

A Review of Lean Management Models at King Khaled International Airport (KKIA)

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Abstract: This study evaluates processes of enhancing service quality that is provided to airports' customers. Applying lean practices can assure the enhancement of service quality from the customers' perspective. Through this study King Khalid International Airport (KKIA) has been chosen for the purpose of enhancing the passenger's flow, by applying two Lean practices, which are SERVQUAL and Lean Six Sigma 'DMAIC' or Define, Measure, Analyze, Improve and Control. These two practices are chosen because SERVQUAL is described as one of the best Lean's methods as it use five stages to evaluate them and improve service quality and DMAIC used for the purpose of enhancing the Level of Service (LOS) which can be applied in airports. Through this study, several studies about applying Lean algorithms in International Airports for improving performance and LOS have been reviewed. This study also reviewed the effects of applying these practices specially SERVQUAL and DMAIC on these airports and how they enhanced and improved the overall level of service.

Key words: DMAIC, KKIA, lean management, LOS, performance, SERVQUAL

INTRODUCTION

KKIA is located approximately 25 km away from the city centre of Riyadh and is one of the three main international airports in the Kingdom of Saudi Arabia (KSA). Since the airport started operating in 1983; it is the gateway to the capital of KSA, Riyadh (Kloosterziel *et al.*, 2009).

Service quality is defined as "the customers' long-term and cognitive evaluations of a firm's service delivery" (Lovell and Wright, 2001) Potential improvement in service quality and speed in dealing with customers can be overshadowed by the opportunities of cost reduction. There is a growing awareness of the importance to deliver high quality service with shorter lead times. And, from this opens many business opportunities to improve service quality through reducing the service level's variations and increasing the service delivery speed. Additionally, there has been rapid growth in implementing and developing new algorithms for improvements in service levels such as Lean Six Sigma (Su *et al.*, 2006) and SERVQUAL.

The purpose of responding to customer's demand is creating more value for services. Creating more service value at lower costs is the Lean objective. A Lean Six Sigma methodology known as DMAIC is based on five stages for solving a problem, which are Define, Measure, Analyze, Improve and Control. Through applying these five stages, the objective of Lean can be applied for any process (Su *et al.*, 2006).

SERVQUAL is another method used for achieving the Lean objective and is described as one of the best in the field of assessing and evaluating perceptions and expectations. SERVQUAL has five stages for the purpose of estimating the quality of service; these stages are "tangibles, reliability, responsiveness, assurance and empathy". And can be applied for the purpose of achieving the objective of Lean via focusing on the customer expectations (Choua *et al.*, 2011).

Aim and scope: The main aim of this study is to review the principles and models of lean management in KKIA and make a comparison between models applied at different airports; the comparison will concentrate on the effectiveness of different models on the customer satisfaction.

This study has been done during the Ph.D. plan at the Department of Mechanical and Design Engineering; Plymouth University, UK. Data collection for the manuals and information of KKIA was conducted at the Kingdom of Saudi Arabia (KSA).

LITERATURE REVIEW

Kloosterziel *et al.* (2009) discussed in details the passengers' flow process in KKIA which starts with the entry of passengers to the building through the elevated departure road after parking the car in the basement of the airport land. The departure level can be reached through the vertical circulation from the airport's basement via the

arrival's level. Hold baggage is security checked via an X-ray scan, before being placed on conveyor belts at check-in for transporting baggage to the makeup area located in the basement. After check-in, a ticket check is necessary which is followed by passenger's and hand baggage's checks using the X-ray machines. Passengers can then enter the airside departure lounge. Finally, passengers can only board the aircraft after completing boarding pass control check. The international departure flow has the same discussed procedure (domestic departing passengers) with a single exception that the passenger should pass through immigration office before the security check in order to check foreign passports. "Domestic arriving passengers walk directly into the baggage reclaim hall that is connected via a welcome hall to the arrival curb or go down and enter the parking area via a corridor". The other type of passenger flow is the international arrival flow where international passengers enter the terminal via the passenger loading bridges. Within the terminal, international passengers pass through in order; immigration check; passport control; baggage

reclaim; and customs control which is prior to the welcome hall. The passengers are then able to enter the arrival curb directly or go to the parking area in the basement via a corridor. Through the transfer flows, the port of entry procedures should be followed; hence passengers with connecting flights should collect their baggage, recheck again and wait for the next flight. These passengers should follow the same discussed procedures for departure and arrival, while the international to international passengers are passing in KKIA through separate security and passport check. They ascend to the departures level for boarding directly after the controls and security check. For the domestic to domestic passengers; no security check is necessary and hence passengers can flow directly to the departure hall. Transit passengers should remain at the airside or in the same aircraft depending on the arrangements of the flight and the airport. Transit passengers are not supposed to collect the baggage and they are supposed to check their hand baggage, while they are able in some cases to transfer their way of travelling. Figure 1 represents the types of passenger flow in KKIA (Kloosterziel *et al.*, 2009).

