USING AIRPORT COLLABORATIVE DECISION MAKING (A-CDM) NETWORK TO IMPROVED AVIATION INDUSTRY SERVICE QUALITY

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ABSTRACT

The airport collaborative decision-making (A-CDM) network brings together airports, airlines, and air navigation service providers to share timely and accurate information in order to facilitate optimal decision-making, plan operations and improve air traffic management. Research found that aviation service quality can be improved by integrating the A-CDM network and SERVQUAL together with Kano's model to enhance service quality and improve network operational efficiency. The theory and methods of the A-CDM network combined with information technology and process innovation can maximise the serviceability of the aviation industry to improve network operation at the airport concerned.

KEYWORDS

Airport collaborative decision-making (A-CDM), SERVQUAL, Kano's model, service quality, aviation industry network operations

1. INTRODUCTION

The aviation industry plays a vital role in air transportation, affecting customers and economic growth both directly and indirectly. Air transportation enhances quality of life by enabling the movement of people and products all over the globe quickly and safely. Customer loyalty in the aviation industry is influenced by customer satisfaction, which leads to growth and maximises profitability. Service quality can be defined as the extent to which a service meets customers' needs or expectations [1]. It can also be defined as the difference between customers' expectations of a service and the perceived service. Service quality in the aviation industry impacts on increasing passenger demand and profitability, and through new and repeat purchases from more loyal passengers [2].

Over the years, the aviation industry has grown rapidly and this trend is continuing. The service quality impact of aviation is an important consideration with regard to airline operations, airport operations, and air traffic management caused by facility and airspace capacity. Increased capacity, efficiency and improvement of the aviation industry are the main goals. This creates an important supply and demand for the airport facilities and airspace capacity utilised by airlines. Outstanding airport facilities such as terminal buildings, aircraft parking areas, runways, taxiways and airspace capacity all support and enhance airline service.

The introduction of airport collaborative decision-making, or A-CDM, in the aviation industry aims to improve airline operational efficiency by integrating resources and operational data of airlines, airports and the air traffic management network with innovative processes. A-CDM is an

DOI:10.5121/ijcsit.2023.15105

important practical aspect of the aviation industry that is applied to improve airline, airport and air traffic management. A-CDM is a key factor that enhances all aspects of the airline industry. The airport slot coordinator will envisage how many additional slots can be approved; the airline operator will calculate how many flights can be scheduled based on passenger demand; and the air traffic control unit is responsible for developing suitable techniques to maximise the airport runway capacity together with the surrounding airspace. At the same time, the aviation ground handling equipment unit will utilise its resources adequately and service however many additional aircraft it can with the resources that it has available. This will lead to increased airline service quality through improved operational efficiency in the aviation industry.

The purpose of A-CDM is to improve the aviation industry network together with airport operational standards, and that has an impact on the airline turnaround process during preparation of the pre-flight phase. It also impacts on the aircraft take off phase and the approach for landing phase. A-CDM is primarily concerned with the effective operational network of airlines, airports and air traffic management. Consequently, the aim of A-CDM is to improve air traffic flow and capacity management by taking effective steps to reduce aircraft taxi times and turnaround times, which directly translate into economic benefits and improved environment-friendly conditions. However, due to the diverse composition of many actors in the network, the assessment of overall turnaround performance relies on the A-CDM network that includes airport and airlines management, air navigation service providers for air traffic management, and agency handing for ground operations at the airport concerned.

2. REVIEW OF LITERATURE

The A-CDM network purposes to improve aviation operational efficiency by reducing airport delays, improving the predictability of events during the progress of a flight, and optimising the utilisation of resources [3]. In order to support A-CDM network accomplishment, the network participants need to co-operate with up-to-date and accurate information through network operation procedures along with automatic processes, and a user-friendly network should be adopted and followed. According to Ghosh et al., one factor to help achieve optimal efficiency is the aircraft as the key connecting element between aviation industry stakeholders such as airlines, airports, air navigation service providers (ANSPs) and manufacturers [4].

According to the Civil Air Navigation Services Organisation [5], the principle of A-CDM is to put in place agreed cross-collaborative processes including network communication protocols, training, procedures, tools, regular meetings and information sharing, which moves ATM operations from stovepipe decision-making into a collaborative management process that improves overall system performance and benefits the individual stakeholders.

