Assessment of the Level of Service (LOS) in the Check-In Area of the Ninoy Aquino International Airport Terminal 3 Using IATA Standards

Ceres Victoria O. CEDO
BS Civil Engineering
University of the Philippines
Los Baños, College, Laguna
E-mail: cerescedo@gmail.com

Marloe B. SUNDO, PhD
Associate Professor
Department of Civil Engineering
University of the Philippines
Los Baños, College, Laguna

Abstract: The poor rating of the Ninoy Aquino International Airport (NAIA) among other international airports in the world (Wong, 2014) emphasizes the need to improve the current situation. The assessment of the Level of Service (LOS) at the check-in area of the NAIA Terminal 3 used the International Air Transport Association (IATA) standards. The LOS rating was based on the peak hour demand in December 2015, a peak month experiencing high passenger congestion. The most congested check-in island was found to operate as low as LOS F, while others operated at above LOS C – exhibiting an imbalance in the utilization of the check-in islands in Terminal 3. The peak hour queuing area, capacity and active check-in counters were found inadequate to meet the IATA recommended minimum of LOS C. Apparently, check-in island distribution was airline-specific, thus airlines handling few flights within the day had under-utilized check-in islands, while those with several and often fully-booked flights suffered congestion.

Key words: Airport congestion, NAIA Terminal 3, Level of Service, IATA, check-in area

1. INTRODUCTION

Airport problems have been a major issue in the Philippines for the past two decades, specifically of passenger and runway congestion. These problems are the root of the worldwide negative perceptions about the NAIA, which in turn have had negative impacts on the country's financial and economic image in the international scene. The Ninoy Aquino International Airport (NAIA) is considered an "inferior entry port to Asia-Pacific" owing to the inadequate passenger terminal facilities and very limited airside facilities for aircrafts (Salas & Lidasan, 1998). In terms of the quality of service, NAIA has also been regarded as the worst international airport for three consecutive years (2011 to 2013), and ranked as 4th Worst Airport in the world in 2014 (Wong, 2014).

Among the four NAIA Terminals, Terminal 1 is the most congested, usually operating beyond its capacity (MIAA, n.d.). It was designed to accommodate 4.5 million passengers annually, a capacity that has been reached since 1991 (Luz, n.d.). The recent refurbishment of NAIA Terminal 1 increased the maximum capacity of the Terminal to 6 million passengers per year (MIAA, n.d.). However, this was found still insufficient to accommodate the continuously increasing number of flights and passenger volume at the airport. NAIA Terminal 3 was built to decongest NAIA Terminal 1. However, landside and airside problems still arise. Are the NAIA Terminals already being used optimally? Is there a need to modify NAIA's system of managing the utilization of its facilities and open areas, and the handling of passenger traffic?

The quantitative measure of the actual operating conditions in an airport and the passengers' satisfaction is its Level of Service (LOS). Knowing the existing LOS of the NAIA Terminals would be the best way to assess whether the desired level of service is rendered and maintained in the airport. Furthermore, this LOS value would be useful in future passenger terminal area planning for a better service of NAIA. Developments and operational optimizations could ease up the negative perceptions about the NAIA Terminals.

One of the components of an airport passenger terminal that has significant impact on an airport terminal Level of Service (LOS) is the check-in area. It is commonly observed that check-in areas of the NAIA Terminals that handle both local and international flights experience passenger congestion on a daily basis, the worst times occurring during Christmas holidays and summer season. If one is to improve the passengers' perception of the quality of service of NAIA, improving the LOS during the check-in process will ensure positive results. To achieve this, it would first require the assessment of the existing LOS at the check-in areas (Correia & Wirasinghe, 2005). Subsequently, changes and adjustments for improvement may be planned on.

In the present study, the Level of Service (LOS) of NAIA Terminal 3 Check-in Area was assessed last December 2015, based on the IATA space standards. The study also monitored and assessed the utilization of the most congested check-in area of Terminal 3.

