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Using TRIZ to enhance passengers' perceptions of an airline's image through service quality and safety

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ABSTRACT

To improve the impacts of airline image, service quality and safety on passenger perceptions, this paper examined and presented three case studies to identify the factors that influenced service quality in the airline business, and passenger perceptions of airline image. A literature review on service quality measurement (SQM) and airline safety analysed case studies. The quality management framework SERVQUAL with five service quality dimensions including reliability, assurance, tangibility, empathy and responsiveness was used to assess passenger requirements. Selected criteria from airline services and the Kano model measured customer satisfaction. Airline safety criteria were studied and TRIZ techniques were employed to integrate improved service quality without compromising safety regulations, to best enhance airline image.

1. Introduction

In 1987 an open sky policy was implemented in the airline industry (Chang and Chiu, 2009) and this business freedom for flight operations resulted in increased competition among airlines. Consequently, in most parts of the world, the deregulation of the airline business has affected industry competition. During the past decade, two major airline business models were classified according to their strategic plans. The traditional model covered the comprehensive service package and the other concerned low cost airlines offering reduced prices with minimum extras (Tiernan et al., 2008a, b). Full service airline criteria include seats with space to recline, leg room, in-flight entertainment, baggage processing, meal service, in-flight amenities, a choice of first, business or economy class travel and partners such as Star Alliance, Sky Team and Oneworld. Air carriers identified the major strengths and weaknesses of their services related to their brand positioning (Wen and Chen, 2010). Competition in the airline business caused airlines to resort to different strategies such as intensive marketing, advertising and promotions combined with price and ticketing sales. In the airline business regulatory safety requirements are the top priority; air safety records reflect airline image, while high quality service is associated with passenger expectation (Liou et al., 2008). Airline businesses have consolidated their images, using integrated methods to manage the improvement of passenger satisfaction.

This paper examined the effect of airline image on passenger perception of service quality and safety operations. Part two reviewed the literature on service quality management, airline service criteria and SERVQUAL measurement, the Kano model and customer satisfaction coefficient analyses, airline safety criteria and rankings and TRIZ application tools. Part three examined three airline service quality case studies and Part four presented and discussed the conclusions.

2. Literature review

The term ‘service quality’ has been used in evaluating service quality through customer satisfaction. The competitive advantages in offering superior service quality include increasing an airline's market share. Efforts to increase adherence to aviation safety should be prioritised (GASP ICAO, 2014) to improve airline image.

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Given the large variety of service quality definitions, formulations from customer perspectives and perceptions are important dimensions (Lewis, 1993). One definition of service quality is the level required to meet customer expectations (Gronross, 1982).

Improvements in service quality can increase both profits and client base through new and repeat purchases from loyal customers (Gilbert and Wong, 2002). Service characteristics cannot be produced in advance, therefore they must always exceed customer expectations and outcomes. Customer satisfaction influences loyalty, which then stimulates growth to maximise profitability (Heskett et al., 1994).

2.1. Airline service quality management using the SERVQUAL method

Previous airline service studies used the SERVQUAL method to evaluate service quality (Park et al., 2005). SERVQUAL is a framework to measure service quality using the gap theory model. This has five service quality dimensions included reliability, assurance, tangibility, empathy and responsiveness, with 22 attributes that define service quality as the degree of discrepancy between customer expectation and customer perception of the service performance they received (Gronross, 1982; Parasuraman et al., 1988; Wongrukmita and Thawesaengskulthai, 2014). Service quality in the airline industry is complex and differs from other industries (Feng and Jeng, 2005). Airline service quality includes safety procedures, in-flight comfort, hospitality and service accuracy. The airline industry service items are defined by IATA (International Air Transportation Association) and include reservation seating capacity, ticketing, check-in processes, in-flight services, baggage handling and post-flight service (Feng and Jeng, 2005).

2.2. Kano's attractive quality theory and the customer satisfaction coefficient

In 1984, Dr. Noriaki Kano and his colleagues (Kano et al., 1984) developed a model to identify core customer requirements and areas of product and service improvement by examining the non-linear relationship between service performance and customer satisfaction (Ankur et al., 2010).

According to Matzler and Hiterhuber (1998) (Fig. 1), attractive quality separated Kano's service requirements into Must-be (M), One-dimension (O), Attractive (A), Indifferent (I) and Reverse (R). The customer satisfaction coefficient (CS) measures qualitative values of customer satisfaction and dissatisfaction. The Kano model and the CS formula are applied to indicate the qualitative values of the customer satisfaction index (Berger et al., 1993; Ankur et al., 2010) (Table 1).

