline services.

According to the analytical results for service failure occurrences, Items 7 (in-flight entertainment), 8 (comfort of aircraft seats), 9 (in-flight snack service), and 12 (flight punctuality) had the highest *Oc* values. Respondents indicated that they often encountered poor services concerning these attributes. Specifically, Items 8 (comfort of aircraft seats) and 12 (flight punctuality) had high degrees of importance, but low degrees of satisfaction. Therefore, these two attributes had a high quality risk, and should be prioritized for improvement. To explore total quality risk, we performed FMEA and calculated the Cr^{QR} value.

The Cr^{QR} value of Item 8 (comfort of aircraft seats) was 0.957, and was ranked highest (Table 6), and thus, it was the highest risk quality item, indicating that it should be improved and that its deficiencies were frequent. This phenomenon is dependent on cabin class, cabin space, and the assessment of costs versus benefits. However, if limitations for seat space and discomfort can be overcome, the IEI value can be raised considerably.

Item 12 (flight punctuality) had the second highest Cr^{QR} value, at 0.952. Because punctuality had the highest degree of importance among all of the attributes, its IEI value was the highest. Another reason for its high Cr^{QR} value was related to the high rate of occurrence, meaning that flights are seldom on time, according to respondents' experiences. Moreover, the Cr^{QR} values of Items 2 (service attitude of airline employees), 3 (ability of airline employees to manage customer complaints), 6 (cleanliness of aircraft interior), and 9 (in-flight snack service) exceeded 0.9, indicating that they were priorities for improvement.

The attribute with the lowest Cr^{QR} value was Item 4 (appearance of airline employees). The quality risk result was the lowest because respondents did not regard this item as having a substantial degree of importance, and the degree of satisfaction was not poor. The Cr^{QR} values of Items 1 (service efficiency of airline employees), 13 (convenience of reservation, ticketing, and check-in service), and 14 (luggage check-in service) were also relatively low, likely because failures associated with these items were uncommon, and the respondents did not regard these items as being of poor quality, such

Table 6
Result of FMEA for quality risk.

Items	*IEI*	*Oc*	RPN^{QR}	Cr^{QR}	
				Value	Rank
1. Service efficiency of airline employees	0.125	1.992	0.249	0.686	14
2. Service attitude of airline employees	0.667	1.890	1.260	0.938	5
3. Ability of airline employees to handle customer complaints	0.714	1.898	1.356	0.942	4
4. Appearance of airline employees	0.047[a]	1.754	0.083	0.059	15
5. Appearance of aircraft facilities	0.395	1.920	0.758	0.897	9
6. Cleanliness of aircraft interior	0.603	1.981	1.195	0.935	6
7. The in-flight entertainment of airplanes	0.233	2.013	0.468	0.833	10
8. Comfort of aircraft seats	0.872	2.067	1.802	0.957	1
9. In-flight snack service (items, tastes, freshness, quantity, etc.)	0.634	2.217	1.406	0.944	3
10. Availability of in-flight duty-free sales	0.212	1.930	0.410	0.809	11
11. Flight information provided by airlines	0.416	1.840	0.766	0.898	8
12. Flight punctuality	0.773	2.123	1.640	0.952	2
13. Convenience of reservation, ticketing and check-in service	0.195	1.773	0.345	0.774	12
14. Luggage check-in service	0.172	1.650[b]	0.283	0.724	13
15. Communication channel for passenger claims or complaints	0.447	1.719	0.768	0.898	7

Note.
[a] Means target of IEI (IEI_{Tg}).
[b] Means target of Oc (Oc_{Tg}).

that improvements would not measurably increase satisfaction.

5. Conclusion and discussion

Previous studies on airline service quality have examined quality attributes or service quality in general as well as from the perspective of positive influence. However, service failure may reduce customer satisfaction, and should be managed from the perspective of risk control to prevent a loss of satisfaction. Because few studies have examined quality risk in relation to airline services, for this study, we developed a quality risk assessment model that measures airline service quality risk by integrating the Kano model and FMEA. This study targeted two major Taiwanese airlines, and we used a questionnaire for data collection. The evaluation of quality risk was quantified, and improvement priorities were provided for different attributes, providing these two airlines with an effective strategy for managing and improving their service quality.

This research contributes to the literature by providing a novel quality risk assessment model. In addition, it provides airlines with a baseline for service quality risk assessment, and offers managers a model that quantifies quality risk. The Cr^{QR} value integrates the Kano model, degrees of importance and satisfaction, and the occurrence of service failures to quantify quality risk. This study also confirmed through a literature review and test results that the Kano model is effective, and that FMEA can be a useful tool for prioritizing airline service quality attributes for improvements.

