



Implementation and Development of a Global Index for Level of Service Evaluation at Airport Passenger Terminals: Hajj Terminal Saudi Arabia

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Abstract

This paper develops a global index for Level of Service (LOS) assessments at airport terminals. Its key role is naming the most significant attributes by considering user experience. This study was carried out in the Hajj terminal of the King Abdul-Aziz International Airport, and included a survey with one hundred travelers at the airport in 2011. The results of this study showed that processing time was among the most important measures affecting the users' observation of the level of service. The outcomes of this study point to the fact that some terminal attributes not examined in this study might have an input to the evaluation of LOS.

Keywords: airport, terminal, LOS, Hajj, global index.

1. Introduction

In the last few decades, the advancement of airport passenger terminals' administration-related measures has been one of the significant issues for airport operators, in the development of level of service (LOS) in particular. This has prompted various LOS improvements via air transportation offices, together with the Federal Aviation Administration (FAA) [1-4].

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Regardless of the pressure on these operators or organizations, the proposed LOS benchmarks and techniques have been the subject of assessment by experts. One of the fundamental issues is the absence of traveller data or “lack of passenger input”. A few studies have likewise been embraced the idea of LOS assessment considering clients’ observations or passengers’ views. A large portion of them have presented outcomes dependent upon poor input data, and were not fit to be given a high level of importance for checking and criticizing the hypotheses considered.

Furthermore, most research work kept tabs on distinct elements of the airport traveller terminal (BHS, check-in counter, flight lounge, etc.), ignoring the ‘in general’ assessment. A wide measure reflecting the terminal overall (e.g., LOS) for a given sort of traveller (e.g., arriving) might be helpful in setting up, operating, configuring and administrating levels. With this kind of measure, it might be feasible to recognize the level of significance credited to distinct elements by travellers, and to prioritize some development needs over others.

Moreover, it might give a measure by which to examine different airport terminals with the end goal of evaluating their efficiency. The key challenge when creating an ‘in general’ measure is the data gathering. It is generally easy to gather attributes of distinct resources (e.g., the queuing time at the passport check counter) instead of getting in general measures (e.g., total waiting time in the airport by each passenger). A few issues must be tackled before attempting to gather overall measures. This study aims to give a technique to such an attempt, represented by an investigation of the King Abdul-Aziz International Airport, that will be modelled later upon the output of this survey.

A comprehensive review and evaluation of past studies on LOS has been introduced in [5]. Mumayiz and Ashford [6] proposed a perception–response idea, utilizing graphical presentations developed from traveller reactions regarding the LOS gathered from some airports in the UK. Omer and Khan [7] engaged the idea of a utility hypothesis to create a relationship between characteristics of resources and facilities like waiting time or space available and client reactions (0 or 1) about the LOS presented. A psychometric scaling procedure was conducted by Müller and Gosling [8] to acquire a quantitative measure of LOS that could be employed within a relationship like the one created by Omer and Khan [7].

Seneviratne and Martel [9] created LOS principles for a few elements of the runway traveller terminal. The determination of the most significant parts and measures was dependent upon a study of Canadian runways [10]. Ndoh and Ashford [11] utilized hypotheses of observation and scaling to assess LOS on runway access, utilizing 12 characteristics like cost, comfort, access to information and so on.

Park [12] employed fuzzy logic to determine LOS measures for particular elements of the airport terminal. The approach was connected to the Seoul Kimpo Airport. Yen [13] conducted a review of Austin Municipal Airport in Texas, USA. He connected paired “logic” models to gauge a “long” model and a “short” model. The approach anticipates the probabilities that a traveller rates service on the basis of identified time measures. Yen et al. [14] displayed a quantitative model to characterize the level of service at airport terminals. The model utilized fuzzy logic to associate subjective service rankings to time estimations of related waiting or service procedures.

Fernandes and Pacheco [15] used data envelopment assessment to assess the capacity of some Brazilian airports, taking into account a few operational parameters e.g., number of check-in counters, normal space accessible for every traveller, and so on. Magri and Alves [16] assessed the LOS presented by a number of Brazilian airports as a capacity of 36 subjective parameters proposed by the Airports Council International (ACI) [2].

2. Facilities and characteristics of the airport terminal

The terminal area is the main crossing point connecting the runway and the rest of the airport. It is divided into three areas based on its functionality as has been described by Horonjeff et al. [17], and its activities can be listed as follows:

- The access area – where the traveller moves from the access area to the traveller handling and processing area. Parking, loading and unloading of travellers are done within this functional area.
- Processing – where the traveller is handled in the beginning, end, or in-between part of his transportation journey. The essential exercises in this area are ticketing, check-in, luggage collection, seat arrangement and allocation, security check, administration and security.
- The flight edge – where the traveller moves from the processing region to the airplane. The exercises that happen here incorporate gathering, movement to and from the airplane, and boarding and unloading passengers.

To give an overall LOS assessment, it is important to point out the kind of movement being referred to. Travellers might be separated into three sets as stated by their movement nature: arriving, departing, and transferring. Every one of these sets will have a dissimilar collection of necessities and requirements and, as a rule, will even make utilization of certain resources. For example, travellers in departing mode will not make utilization of the baggage claim resources, and arriving travellers will not utilize the check-in area.

Subsequently, every movement type will have a LOS record which as an overall index includes the traveller's full terminal experience rather than simply evaluating one resource office or facility. In this survey, just-arriving international passengers are studied; nonetheless, the strategy displayed in this survey can likewise be connected to assess the LOS for departing passengers [18]. Also, this examination focuses on operational parts of the terminal: therefore, any different segments situated outside of the terminal building are not dealt with.