2.1. Participants Concerned in Airport Collaborative Decision-Making (A-CDM)

Airline Operator: One of the main operating costs of an airline is the fuel consumed by the aircraft in all phases of the flight. While still on the ground, the engines start up and fuel is consumed, which impacts on cost. Without proper A-CDM arrangements, flight delays will increase the airline cost through the additional allocation of manpower to deal with the non-alignment of services. In some cases, flight cancellations may occur due to inadequate and untimely aircraft rotation, leading to an increase in airline operating costs. Airlines are faced with reduced flexibility and increased congestion at airports. This manifests as lost business and, inevitably, higher costs.

Airport Operator: Airport congestion can also result in increased costs as this negatively affects the airline companies through loss of reputation and image because of unsatisfied passengers. Airport revenues come primarily from departure and arrival costs related to airline flight schedules. Inefficient air traffic coordination can lead to airport congestion and cause flight delays, and this, in turn, leads to loss of income. Also, regarding the performance dimension, irregular and inconsistent coordination leads to reduced operational efficiency, with the knock-on effect of asymmetrical capacity utilisation and unnecessary reallocation of flights, resulting in extra and unplanned costs for the airline operator.

Air Traffic Control Unit: A-CDM accomplishment could lead to increased efficiency of air traffic control (ATC) with enhanced responsibility for any adverse weather conditions, runway limitations, and other unforeseen emergency situations that many occur. Lack of coordination could result in a reduction in air traffic predictability, and this will inevitably impact on the operational efficiency of the ATC and manifest as a slower response rate to counter any adverse situation. ATC could face a loss in revenue from the inability to pass additional traffic through an already congested airport.

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2.2. A-CDM in Aviation Industry Operational Concept Model

The operational concept of A-CDM in the aviation industry is a process and network to identify information sharing, trust and collaboration as three participants in A-CDM at airports. In view of ATC, A-CDM information sharing replaces the "first come, first served" principle with the "best planned, best served" principle, and this is supported by pre-departure procedures. The aircraft ground handling unit can estimate accurate off-block and on-block times to accurately predict pre-departure sequencing from ATC [6]. Information sharing also makes it possible for the approach to be achieved through confirmations in the flight plan. Accurate information exchange is also vital for the air navigation service provider (ANSP) to allow usage of space for departing and arriving flights. For A-CDM participants in the aviation industry, real-time information through the network is important for effective cooperation between each of the separate functions.

The activities of airlines and airports are complementary in nature, but the industry is in need of better coordination between all the aviation partners, including airport operators, ground handling, crew coordination, airlines and air traffic controllers, if operational efficiency is to be achieved. A-CDM enables the partners to share information and work together more efficiently and transparently with the common goal of improved overall performance, bringing a universal situational awareness between all partners involved, as well as refining the processes and information flow, as shown in Fig. 1.

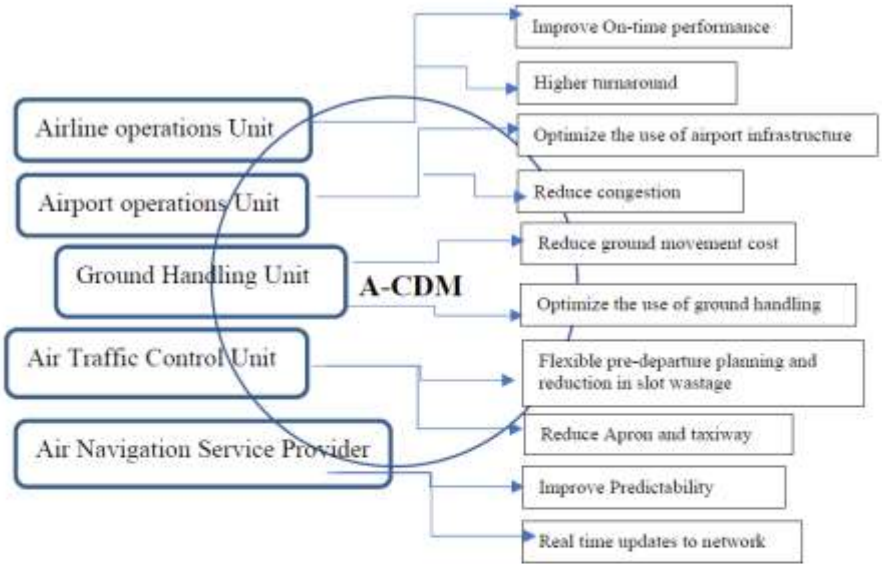

Fig 1. Airport collaborative decision-making (A-CDM) enables the network partners to share information and work together (Adapted from: Distribution Lab Analysis, Eurocontrol)

