

Airline Service Quality Analysis Using Integration of Fuzzy Servqual, PGCV Index, and TRIZ Methods in Indonesian Full-Service Carrier Airlines

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Abstract— The airlines in Indonesia consist of full-service carrier (FSC), medium service carrier (MSC) and low-cost carrier (LCC) category. FSC has some characteristics where the baggage policy is free up to 20 kg, available in food, beverages, magazines, entertainments such as audio and video, economic or non-economic flight classes, executive lounge facilities and classrooms, and seating spaces. Preliminary research conducted in one of the FSC airlines showed some consumers complained about customer satisfaction issues. Based on these problems, the research objectives are to measure customer satisfaction of FSC airlines, to identify problematic service criteria with fuzzyservqual and PGCV index, and to design a system improvement using the TRIZ Method. The result of services quality measurement described that there are 12 criteria unsuitable for the passenger's expectation. The results of TRIZ analysis obtained suggest for improvement such as the placement of professional flight attendants when flying, providing support facilities such a waiting room to increase passenger convenience, placing expert staff for sympathetic information that can be accessed by passengers.

Keywords— FSC; service quality; fuzzyservqual; PGCV index; TRIZ methods.

I. INTRODUCTION

Air transportation using airplanes as a transportation mode that transports passengers and goods and is popular transportation in today's modern era. The commercial air transport industry is proliferating from year to year. This is proven by the results of the Census Directorate General of Transportation indicating that the number of domestic air transport passengers in 2003 was 19,285,473, then from year to year increased until the number of passengers air transportation users in 2015 was 72,563,813 people [1]. The rapid development of the aviation industry in Indonesia resulted in competition among airlines. This can be seen from the fixed offering price given, the quality of service and promotion offered to passengers. The airlines in Indonesia consist of several types of full-service carrier (FSC), medium service carrier (MSC) and low-cost carrier (LCC). The difference between the three types of airlines is the services provided such as the availability of food, snacks, and baggage capacity. Referring to Regulation of the Minister of Transportation of the Republic of Indonesia Number 14 of 2016 Article 5 Chapter II, it explains that the domestic full-service air transport service group has additional services, the maximum baggage policy of 20 kg is free of charge. It provides food, beverages,

magazines/newspapers, entertainment such as audio and video as well as provide services for economic or non-economic flight classes, executive lounge facilities and executive classrooms, and seating spaces. According to the Center for Asian Pacific Aviation and traveloka.com website, the airline which belongs to the FSC category are Batik Air and Garuda Indonesia. Service quality affects consumer satisfaction of air transportation users. Satisfaction as feelings of pleasure or disappointment experienced after comparing the performance perceptions with expectation [2]. The service quality encompasses five dimensions: consisting of tangibles, reliability, responsiveness, assurance, and empathy [3]. If the customer is satisfied with the service quality provided, it will arise customer loyalty, so that customer interest increases and eventually makes the customer repurchase [4]. Good quality products/services produced by good marketing program support will be able to increase customer satisfaction [5]. Several studies related to customer satisfaction in airlines have been done, such as factors affecting customer satisfaction at Malaysia Airlines [6], application of service quality and safety approach to improving passenger perception of the airline [7], and a study of domestic flight service quality criteria using VIKOR methods [8]. VIKOR is also used to rank the best airline concerning attributes such as tangibility, reliability,

security, and safety [9], created an evaluation model for service innovation impact [10], customer satisfaction and customer value. The result showed that customer value was influenced by customer satisfaction and service innovation enhancement in an airport. The relationships among airline tangibles, quality of personnel, satisfaction with the airline, the intention to repurchase and intention to recommend the airline was examined [11]. How the present state of airline business diversification has been achieved at both Lufthansa and Emirates using a mix of qualitative and quantitative methodologies was investigated [12]. The service quality attributes of airlines about their effect on customer satisfaction in a cross-cultural context by integrating the Servqual scale and the Kano model in a complementary way was also examined [13].