2. REVIEW OF LITERATURE

2.1 Relevant Concepts

Level of Service. Level of Service (LOS) is an assessment of the ability of an airport subsystem to meet its required services. For the check-in area, the LOS Space Standards gives a range of values, for each LOS Level, based on the area occupied per passenger. In the latest (9th) edition of the IATA ADRM, IATA included the number of luggage and carts used per passenger in the assessment of LOS. Since passengers have a tendency to secure a "comfort zone" or space to avoid intimate contact, IATA (2004) also mentioned the concept of 'passenger behavior and perception,' as yet an unquantifiable component. This shows the tendency of passengers, regardless of the congestion conditions (i.e. overflowing queue), to perceive a lower LOS than what they are actually experiencing during high congestion. IATA (2004) also discussed appropriate methodologies for data collection for planning and development purposes, including the determination of check-in counter requirement.

Airport Cooperative Research Programs (ACRP). Regarding passengers' perceptions of the airport's LOS, ACRP Report 55 (2011) showed that crowding of people at the terminal does not affect the passengers' perception of the level of service of the system, nor does the amount of space available to them. It was mentioned that deliberately expanding the size of the area will not result to a higher level of passenger satisfaction (Transportation Research Board, 2011). It was reported that passengers were more apprehensive about flight delays, which leads to increased waiting time. The Board (2010b) concluded that lower waiting times will result to positive passenger perception, since passengers have up to 25 minutes of waiting time tolerance. Waiting in a queue for processing by stuffed check-in counters and in baggage claim also contributes to lower perceived LOS (Transportation Research Board, 2011).

2.2 Related Studies

NAIA and CLARK as Development Options. The study of Salas and Lidasan (1998) weighed NAIA and Clark International Airport (CLARK) as a substitute choice in aiding the development aviation industry in the Philippines. NAIA was seen with several landside and airside defects while CLARK was seen as a long-term option as entry point of the country due to its massive runways and large available land (Salas & Lidasan, 1998). They pointed out that NAIA will remain as the "dominant international gateway of the Philippines" (p.5). However, this study has been conducted 18 years ago, and passenger growth has increased since then. Thus, the current level of service of the NAIA Terminals is essential for the assessment and design of future developments of the Philippine international airports.

Methodology Using Site-Specific Standards. Aly and Adisasmita (2013) studied the check-in facility at the Sultan Babullah Airport, Ternate, Indonesia, using Time Series Method and a cross sectional survey. They used site-specific standards based on models unique to the Sultan

Babullah Airport to measure the required check-in area and the required number of check-in counters. For the flight selection, they used the airlines with the biggest number of passengers to characterize the level of service of the check-in area. The flight selection basis was adopted in the present study since NAIA Terminal 3 is also airline-specific.

Queuing Theory. De Neufville and Odoni (2003) discussed the flows and queues in airport systems using the queuing theory. They defined the Queuing Theory as the "mathematical study of congestion" and used it to establish the relationship between arrival rate and waiting time or dwell time of the occupants in the system. They also suggested quantitative mathematical models for computation of the required area, existing capacity and the space occupied per passenger based on IATA standards. They emphasized that the waiting time are not explicitly defined in the IATA space standards. Thus, dimensional analysis is needed to obtain the correct value for estimating parameters in using the IATA space standards.

Time Block Concept. Ahyudanari and Vandebona (2005) adopted the Time Block Concept based on the average service time and arrival rate of passengers, and the number of check-in counters as inputs. They considered fluctuations of demand, network issues, flight scheduling, and facilities design including check-in counters and space for queues as causes of congestion. The time block concept uses "counting periods adopted in data collections related to passenger flows, wherein the counting period is divided into time blocks of equal size based on the average service time" (Ahyudanari & Vandebona, 2005). Their proposed model was found to be useful for airport relocation planning and for operational analysis, specifically on congestion.

3. METHODOLOGY

3.1 Peak Month

In accordance with IATA Airport Development Reference Manual (2004) and based on the historical data (i.e. operational statistics from the MIAA) the actual survey in NAIA Terminal 3 was done in December 2015.The month of December is one of the peak months of NAIA, based on the data from 2011-2014 (Figure 1), and the peak month for Year 2015, which was also the time that the study was conducted.