2.3. Airport Collaborative Decision-Making (A-CDM) Processes and Information Exchange Network

Implementation of A-CDM key activities involves information sharing and network integration across the participants, being the airline operator, airport operator and air traffic control unit cooperative [3]. The five phases of network integration are as follows.

Phase I: Streamlining Information Sources

This phase looks at integrating and centralising information flows within the air travel value chain. Key tasks revolve around defining a data integration strategy and conducting an AS-IS analysis of existing IT systems in order to create a streamlined, integrated IT foundation.

Phase II: Turnaround Performance Improvement

Here the focus is on improving the efficiency of the turnaround process. Key tasks for this phase include mapping the AS-IS turnaround process, identifying key milestones, and assigning timing and priority of updates along key milestones.

Phase III: Transparency in Sequencing

This phase promotes a more efficient and egalitarian sequencing process for flight management. Key activities include mapping the AS-IS taxi time calculation and sequencing process, at the same time identifying various parties and factors that influence taxi time and sequencing. There may also be a need to evaluate software solutions that can analyse all influencing factors to calculate more accurate taxi times.

Phase IV: Dynamic Take-off Predictability

Phase IV looks to improve take-off predictability both at the current airport and in the broader air travel network. Priority activities during this phase include building data flows from turnaround and sequencing processes to calculate more accurate take-off times. This information is shared with the central flow management unit (CFMU).

Phase V: Business Continuity Planning

The final phase focuses on preparing for contingencies and/or emergencies by building a business continuity plan. The key task in this phase is to establish disaster recovery and business contingency plans for all IT and information sharing platforms at an airport.

2.4. SERVQUAL and Kano's Model Integrated to Analysis in A-CDM network

An airline company can obtain a leading market share through offering superior service quality with an understanding of competitive advantages in the airline business. According to the information, processes and system exchange in A-CDM, the aviation industry, including airline operation processes such as pre-flight, in-flight service and post-flight service, can be assessed for service quality improvement. Gronross [1] and Parasuraman, Zeithaml, and Berry [7] developed a disconfirmation measurement called the GAP model. The SERVQUAL instrument is used to measure service quality and its five dimensions. The five dimensions are tangibles, reliability, responsiveness, assurance and empathy, containing 22 scales. Airline service quality is an important factor and should be evaluated. The RATER model of SERVQUAL with 22 criteria has been proposed as one method to measure airline industry service quality [8]. Service processes in the airline industry, including reservation and ticketing, check-in, boarding the aircraft, in-flight service and post-flight service, can all be assessed for service quality improvement.

The various service quality definitions can be formulated from the customers' perspective and what customers perceive to be important dimensions of quality. Service characteristics cannot be produced in advance; the quality of service must exceed customers' expectations and service quality outcome is also important. Customers' satisfaction will influence their loyalty, and growth and maximised profitability are primarily stimulated by customer loyalty. There is a complexity of service quality in the airline industry that is different from other service industries and includes comfortable seating, the ticketing and check-in process, the in-flight atmosphere, baggage service and arrival service at the destination [9].

Table 1. Aviation industry service quality criteria measurement applied with A-CDM network based on the SERVQUAL model