Correia and Wirasinghe [5,3,4] considered the below listed factors in extracting the performance measures that evaluate the airport terminal:

- Curbside.
- Immigration and passport check.
- Baggage claim.
- Security checking area.
- Arrival lounge.
- Circulation regions (hallways, stairs, lifts, and so forth.).

Lastly, this survey introduces a general LOS assessment as a capacity and functionality of the listed elements which inspired the prepared study:

1. Processing time experienced in the airport terminal: Total processing time required for passport control unit processing, customs inspection, luggage claiming and any other resources in the airport.
2. Delay in the airport terminal: Service times: check-in, baggage claim, waiting times, variability of wait, etc.
3. Comfort cleanliness in the airport terminal: This concerns lighting and congestion level of waiting areas/lounges, and ambience of the airport as a whole.
4. Courtesy of staff in the airport terminal: Helpfulness, support and courtesy of the terminal employees.
5. Convenience in the airport terminal: Availability/accessibility of trolleys, washrooms, shops, restaurants, money exchange, cash machines, luggage carts, and rental facilities trolleys, Accessibility and facilities for the disabled.
6. Information visibility: Clearness and/or frequency of information display for flights, airport facilities and signposting. Flight information display system (FIDS).
7. Security: Satisfaction and feeling secured about security facilities and airport safety factors.
8. Service: Service "justice" (first in, first out), spatial logic, signing or sightlines reasonableness.

Four LOS measures are incorporated in the examination, as they have been distinguished as extremely significant for travellers [19]: "walking distance, total time, orientation and security environment". The security environment factor varies essentially from security screening. The security environment depends on the clients' recognitions of security all around the terminal facilities. This is a subjective variable, which may impact on the in general LOS to a certain degree. Then again, security screening depends on the nature of the experience of the traveller when being checked at the security x-ray screening area.

Although some elements do not seem to be directly handled by the airport management company or the operator, they could have significant influence throughout the design and management phases. As an example, check-in counters are sometimes managed by airlines however they are typically planned and designed by the operators themselves. Moreover, in several countries the operator is answerable for allocating check-in areas consistent with demand priorities. The following are short details of the elements and measures that are studied.

2.1 Enplaning curb side

The curb side component is the crossing point between the terminal building and the ground transportation framework. High activity volumes and peaks, in addition to the complex streams of blending individuals and vehicles, may bring about far-reaching movement congestion at the curb side region. This may thus cause annoyance, disappointment, and suspension to travellers in large airports. Arbitrary standard requirements in various airports may prompt oversized or undersized offices. The airport group is, for that reason, intrigued by an approach that could prompt rational standards [20].

2.2 Passport control process and immigration

The immigration department is responsible for passport control in airport terminals by permitting entry to the

country. This will need to include checking and verifying passports, work permits, landing cards, or Visit/Hajj/Umrah visas through the use of four databases (as listed by Shanks and Bradley [21]): the biometric/passport database, airport security database, police database, and immigration database. Shanks and Bradley [21] concluded that databases should be integrated to attain better performance.

2.3 Baggage handling system

The airport operator or the airport authority does the baggage handling administration for the carriers. The Baggage Handling System (BHS) is progressively robotized and automated, utilizing the barcode tags to distinguish and control the luggage through a computer system, and failures can originate from the mechanical conveyor and electric supply. For instance, Heathrow Airport has a framework with a cost of £42 million. This was introduced between 1995 and 1998 by BAA and is 1.4 km long, stretching from terminal 1 to terminal 4. The conveyer generally has a width of 0.9 m and such a framework can distinguish items by carrier, flight no, and traveller. Additionally, the baggage make-up region is a crucial area for the departure and arrival process [22]. Edwards gave more details about the baggage system (Figure 1).