2.3. SERVQUAL and Kano's model applied to airline service measurement

Table 2 summarises airline service quality measurements obtained by SERVQUAL and Kano's attractive quality model (Matzler and Hiterhuber, 1998; Berger et al., 1993).

Airline service criteria categorised by the SERVQUAL RATER and the Kano model to identify the Customer Satisfaction Index indicating overall passenger satisfaction are listed in Table 2.

2.4. Airline safety criteria and ranking

Airline safety criteria are determined by IOSA (IATA Operational Safety Audit), ICAO (International Civil Aviation Organisation) and the FAA (Federal Aviation Administration). According to airlineratings.com, airline safety ratings are based on a comprehensive holistic safety analysis of factors that impact safety. Analyses utilise information from the world's aviation governments as well as crash data. Table 3 shows the criteria used for airline safety ratings. Each airline has the potential to earn seven stars (*) credit for safety assessment with the criteria for the best safety ranking.

Airline safety index rankings are based on the JACDEC (Jet Airliner Crash Data Evaluation Centre) annual safety calculations. International safety benchmarks such as IOSA and USOAP (Universal Safety Oversight Audit Programme) country factors are also a time weighting factor that increases the effects of recent accidents and weakens the impact of past accidents (ICAO, 2004., 2006); (ICAO USOAP 2011). Table 4 shows the criteria for calculating the safety index and the resulting safety index ranking, including the Annual Revenue Passengers Kilometres (RPKs) which measure of passenger traffic calculate with number of paying passengers multiply by kilometres flown, IOSA Membership and Country Transparency (JACDEC, 2013).

2.5. TRIZ for service quality in the airline industry

Genrich Altshuller developed TRIZ by analysing more than three million patents and discovering that the patterns predicted breakthrough solutions to problems. TRIZ is now increasingly used in Six Sigma processes, project management, risk management and innovation initiatives. It solves problems by analysing their repeatability, predictability and reliability by relying on the study of the patterns of problems and solutions. A TRIZ perspective in service industries demonstrates that the TRIZ's 40 Inventive Principles in service operations differ from physical product development (Zhang et al., 2009). For example, unique service industry characteristics include customer participation, simultaneity, heterogeneity, intangibility and perishability which can help resolve airline service problems. An empirical study on developing a new service

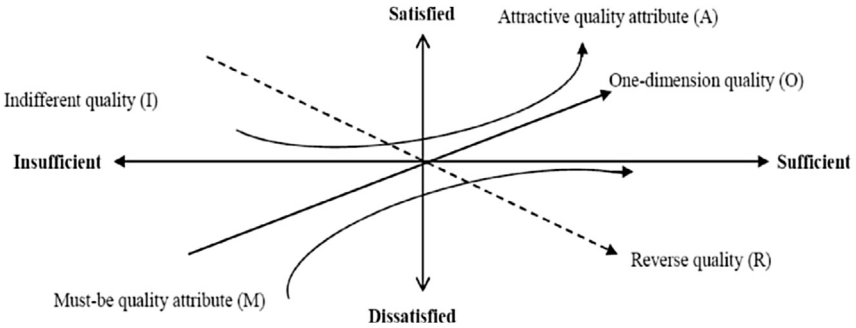

Fig. 1. Kano's excitement and basic quality model adapted from Matzler and Hiterhuber (1998).

Table 1
A summary of Kano's model and the Customer Satisfaction Coefficient (CS) formula.

Requirements	Meet product or service requirement	Customer satisfaction coefficients
Must-be quality (M)	The customer becomes very dissatisfied if this requirement is not met, but if sufficient it will not result in more satisfaction.	**Formula: Satisfaction index** $(SI) = \frac{(A+O)}{(A+O+M+I)}$
One-dimension quality (O)	The higher performance, the more improvement in customer satisfaction	**Formula: Dissatisfaction index** $(DI) = \frac{(M+O)}{(A+O+M+I)\times(-1)}$
Attractive quality (A)	Absence does not cause dissatisfaction but will fulfil the customer requirement and lead to more customer satisfaction.	
Indifferent quality (I)	The customer is not very interested, whether it is present or not.	
Reverse quality (R)	The customer has no desires and expects the reverse.	

Table 2
Airline service quality measurement based on SERVQUAL and Kano's Model.