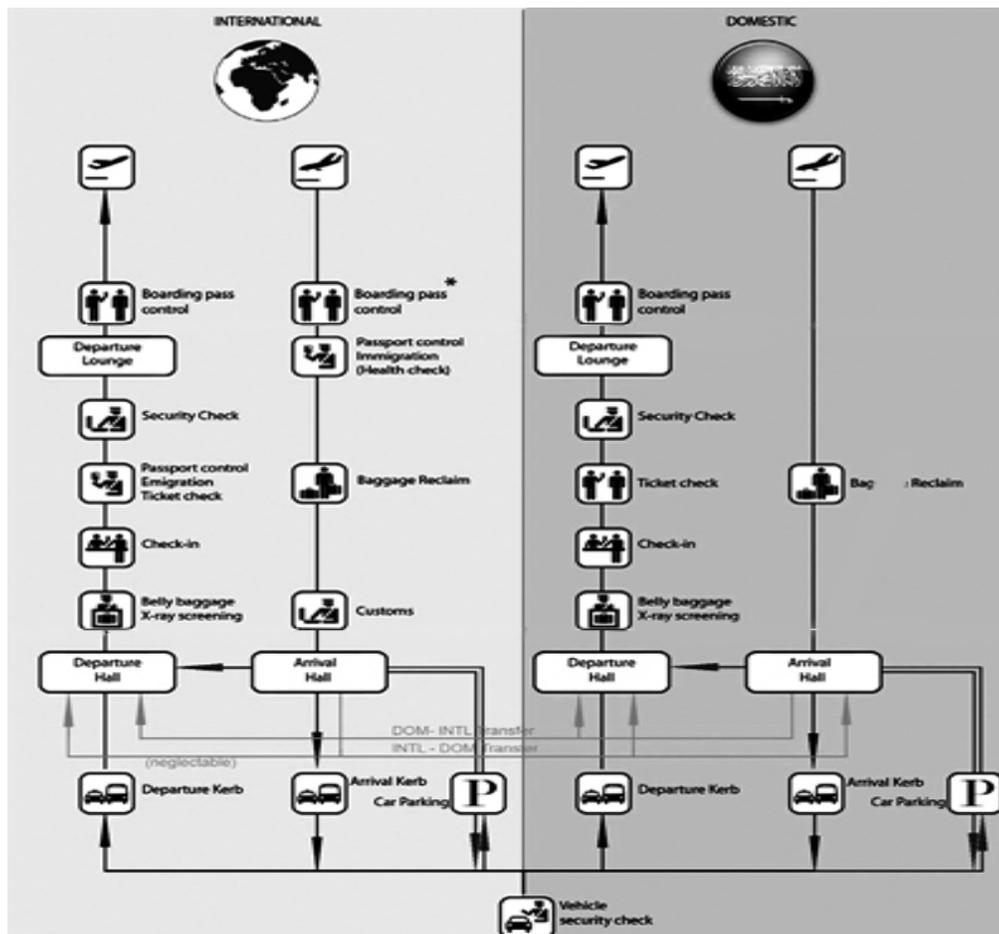


Fig. 1: Passengers flow scheme through the airports terminals (Kloosterziel *et al.*, 2009)

Su *et al.* (2006) discussed the effectiveness of Quality in the airports as a solution for the slow processes and vibrations reflected by customer satisfaction. It has been shown that Lean management with Six Sigma model can be combined and used as an integrated methodology of Lean Six Sigma for the purpose of improving service-quality. The effectiveness of the introduced methodology can be measured through help-desk services that deal directly with costumers' complaints. While DMAIC methodology is suggested as a six sigma tool for solving business problems and Lean of Process mapping. The rationale behind combining both methodologies was strongly presented in both sharing intent for cost reduction and productivity enhancement where Six Sigma focus its attention on minimizing process variation and enhancing control and Lean eliminates the wastes and promotes flow and standardisation for work (Su *et al.*, 2006).