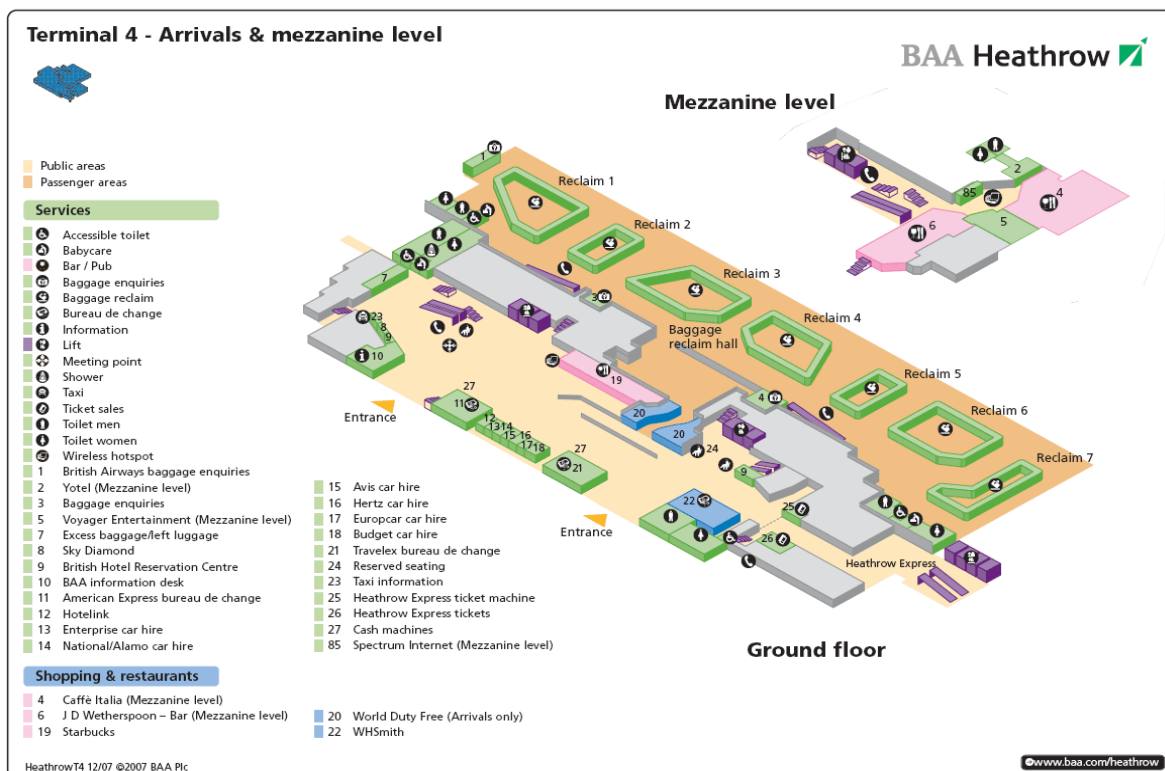


Figure 1: Baggage Handling System in terminal 4 of Heathrow Airport [22]–[24].

3. The Hajj complex at King Abdul-Aziz Airport

This piece of architecture was designed by Skidmore Owings and Merrill in 1985. The terminal is known to be occupied during Hajj time or the pilgrimage period of the last month in the Islamic Hijri lunar year. The flights are scheduled a month before the Hajj starting date; only arrival flights form the traffic during that period. Then

after Hajj performing time the departure mode is set up in the terminal. All scheduled flights depart from the terminal. The Hajj season's terminal occupation lasts from six to eight weeks. The passenger flow area is naturally lit and a ventilated open-air structure. Recently, in 2007, the PPMDC company was formed in partnership with Aéroports de Paris and was granted a 20 years' BTO contract with the Saudi Government. BTO stands for Build Transfer Operate and is part of the Saudi privatization programme. It aims to ensure a better service and launch a new benchmark of customer orientation in that particular area. They air-conditioned and developed the structure by dividing the terminal into modules to allow a better level of management (see Figure 2).



Figure 2: The PPMDC offered a development design based on visual contact and guidance for passengers (through diverse colours).

The terminal is divided into five modules with a different colour for each module from the aircraft PBBs (Passengers Boarding Bridges) up to the passenger bus pick up area outside the terminal; these are distinguished easily by passengers for easy reference and guidance.

Therefore, the Hajj Terminal is dedicated to being an international entry for pilgrims worldwide. Lately, it has also been utilized for Umrah ('short pilgrimage' or 'lesser pilgrimage') seasons.

The design makes reference to the tented structures inspired by the culture and the history of the region. The terminal can handle up to 80,000 passengers at any time with a total area of 190,000 square meters. In 1990, the terminal gained an Aga Khan Award for building design for the way it satisfied the needs of international air transportation with a spiritual aspect.

3.1 Baggage claim

The baggage claim area (or baggage reclaim) in airport terminals is an area where arriving travellers claim checked-in baggage after landing from their airline flight. Commonly, the baggage claim area consists of conveyor systems or baggage carousels. To report missing baggage or to claim oversized baggage, the baggage

claim area usually includes an airline's customer service desk. The baggage claim area is an area which comes after the immigration and passport check counters in international airports. Where conveyers are allocated and assigned for each flight depends on how far it is from the gate for the arrival flight in large airport terminals, as in this case. The Hajj terminal has the advantage of ten baggage conveyor belts with usability for both departure and arrival baggage with adding portable check-in counters. The baggage claim system can be either a single-level system or a multi-level system. In the former the items are delivered from a door or a hole in the wall while the latter has a feeder from either above or below the existing floor (see Figure 4).

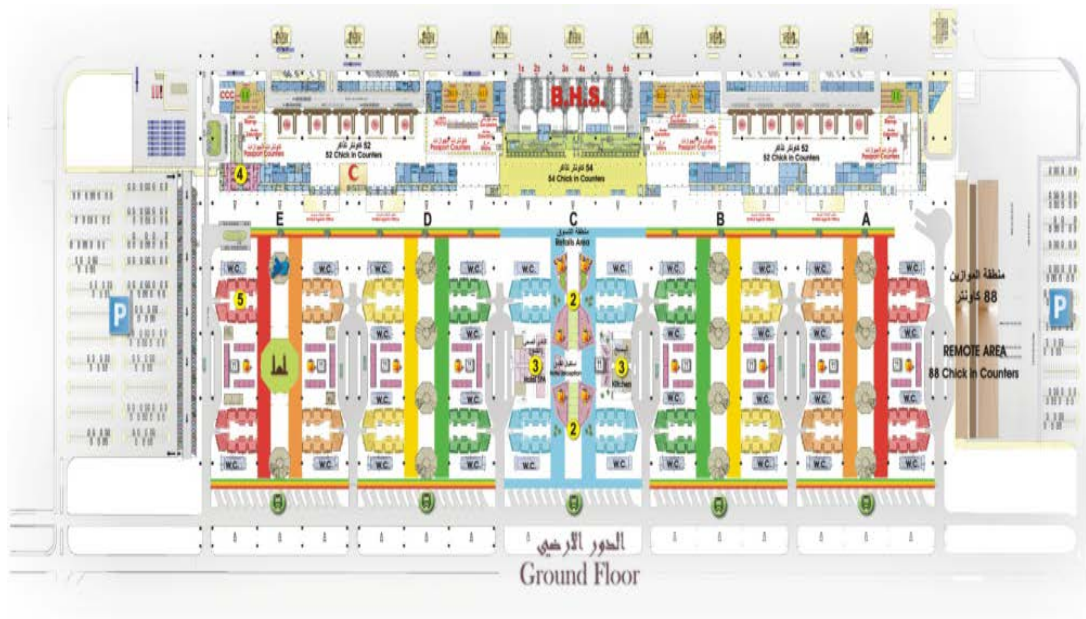


Figure 3: Ground floor of the Hajj terminal shows the five different modules.