Based on preliminary research conducted in one of the FSC airlines informed that consumers still complain about customer satisfaction issues. A total of 50 respondents responded to the questionnaire. From the results of the preliminary questionnaire, the passenger complaint rate is still above 30%. Their complaints include lousy food, less friendly flight attendants, lack of entertainment facilities such as earphones and non-functioning LCDs. This condition indicates that the service provided by one of the FSC airlines has not fulfilled the characteristics of service standard by Regulation of the Minister of Transportation of the Republic of Indonesia No. 14 the year 2016 Article 5 Chapter II.

Based on these problems, the objective of the research is to measure customer satisfaction of FSC airlines, then to identify problematic service criteria with the fuzzyservqual method and Potential Gain Customer Value (PGCV) index, and the last is to design a system improvement using the Theory of Inventive Problem Solving (TRIZ) method. Comparing with Servqual, Fuzzyservqual is better in finding out the benchmark of one's evaluation of the service quality provided [14,15]. The Fuzzy set method also presents uncertainty because it uses linguistic variables rather than quantitative variables to present imprecise concepts [16]. By using the Fuzzyservqual method, the perception of each person in giving assessment can be equated. So the results of quality measurement with the method that is still ambiguous can be overcome. The Fuzzyservqual method was used to determine the problematic criteria and services that need to be improved [17]. It was used to focus on measuring airline service quality from international passengers by using weighted servqual scores as a calculation method [18]. The Fuzzy weighted Servqual method constructed to evaluate and understand the airline service quality [19]. In this research, PGCV Index is used to prioritize the improvement of quality attributes based on the potential value of customer satisfaction. PGCV index is excellent in recommending improvements from top to lower priority over the customer satisfaction [20]. TRIZ method is used to design the improvement because this method is systematic. TRIZ elaborated processes from problem identification phase until problem-solving, so that the improvement design can be applied systematically. TRIZ has proven its effectiveness and efficiency in technical solving [21], and that is one of the most used methods of optimization with the comprehensive coverage [22]. TRIZ was adopted in quality

improvement, reduction of product pollution, launch of new product, productivity improvement, product/process innovation, safety improvement and cost reduction [23]. TRIZ is a product and process innovation method to get solution and innovations that use various tools [24].

II. MATERIAL AND METHOD

A. Research Design

This study is descriptive research, that has two objectives, first is to measure certain social phenomena, and second is to describe the detail occurrence of an aspect of social phenomena [25]. This research was conducted by survey method using questionnaire. The questionnaire is an efficient data collection technique if researchers know the exact variables to be measured and know what can be expected from respondents [26].

B. Population and Sampling

The population is the whole subject of the research [27]. Meanwhile, the population is generalization region consisting of objects or subjects that have certain qualities and characteristics defined by the researchers to learn and then to draw conclusions [28]. Population in this research is passenger plane FSC, that is Garuda Indonesia and Batik Air. The sampling technique used in the population is nonprobability sampling, that is judgment sampling. Determining the amount of the minimum representative sample depends on the number of times the indicator of minimum 5 up to 10 [29]. The number of respondents in this research are 150 for each FSC airlines.

C. Identification of research variables

The variables used in this research include reliability, responsiveness, assurance, empathy, and tangible evidence provided by FSC airline passengers, Garuda Indonesia and Batik Air. The identification of the research variables is described in Table 1 and 2.