Choua *et al.* (2011), evaluated the quality of airline services. They presented a method known as weighted SERVQUAL model for airline's service evaluation. Previously SERVQUAL method has been used by researchers in this field but weighted SERVQUAL have been studied by a limited number of researchers. Researchers suggested the use of linguistic terms in order to describe and explain the perception value, expectation value and the evaluation criteria's weight. Hence, the theory of fuzzy was suggested for the process of evaluating the quality of airline services to deal with the uncertainties that might be encountered. Hence they assumed the establishment of the weighted SERVQUAL method that is fuzzy based for the purpose of evaluating the airline's quality service. Furthermore, they provided interesting suggestions for the improvement of the quality of services in the airport (Choua *et al.*, 2011).

Liou and Tzeng (2007) introduced a non-additive model developed by their study for improving and evaluating companies and airlines' service quality. They stated that quality of service was a composite of many attributes and independent characteristics that might be evaluated incorrect using conventional additive method. For that reason they proposed a fuzzy integral, based on factor analysis for the purpose of integrating the inter-dependent performance for attribute ratings. For the hierarchy analytic process a comparative approach of pair-wise was adopted for the purpose of determining weight. And as a final step simple additive method for weight and Grey relation analysis are used for the purpose of finding the service quality of airline (Liou and Tzeng, 2007).

Kuo and Liang (2011) presented an efficient procedure for the purpose of evaluating "Northeast Asian International Airports' service quality" through managing customer surveys. They found that the service quality evaluation was Multi Criteria Decision-Making (MCDM). Through uniting the "VIKOR" concepts, which is a technique lied on defining the negative and positive ideal

points and the concepts of the Gray Relation Analysis (GRA), the MCDM; which is a fuzzy method that is considered as a new method and was proposed for the purpose of dealing among the problems and difficulties of evaluating the service quality in international airports. The authors mentioned that an experimental study was proposed for the purpose of evaluating seven major International airports' service Northeast-Asian regions; the evaluation has been put forth for the purpose of illustrating the proposed model's application. The results of this research proved that the procedure was efficient for tackling the difficulties and problems of MCDM that involves qualitative attributes' subjective assessments in a fuzzy environment (Kuo and Liang, 2011).

Fodness and Murray (2007) developed a service quality conceptual model in an airport through an empirical investigation of passengers expectations about the service. They developed a self-report scale through using quantitative research for the purpose of measuring the expectations of passenger of airport service quality, then they tested the dimensionality and finally they evaluated scale validity and reliability. This study has provided several implications about the airports' service quality for research and practice. The researchers also supported relationships between that dimension which is primary with two composed sub dimension services that contribute to the productive activity of passengers and maintenance, as well (Fodness and Murray, 2007).

Lubbe *et al.* (2011) showed how service quality at airports became increasingly important with the continued growth in the air traffic. They investigated the quality service for passengers' perceptions at O.R Tambo International Airport (ORTIA), South Africa, by applied existing models which placed the passenger expectations' concept central to measure specific performance level for an airport, resulting in investments in airport improvements and staff training. Leisure and business travellers were shown to be critically important in the performance level and services offered by airports and particularly at ORTIA and there were significant differences between the frequent and infrequent travellers' perceptions (Lubbe *et al.*, 2011).

Chang and Yeh (2002) in an article titled "A survey analysis of service quality for domestic airlines" presented an effective approach for evaluating domestic passenger airline's service quality by customer surveys. This reflected the inherent impression and subjective of the perceptions of customer in order to quantify levels of quality that are provided by airlines with multiple service attribute respective, resulting in survey results processed and represented as fuzzy sets. Fuzzy Multi-criteria Analysis (MA) model was used for the purpose of formulating the evaluation problem. An effective algorithm was used to solve the model; this algorithm incorporated the attitude of decision makers or preference for assessment of customer on performance rating and

criteria weights. They mentioned a domestic airlines' empirical study on a competitive route in a high-way in Taiwan which was conducted to demonstrate the approach's effectiveness (Chang and Yeh, 2002)

Adler and Berechman (2001) discussed in the article titled "Measuring airport quality from airlines' view point: an application of data envelopment analysis" a model for the purpose of determining the relative quality and efficiency of airports as an effective strong factor on the choice of airlines hubs. Previous studies used subjective data from passenger for evaluating airports' quality, whereas they proposed to define airport quality from the viewpoint of airlines. Accordingly they solicited evaluations of airlines several non-European and European airports through detailed questionnaires. The median score's statistical analysis had shown that those evaluations vary in a considerable way relative to the airports and quality factors. They used Data Envelopment Analysis (DEA) as a key methodology for the purpose of determining the relative airports' quality level. This methodology was adapted through using the component analysis principle (Adler and Berechman, 2001).