Figure 4: Single-level system (left) and multi-level system (right).

3.2 X-ray security screening

The main purpose of this area is detecting and preventing explosive or illegal items from entering the country in

the arrival area of the passenger process flow. Weapons, drugs and money are examples of unauthorized items.

The reason for screening travellers before departure is to detect and prevent the carrying of items which could be harmful as a weapon or generally represent a danger to flight security. To accomplish that objective, it is important to examine the travellers, their portable items and baggage, in a way that is not too intrusive as that could reasonably be found to bring a large amount of anxiety and distress to the traveller. Moreover, the screening procedure must be quick and efficient so as to keep it away from a bottleneck in the traveller stream.

Security lanes are the typical models for traveller security checkpoints in most international airports. Each one of the security lanes contains an X-ray scanner. Travellers are asked to go through the magnetometer, which alerts the staff if a metal item is discovered. The traveller's lightweight objects, for example, satchels, smart phones, small packs, are examined by the X-ray. The channels are installed at entries to the areas of access to the boarding gates, making a "protected" zone where all boarding gates are available and accessible solely to individuals who have been screened.

3.3 Departure lounge

The departure lounge is an area that gathers and assembles passengers prior to their flight, allowing them to wait for their boarding time. It is usually designed to contain boarding passengers before their departure (in 15 mins), with the assumption that this is the aircraft boarding time. The lounge should have the capacity to hosting all waiting passengers, despite the fact that not all will need to wait there. Sophisticated procedures for planning departure lounges have been talked about in [25] and [26]. It is a necessity to permit only checked-in passengers into these lounges.

3.4 Circulation areas

Commonly, the circulation area component is seen as an issue and analysed using measures and standards, such as those offered by IATA International Air Transport Association [27]. The passenger's walking distance, their pace, the number of level changes and the level of interference the passenger comes across while walking are important measures in the evaluation of this area.

3.5 Concessions

Seneviratne and Martel [9] discovered that approachability to services and facilities is the second most important indicator of performance in waiting areas in their passenger survey. The survey included rest rooms, restaurants and retail outlets.

3.6 Walking distance

One of the things that is least understood is the effect of walking in terminals, found to be the most significant and most controversial aspect. In some airports, walking distances, particularly for transfer travellers, turn out to be very long. Numerous analysts have utilized it as a critical measure of LOS or the level of service for a terminal:

[3], [4], [9], [28]–[30]. In spite of the fact that its significance as a measure is known, there is no valid study to assess the influence of the walking distance on the LOS by considering passenger opinions.

3.7 Orientation

Hart [31] defined orientation as a passenger's discernment of nearby positions while passing through, whether on foot or using a supporting object like a car. Passenger dissatisfaction, inconvenience, disappointment, frustration and delays are some observed consequences of airport poor orientation systems. Obviously, there is a relationship between orientation and walking distance. Progressed methodologies for measuring orientation have been suggested by [32]. An essential methodology for measuring the LOS orientation has been offered by [33].

3.8 Total time

Lowering travel time between departure point and destination location is the primary playing point of air transportation compared with other modes of long distance transportation. A summation of access time, terminal time and airtime generates the total travel time. The access time is an issue which has a high significance. In some incidents, the access time goes beyond the air time (for example on a 500km flight between two large city airports, the time spent in the airports can be twice the air journey).

4. Theoretical framework

It is helpful to examine the diverse hypotheses on which the methodology for overall LOS can be built, as inspired by [3], [4]. For a weighted average methodology, it is expected that travellers consolidate their encountered observations at diverse terminal segments into a weighted average of individual LOS. A key step in this strategy is deciding the weights connected with each segment, which means their comparative significance as appointed by travellers. These weights are of high significance for operation supervisors and planners, in light of the fact that they will permit them to focus their consideration on the most significant segments.

By applying this consideration, an awful traveller encounter in a given segment might be offset by a great encounter in a different one. An additional method that could be used for overall LOS assessment is dependent upon the greatest LOS assessment. Thus, it is expected that travellers assess the overall terminal LOS by the greatest LOS value encountered in any of the terminal segments. Bearing that in mind, a traveller encountering LOS A at passport check, however LOS C for all remaining segments, will even now appoint LOS A to the overall terminal level of service.

The inverse of this methodology is to accept that travellers assess their overall terminal LOS by the worst encounter they confront. For example, if a traveller encounters LOS A for all segments, with the exception of baggage claim, where encounters a LOS E, overall terminal experience will be assessed as LOS E.

In spite of the fact that these two assumptions are basic in nature, they speak to elective ideas to the weighted normal methodology, which needs data (weights) that are not easy to accumulate. A change to the greatest and least LOS methodologies might utilize noticeable measures of LOS, for example, mode, average or mean.

Assume for terminal segments, we can get a vector speaking to LOS assessments for all the distinctive parts, e.g.,

$V : (A, C, D, A, A, B, D, A)$

This vector could deliver LOS assessments for an arriving path:

Passport check (LOS A), baggage claim (LOS C), X-ray (LOS D), etc.