Service quality measurement and dimensions		Criteria	Measurement formulae based on Kano's Model
SERVQUAL	**Empathy**	1 Employees provide individual attention to the passenger	**Satisfaction index** $(SI) = \frac{(A+O)}{(A+O+M+I)}$
		2 Alternative flight schedules are available	**Dissatisfaction index** $(DI) = \frac{(M+O)}{(A+O+M+I)\times(-1)}$
		3 Airline schedules are convenience	**M** = Must-be quality
		4 Airline handling includes modern equipment and facilities	**O** = One-dimension quality
		5 Employees understand the passenger's specific needs	**A** = Attractive quality
		6 Employees provide speed handling	**I** = Indifferent quality
	Assurance	7 Flight safety operations	
		8 Airline performed confident actions with passenger tangibles	
		9 Provide necessary information	
		10 Airline staff have the knowledge to answer questions	
		11 Employees willingness to help	
		12 Employees promptly handle of flight delays	
	Reliability	13 Flights are On-time	
		14 Airline staff performed accurate service during the case	
		15 Insistence on travel service	
	Responsiveness	16 Interest in solving flight delay problems	
		17 Employees are willing to help in unexpected situations	
		18 Courtesy of crew	
	Tangibility	19 Modernized aircraft and seat comfort	
		20 In-flight entertainment facility	
		21 Appearance of employees	
		22 Quality of meal service	

Table 3
Safety assessment criteria adapted from airline ratings.

Criteria	Yes	No	Credit
Is the airline IOSA certified? *(If yes, two stars are awarded; if not, no star is given)*	/		**
Is the airline on the European Union (EU) Blacklist? *(If no, a full star is awarded; if yes, no star is given)*		/	*
Has the airline maintained a fatality free record for the past 10 years? *(If yes, a full star is awarded)*	/		*
Is the airline FAA endorsed? *(If yes, a full star is awarded; if not, no star is given)*	/		*
Does the country of airline origin meet all 8 ICAO safety parameters? *(If yes, two stars are awarded)*	/		**
Has the airline's fleet been grounded by the country's government aviation safety due to safety concerns? *(If yes, an additional star will be taken off the total for five years from the timing of grounding)*		/	
Does the airline operate only Russian built aircraft? *(If yes, an additional star will be taken off the total)*		/	

design was conducted with tourists on Singapore's Sentosa Island and a university canteen (Chai et al., 2005). As shown in Table 5, these guidelines are used to interpret the TRIZ Principles and patterns found in airline service development.

According to the literature review on the purposes of improving airline image, passenger perceptions of service quality and safety operations should be evaluated using TRIZ principles to integrate and improve the contradictions.

The proposed model in Fig. 2 is adapted from the SERVQUAL five service quality dimensions including tangibles, reliability, responsiveness, assurance and empathy. The Airline Service Criteria's 22 scales such as flight safety operations, flights are on-time, quality of food and beverage (Gronross, 1982; Parasuraman et al., 1988), as defined by IATA include items such as seat capacity, ticketing, check-in processes, in-flight services, baggage handling and post-flight service (Feng and Jeng, 2005). Kano's model has been integrated to determine the Customer Satisfaction Index (CS), which rates the overall passenger satisfaction level. According to JADEC, safety is the top priority in the airline industry. The airline safety index rankings are based on the JACDEC annual safety calculations (JACDEC, 2013).

TRIZ principles have been applied to resolve contradictions between airline service criteria and safety to improve passenger expectations and perceptions and thereby improve airline image. This paper summarised the interpretation of TRIZ's 40 Inventive Principles applied to service developments in airline operations. A proposed TRIZ for aviation services based on three in-depth case studies is also presented.

Table 4
Safety Index calculation components and JACDEC airline safety Index and rankings.

Criteria	Method for calculating index
Annual Revenue Passengers Kilometres (RPKs)	Cumulative Revenue Passenger Kilometres (RPKs) and the operating of the airline over the past 30 year.
Fatalities	The Index considers the number of victims depending on the age of the airline up to 30 years prior.
Total losses or Hull Losses Accident	Refers to operations where the aircraft was destroyed or was no longer repairable.
Serious Incidents	Concerned the "critical mass" of the air accident
Accident-Free Years	The relationship between the accident history and airline performance.
IOSA Membership	Recognized programme of the airline association IATA
The Time Factor	Older accidents contribute to the safety index less than newer ones.
Country Transparency	Transparency of the controlling authority in an Aircraft Accident Investigation