Correia *et al.* (2008) detailed a methodology that can be used for developing the standards LOS at terminals of airport on the perceptions of user. The methodology was developed in order to derive quantitative values in passenger perceptions of service, which the researchers developed from airport surveys. An evaluation of the check-in counter was done, which had a bearing on the perceptions of user of LOS: space available per person, waiting time and processing time. Data obtained from survey of a passenger was used through this study at "São Paulo/Guarulhos International Airport". The results showed the ability for quantitative perception scales to be driven from qualitative data survey (Correia and Wirasinghe, 2005).

Correia and Wirasinghe (2005) developed measures of overall LOS for the passenger terminals. Furthermore, they discussed the importance of these measures and their usefulness for evaluating the overall LOS according to the user's perceptions in a single scale. The procedure of airport's assessment as an entire unit has been done through collecting several physical variables with regard to socio-economic variables and observing passengers who may influence the evaluation process. A technique of psychometric has been used to obtain the quantitative ratings of LOS from the survey data and to obtain and find arithmetical associations between the quantitative ratings and the global indicators. The methodology and its application were illustrated at the "Sao Paulo/ Guarulhos International Airport" in Brazil. Their study aimed mainly to provide a method which is useful to collect the passengers' responses concerning the overall LOS at the airport passengers' terminal (Correia *et al.*, 2008). They also discussed and provided a method for collecting the responses from the passengers for the LOS at the airport

passengers' terminal. It was found to be complex, but the responses showed that the approach was appropriate to derive the relationship (quantitative type) between the passengers' responses and the physical measures. They used the psychometric technique for scaling and to obtain the quantitative LOS measures. In their research, they performed regression analysis to obtain the relationship between global indices and the quantitative LOS. Furthermore, they indicated the usefulness of the discussed methodology to be applied in Brazilian airports and/or international airports as well. They have concluded that the overall measure of the LOS at the passengers' terminal can be better understood and measured using the proposed methodology (Correia *et al.*, 2008).

Tam and Lam (2004) discussed and proposed an innovative idea related to the passengers' orientation at the passengers' terminal. In some cases, the passenger is not able to define his/her destination; however, signs are available to guide the passenger to the appropriate gate/terminal. They described the quantitative measure and usage visibility index to evaluate the passengers' ease of finding for the required terminal in the Hong Kong International Airport (HKIA). They proposed a set of standards for the LOS for the passengers' orientation into the airport. All proposed standards were based on the terminal's visibility indices. In the results, they defined the facilities that require orientation improvement based on matching the facilities' weight and the corresponding visibility index. Hence it was approved that the visibility index and the proposed standards of LOS should be used for the improvement and design of the layout and way-finding in the passengers' terminal (Tam and Lam, 2004)

Yu (2010) presented a model known as "Slacks-Based Measure Network Data Envelopment Analysis (SBM-NDEA)". The model was introduced for performance measurement with "quasi-fixed inputs" of terminal, apron and runway areas and provisions of free linking capacity as well. Operations efficiency in the airport is decomposed into service and production efficiency. Landside and airside aspects are the further decompositions of the service efficiency. Based on his proposed model; the empirical findings suggested that the efficiency in the service process is not guaranteed by the airport's production efficiency in the Taiwan's domestic airports. In his research, output shortfalls and input excess were estimated with respect to service and production processes (Yu, 2010).

Barros *et al.* (2007) stated that there are differences between the needs of the transfer passengers and the terminating and originating passengers. Their research analyzed different views for the transfer passengers regarding the services' quality at the terminal building, regression analysis were carried on the data collected at "Bandaranaike International Airport in Sri Lanka". Services and facilities of the transfer passengers were identified with the strongest regard to the overall level of service. Their analysis results have shown that the

courtesy of the “quality of the flight information display” and the “security check staff” are of high value by the transfer passengers (Barros *et al.*, 2007).

Appelt *et al.* (2007) introduced a full discussion for the check-in systems in airports. The research included that delays in check-in systems can vary with “times of the day”, “day of the week” and “check-in modes related to customers’ preference”. The article included that in order to build any simulation model for predicting any delay in check-in systems, data should be collected for the check-in-system. The processes of data collection, simulation modeling and the analysis scenario for the check-in-process at “Buffalo Niagara International Airport” were explained in their study. Their study showed that in order to gain the necessary information related to the passengers’ experience, results obtained can be linked to other processes such as parking and security checkpoints. Finally, the results have shown that the study was successful to observe the main aim which is the identification of delays in the check in process and the creation of valuable scenarios to improve the efficiency (Appelt *et al.*, 2007).