The most used value found in the above vector is LOS A (four times), which can be the modal value. The average is between A and B, and the mean may be calculated just if numerical qualities are given out to the letters. By chance, LOS A is additionally the greatest LOS value yet that may not be the situation for different cases.

The minimum quality (LOS D) is a long way from the mode and happens for only two segments. The injustice of applying the base LOS value method for this assessment is obvious, particularly if the part represented by LOS D is not "that significant" as stated by client observations. The mode, average and mean quality methodology can likewise show disapproval dependent upon a relative weight viewpoint; the facts may prove that the most used LOS value really speaks about segments that do not have high weights as stated by travellers' opinions.

In spite of the fact that the weighted average methodology is more sophisticated, requiring data that are generally not easy to acquire, it has the ability to speak about an adjusted and satisfactory overall LOS assessment. This is the methodology utilized as a part of this paper. In this manner, a suitable approach needs to be advised to focus on the relative weights of distinctive parameters from the client's perspective.

4.1 Additive approach

The additive approach is used for acquiring the composite equations expressing the overall level of service for the inspected terminal. By applying this approach, the composite comparison might be created as:

$$\text{LOS(Overall)} = \sum w_i \text{LOS}(X_i) \quad (1)$$

Where w_i are positive weights around the terminal parts or segments and characteristics, X_i (passport check counter, baggage claim, total time, walking distance, and so on). This function facilitates the divided contributions of the distinctive attributes to acquire the collective level of service assessment. It is the most recognized of the multi-quality representations, and it is dominant due to its significance to some genuine issues and its relative unfussiness [34]. It has to be said that the utilization of the weighting plan is conceivable if certain associations are found. These are identified to be the idea of worth independence and are characterized by the associated explanations [35].

The relative significance of fulfilling separate qualities or attributes does not rely on the different levels to which every attribute has itself been fulfilled. Noticeably, their relative significance is considered as being steady in this matter. The specific rate at which improved fulfilment or satisfaction of any given characteristic or attribute helps total value is independent of the level of satisfaction attained on that and different characteristics. Such rates are

viewed as steady. The rate at which management might be ready to swap reduced satisfaction on a single characteristic or attribute for improved satisfaction on different attributes, to protect the same overall satisfaction value, is independent of the level of satisfaction already attained by some or every characteristic or attribute.

There are a few methodologies that could be useful to check whether the illustrative variables are additive independent and if each two qualities or attributes are irrelevant to each other's. Utilization of examination of association will be made between variables to focus on the level of multi-collinearity between them as suggested by [36]. Assuming that it is found that the variables are not free of one another, the examiner must deal with decreasing the dimensionality of the issue [34].

4.2 Weighting values

Weighting functions have been applied in the earlier studies through a range of reachable techniques, including rating, ranking and pair wise comparisons. The ranking approach is helpful for getting the most essential quality in a given set. On the other hand, it is not able to give the quantitative selections to alternate characteristics. The use of this system in LOS evaluation has been examined by Müller and Gosling [8]. Another approach to work out this problem might be the use of the rating; nonetheless, it is not clear if travellers can significantly and seriously answer questions requesting them to appoint relative qualities to broadly distinctive measurements.

The pair wise approach for comparison is more mature and can conquer the challenges connected with the rating and ranking approaches as it is recognized as an analytical hierarchy process (AHP) [37,38].

The core of the AHP system is the report of the relative weights. Expecting to work with n criteria, the method secures an $n \times n$ pair wise comparison lattice that reveals the decision of the relative significance of the diverse criteria. These comparisons are created utilizing a preference scale, which allocates numerical qualities to diverse degrees of preference. From the utilization of the three techniques, it is clear that the pair wise examination is likewise a great technique for acquiring significant relative weights of the segments. Nonetheless, its data requirements are huge to the point that it can be hard to implement.

The proposed approach can get weights without essentially asking travellers direct questions. This technique could be clarified by the next associated sample.

In a situational study, participants are approached to state LOS evaluations for each of the eight attributes offered (Processing time, Delay, Comfort Cleanliness, Courtesy of staff, Convenience, Information visibility, Security, Service and so on.) in addition to an overall LOS evaluation. At that point, a regression might be fitted as:

$$\text{LOS(Overall)} = w_1 \times \text{LOS}(A_1) + w_2 \times \text{LOS}(A_2) + \dots + w_8 \times \text{LOS}(A_8) \quad (2)$$

where LOS (overall) is overall LOS measure; $\text{LOS}(A_1), \text{LOS}(A_2), \dots, \text{LOS}(A_8)$ is LOS evaluations for individual components; w_1, w_2, \dots, w_8 are weights. The weights, w_1, w_2, \dots, w_8 , are the parameters of the regression mathematical representation, which might be found by the ordinary least squares (OLS) technique. Therefore, the weights are "revealed" by the travellers' observations of the relative significance of each element.

5. Data collection

A comprehensive traveller survey was carried out, keeping in mind the aim to acquire participant observations upon the level of service. A revealed preference procedure was utilized, implying that the inquiries concerned the assessment of real encountered experiences. Questionnaires and interviews were carried out in the terminal plaza, just minutes after the experience of the arrival passenger flow process.

5.1 Questionnaires

A set of logical steps that should be adapted to create a high-quality questionnaire, as proposed by Aaker et al. [39], was taken into consideration. A review was made of various airport studies through some journals [1]–[4]. A pilot study was done and feedback taken from academia and participants at the King Abdul-Aziz International Airport - Hajj terminal. A few alterations were prepared, and the enhanced survey was carried out at the end of the year 2011 (end of 1432 Hijri year) on the 11th and 12th of the Hijri year.