RATER dimensions	Aviation Industry Service criteria	Ref CODE
1. Responsiveness	Participants' interest in solving flight delay problems	R1
	Employees' willingness to help in unexpected situations	R2
	Courtesy of participant	R3
2. Assurance	Flight safety operations	A1
	Participant performed confident actions with customer tangibles	A2
	Participant provided necessary information	A3
	Staff have the knowledge to answer questions	A4
	Staff willingness to help	A5
	Staff promptly handle flight delays	A6
3. Tangibility	Modernised equipment and tools	T1
	Airport facilities	T2
	Appearance of employees	T3
	Quality of service	T4
4. Empathy	Employees provide individual attention to the participant	E1
	Alternative equipment and tools are available	E2
	Cooperates are convenience	E3
	Situation handling includes modern equipment and facilities	E4
	Employees understand the participant's specific needs	E5
	Employees provide speedy handling	E6
5. Reliability	Flights are on-time	Re1
	Participant performed accurate service during the case	Re2
	Participant insistence on travel service	Re3
Airline service quality measurement based on SERVQUAL and Kano's model [10]		

Kano's model was developed in 1984 by Dr Noriaki Kano and his colleagues. The model identified customer requirements and areas of service or product improvement by examining the nonlinear relationship between service performance and customer satisfaction [11]. To be applied in airport service, Kano's model distinguishes three types of service requirement.

A = Attractive requirements. Attractive requirements are neither explicitly expressed nor expected by the passenger. Fulfilling these requirements leads to more than proportional satisfaction. If they are not met, however, there is no feeling of dissatisfaction. These requirements are the product or service criteria that have the greatest influence on how satisfied a passenger will be with a given service.

M = Must-have requirements. A passenger regards the must-have requirements as prerequisites: he or she takes them for granted and therefore does not explicitly. These are basic service criteria applied in airport service. The passenger will be extremely dissatisfied if must-have requirements in service are not fulfilled to their expectation. On the other hand, as the passenger takes these requirements for granted, their fulfilment will not increase his satisfaction. Airport service fulfilling the must-have requirements will only lead to a state of not being dissatisfied.

O = One-dimensional requirements. With regard to these requirements, passenger satisfaction is proportional to the level of fulfilment: the higher the level of fulfilment, the higher the passenger's satisfaction, and vice versa. These requirements are usually explicitly demanded by the passenger.

I = Indifferent quality. Whether the airport service is present to passenger or not. The passenger is not very interested on this service.

R = Reverse quality. This reverse airport service quality has no passenger desires and expectations.

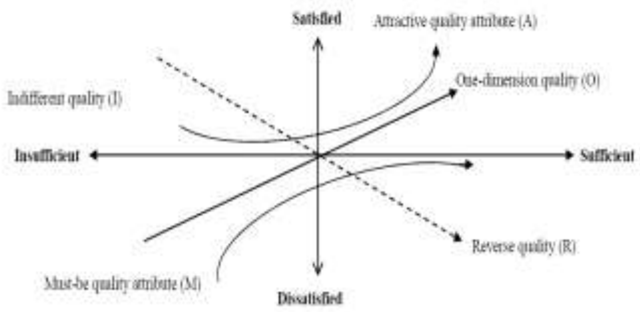

Fig. 2. Kano's excitement and basic quality model [10]

Based on Kano's excitement and basic quality model, the customer satisfaction (CS) formula is applied to indicate the qualitative values of the customer satisfaction index. According to Fig. 2, Ankur and colleagues [11] identified the CS coefficient measures of qualitative values of customer satisfaction and dissatisfaction. Attractive quality separates Kano's service requirements into must-have requirements (M), one-dimensional requirements (O), attractive requirements (A), indifferent quality (I) and reverse quality (R).

The passenger satisfaction coefficients formulae are as follows.

SI: Satisfaction index formula $$(SI) = \frac{(A+O)}{(A+O+M+I)}$$

DI: Dissatisfaction index formula $$(DI) = \frac{(M+O)}{(A+O+M+I)\times(-1)}$$

2.5. A-CDM and Airport Service Quality Improvement Analysis

The analysis has been conducted based on SERVQUAL and Kano's model as in the research by Jeeradist, Thawesaengskulthai, and Sangsuwan [10] [11]. The systematic approach to service quality improvement has been developed based on SERVQUAL and Kano's model. The purpose is to improve service quality at the airport through attractive quality in terms of passenger satisfaction, integrating SERVQUAL and Kano's model.