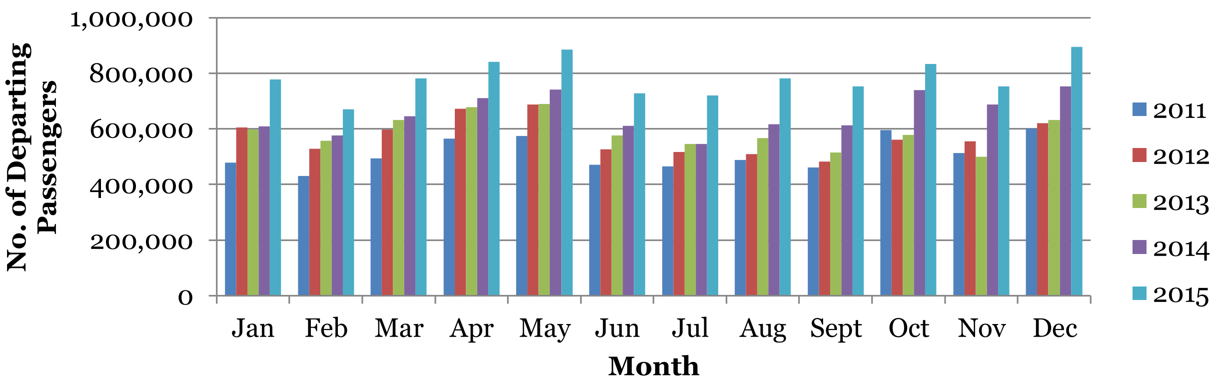

Figure 1. Total departing international and domestic passengers at the NAIA Terminal 3 (*Source: Manila International Airport Authority, 2015)*

3.2 Survey Days and Time

According to IATA (2004), the selected day on an average week of the peak month should be representative of the actual regular operations on a weekly schedule. Thus, days for data gathering included one weekday and one weekend, (i.e. Saturday, Sunday and Monday) to account for possible differences in operations between the days. The actual survey days selected were December 12-14, 2015, which were also the days that were approved by the governing authorities - the General Manager of the Manila International Airport Authority (MIAA) and Terminal Manager of NAIA Terminal 3. From the flight schedule of the day, the time period with the most number of overlapping flights was selected for the data gathering, under the assumption that it was the peak hour and that highest congestion in the check-in island would occur at this timeslot. Thus, in this study, the most congested check-in island among all the check-in islands (i.e. A1-14 to E14-28) were the ones considered for the data gathering, and the time period was assumed to be the peak hours for the entire check-in area for the day.

Though the airport renders 24-hour service, the time of observation did not include after midnight hours (i.e. 12 midnight to 6am) due to the unavailability of observers, under the assumption that the peak hour will not occur within these hours which was confirmed upon data analysis. Moreover, it is assumed that if the daily flight schedules show that there is a possibility of the peak hour occurrence during these times, this peak hour volume is less than or at most, equal to the occurring peak hour during the survey hours.

3.3 Video Recording during Survey

During the entire duration of data gathering, two video cameras were installed on the 4th floor overlooking the check-in areas, such that the actual check-in operations were not disturbed. It served as a monitoring device, recording real-time occurrences at the queuing area for the selected flight and check-in islands.

3.4 Arrival Rate

Passenger arrival corresponds to the time the passenger enters the check-in island for his flight. The arrival rate used for the LOS determination of the check-in area was from the peak hour – representing the most congested hours of the terminal. The arrival rate was measured as the number of passengers arriving every 10 minutes and this was observed until the check-in counters for that flight closed or the queue congestion has dissipated – indicating that the peak hours have passed. The computed arrival rates for the three observation days were then integrated in a graph by choosing the maximum arrival rate from the three-day data gathering. This graph was used to establish the peak hour – represented by the highest number of arriving passengers within a six-consecutive 10-minute observation intervals.

3.5 Waiting Time

Waiting time was measured as the time when the passenger joins at the end of the queue until his exit from the queuing area, to proceed for check-in processing at the next available check-in counter. It was measured using two methods, the time block concept model, and the video recording analysis.

The time block concept model by Ahyudanari and Vandebona (2005) is a simplified model for measuring the waiting time. This model is dependent on the measured average service rate and the number of active check-in counters in the analyzed check-in island. This method uses "time blocks" with sizes equal to the average service time during peak hour, and incorporates the counting periods used during actual data gathering for passenger flow measurements. The passengers were grouped according to their order of accommodation for processing in the check-in counters. The number of passengers accommodated first is equal to the number of active check-in counters. Theoretically, this first group stays at the check-in counters for processing for a period equal to the service time. Thus, the next group of passengers to be accommodated will have to wait for duration equal to that of the service time. This cycle will continue showing that the waiting time for passengers propagate. This model has the advantage of 'randomness' in selecting passengers for observation to obtain the dwell time. In the other method, the video recording data gathering, passengers in the video were randomly selected. The waiting time for each selected passenger was calculated and averaged.