Essential improvements were considered such that few variables needed to be available in the LOS assessment and time was spent trimming each component or segment. These modified variables were ideas given by the passengers to the survey conductor: These variables were recommendations made via airstrip clients to the questioners: getaway time, total delay in the terminal, and vaccine time.

6. Case study of Hajj terminal at King Abdul-Aziz Airport International Airport

King Abdul-Aziz International Airport handled almost 18 million passengers in 2012 [40], making it one of the busiest airports in the Middle East. The design view of the terminal buildings is presented in Figure 4. The terminal buildings are designed as five modules with ten jet ways, the first of which is equipped for Airbus 380. There are some commercial stores and services, such as restaurants and banks, in the Plaza area.

6.1 Summary of responses

A hundred passengers were interviewed in a survey at the Hajj terminal of King Abdul-Aziz International Airport; the survey was carried out in October 2011. A pilot survey was carried out initially, where 19 passengers were interviewed. Passengers were interviewed after their arrival at the end of the journey process. All the passengers were international travellers and intending to perform Hajj in Makkah. The results are presented in percentages as shown in Table 1.

Out of the total passengers, 89% were male and 11% were female. A minor portion of results (8) were found to be insufficient and removed from the calculation. It can be seen from Figure 5 that the LOS evaluations are not uniform along with different characteristics. Nonetheless, the overall LOS evaluations are approximately relative to each LOS attribute. This relativity implies that the hypotheses proposed may be logical. After that, the relationship function is explained and identified.



Figure 4: First floor layout of the Hajj terminal buildings

Table 1: Table Distribution of responses in the Hajj terminal

Category	1-unacceptable 2-poor 3-regular 4-good 5-excellent				
	1. Processing time in the airport terminal	0	0	42.9	35.7
2. Delay in the airport terminal	7.1	3.57	39.3	32.1	17.9
3. Comfort and cleanliness in the airport terminal	3.6	7.14	21.4	35.7	32.1
4. Courtesy of staff in the airport terminal	3.7	3.7	22.2	44.4	25.9
5. Convenience in the airport terminal	0	22.2	25.9	29.6	22.2
6. Information visibility	0	14.8	22.2	48.2	14.8
7. Security	0	0	18.5	48.2	33.3
8. Service	0	11.1	11.1	55.6	22.2
9. Overall LOS	0	2.38	35.7	45.2	16.7

7. Data analysis

As earlier assumed, an examination will be performed between the overall LOS passenger evaluations (1–5) and LOS passenger evaluations (1–5) for distinct parts and qualities by regression. However, a few from the earlier process must be remade. This process incorporates adapting a statistical study to verify the in-between correlations, the importance of parameters, and the fitness of the model.

7.1 Correlation among variables

An issue regularly experienced in multi regression is multi-collinearity, or the measure of “overlapping” data about the dependent variable that is given by a few independent variables [37]. This issue normally happens at the time when the independent variables are strongly connected or correlated. The relationship variable determines the level of collinearity between two factors. A perfect (linear) negative relationship occurs if the correlation equals -1; on the other hand a perfect (linear) positive relationship happens if the correlation equals +1. Nonlinear relations can be represented with a correlation of 0. Correlations between all rating measures using Pearson correlation are illustrated in table 2.

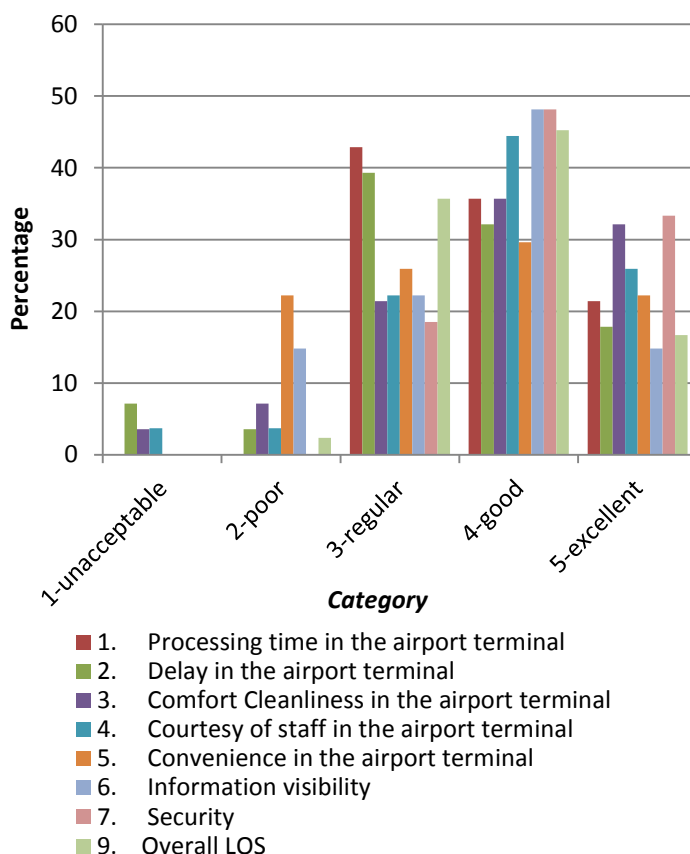


Figure 5: Percentage of terminal rating responses. Categories (LOS Ratings): 1-unacceptable; 2-poor; 3-regular; 4-good; 5-excellent.