TABLE I
OPERATIONAL DEFINITIONS

Dimension	Operational Definition
Reliability (RL)	The ability to deliver services that match the promises offered
Responsiveness (RS)	The response of employees in helping customers and provide services that quickly and responsive, which includes the readiness of employees in serving customers, the speed of employees in handling transactions and customer complaints.
Assurance (AS)	Includes employees' ability to understand product knowledge properly, quality of hospitality, attention, and courtesy in providing security in utilizing the services offered and the ability to instill customer confidence in the company.
Empathy (EP)	Individual attention is given by the company to customers such as ease to contact the company, the ability of employees to communicate with customers, and the company to understand the wants and needs of customers
Tangible (TN)	Includes the appearance of physical facilities such as buildings and office font spaces,

Dimension	Operational Definition
	availability of parking spaces, cleanliness, tidiness, room comfort, completeness of communication equipment, entertainment and employee performance

Source: [30]

TABLE II
RESEARCH VARIABLES

Code	Attribute
RL1	There is an explanation for passengers regarding flying conditions
RL2	Detailed flight departure time information
RL3	An agent that serves all the information needed
RL4	Explanation of procedures and flight routes
RL5	The flight attendants demonstrate safety procedures
RL6	Display flight information from the monitor
RL7	Information on arrival time at the right destination
RL8	The reservation process is easy
RL9	There is information on check-in time
RL10	There is information about baggage provisions
RL11	Explanation of procedures and flight routes
RL12	There is information from flight attendants that the plane will land
RL13	Reservation service from the sales force, ticketing counter or agent
RS1	Clear payment service and standard procedures
RS2	An agent that serves all the information needed
RS3	Fast and responsive service upon reservation
AS1	Warranty for those who have booked tickets
AS2	The accuracy of flight schedule
AS3	Compatibility of fees paid with flight cost information
AS4	Responsive services during the delay
EP1	Sympathetic information-giving services
EP2	There is customer care at the airport
EP3	Flight attendants serve passengers while flying
EP4	Flight attendants helped passengers to bring down goods
EP5	Flight attendants greeted pleasantly on exit
TN1	Availability of reservation facilities
TN2	Comfortable waiting room
TN3	Nice check in service from counter
TN4	Availability of adequate baggage facilities
TN5	The available counter at the airport for flight information
TN6	Written safety instructions are provided
TN7	Completeness of facilities from the official agent (ticketing office)
TN8	Cozy cabin seats
TN9	Sufficient supporting entertainment facilities
TN10	Available special meat
TN11	The presence of baggage services from airlines
TN12	Available onboard shopping

Source: [7, 15, 18, 30]

D. Measurement of Customer Satisfaction and Identification of Problematic Variables using Fuzzyservqual and PGCV Index

For eliminating the subjective of the respondents, the questionnaire data will be obtained by using the Fuzzy method. Data analysis was performed with the initial phase

of integrating servqual with fuzzy. Fuzzyservqual integration performed include:

- Establishment of membership function with a triangular fuzzy number to measure customer's perception and expectation, the triangular fuzzy number is a fuzzy number with a piecewise linear membership function [31], calculation of service quality gap value, weight calculation, calculation of weighted servqual value and criteria level importance rating. The triangle curve is a building between two lines (linear) [32].
- Fuzzyfication process using the Overall Effectiveness Measure (OEM) formula that generates values (a, b, c) for each attribute. OEM formulas are as follows:

$$OEM_i = \left(\frac{1}{N}\right) \times ((PM_i^j \times PI^1) + \dots + (PM_i^j \times PI^N)) \quad (1)$$

- Defuzzification by using Arithmetic Mean with the formulation as follows:

$$Defuzzifikasi = (axbxc)^{1/3} \quad (2)$$

Potential Gain Customer Value (PGCV) is a tool frequently used in marketing analysis methods to measure customer satisfaction quantitatively. The calculation steps of PGCV index are as follows ACV (Achieved Customer Value), UDCV (Ultimately Desired Customer Value), PGCV used eq. (3), (4) and (5) consequences [33]:

$$ACV = I \times P \text{ (which is obtained)} \quad (3)$$

$$UDCV = I \times P \text{ (Maximum possible)} \quad (4)$$

$$PGCV = ACV - UDCV \quad (5)$$

E. Design of Improvement using TRIZ Methods

The TRIZ method is an extension of "Teoriya Resheniya Izobreatate Iskikh Zadach" in the Russian language or "Theory of Inventive Problem Solving" in the English language. TRIZ has advantages over other methods of solving the most difficult types of known problems but the unknown cause and searches direction. TRIZ has proven its effectiveness and efficiency in technical solving [21]. TRIZ includes a practical methodology, tool sets, a knowledge base, and model-based technology for generating new ideas and solutions for problem-solving [34]. TRIZ method can analyze conflict to get the innovation strategies [35], so allow solving the contradictions are defined [36]. TRIZ assumes that problems related to innovative design involve one or more contradictory statements and that when one parameter improves, another may deteriorate. TRIZ places 39 parameters, identified through patent analysis, into a matrix in which technical contradictions can be detected. It also outlines 40 principles of the creative invention to resolve the contradictions, and solutions are achieved by matching the contradiction with its appropriate principle [37]. TRIZ has some step, i.e., problem identification, initial solution problem analysis, problem modeling, contradiction analysis and contradiction elimination to solution proposals.

III. RESULTS AND DISCUSSION

A. Calculation Results of Fuzzy Servqual and PGCV index

Based on the result of data validation test with Corrected Item-Total Correlation value > r table then, the valid service attribute of Garuda Indonesia Airlines there are 26 service attributes, while for Batik airline there are 29 service

attributes, while for reliability test with Alpha Cronbach > 0,60, showing all the reliable service quality variables.

Gap value of each variable is obtained from the reduction of the average value of perception with the average value of customer expectations on each variable. Table 3 and 4 consequences shown the results of FSC Airline gap calculations. The calculation of Gap value by using fuzzyservqual method indicates that the service given is still not by the airline's passenger expectations. Thus, service improvement is prioritized on the criteria of higher value than the average gap. The PGCV index and the priority of improvement based on the ranking rank PGCV Index had the higher value then made a significant improvement priority.

TABLE III
CALCULATION RESULTS OF BATIK AIR AIRLINE GAP

Code	P	E	Gap	ACV	UDCV	PGCV
RL4	0,47	0,50	-0,03	4,24	10,45	6,21
RL5	0,60	0,60	0,00	7,20	13,07	5,87
RL6	0,50	0,52	-0,02	9,48	16,14	6,64
RL7	0,51	0,63	-0,12	10,41	16,13	5,72
RL8	0,54	0,72	-0,18	5,55	12,00	6,45
RL9	0,53	0,61	-0,08	7,69	14,70	7,01
RL10	0,53	0,58	-0,05	6,61	12,00	5,39
RL11	0,53	0,53	0,00	5,58	11,16	5,58
RL12	0,56	0,59	-0,03	7,69	14,70	7,01
RL13	0,49	0,53	-0,04	6,54	16,13	9,59
RS2	0,45	0,52	-0,07	7,20	16,13	8,93
RS3	0,46	0,60	-0,14	3,33	7,73	4,39
AS1	0,48	0,65	-0,17	4,28	9,26	4,98
EP1	0,48	0,62	-0,14	7,74	16,13	8,39
EP2	0,47	0,65	-0,18	5,80	8,99	3,19
EP3	0,47	0,67	-0,20	6,34	9,83	3,49
EP4	0,41	0,55	-0,14	9,49	14,70	5,21
EP5	0,47	0,56	-0,09	8,06	12,50	4,43
TN1	0,47	0,59	-0,12	6,80	14,69	7,90
TN2	0,48	0,68	-0,20	7,46	16,13	8,67
TN3	0,47	0,62	-0,15	5,14	13,07	7,93
TN4	0,52	0,62	-0,10	6,61	13,77	7,16
TN5	0,46	0,62	-0,16	6,54	16,13	9,59
TN6	0,55	0,64	-0,09	7,59	13,77	6,18
TN7	0,49	0,57	-0,08	10,41	16,13	5,72
TN8	0,52	0,69	-0,17	10,41	16,13	5,72
TN9	0,44	0,59	-0,15	10,41	16,13	5,72
TN10	0,43	0,53	-0,10	6,15	11,16	5,01
TN11	0,54	0,59	-0,04	6,35	14,70	8,35