Rank	Airline	Index	Rank	Airline	Index
1	Air New Zealand	0.007	31	United airlines	0.057
2	Cathay Pacific Airways	0.008	32	Swiss	0.064
3	Finnair	0.010	33	Ryanair	0.066
4	Emirates	0.010	34	Malaysia Airlines	0.072
5	EVA Air	0.010	35	Jet Airways	0.078
6	British Airways	0.011	36	China Eastern Airlines	0.082
7	Tap Portugal	0.012	37	Aeroflot	0.103
8	Etihad Airways	0.012	38	Alitalia	0.121
9	Air Canada	0.012	39	Lan Airlines	0.127
10	Qantas	0.013	40	Air France	0.141
11	Qatar Airways	0.013	41	American Airlines	0.145
12	All Nippon Airways	0.015	42	Air China	0.168
13	Virgin Atlantic Airways	0.015	43	US Airways	0.169
14	Hainan Airlines	0.015	44	Iberia	0.172
15	Virgin Australia	0.015	45	Alaska Airlines	0.180
16	Jetblue Airways	0.015	46	Japan Airlines	0.208
17	KLM	0.015	47	Thai Airways Intl	0.211
18	Lufthansa	0.016	48	China Southern Airlines	0.235
19	Shenzhen Airlines	0.018	49	Asiana	0.255
20	Easyjet	0.018	50	Scandinavian Airlines	0.282
21	Thomas Cook Airlines	0.023	51	Turkish Airlines	0.376
22	Westjet	0.026	52	Korean Air	0.396
23	Transaero Airlines	0.027	53	Saudia	0.548
24	Southwest Airlines	0.028	54	Gol Transportes Aereos	0.689
25	Jetstar Airways	0.030	55	Garuda Indonesia	0.802
26	Air Berlin	0.034	56	Tam Airlines	0.890
27	Delta Air Lines	0.038	57	Air India	0.934
28	Thomson Airways	0.046	58	China Airlines	1130
29	Condor	0.050	59	Vietnam Airlines	1544
30	Singapore Airlines	0.052	60	Lion Air	1899

Table 5
TRIZ Principle suggested for the airline industry.

TRIZ principles	Airline service quality improvement
#1 Segmentation	Improvements in service delivery efficiency by segmenting into service categories.
#5 Consolidation	Collaboration Air Traffic Service Unit to enhance service.
#9 Prior counteraction	Supporting online software enhances safety procedures before introducing a flight or service.
#14 Spheroidality	Passenger feedback and information from staff to solve conflicts.
#16 Partial or excessive actions	Giving passengers prior notices of temporary unavailability of services can prevent the loss of customer loyalty due to 'blind' waiting.
#19 Periodic action	Airline equipment inspections should be regular to prevent accidental breakdowns.
#22 Convert harm into benefit	Flight delays cause service failure; thus, providing hotel accommodations or serving meals can turn a potentially poor passenger experience in to a good one.
#24 Mediator	To improve the Air Traffic Control method by appointing a manager to intervene between the Air Traffic Control division and the work related to the aircraft.
#37 Thermal expansion	Increase sectors for Air Traffic Service in peak periods for air traffic flow and to avoid flight delays.

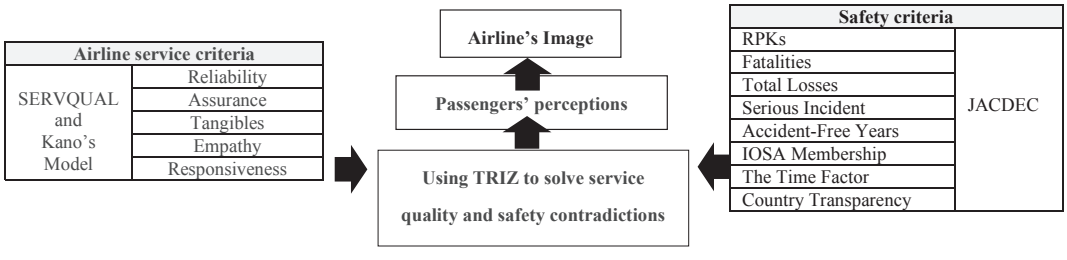

Fig. 2. Proposed integrated model of service quality and safety to improve airline images using TRIZ.

3. Methodology

The qualitative method and questionnaire were based on SERVQUAL's five dimensions and Kano's model, which included the Attractive, One-dimension, Must-be and Indifferent categories. Focus groups and personal interviews were conducted, as well as direct or participatory observations of 261 participants which are airline passengers and aviation industry employees. The questionnaire was developed following the steps shown in Fig. 3.

The questionnaire was developed according to the process in Fig. 3. Testing and revision of the Kano model was done by formulating pairs of questions on the service attributes for which feedback from airline passengers and employees was important. The questionnaire was constructed through pairs of passenger requirement questions. Consequently, each question had two parts, as shown in Table 6 (Kano et al., 1984; Berger et al., 1993).

Perceptions were next categorised into quality dimensions based on respondent perceptions of the quality attributes' functional and dysfunctional forms. Examples of three potential customer requirements in the Kano questionnaire are shown in Table 6. Questions 1A, 2A and 3A capture the respondent's feelings when an airline service possesses a certain attribute, while questions 1B, 2B and 3B captures the respondent's feelings when an airline service does not provide that attribute. For each question the passenger selected one of five alternative answers described as: 1 = I like it that way, 2 = This is how it should be, 3 = I am neutral, 4 = I can live with this and 5 = I dislike it that way.