The addition or subtraction of variables should be made carefully. A model can turn out to be non-representative for the reason that significant variables are counted or unacceptably taken out. Furthermore, every airport might have a distinctive model requirement, which can be a function of financial, operational and socio-economic attributes. The connection between these attributes variables is significant, yet it is not by any means the only criterion for addition or subtraction of those variables in the model.

Table 2: Correlations between all rating measures using Pearson correlation

		<i>Processing time</i>	<i>Delay</i>	<i>Comfort</i>	<i>Cleanliness</i>	<i>Courtesy of staff</i>	<i>Convenience</i>	<i>Information visibility</i>	<i>Security</i>	<i>Service</i>	<i>Overall LOS</i>
<i>Processing time</i>	Pearson Correlation	1	.527**	.224*	.589**	.579**	.403**	.327**	.287**	.713**	
	Sig. (2-tailed)		0	0.04	0	0	0	0	0.009	0	
	N		84	84	81	81	81	81	81	84	
<i>Delay</i>	Pearson Correlation		1	-	.432**	.480**	.427**	0.19	-0.06	.543**	
	Sig. (2-tailed)			0.064	0	0	0	0.08	0.611	0	
	N			84	81	81	81	81	81	84	
<i>Comfort</i>	Pearson Correlation			1	.545**	.292**	.322**	.516**	0.14	.332**	
	Sig. (2-tailed)				0	0.008	0.003	0	0.214	0.002	
	N				81	81	81	81	81	84	
<i>Cleanliness</i>	Pearson Correlation				1	.468**	.568**	.628**	.461**	.606**	
	Sig. (2-tailed)					0	0	0	0	0	
	N					81	81	81	81	81	
<i>Courtesy of staff</i>	Pearson Correlation					1	.656**	.489**	.260*	.562**	
	Sig. (2-tailed)						0	0	0.019	0	
	N						81	81	81	81	
<i>Convenience</i>	Pearson Correlation						1	.491**	.368**	.450**	
	Sig. (2-tailed)							0	0	0	
	N							81	81	81	
<i>Information visibility</i>	Pearson Correlation							1	.567**	.467**	
	Sig. (2-tailed)								0	0	
	N								81	81	
<i>Security</i>	Pearson Correlation								1	0.16	
	Sig. (2-tailed)									0	
	N									81	
<i>Service</i>	Pearson Correlation									1	
	Sig. (2-tailed)										
	N										

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

The greatest correlation value was located between the evaluations of overall LOS and processing time. The cause behind this is that arrival travellers take a long time during their flight journey and the airport handles a high capacity of international passengers. There are additionally quite strong correlations found between the courtesy of staff and security, between overall LOS and courtesy of staff and between information visibility and convenience.

7.2 Composite evaluation

The evaluations of the attributes are collected as:

$$\begin{aligned}
 \text{LOS(Overall)} = & \\
 & w_0 + w_1 \times \text{LOS(Processing time)} + w_2 \times \text{LOS(Delay)} + w_3 \times \text{LOS(Comfort Cleanliness)} + w_4 \times \\
 & \text{LOS(Courtesy of staff)} + w_5 \times \text{LOS(Convenience)} + w_6 \times \text{LOS(orientation)} + w_7 \times \text{LOS(Security)} + w_8 \times \\
 & \text{LOS(Service)} \tag{3}
 \end{aligned}$$

Where LOS (overall) is overall airport terminal LOS evaluations; LOS (Processing time), LOS (Delay), LOS(Comfort Cleanliness), LOS (Courtesy of staff), LOS (Convenience), LOS (orientation and Information visibility), LOS (Security) and LOS (Service) are LOS evaluations for every single characteristic or attribute; w_0 is intercept; and $w_1, w_2, w_3, w_4, w_5, w_6, w_7$ and w_8 are coefficients or parameters of the mathematical equation as exposed in Tables 3-6 out of the SPSS by entering the questionnaire results.

Table 3: Variables Entered/Removed^b

<i>Model</i>	<i>Variables Entered</i>	<i>Variables Removed</i>	<i>Method</i>
1	W1, W2, W3, W4, W5, W6, W7, W8 ^a	.	Enter

a. All requested variables entered.

b. Dependent Variable: Overall

Table 4: Model Summary

<i>Model</i>	<i>R</i>	<i>r Square</i>	<i>Adjusted R Square</i>	<i>Std. Error of the Estimate</i>
1	.838 ^a	0.703	0.67	0.420

a. Predictors: W0, W1, W2, W3, W4, W5, W6, W7, W8

Table 5: ANOVA^b

<i>Model</i>		<i>Sum of Squares</i>	<i>df</i>	<i>Mean Square</i>	<i>F</i>	<i>Sig.</i>
1	Regression	30.117	8	3.765	21.304	.000 ^a
	Residual	12.723	72	0.177		
	Overall	42.84	80			

a. Predictors: W0, W1, W2, W3, W4, W5, W6, W7, W8

b. Dependent Variable: Overall

Table 6: Coefficients^a

<i>Model</i>		<i>Unstandardized Coefficients</i>		<i>Standardized Coefficients</i>	<i>t</i>	<i>Sig.</i>
		<i>B</i>	<i>Std. Error</i>	<i>Beta</i>		
1	W0	0.465	0.369		1.262	0.211
	W1	0.562	0.09	0.607	6.275	0
	W2	0.074	0.071	0.109	1.048	0.298
	W3	0.043	0.067	0.063	0.636	0.527
	W4	0.055	0.091	0.073	0.6	0.551
	W5	0.001	0.07	0.001	0.008	0.993
	W6	0.035	0.078	0.044	0.452	0.653
	W7	0.281	0.108	0.273	2.616	0.011
	W8	-0.185	0.082	-0.222	-2.254	0.027

a. Dependent Variable: Overall

Replacing the LOS evaluations of the equation with the answers (1–5) of the assessment done at the Hajj Terminal of King Abdul-Aziz International Airport, and creating a regression study, will offer the parameter values $w_1, w_2, w_3, w_4, w_5, w_6, w_7$ and w_8 as the coefficients of the regression equation, and w_0 as the constant or intercept. Thus, the coefficients are acquired, representing the passenger observations of the relative significance of elements.