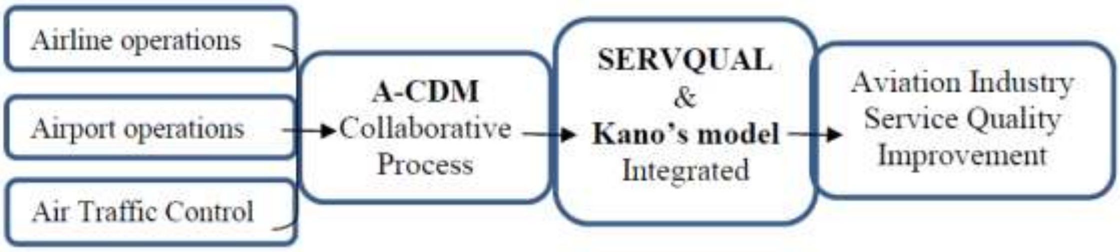

Fig. 3. Proposed integrated model of A-CDM network and SERVQUAL to enhance aviation industry service quality

The research conceptual framework shown in Fig. 3 was developed based on SERVQUAL and Kano's model in Jeeradist, Thawesaengskulthai, and Sangsuwan's [10] past research. The literature review studied the case of service quality failure caused by severe weather conditions at the airport terminal service. In the interests of safety, flights are unable to operate in severe weather conditions, and so cancellation or delaying the flight to await improved weather is the best practice for airline operations.

3. SYSTEM MODEL

The research framework was developed by integrating A-CDM and five dimensions of the SERVQUAL and Kano's model forming part of this study. The research was conducted through personal interviews, focus group interviews, and direct or participatory observation with the population, which consisted of aviation personnel including airline flight operations officers, airport operational staff, air traffic controllers and passengers with experience of the service in the aviation industry. The methodology for collecting data and systems analysis is shown in Fig. 4.

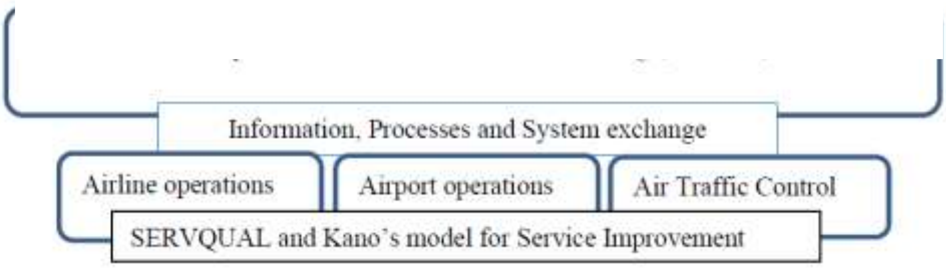

Fig. 4. The integration process of information, processes and system exchange in the A-CDM with SERVQUAL and Kano's model

3.1. Analysis in Aviation Industry Service Quality Improvement

The research framework shown in Fig. 3 was developed based on the proposed integrated A-CDM network, SERVQUAL and Kano's model to enhance the aviation industry service quality. The systematic research approach to the aviation industry proposed service improvement with attractive quality development based on A-CDM and SERVQUAL to enhance the aviation industry service quality.

3.2. Empirical Processes in Aviation Industry Service Quality Improvement

The qualitative method and questionnaire were based on the A-CDM network and SERVQUAL's five dimensions as the RATER model. These included reliability, assurance, tangibility, empathy and responsiveness, with 22 attributes that defined service quality as the degree of discrepancy between aviation industry participants' expectations and their perception of the service performance they received [1] [7]. Both group and individual interviews were conducted, together with direct or participatory observations of aviation industry participants, which included aviation industry employees and customers. The questionnaire was developed following testing and revision of the A-CDM and SERVQUAL models by formulating questions on the service attributes to gain feedback from aviation industry employees, as shown in Fig. 5.