To compare service quality preferences in different situations, three case studies were conducted. Case 1 detailed the problem of long flight delays due to weather conditions at the destination airport. Case 2 looked at Air Traffic Congestion which affected airline safety and service quality. Case 3 related to problem solving of airline service quality due to the technical disruption of service equipment, such as passenger seat malfunction. Each problem was identified for solution. Contradictions occurred when safety was the first priority for the airline, but service quality did not reach passengers'' expectations. TRIZ was considered in these three case studies.

Case 1. Flight delays due to poor weather conditions caused the airline service quality to fail. The flight was unable to transport passengers to their destinations due to adverse weather which resulted in unsafe landing conditions. The problem solving process is shown in Fig. 4. The airline investigated the situation and used TRIZ techniques to solve the contradictions to improve services and airline image.

Identify and evaluate the problem: To maintain safety, flights cannot operate in severe weather. The best practice for airlines is therefore to cancel or delay the flight and wait for improved weather conditions. However, front-line staff must handle passenger concerns. This analysis identified passengers' requirements using SERVQUAL and the Kano model. The satisfaction index (SI) and dissatisfaction index (DI) were also calculated (Kano et al., 1984; Berger et al., 1993) (Table 7).

Problem solving using TRIZ: Airline service improvement was evaluated with SERVQUAL and the Kano model. An SI value closer to 1 indicated higher satisfaction. For the DI in which the service item did not exist for the passenger, the closer the coefficient is to −1, then the higher the dissatisfaction (Sauerwein et al., 1996; Hejaili et al., 2009). As shown in Table 8, TRIZ can be used to improve service quality.

When information concerning severe weather and safety is not properly and timeously announced to passengers they will complain and be dissatisfied. TRIZ# 9 suggests that airlines should provide software to support online enquiries of safety procedures to inform passengers before the flight. TRIZ#14 suggests that feedback and information from the passengers and employees can be useful in solving the problem. TRIZ#16 suggests that when airlines provide early notice to passengers regarding the temporary unavailability of services, loss of customer loyalty due to 'blind' waiting can be prevented, and TRIZ# 22suggests that when flight delays cause service failures, providing hotel accommodations or serving meals can turn a potentially poor passenger experience into a positive one.

Case 2. Airline services may be disrupted due to air traffic congestion when sequencing take-off. Air traffic capacity en route also entails the necessity to hold aircraft on the ground awaiting take-off clearance from the Air Traffic Control Unit. When there are delays in flight schedules passenger services are disrupted and connecting flights may be missed. Therefore, passenger satisfaction will be reduced and the airline reputation tarnished. Fig. 5 shows the problem solving process for airline service quality challenges caused by air traffic congestion.

Identify and evaluate the problem: Flight delays caused by air traffic congestion both on the ground and en route can affect airline service quality. Congestion at the airport and in the airspace as it affected airline scheduling was studied. According to SERVQUAL and the Kano model survey, Table 9 shows that technology combined with policy, and organising the concerned units by TRIZ solutions marginally increased functional capacities and improved airline scheduling.

Problem solving using TRIZ: The SI and DI calculations were based on Kano's formula (Kano et al., 1984; Berger et al., 1993). The Air Traffic Flow Management (ATFM) programme was developed by the Global Navigation Satellite System (GNSS) to transform technology and improve problem resolution (Arshad, 2009). As shown in Table 10, the following TRIZ principles were used: #1: Segmenting service categories to improve service delivery efficiency, #5: Collaborating with the Air Traffic Service Unit to enhance service, #24: Improving Air Traffic Control by appointing a manager to communicate between the Air Traffic Control division and the work related to the aircraft and # 37: Increasing control sectors for Air Traffic Service during the high season to improve air traffic flow.

Case 3. Developing new entertainment systems can increase passenger comfort during flights. This case described the solution of an airline service quality problem that resulted from entertainment equipment technical malfunction. Providing passengers with comfort promotes airline image and service quality is disrupted when equipment develops technical problems. Fig. 6 shows the TRIZ problem solving process used to improve airline service.

Identify and evaluate the problem using SERVQUAL and the Kano model: Entertainment system malfunctions affect passenger satisfaction and perceptions of service quality. Research has shown that aircraft equipment malfunctions cause flight delays or cancellations for maintenance(see Table 11).

Fig. 3. The questionnaire development process as adapted from Walden et al., 1993.

Table 6
Examples of potential customer requirements based on a Kano questionnaire measuring satisfaction index (SI) and dissatisfaction index (DI).