The outcomes of that regression are revealed in Table 3-6. Statistically, it is observed from Table 6 that the convenience parameter has a chance of 99% to be zero. That inspired the researcher to remove this attribute from the analysis. Even though it may be found to be a very essential measure for the overall airport terminal assessment, it seems that travellers at Hajj terminal of King Abdul-Aziz international airport might not consider

or value this attribute. The regression study consists of 81 perceptions. The 19 participants prepared in the pilot survey conducted at the beginning of the Hajj season are not considered for the reason that some modifications were made to the survey. The following regression will now consider these 81 participants, due to the absence of some attribute values which are no longer items of the overall LOS examination.

7.3 Regression with no Convenience

Table 7 represents the variables that were used in the multiple regression model concerning Residential Improved properties in Calumet Township.

Table 7: Variables Entered/Removed^b

<i>Model</i>	<i>Variables Entered</i>	<i>Variables Removed</i>	<i>Method</i>
1	W1, W2, W3, W4, W5, W6, W7, W8 ^a	.	Enter

a. All requested variables entered.

b. Dependent Variable: Overall

Table 8: Model Summary

<i>Model</i>	<i>R</i>	<i>R Square</i>	<i>Adjusted R Square</i>	<i>Std. Error of the Estimate</i>
1	0.838 ^a	0.703	0.675	0.417

a. Predictors: W0, W1, W2, W3, W4, W5, W6, W7, W8

Table 9: ANOVA^b

<i>Model</i>		<i>Sum of Squares</i>	<i>df</i>	<i>Mean Square</i>	<i>F</i>	<i>Sig.</i>
1	Regression	30.116	7	4.302	24.685	0.000 ^a
	Residual	12.723	73	0.174		
	Overall	42.840	80			

a. Predictors: W0, W1, W2, W3, W4, W5, W6, W7, W8

b. Dependent Variable: Overall

Table 10: Coefficients^a

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	
		B	Std. Error	Beta			
1	W0	0.465	0.350		1.326	4.1.	0.189
	W1	0.562	0.081	0.607	6.914	4.2.	0.000
	W2	0.074	0.069	0.109	1.069	4.3.	0.289
	W3	0.043	0.066	0.063	0.644	4.4.	0.521
	W4	0.055	0.088	0.073	0.619	4.5.	0.538
	W6	0.035	0.068	0.044	0.521	4.6.	0.604
	W7	0.282	0.103	0.273	2.728	4.7.	0.008
	W8	-0.185	0.081	-0.222	-2.272	4.8.	0.026

a. Dependent Variable: Overall

The Hajj terminal is found to be fast enough and with no issues to travellers. The convenience element is not mandatory, and some passengers did not have a well-built judgment about its level of service because they had not encountered it. One variable was ignored in the analysis, due to the characteristics of the terminal. This was the ‘purpose’ variable; as the terminal is devoted to Hajj passengers (trip purpose is performing Hajj). Usually passengers are asked whether their purpose is business, combined business/non-business or non-business, but in this case this question was not applicable.

One of the steps in refining the survey was the removal of likely outliers. The outliers were found in this survey as evaluations of participants that were obviously conflicting. It could be a passenger that assessed the overall airport terminal as 5, but assessed all or most elements as 1 or 2. Five cases showed this conflict and were ignored before the study.

The regressions without these outliers are presented in Table 7 - 10. The weights of

Table 10 could be substituted into Equation 2 to give the following (by removing neglected part of $w_5 \times \text{LOS}(\text{Convenience})$):

$$\begin{aligned} \text{LOS(Overall)} = & \\ & w_0 + w_1 \times \text{LOS(Processing time)} + w_2 \times \text{LOS(Delay)} + w_3 \times \text{LOS(Comfort Cleanliness)} + w_4 \times \\ & \text{LOS(Courtesy of staff)} + w_6 \times \text{LOS(orientation)} + w_7 \times \text{LOS(Security)} + w_8 \times \text{LOS(Service)} \end{aligned} \quad (4)$$

As acknowledged by Equation 4, the most significant element for travellers is the processing time. That appears obvious, as long flight passengers need to rest and any extra time they spend in the airport causes stress. Security is the second most significant element. The relatively low significance of the orientation, information visibility and comfort cleanliness elements, when compared to the processing time and security, can be clarified by the fact that, at the Hajj terminal in the King Abdul-Aziz international airport, travellers are accustomed to spending a long time in these latter two elements. The constant 0.465 shows that additional variables might be integrated in this study. It implies that there are elements of the overall LOS that are not denoted by the descriptive attributes integrated in the survey. It also indicates that different ‘what if’ scenarios and different modelling techniques, even nonlinear, might be considered like DES and ANFIS.

8. Summary

This paper has produced the global index for LOS assessments at airport terminals. Its key role is naming the most significant attributes by considering user experience. This study was carried out in the Hajj terminal of the King Abdul-Aziz International Airport and classified the processing time among the most important measures affecting the users’ observation of the level of service. The outcomes of this study also point to the fact that some terminal attributes not examined in this study might have an input to the evaluation of LOS.

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