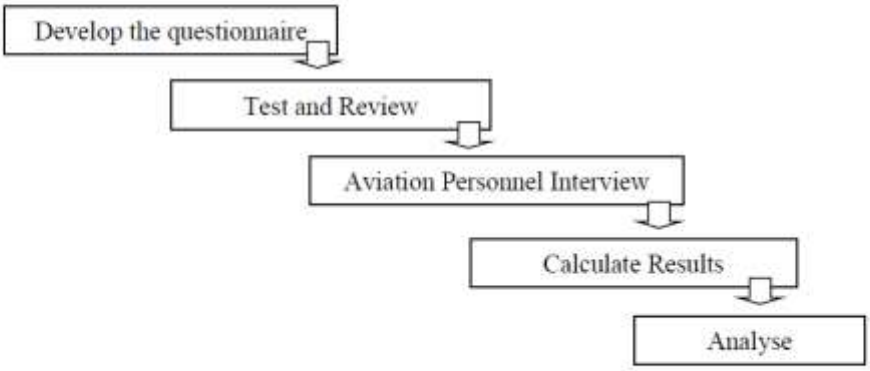

Fig. 5. The questionnaire development process

4. PROPOSED METHOD

This qualitative research has been developed through study of the five dimensions of the SERVQUAL, personal interviews, focus group interviews, and direct or participatory observation of the population that consists of airline passengers and airport and airline staff who have experienced the services in the airport terminal. The methodology for collecting the data includes the literature review and the historical case study.

4.1. Analysis of Airline Service Quality Improvement

The research framework proposed for airport terminal service improvement with the service criteria as shown in Fig. 1 was developed based on SERVQUAL and the five dimensions of the RATER model [10]. The purpose is to improve the passenger experience by using airport terminal service criteria for the measurement of airport service quality with a passenger satisfaction survey method.

4.2. Empirical Case Study of Airport Terminal Service Quality to Improve the Passenger Experience

The case study focuses on the service quality failures caused by airport congestion due to severe weather conditions. In the interests of safety, flights are unable to operate in severe weather conditions; thus, cancellation or the delay of flights in order to await improved weather is the best practice for airline operations. The survey was conducted with a questionnaire based on SERVQUAL and the five dimensions of the RATER model as shown in Table 2.

Table 2. A summary of airport terminal service quality measurement based on SERVQUAL and the five dimensions of the RATER model

Service measurement dimension	**Criteria code**	***PERC%**	****EXP%**	**SI**	**DI**
Responsiveness	R1	60	85	81	-47
	R2	80	95	75	-35
	R3	95	92	78	-72
Assurance	A4	91	95	82	-17
	A5	87	95	70	-82
	A6	89	95	73	-87
	A7	82	91	81	-76
	A8	78	90	79	-72
	A9	81	93	71	-89
Tangibility	T10	92	95	84	-73
	T11	91	95	87	-69
	T12	89	95	92	-76
	T13	91	95	84	-79
Empathy	E14	86	97	78	-89
	E15	67	94	83	-78
	E16	91	95	88	-82
	E17	94	92	91	-87
	E18	82	90	82	-86
	E19	87	95	87	-72
Reliability	RE20	81	92	91	-85
	RE21	89	92	79	-87
	RE22	78	90	73	-89

Note:
*PERC = Passenger perception, **EXP = Passenger expectation
SI = Satisfaction index, DI = Dissatisfaction index
Results for SI or DI are based on creiteria measurement

Fig. 6. Airport terminal service quality satisfaction and dissatisfaction index

5. RESULTS

The data in Table 2 and Fig. 6 show the results based on the airport terminal service quality measurement with SERVQUAL, the five dimensions of the RATER model and the 22 criteria. The satisfaction index (SI) and dissatisfaction index (DI) have been calculated based on customer surveys. The problem identification is as follows.

1) The responsiveness evaluation shows that the service code R3 has the lowest DI at -72 and concerns the courtesy of the ground handling staff. The highest SI code is R1 at 81 and concerns solving flight delay problems.
2) The assurance evaluation shows that the service code A9 has the lowest DI at -89 and concerns employees' prompt handling of flight delays. The SI code is A4 at 82, which refers to airport safety operations.
3) The tangibility evaluation shows that service code T13 has the lowest DI at -79 and concerns the quality of the ground support equipment and facilities. The highest SI code is T12 at 92, which concerns the appearance of the airport staff.
4) The empathy evaluation shows that service code E14 has the lowest DI at -89 and concerns employees providing individual attention to passengers. The highest SI code is E17, which is that the airport handling includes modern equipment and facilities.
5) The reliability evaluation shows that service code RE22 has the lowest DI at -89 and concerns airport staff performing accurate service procedures during an irregularity. The highest SI code is RE20 at 91 and concerns airport operations supporting flights being on time.