Potential customer requirements	1	2	3	4	5
1A. How would you feel if the aircraft is safe to operate according to schedule?					
1B. How would you feel if the aircraft is not safe to operate according to schedule?					
2A. How would you feel if an airline employee offered you an extra leg room seat when you boarded the aircraft?					
2B. How would you feel if an airline employee did not offer you an extra leg room seat when you boarded the aircraft?					
3A. How would you feel if the airline arranged a special sightseeing trip during a long flight delay?					
3B. How would you feel if the airline did not arrange a special sightseeing trip during a long flight delay?					

Where 1 = I like it that way, 2 = this is how it should be, 3 = I am neutral, 4 = I can live with this, 5 = I dislike it that way.

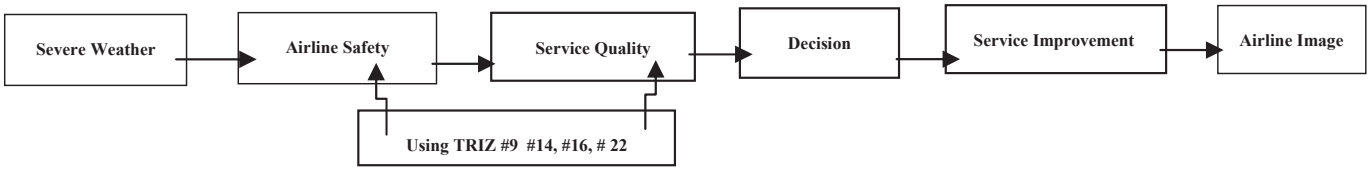

Fig. 4. Using TRIZ in the airline safety and service quality integration process for adverse weather conditions.

Table 7
Customer requirement survey after severe weather conditions using SERVQUAL and the Kano model.

Customer requirements	A	M	O	I	SI	DI	Customer requirements	A	M	O	I	SI	DI
Empathy							**Reliability**						
1 Employees provide individual attention to the passenger	15	60	10	15	.25	−.70	13 Flights are on-time	11	69	12	8	.23	−.81
2 Alternative frequent flight schedules	25	35	25	15	.50	−.60	14 Airline staff perform accurate service during the case	19	48	21	12	.40	−.69
3 The airline schedule is convenient	33	17	38	12	.71	−.55	15 Insist on travel services	53	27	13	7	.66	−.40
4 The airline has modern equipment and facilities	21	36	17	26	.38	−.53	**Responsiveness**						
5 Employees understand the passenger's specific needs	14	57	21	8	.35	−.78	16 Interested in solving delayed flight problem	19	63	13	5	.32	−.76
6 Employees provide speed handling	23	31	27	19	.50	−.58	17 Employees are willing to help you in unexpected situations	21	47	17	15	.38	−.64
Assurance							18 Courtesy of crew	17	43	28	12	.45	−.71
7 Flight safety operations	5	82	10	3	.15	−.92	**Tangibility**						
8 Airline performed confident actions with passenger tangibles	12	68	12	8	.24	−.80	19 Modernized aircraft and seat comfort	54	31	8	7	.62	−.39
9 Provide necessary information	17	23	37	23	.54	−.60	20 In-flight entertainment facilities	52	27	19	2	.71	−.46
10 Airline staff have the knowledge to answer questions	24	31	19	26	.43	−.50	21 Appearance of employees	31	47	15	7	.46	−.62
11 Employees are willing to help	45	29	19	7	.64	−.48	22 Quality of food and beverage	48	32	11	9	.59	−.43
12 Employees promptly handling flight delays	11	73	14	2	.25	−.87							

Table 8
TRIZ applied to improve airline service quality problems caused by adverse weather conditions.

TRIZ principles	Airline service quality improvement
#9 Prior counteraction	Providing software to support online enquiry of safety procedures before the flight.
#14 Spheroidality	Passenger and employee feedback and information to solve the conflict.
#16 Partial or excessive actions	Prior notice can prevent customer loyalty loss due to blind waiting.
#22 Convert harm into benefit	Providing hotels, day rooms or serving meals increases passenger experiences.

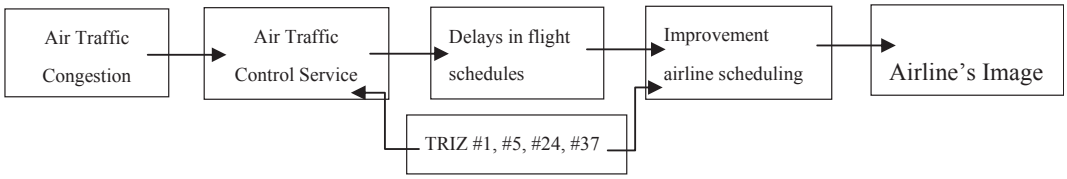

Fig. 5. Using TRIZ in the airline safety and service quality integration process for air traffic congestion.