Brunetta and Romanin-Jacur (2004) discussed and implemented a flexible and friendly simulation model for the passengers and baggage flow at the airport’s terminal. They discussed the lack of flexible and friendly operational model for the operations at the landside which was the motivation to create a new adaptable simulation model for various configurations in the airport; this aimed to estimate the time behaviour for the baggage and passenger flow at the terminals, the capacities of different elements and the delays at the airport’s terminal. They mentioned that the model’s validation was conducted by comparison with the results of earlier research about the future Athens airport’s average behaviour. Interesting dynamical results were provided through the proposed model, for both, baggage and passenger movements in the airport (Brunetta and Romanin-Jacur, 2004).

Popovic *et al.* (2009) mentioned that in modern society, airports can be considered as one of the most complex and largest systems. Studies of observational field were conducted to investigate passenger’s interaction within and experiences in an international airport. Their study discussed how people’s experience can be mediated through activities in the airport. An example was provided that the movement through the “security screening process” is discussed from staff and passenger perspectives. Passenger activities were illustrated through the research findings as shared and complex and can be supported by their proposed terminal design. Hence, the conducted research has the potential impact and influence on the airport design and to improve the passengers flow through the precincts of the airport (Popovic *et al.*, 2009).

Kaashoek and Samola (2010) discussed the importance of the use of technologies in the field of international air transport to reduce the costs and complexities, improve customer services and manage large groups. These improvements have determinants that are streamlining and automation of the business process. Simplifying the business as a program standardizes and simulates the development of electronic freight handling, electronic ticketing, bar coded boarding passes, radio frequency identification, freight message improvements, baggage management improvement and common use self-service. Self-service check-in kiosks replaced traditional check-in desks as a partial process in order to start the redesign program. Results showed overall improvements in the services (Kaashoek and Samola, 2010).

Sohail and Al-Gahtani (2005) studied and measured the quality of service at the “King Fahd International Airport” (KFIA) in Dammam, Saudi Arabia. They reviewed the airport’s developments and the challenges encountered in maintaining the services’ standards. Moreover, they undertook an evaluation for the airport services and the related quality. Empirical research was used in which the data were collected from 188 respondents in order to determine the factors influencing the process of evaluation for the quality of services. Data was evaluated and the level of travellers’ satisfaction on different 25 dimensions was obtained, then they discussed the implications. The results for the empirical research indicated that the passengers/travellers are satisfied with the quality of service that KFIA provides (Sohail and Al-Gahtani, 2005).

Spreng and Mackoy (1996) presented that satisfaction and service quality have been conceived to be separated constructs, but the researchers found that the relationship between them was not clearly understood. They mentioned that these two constructs are too similar, while there were few numbers of researches that examined the difference between them in an empirical way. The researchers discussed the conceptual arguments for the difference and examined this difference through testing service satisfaction and quality model proposed through their study. The results of the proposed model showed that there is difference between the two constructs. And it was concluded that there are several modifications in order to support the model (Spreng and Mackoy, 1996).

Figure 2 represents the Gaps model that was designed in order to explain the gaps that may affect the assessment of the customer of the service quality. There are four gaps in the model that are considered as the major contributions to the gap of service quality that may be perceived by the customer:

- **Gap 1:** represented as “Consumer Expectation-Management Perception Gap” and it is the formula of the policy of service delivery, that the management is not interpret of perceive customer expectations in correct way.