TABLE IV
CALCULATION RESULTS OF GARUDA INDONESIA AIRLINE GAP

Code	P	E	Gap	ACV	UDCV	PGCV
RL3	0,53	0,80	-0,28	9,37	13,73	4,36
RL4	0,57	0,79	-0,22	11,65	17,07	5,42
RL5	0,59	0,79	-0,20	11,65	17,07	5,42
RL6	0,60	0,80	-0,20	6,65	12,90	6,25
RL12	0,59	0,84	-0,25	7,15	14,25	7,09
RL13	0,56	0,79	-0,24	10,74	15,73	4,99
RS1	0,55	0,81	-0,27	7,15	14,26	7,094
RS2	0,51	0,78	-0,27	6,65	14,88	8,23

Code	P	E	Gap	ACV	UDCV	PGCV
RS3	0,52	0,82	-0,30	11,65	17,07	5,42
AS1	0,54	0,85	-0,31	8,35	17,07	8,72
EP1	0,61	0,81	-0,20	9,73	14,25	4,52
EP2	0,59	0,83	-0,24	9,37	17,07	7,70
EP3	0,58	0,84	-0,26	8,57	17,07	8,50
EP4	0,56	0,77	-0,22	11,65	17,07	5,42
EP5	0,56	0,79	-0,24	10,74	15,73	4,99
TN1	0,56	0,80	-0,24	6,20	13,29	7,08
TN2	0,59	0,83	-0,25	7,28	14,88	7,60
TN3	0,57	0,84	-0,27	7,47	14,88	7,41
TN4	0,58	0,82	-0,25	8,35	17,07	8,72
TN5	0,57	0,84	-0,27	8,35	17,07	8,72
TN6	0,62	0,84	-0,22	8,64	15,73	7,09
TN7	0,56	0,81	-0,25	8,15	17,07	8,91
TN8	0,61	0,86	-0,25	6,75	10,73	3,98
TN9	0,60	0,84	-0,24	8,48	14,88	6,40
TN10	0,58	0,77	-0,20	11,65	17,07	5,42
TN11	0,60	0,81	-0,21	11,65	17,07	5,42

B. Proposed Design for Quality Improvement Using TRIZ

Step 1: Analyze the Initial Solution Problem

Based on the gap calculation from Fuzzyservqual and PGCV index, the criteria for improvement for each airline are obtained. Recapitulation of problematic service quality criteria based on the priority improvement scale is as in table 5 and 6 consequences as follows:

TABLE V
RECAPITULATION OF BATIK AIR PROBLEMATIC CRITERIA

Code	Criteria
TN5	Available counter for flight information
TN2	Comfortable waiting room
EP1	Sympathetic information-giving services
TN3	Nice check in service from counter
TN1	Availability of reservation facilities
RL8	The reservation process is easy

TABLE VI
RECAPITULATION OF GARUDA INDONESIA PROBLEMATIC CRITERIA

Code	Criteria
TN7	Completeness of facilities from the official agent
EP4	Flight attendants helped bring down passenger goods
TN5	The available counter at the airport for flight information
EP3	Flight attendants serve passengers while flying
RS2	An agent that serves all the information needs
TN2	Comfortable waiting room

Based on the consumer's expectation of the above problematic criterion, a preliminary improvement solution for the solution is solved, the initial solution as in table 7 as follows.

TABLE VII
INITIAL SOLUTION

Batik Air	Garuda Indonesia
Increase the number of the information counter	Addition of completeness in ticketing counter
Provides convenient lounge	Advanced training for flight

facilities	attendants
Designing complete information	Increase the number of the information counter
A more pleasant check-in service	Advanced training for flight attendants
Addition of reservation facility	Added Information agent
Easy reservation process	Added lounge facilities

Step 2: Problem Modeling and Contradiction Analysis

The problem modeling is done by using a functional diagram to analyze the causation arising from initial solution. Improving Feature and working feature shown in table 8 and 9 consequences as below.