Problem solving using TRIZ: The following TRIZ Principles were used to improve airline services: #9: Before commercialising a new service, a preventive analysis should be conducted to identify potential failure points in the service offering, #16: When it is difficult to achieve 100% success the airline should give prior notice and reasons to the passengers for the temporary unavailability of

Table 9
Customer requirement survey after air traffic using SERVQUAL and the Kano model.

Customer requirements	A	M	O	I	SI	DI	Customer requirements	A	M	O	I	SI	DI
Empathy							**Reliability**						
1 Employees provide individual attention to passengers	28	29	38	5	.66	−.67	13 Flights are on-time	48	23	19	10	.67	−.42
2 Alternative frequent flight schedules	31	21	36	12	.67	−.57	14 Airline staff perform the accurate service during the case	39	31	22	8	.61	−.53
3 Convenience airline schedules	34	41	21	4	.55	−.62	15 Insist on travel services	22	49	12	17	.34	−.61
4 The airline has modern equipment and facilities	59	31	10	0	.69	−.41	**Responsiveness**						
5 Employees understand passenger's specific needs	32	23	39	6	.71	−.62	16 Interest in solving the delayed flight problem	39	23	22	16	.61	−.45
6 Employees provide speed handling	39	23	31	7	.70	−.54	17 Employees are willing to help you in unexpected situations	41	23	26	10	.67	−.49
Assurance							18 Courtesy of crew	27	39	27	7	.54	−.66
7 Flight safety operations	21	56	17	6	.38	−.73	**Tangibility**						
8 Airline performed confident actions with passenger tangibles	21	61	10	8	.31	−.71	19 Modernized aircraft and seat comfort	38	21	23	18	.61	−.44
9 Provide necessary information	39	37	21	3	.60	−.58	20 In-flight entertainment facilities	41	19	32	8	.73	−.51
10 Airline staff have the knowledge to answer questions	41	31	13	15	.54	−.44	21 Appearance of employees	22	39	19	20	.41	−.58
11 Employees are willing to help	39	41	12	8	.51	−.53	22 Quality of food and beverage	53	26	19	2	.72	−.45
12 Employees promptly handle flight delays	21	37	23	19	.44	−.60							

Table 10
TRIZ applied to improve airline service quality problems caused by Air Traffic Service.

TRIZ Principle	Airline service quality improvement
#1 Segmentation	Improve service delivery efficiency by segmenting into service categories.
#5 Consolidation	Collaborate with the Air Traffic Service Unit to enhance services by transforming existing technology into new technologies or methods.
#24 Mediator	Improve Air Traffic Control by appointing a manager to communicate between the Air Traffic Control division and the work related to the aircraft.
#37 Thermal expansion	Increase control sectors for the Air Traffic Service Unit during the high season to improve air traffic flow and prevent flight delays.

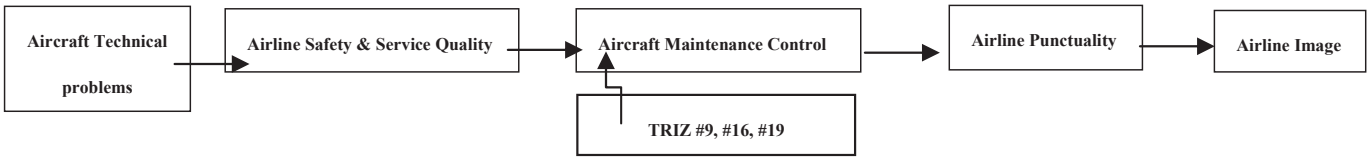

Fig. 6. Using TRIZ to resolve Airline image problems caused by technical malfunctions.

Table 11
Customer requirement survey after aircraft technical problems using SERVQUAL and Kano's model.