3.6 Service Rate

The service rates from each observed check-in island were treated independently from each other due to the airline-specific distribution of the islands. The service rate used for LOS analysis was the service rate from the established peak hour. Though multiple counters were open for each flight, the service rate of each counter was treated independently. Three (3) to four (4) check-in counters were assigned to an observer.

3.7 Determination of the Level of Service in the Check-in Queuing Area

The LOS assessment in this study focused on the queuing in the check-in area and does not include the waiting area for passengers about to check-in since there has not been reports regarding congestion at the waiting area for check-in. The assessment included the required service rate or processing time, queuing area capacity, and number of required check-in counters to operate at a minimum LOS C.

In accordance with the IATA Airport Development Reference Manual (2004), the level of service space standards at check-in for single queue was measured based on the four (4) different sets of space standards and further classified from Level A through E, shown in Table 1. Each level represents characteristics of the quality of service, level of comfort, extent of delay, and the type of passenger flow in the check-in area.

Table 1. IATA Level of Service Space Standards (m^2/occupant) at Check-in.
(Source: IATA Airport Development Reference Manual, 2004.)

CLASSIFICATION	LEVEL OF SERVICE (m^2/occupant)				
	A	B	C	D	E
Few carts and few passengers with check-in luggage (row width 1.2m)	1.7	1.4	1.2	1.1	0.9
Few carts and 1 or 2 pieces of luggage per passenger (row width 1.2m)	1.8	1.5	1.3	1.2	1.1
High percentage of passengers using carts (row width 1.4m)	2.3	1.9	1.7	1.6	1.5
'Heavy' flights with 2 or more items per passenger and a high percentage of passenger using carts (row width 1.4m)	2.6	2.3	2.0	1.9	1.8

Using the computed arrival rate, average dwell time and available area during the established peak hour, the level of service of the check-in area was also assessed on the basis of the available floor area, the peak-hour capacity, the required number of check-in counters. All standard values used in the computation were based on LOS C, this being the standard minimum LOS recommended by IATA (2004), where the system experiences acceptable delays while rendering good quality of service at reasonable costs.

3.8 Space/Area Calculation

The formula by de Neufville and Odoni (2003) was used in Equation 1, for the determination of the space required by the existing actual *passenger load* and *dwell time*,

$$Area_{req} = Load \times Space\ Std. \times Actual\ Dwell\ Time \quad (1)$$

where: $Area_{req}$: area required by the existing situation (m^2)
where:

Load: the actual arrival rate of the passengers per hour at the queue (passengers/hour)
Space Std.: standard area occupied by a passenger as set by IATA
Actual Dwell Time: measured waiting time of the passengers in the queue (hour)

The standard dwell time based on previous studies is equal to 25 minutes which is the maximum tolerable waiting time of passengers (Transportation Research Board, 2011). Actual dwell time in NAIA Terminal 3 was calculated using the data gathered and Equation 2. The calculated value was then used to identify the LOS according to IATA standards (Table 1).

$$Space = \frac{Area}{Load \times DwellTime} \quad (2)$$

where: *Space*: actual area occupied by each passenger in the queue (m^2/person)
Area: existing available queuing area for check-in (m^2)
Load: actual arrival rate of the passengers per hour at the queue (passengers/hour)
Dwell Time: actual average waiting time of the passengers in the queue (hour)

3.9 Capacity Assessment Analysis

For the determination of the maximum capacity of the allocated check-in queuing area in order to operate under LOS C conditions, Equation 3 by de Neufville and Odoni (2003) was used. Since results showed that the average dwell time experienced by the passengers in the queue was less than the maximum tolerated waiting time of passengers (i.e. 25 minutes), the actual dwell time was used in the study to determine the maximum capacity.

$$Capacity_{max} = \frac{Area}{SpaceStandard \times DwellTime} \quad (3)$$

where: $Capacity_{max}$: maximum number of passengers per hour that be accommodated by the existing area (passengers/hour)
Area: existing available queuing area for check-in (m^2)
Space Standard: standard area occupied by a passenger as set by IATA in accordance with the desired LOS(m^2/passenger)
Dwell Time: tolerated waiting time of the passengers in the queue (hour)

The actual operating capacity of the existing area was calculated using Equation 4. This measures the occupied capacity during the peak hour.

$$Capacity_{act} = \frac{Area}{Space \times DwellTime} \quad (4)$$

where: $Capacity_{act}$: actual number of passengers per hour that can be accommodated by the existing area (passengers/hour)
Area: existing available queuing area for check-in (m^2)
Space: actual area occupied per passenger (m^2/passenger)
Dwell Time: actual average waiting time of the passengers in the queue (hour)

Values from Equation 3 and Equation 4were compared to assess the adequacy/inadequacy of the existing area under peak hour conditions.