TABLE VIII
IMPROVING FEATURE

Explanation	Engineering Parameters
Increasing the number of the counter at the airport	Skipping (#21)
Convenient lounge facilities	Stability of the subsystem (#13)
Clear Information Service	The accuracy of measurement (#28)
Service Accuracy	Speed (# 9)
Stewardess Training	Color changes (#32)
Easy service procedure	Ease of manufacture (#32)

TABLE IX
WORKING FEATURE

Explanation	Engineering Parameters
Added Facility	The volume of a stationary object (# 8)
Additional Facility expense	Color changes (#32)
Addition of Information	Device complexity (# 36)
Service design improvements	Shape (#12)
Additional training costs	Periodic action (#19)
Added employee	The volume of moving object (#7)

Step 3: Contradiction Elimination based on TRIZ Inventive Principles

The purpose of the different analysis is to identify two conflicting components in the system or two different terms on the same element or condition. After that to make improvements from the existing problems carried out the elimination of contradictions based on TRIZ Inventive principle. The inventive principle for each contradiction can be seen in Table 10 below.

TABLE X
INVENTIVE PRINCIPLE EACH CONTRADICTION

Improving Feature vs. Working Feature	Inventive Principle Weight
Skipping (#21) vs Volume of stationary object (#8)	30,6,25

Stability of the subsystem (#13) vs Color changes (#32)	35,19
Accuracy of measurement (#28) vs Device complexity (#36)	15,3,29
Speed (#9) vs Shape (#12)	35,13,15,34
Color changes (#32) vs Periodic action (#19)	28,26,7,1
Ease of manufacture (#32) vs Volume of moving object (#7)	13,29,1,40

Based on table 10, the inventive principle that emerged was 1, 6, 7, 13, 15, 19, 25, 26, 28, 29, 30, 35, and 40 . While inventive principle no. 1, 13, 15, 29, and 35 happened twice as well as others only appeared once. Then the elimination of contradictions against the inventive principle emerged. The preparation of a solution based on the inventive principle is what happens at least twice [38].

Step 4: Application of Inventive Principle

The proposed improvements by the principle of TRIZ consist of five recommendations. Firstly, based on the first principle, the airlines should make a segmentation for their passengers that distinguish full service, medium service, and low service. This segmentation is intended to provide different services for every price paid.

Second proposed solution, based on the sub-principle of "invert the action(s) used to solve the problem (e.g., instead of cooling an object or system, heat it)" whereby the airline can update information services with a more sophisticated system so it can facilitate passengers to conduct information search activities without having to ask the officer.

Third solution based on the sub-principle of "allow (or design) the characteristics of an object, external environment, or process to change to be optimal or to find an optimal operating condition" in 15th principle [14]. The airline can place expert staff who are familiar with the flight information in each airport counter so that passengers can access the sympathetic information process.

The fourth solution, based on the sub-principle of "pneumatics and hydraulics (intangibility)," in 29th principle [14], the airline should prefer aircrew or flight attendant and steward, during the flight entrusting to the stewardess or steward has to experience and has an understanding of the best flight service.

The fifth solution, based on the sub-principle of "change an object's or system's physical state" in 35th principle [14], airlines should improve the airport waiting room by adding supporting facilities that provide comfort for passengers such as more comfortable seats, reading area, and playground.

IV. CONCLUSIONS

Based on the measurement result of the FSC service quality, there are 12 quality criteria which indicate that the service received by the passenger is not suitable for the passenger's expectation. Therefore the problem criterion requires service quality improvement. Based on the analysis of TRIZ obtained suggestions for improvement such as the placement of flight attendants who are professional when flying, providing support facilities waiting room to increase

passenger comfort, placing expert staff for sympathetic information that can be accessed by passengers.

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