Customer requirements	A	M	O	I	SI	DI	Customer requirements	A	M	O	I	SI	DI
Empathy							**Reliability**						
1 When technical problems occur, individual attention is provided to passengers	27	42	23	8	.50	−.65	13 Flight On-time	19	43	21	17	.40	−.64
2 In the case of technical problems, airlines provide alternative frequent of flights	35	25	25	15	.60	−.50	14 Airline staff performed accurate service during the case	21	39	26	14	.47	−.65
3 Airline schedule convenience	21	39	21	19	.42	−.60	15 Insist on travel service	29	42	21	8	.50	−.63
4 The airline has modern equipment and facilities	23	21	49	7	.72	−.70	**Responsiveness**						
5 Employees understand the passenger's specific needs	22	41	24	13	.46	−.65	16 Interest in solving problem of delay flight problem	28	21	39	12	.67	−.60
6 Employees provide speed handling	31	35	24	10	.55	−.59	17 Employees willing to help you against unexpected situations	29	41	23	7	.52	−.64
Assurance							18 Courtesy of crew	27	54	12	7	.39	−.66
7 Airline performed safety operations	19	71	10	0	.29	−.81	**Tangibility**						
8 Airline performed confident s with passenger tangibles	27	33	29	11	.56	−.62	19 Modernized aircraft and seat comfort	62	16	20	2	.82	−.36
9 Provide necessary information	37	32	26	5	.63	−.58	20 In-flight entertainment facility	57	19	20	4	.77	−.39
10 Airline staff have the knowledge to answer questions	19	41	27	13	.46	−.68	21 Appearance of employees	49	27	20	4	.69	−.47
11 Employees are willingness to help	23	31	37	9	.60	−.68	22 Quality of food and beverage	21	23	39	17	.60	−.62
12 Employees give prompt handling of flight delay	29	45	25	1	.54	−.70							

Table 12
TRIZ applied to improve airline service quality problems that are caused by technical problems.

TRIZ Principle	Airline service quality improvement
#9 Prior counteraction	Before introducing a new service, preventative analyses should identify potential failure points.
#16 Excessive actions	Giving Prior notices and explanations to passengers for the temporary unavailability of services to prevent dissatisfaction and loss of customer loyalty.
#19 Periodic action	Airline equipment inspections should occur regularly to prevent accidental breakdowns.

services to prevent customer loyalty loss, #19: Equipment should be regularly inspected, including checking the aircraft during ground stops at line stations or at the base to prevent accidental breakdowns (Table 12).

4. Discussion and conclusion

In the airline industry, safety and serviceability are conducted by FAA, ICAO and IATA regulations and policies. There are many factors that affect the safety index and airline service such as aircraft characteristics and maintenance conditions, crew operations, air traffic control, weather conditions and airline management business strategies (Liou et al., 2007). According to the three case studies, service quality and safety contradictions may impact on airline image. Using inventive TRIZ principles to solve these conflicts provides a unique way of systematic thinking, by improving airline safety and service quality management integration to enhance airline image (Chai et al., 2005). Understanding the TRIZ contradictions as applied to the airline business will promote top quality service.

This research was conducted to identify service quality problems by interviewing passengers and employees, facilitating focus groups and observing airline operational procedures. The SERVQUAL dimensions integrated with 22 criteria from the Kano model were used as guidelines to survey and measure the quality of airline service. The safety operation survey was developed according to FAA regulations, IOSA, USOAP criteria and JACDEC annual safety calculations. Problem solving was performed by applying TRIZ principle to airline services. The evaluation resulted in a framework that integrated safety operations and service quality to improve airline image.

This research was based on three empirical case studies of safety and service quality contradictions. Case 1 presented an airline service quality problem resolution for flight delay due to adverse weather conditions. The problems were identified and it was found that severe weather conditions cause flight delays or cancellations. Because of airline safety regulations a contradiction occurred when safety was a priority, but the service quality did not meet passenger expectations. Thus, it was important to consider TRIZ principles #9, #14, #16 and #22. The solution suggested that extra services for passengers should be provided; this could turn a potentially poor customer experience into a good one. Case 2 demonstrated an airline service quality problem due to Air Traffic Congestion disruptions. Air traffic congestion, both on the ground at the airport and in the control zone or control area causes flight delays for scheduled departures and arrivals. Problem solving using TRIZ principles #1, #5, #24 and #37 was applied, linking technological policies and organisational solutions to increase air traffic volume capacity. Case 3 resolved airline service quality resulting from service equipment breakdowns. A passenger entertainment system malfunction causes flight delays or cancellations for maintenance. Problem solving using TRIZ principles #9, #16, #18 and #19 improved both the service quality and passenger satisfaction. The TRIZ theory of inventive problem solving was applied to simultaneously improve service quality and safety.

Improving safety control and serviceability in the airline industry is extremely important for successful airline management. In additional, airline image conformance is related to airline safety control and service quality. Thus, applying TRIZ principles to integrate safety and service quality will enable an airline to improve its image.

The profitability of airlines is influenced by passenger satisfaction which results in loyalty and repeat product purchase. Future research could apply data envelopment analysis (DEA) models. Merkert and Pearson (2015) found that a single-efficiency measure can combine the typical airline targets of maximisation of revenue passenger kilometres (RPKs), customer satisfaction and profitability. They used second-stage truncated regressions to show that only the cabin crew (neither fleet age nor low cost carrier (LCC) operation) had a significant impact on overall airline efficiency.

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