3.10 Check-in Counter Requirement

Check-in counters highly impacts the level of service, and terminal development costs and operations (IATA, 2004). It affects the average waiting time of passengers in the queue corresponding to possible delays. Therefore, it is fitting to know the required number of check-in counters. Assessment of check-in counter requirement was based on the 9th Edition ADRM by IATA (2004). The analysis considered the 30-minute period of peak demand in the check-in area, identified as the three consecutive 10-minute intervals with the highest number of arriving passengers.

4. RESULTS AND DISCUSSION

Ninoy Aquino International Airport (NAIA) Terminal 3 has an airline-specific nature of check-in island distribution – each check-in island is assigned for use by a given airline. A check-in island consists of 10-20 check-in counters on each side (IATA, 2004). In the case of NAIA Terminal 3, one check-in island consists of 14 check-in counters on each side. Each side of the check-in island is identified by a letter and a number corresponding to the series of check-in counters. The assignment of check-in islands to the different airlines, as observed during the data gathering, is shown in Table 2.

Table 2.Airline assignments of the check-in islands

CHECK-IN ISLAND	AIRLINE
A01-A15	Cathay Pacific
A16-A29	Cebu Pacific/Emirates
B01-B09	Air Asia/Singapore Airlines
B10-B15	Singapore Airlines
B16-B23	All Nippon Airways/KLM Royal Dutch Airlines
B24-B29	Cebu Pacific/KLM Royal Dutch Airlines
C01-C15	Delta Air Lines
C16-C29	Cebu Pacific
D01-D15	Cebu Pacific
D16-D29	Cebu Pacific
E01-E15	Philippine Airlines
E16-E29	Philippine Airlines

4.1 Survey Hours Determination

Determination of the survey hours started from the assumption that the peak hours would likely occur within the time period having the highest number of overlapping flights. Since each check-in island is designated to a specific airline, the flight overlaps were analyzed per check-in island. For cases of time periods with the same number of overlapping flights, ocular observation of actual conditions showing which check-in island experiences heavier congestion governed. This assumption was confirmed by the analysis of the daily flight schedules generated by MIAA every early morning during the days of data gathering. The number of flight overlaps during the after-midnight hours is at most equal but often less than the number during the observed time duration.

4.2 Peak Hour Analysis

The data were integrated to establish the normal peak hours throughout an average operating days at the check-in queuing area of NAIA Terminal 3 to account for the possible fluctuations or any difference in passenger flows during weekend and weekday operations. Figure 2 shows the maximum and the average passenger arrival volumes. The maximum volume represents the highest number of arrivals among the data gathered – within each specific 15-minute block, while the average volume represents the average number of arrivals from the data gathered for each specific 15-minute blocks.

Figure 2 shows that the top peak hour occurred from 14:30 to 15:30 of a weekday (i.e. Monday). This is represented by choosing from the maximum values to accurately account for the peak conditions of the congestion. This will also eliminate the differences between the passenger volumes from different days, which might lead to underestimation of the arrival rate during peak hours if the averaged values will be the one considered.