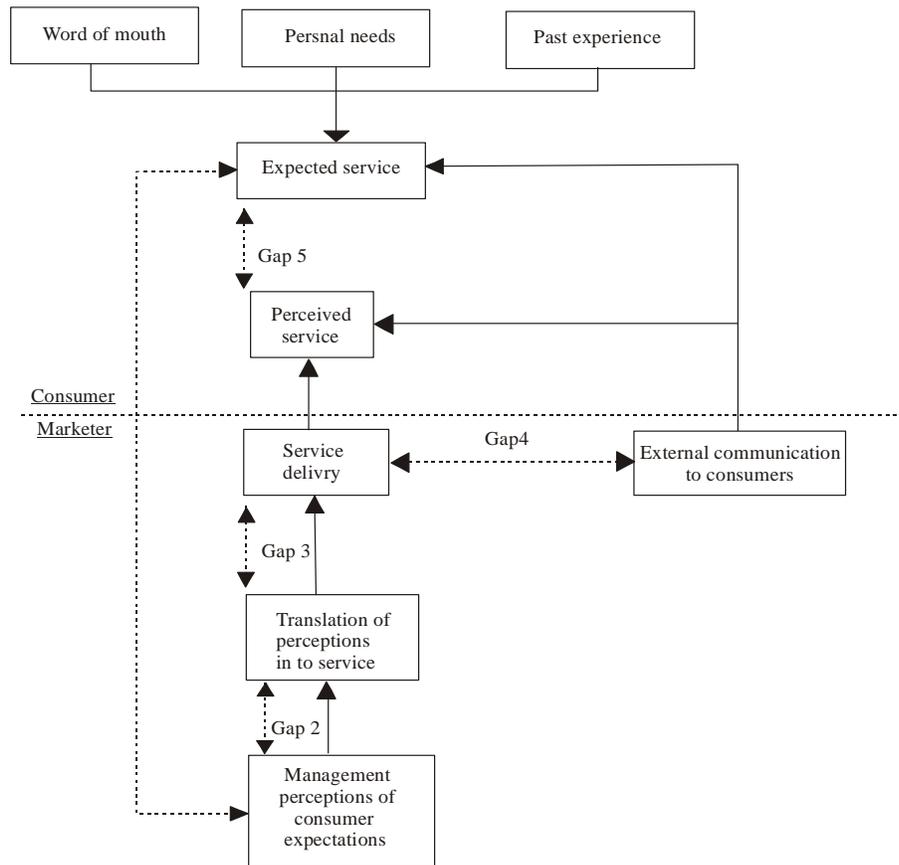


Fig. 2: Gaps Model for service quality (Khan *et al.*, 2007)

- **Gap 2:** represented as “Management Perception-Service Quality Specification Gap”: the employees don’t understand the service policy because it was not translated correctly by the management into rules and guidelines.
- **Gap 3:** represented as “Service Quality specification - service delivery Gap”: rules and guidelines are not translated into rules by employees.
- **Gap 4:** represented as “Service Delivery-External Communications Gap”: the promised external communications that is made for customers didn’t match the substantial service delivery.

The four represented gaps came from the perspective of the delivery, marketing and design of service organisation And they are located all over the organisation between managers, customers and frontline staff (Khan *et al.*, 2007).

RESULTS AND DISCUSSION

This section will include a comparison for different lean management models and suggests the best for KKIA.

The literature survey has reviewed different models and the effectiveness of service quality on the passenger satisfaction and the lean flow of passengers into the airport.

DMAIC is a Six Sigma model that reduces process variation while ServQual is a lean management model that improves the flow process. It was seen that the combination of both models can result in a Lean Six Sigma model for improving the level of service quality in the airport and the overall passenger satisfaction (Su *et al.*, 2006).

Literature survey discussed and covered different methods followed for measuring, improving and controlling the LOS in Airports such as passenger survey, weighted ServQual, Lean Six Sigma model and simulation model. Passenger surveys and direct collection of data from managed questionnaires was the mostly used method for measuring the LOS and improving the quality of services as in the research done by Kuo and Liang (2011), Fodness and Murray (2007), Lubbe *et al.* (2011), Chang and Yeh (2002), Adler and Berechman (2001), Correia and Wirasinghe (2005) and Barros *et al.* (2007); while all studies concerned with the services’

improvement. The most effective method for measuring the LOS is passenger surveys and applying six sigma model that reflect the passengers' perceptions on the LOS and the expectations for better quality of services. Moreover, the method was seen efficient for tackling the difficulties and problems of Multi Criteria Decision-Making (MCDM) that involves qualitative attributes' subjective assessments in a fuzzy environment, in identifying the problems in different areas in the airport, in developing new ideas suggested by passengers, e.g., identification of delays in the check in process and the creation of valuable scenarios to improve the efficiency and for achieving the passenger/customer satisfaction.

CONCLUSION

This study has reviewed the effect of applying Lean models in the International airports for the purpose of evaluating services that are provided to passengers at the terminal buildings, check-in systems, passenger and baggage flows and other airport's services and the measurement of the service quality with applying the suitable algorithm for the purpose of improving the overall level of service. Previous researches are briefed and the effect of applying Lean models was explored, especially Six Sigma and SERVQUAL/passenger survey that will be applied on the King Khalid International Airport for the purpose of improving the performance and level of service for the airport passenger's flow.

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