An overall comparison of the key findings regarding quality risk assessment for airline services generated managerial and operational implications. The Cr^{QR} results indicated that improving the service quality of particular attributes should be prioritized: comfort of aircraft seats, flight punctuality, in-flight snack service, ability of airline employees to manage customer complaints, and the service attitude of airline employees. In other words, these attributes have a higher quality risk than do others, and should undergo considerable improvements because of the frequency of quality issues.

Managers can adopt several strategies to improve these attributes, such as reducing the frequency of service failures, enhancing attributes that contribute significantly to passenger satisfaction as determined by the Kano model, and improving the attributes with high degrees of importance and low degrees of satisfaction. Because it is costly for an airline to attempt to address every customer requirement and avoid all service failures, this model contributes to providing a risk priority ranking for improvement. The attributes with greater risk should be improved first. However, because this study used only a long-haul flight service as an example, the results may be applicable only to airlines flying long-haul routes.

Regarding the managerial implications for long-haul airlines, we recommend that managers apply improvements for attributes with a high quality risk based on the circumstances, such as difficulty of improvement and available resources (time, money, and effort). First, the attribute “comfort of aircraft seats” had the highest quality risk because of its relatively high rate of occurrence and IEI value. However, because aircraft seats are hardware, they cannot be changed often. Therefore, uncomfortable seats may yield more opportunities to produce dissatisfied passengers. The seats of the two Taiwanese airlines were high priorities for improvement, because improvements could increase customer satisfaction more than could improvements in other areas. The hardware is not easily changeable; however, managers may devise long-term plans to improve this issue. Adding more personal space and functionality are two feasible methods for increasing the comfort and convenience of seats. For personal space, adjustments to economy-class seats could be considered to widen the leg room. Interval spaces in front of and behind the seat can also be slightly increased. Reducing the number of economy-class seats in certain airplane models is another option for arranging a comfortable seating space. Many airlines have performed various types of improvements for the design of their seats. It would be advantageous for Taiwanese airlines to use them as references. For functionality, managers can add new equipment (e.g., smartphone holder, cup holders, USB charging port, and mesh storage bag), as well as enhance the multimedia entertainment system to enable passengers to focus on leisure and entertainment activities to reduce their awareness of an uncomfortable seat.

Second, “flight punctuality” and “in-flight snack service” had high quality risks, as indicated by their high failure occurrences and high IEI values. Respondents expressed that flights are often delayed, and that the snack service is often poor. Furthermore, these two attributes had high a_i and low SCI values. However, although failure to provide on-time flights and satisfactory snack service was a frequent occurrence, improving flight delays may not increase satisfaction significantly. Because respondents felt dissatisfied with flight punctuality and snack services, we recommend that managers improve on-schedule performances and in-flight snack services.

The attributes “ability of airline employees to manage customer complaints” and “service attitude of airline employees” had high quality risks. However, their failure was rare. The main reason for the high quality risk was their high SCI values and high a_i, indicating that passengers focus on problem-solving skills and service attributes. Improvements can affect satisfaction markedly. Therefore, managers can reduce the quality risks of complaint management and service attributes by addressing employee training or increasing employee empowerment (Bitner et al., 1994).

This study had several research limitations. First, because of limited time and resources, only passengers from China Airlines and EVA Air departing from Taoyuan International Airport, Taiwan, were surveyed. Regarding demographics, most respondents were students, which may have negatively affected the degree of importance of in-flight sales of duty-free goods. Differences in travel purpose and frequency may also have influenced the findings. Thus, we recommend that further studies gather additional data, enhance sample representation, and broaden the range of the investigation by including additional airlines.

Second, passenger-perceived airline service failure was investigated using a questionnaire. Future studies may determine the failure frequency of each service attribute by using an information technology system, such as the customer relationship management system.

Third, respondents in this study were randomly chosen passengers of the two airlines. However, frequent flyers often have different requests or high degrees of loyalty toward airlines. Thus, this group should be recruited in the future.

Finally, this study proposed a quality risk assessment model. This model can contribute to adding more practical, feasible, and managerial information, and help managers allocate resources efficiently to prioritize service quality improvement based on quality risks. Future research can apply this method to explore and compare the quality risks of various types of airlines (e.g., low-cost carriers and short-haul route airlines).

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