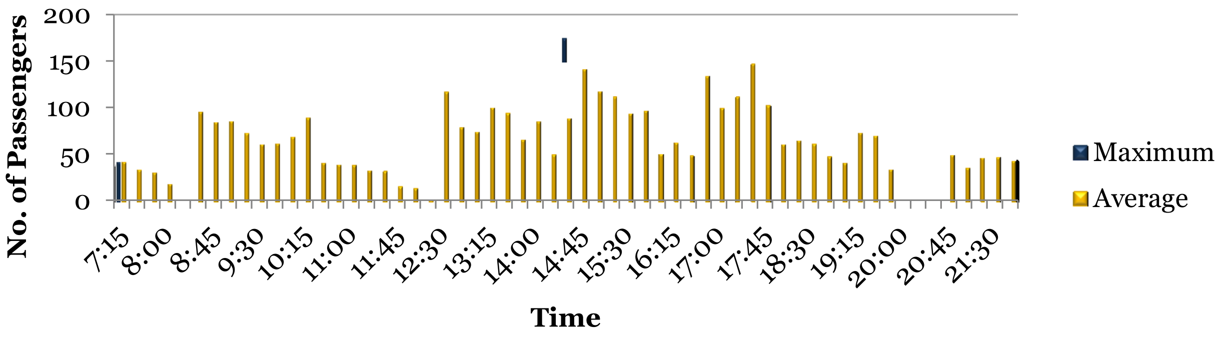

Figure 2.Integrated data on passenger arrivals during the 3-day data gathering.

4.3 Arrival Rate Analysis

Arrival rate assessment was done based on the peak-hour passenger arrivals because this depicts the most congested situations at the NAIA Terminal 3 check-in area. The highest arrival rate at the check-in islands was calculated at 174 passengers every 15 minutes (i.e. 12 passengers per minute or one passenger every 5 seconds). This was observed at Check-in Island D16-D29, at that time occupied by Cebu Pacific for its domestic flights. Summation of the four consecutive 15-minute arrivals during the peak hour showed that 544 passengers entered that check-in island during the peak hour or 9 passengers per minute.

4.4 Service Rate Analysis

Average Service Rate. For a check-in queue system, the service rate may be treated as equal to the departure rate of the passengers in the queuing system. This was based on the '*first-in, first-out*' (FIFO) discipline, i.e. the first passenger to arrive in the queue is the first one served, and that passenger waiting/dwelling time in the queue is dependent on the processing speed of the servers. Thus, service rate in the island represents the overall processing speed of all active check-in counters in the island.

The calculated average service rate in the most critical check-in island during peak hour was 341 passengers/h. This service rate considered all the active counters during the peak hour. Furthermore, the average service rate per passenger was ranging from 2 min. to 3 min. during peak hour. Though this processing speed may be considered as rendering a good level of service, it was evident that there was heavy saturation in queues as exhibited by the intolerable maximum waiting times as experienced by several peak hour passengers at an operation below LOS C. This congestion may be heavily caused by inadequate number of check-in counters and inadequate queuing area, and not much of the service rate itself.

To classify the peak hour operations at LOS C, approximately minimum of 1.6 min./passenger processing time is required. However, this processing time was never achieved by any check-in counter during the 3-day data gathering. It is possible that the service rate of each check-in island is hampered by the unique check-in procedures and computer system that is used by each airline. Improving these components of the airline check-in system could certainly ease up passenger congestion at the check-in area. In addition, increasing the number of active check-in counters for fully-booked flights and during times of simultaneous or overlapping flights would definitely speed up the processing time and hence, raise the LOS.

Behavior of Service and Arrival Rates. Service rates can indicate the potential of the system to meet its demand – the arrival of passengers. Plotted in Figure 3 is the behavior of the service rates and arrival rates. For most cases as seen in the graph, as the demand or the arrival rate of passengers in the queue increased, there was a corresponding increase in the service rate of the check-in counters. There were only approximately 10 out of 60 instances where this generalization did not hold true. Out of these 10 occurrences, only two (2) exhibited an increasing arrival rate but lower service rate. For the other eight (8) instances, the service rates increased though there is a decreased rate of passenger arrivals for check-in. The latter case is an optimal behavior of arrival and service rates as this indicates that processing rates do not necessarily decrease with lower passenger volumes.