In the interest of airport terminal service quality improvement in order to meet passengers' expectations of the implementation of airport terminal service criteria, future research may use Kano's model of attractive requirements, which allows problem solving by fulfilling these requirements in airport service quality criteria with reference to SERVQUAL and the five dimensions of the RATER model. This includes the evaluation of responsiveness, which shows that service code R3 (concerning the courtesy of the ground handling staff) is lowest on the DI, and R1 scores highest on the SI: this concerns solving flight delay problems. Furthermore, the evaluation of assurance shows that service code A9 (employees' prompt handling of flight delays) is lowest on the DI, and A4 (airport safety operations) is highest on the SI. The tangibility evaluation shows that service code T13 has the lowest DI (concerning the quality of the ground support equipment and facilities), whereas the highest SI is code T12, the appearance of airport staff. The empathy evaluation shows that the service code E14 has the lowest DI (concerning employees providing individual attention to passengers), and the highest SI is E17, which is that airport handling includes modern equipment and facilities. The reliability evaluation shows that the service code RE22 has the lowest DI (concerning airport staff performing accurate service procedures in case of an irregularity), and the highest SI is RE20, indicating that the airport operations support flights being on time. The criterion of attractive airport terminal service was analysed and it was found that airport operators could provide extra services to support passengers when the service failure is caused by flight delays or cancellation due to severe weather conditions. In this case, extra service with alternative choices could help to improve airport terminal service quality in terms of attractive service; therefore, airport operators should arrange this extra service for passengers. This will fulfil passengers' requirements and result in a more attractive service.

In this paper, we have focused on the study and proposal of a conceptual framework of airport terminal service quality criteria which is extended to airline passengers' experience. The purpose of service quality management is to achieve higher service quality with an attractive service experience for passengers. Using study and discussion of the methodological issues encountered in airport terminal services, measurement of the airline service impacts of extended scale, and study and discussion of the empirical criteria in airport terminal services that affect airline service quality and passengers' experience, this paper presented the relationship of SERVQUAL and the five dimensions of the RATER model with airport terminal services quality. The study shows that a solution to each of the criteria in airport terminal services should be found in order to facilitate improved serviceability in airport terminal services, as this is extremely important in aviation industry service management. Also, airline passengers' experience is related to the airport terminal service quality improvement. The SERVQUAL and the five RATER model dimensions conducted with 22 criteria can be applied to the relationship in order to support airport terminal service quality improvement and enable airlines to improve the experience of their passengers.

6. DISCUSSION AND CONCLUSION

Airport collaborative decision-making, or A-CDM, is based on the network of service attractions that participants in the aviation industry can expect to receive. There are many factors that may affect aviation service, such as airport congestion due to weather conditions causing flights to be delayed by air traffic management and the safety management system [10]. The processes for service quality improvement in the aviation industry, the research framework and the network analysis indicated that guideline criteria to measure service quality provided to participants can improve the service goals of the aviation industry. The five dimensions of SERVQUAL [1] [7] were integrated with A-CDM network to solve the problem and improve aviation industry service quality and operational efficiency for participants. Understanding the SERVQUAL methods applied to the aviation industry, together with comprehension of A-CDM to improve the aviation industry service quality, is one pathway to attain top service quality for all participants in the A-CDM network.

The qualitative research was conducted following the guidelines of developing the questionnaire, testing and review, interviewing key aviation personnel as informants, calculating the results and analysing problems in the case study by interviewing participants, focus groups, and observing procedures in the aviation industry service [11]. The SERVQUAL model with 22 criteria and the A-CDM network model were applied as guidelines to survey the aviation industry service quality. The research framework and system analysis methodology were developed based on problem solving of aviation industry service quality enhancement using Kano's model [12] [13].
In conclusion, the purpose of this research was to study and propose a conceptual framework to maximise service quality in the aviation industry by integrating the five dimensions of SERVQUAL with A-CDM. The A-CDM network was applied as a tool to improve the aviation industry service quality and link to attractive service improvement. The study showed that the improvement of serviceability in the aviation industry is extremely important in aviation management. Also, aviation industry conformance is related to attractive service quality. Relationships between product dimensions and service quality criteria were applied to the SERVQUAL model and A-CDM network to integrate and identify turnaround performance improvements [14] that could be made in the aviation industry service quality measurement.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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