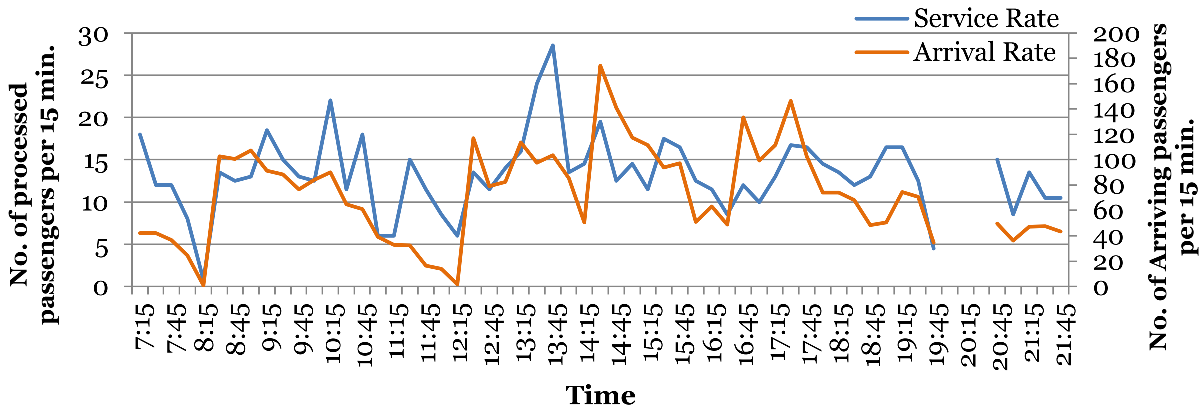

Figure 3. Behavior of Service Rates and Arrival Rates Every 15 minutes.

The data indicate that service rates of the check-in counters were strongly influenced but not solely dependent on the volume of arriving passengers. In majority of the instances, the efficiency of the check-in counters increased as the passenger volume increase; in a few occasions, the processing rate remained high even at lower arrival passenger rate. Furthermore, this behavior indicates that the check-in servers are receptive to the actual conditions in the system by adjusting the efficiency to a higher level enough to cater a fair level of service to the passengers, based on the degree of congestion experienced by the queue in the check-in area.

4.5 Queue Waiting Time Analysis

The waiting time, also known as dwell time, measures the amount of time a passenger spends in the queue – upon its arrival at the end of the queue until its exit upon service in the next available check-in counter. For this study, the waiting times for the check-in process was measured using two methods, (1) time block concept, and (2) from the actual video during data gathering. The waiting time was also initially intended to be measured using the Queuing Theory under probabilistic analysis, but computations show that the data did not fit the model; computations show very unrealistic values for the dwell time. Thus, the analysis of the dwell time using queuing theory will be disregarded for this study. Using the Time Block Concept model, the maximum waiting was 32 minutes, and the average waiting time was computed as 18.3 minutes. Several passengers were also observed from different entry points and results show that the maximum waiting was 31.3 minutes, and the average waiting time of each passenger was 21.8 minutes.

According to the Transportation Research Board (2011), the maximum waiting tolerance of passengers is only 25 minutes, and beyond this, it will result to a lower or negative passenger perception. Since the maximum waiting time measured from the data was approximately 32 minutes, which is more than the maximum tolerated waiting time of most passengers, approximately 20% of the peak-hour passengers experienced an intolerable waiting time.

4.6 Level of Service (LOS) Analysis

Assessment of the LOS of a passenger terminal system is important to determine whether a good quality of service is rendered to the passengers.

Total Area Assessment. For Check-in Island D16-D29 where the peak hour occurred, the approximate total queuing area available was 275.4m², measured by 17 by 45 – 600 by 600mm tiles. This area does not include the common passageway area where the passengers for the two juxtapose check-islands pass through. This area includes the queuing area and the immediate area where passengers stand, behind the "yellow line", next to the check-in counter servers for the processing. The area did not include the area allotted for check-in processing since, upon observation, this section was not used for queuing. However, the area includes the entire width of the check-in area since, theoretically, this could still be utilized for queuing upon the discretion of the airlines.

The total queuing area required by the given passenger arrival rate was determined using the space standards under LOS C with a high percentage of passengers using carts. Two values of the required area were obtained from the two usable values of average waiting time. The total required queuing area was measured to be 282.63m² using time block concept, and 335.93m² using the video recording. It shows that the queuing area is insufficient by approximately 60m² to operate at LOS C. This indicates that peak hour passengers do not experience a good quality of service.

Required Number of Check-in Counters. IATA provided a framework to determine the required number of check-in counters given the peak 30-minute demand and the maximum queuing time (MQT) of the passengers. Based on the data, the peak 30-minute demand is equal to 315 passengers arriving at Check-in Island D16-D29 with only 12 active check-in counters to accommodate the demand. Furthermore, IATA allocates 20% of the counters of the Economy Class for the Business Class. Thus, the resulting 24 Economy class check-in counters will consequently provide 5 check-in counters for the Business Class. Therefore, a total of 29 counters are needed based on the IATA methodology. Based on the IATA standards for the appropriate number of check-in counters, a total of 29 counters are needed to cater the peak hour demand in NAIA Terminal 3. With this result, it is evident that the available check-in counters during the observed peak period was also insufficient for the peak-hour passenger volume. If the number of check-in counter is inadequate, it follows that a good quality service was not rendered to the peak hour passengers, and consequently, this will yield high maximum waiting times experienced by the passengers. Thus, it is suggested that the active check-in counters for airlines with fully-booked and overlapping flights request for more check-in counters, especially during their peak hour. This solution is feasible since it was also observed that several check-in islands assigned to airlines with fewer flights for the day were either not in use or experiencing LOS A, whereas other airlines were experiencing up to LOS F.

LOS Rating Based on IATA Space Standards. IATA set standards to determine the LOS of a system based on the space occupied per passenger. As previously mentioned, the LOS C was the recommended LOS goal to satisfy the passenger needs at economical costs. Moreover, according to IATA (2004), any LOS lower than LOS C is considered to have unstable flow, and LOS E and LOS F already exhibits inadequate and unacceptable level of service and delays. For LOS higher than LOS C, they exhibit a high to excellent level of service with very few to no delays. The Transportation Research Board (2010) further explains that systems experiencing LOS higher than C could theoretically operate at this level for the entire day. The LOS assessment in this study was also based on LOS limits for a high percentage of passengers using carts. As further explained by Transportation Research Board (2010) in ACRP 25, the values for the area occupied per person in the IATA standards represent the lower limit value for each LOS. In Table 1 for high percentage of passengers using carts, it implies that a value of greater than 2.3m²/person is still LOS A but a value less than 1.5m²/person is considered to be a system experiencing LOS F.

The measurement of LOS using the IATA standards depends on the existing total queuing area of 275.4m^2 and the dwell time of the passengers during peak hours. Using the data from the peak hour occurring at 14:30 to 15:30 with an average arrival rate of 544 passengers per hour, the area occupied by each person was then computed to be 1.65m^2/passenger and 1.39m^2/passenger, using the time block concept and the actual video recording, respectively. Though there are two values for the space occupied per passenger, each from the two mentioned methods, it is evident that both values are equivalent to an LOS D and LOS F based on the IATA standards.

According to Ahyudanari and Vandebona (2005), the time block concept yields the lower bound values. Thus, the space occupied per passenger from the time block concept is somehow an underestimation of the actual occupied space of the peak hour passengers in NAIA Terminal 3, and that the resulting LOS D as a representation of the check-in area LOS in Terminal 3 should not be solely bounded by this value. For the resulting LOS F from the actual basis and considered closer to the actual operating conditions in the check-in area of Terminal 3, as defined by IATA (2004), LOS F is an unacceptable level of service and comfort, and experiencing unacceptable delays. The defined unacceptable delays were confirmed by the measured 32-minute maximum queuing time for 98 passengers or 20% of the peak hour passengers. A maximum queuing time of 32 minutes can be considered as unacceptable since according to the Transportation Research Board (2011) and Martel and Seneviratne (1990) (as cited by Ahyudanari and Vandebona), the tolerated maximum queuing time of passengers is only 25 minutes.

The data clearly shows that the highest passenger demand among the most congested hours during the data gathering occurred at Check-in Island D16-D29, and upon analysis, the level of service was found to be around LOS F at its worst, as seen in Figure 4. Moreover, this assessment was based on the peak hour of the terminal upon integration of all the data gathered.

Figure 4.Check-in Island D16-D29 during the Peak Hour

According to IATA (2004), the Transportation Research Board (2010), the Airports Council International – World (2013), the design of the passenger terminal must be based on the peak hour. This framework was also observed and followed by this study. All the assessments and measurements were made based on the peak hour data from all the highly congested queues from the data gathering. However, this LOS F does not hold true for the entire check-in area of NAIA Terminal 3.

Check-in Island B16-B29 (All Nippon Airways). During data gathering, it was also observed that the number of active servers every check-in island varies. In some check-in islands such as B16-B29, there are two airlines sharing the island. Check-in Island B16-B29 is shared by All Nippon Airways (ANA) and Cebu Pacific where only 8 check-in counters belong to ANA while the other 6 check-in counters are for Cebu Pacific. ANA has two international flights every day, the first one departs at 09:45 bound for Narita, Japan (NRT) and the other at 14:45 bound for Haneda, Japan (HND). During the observation the morning flight was more congested than the afternoon flight. In the morning flight, the queue extends even beyond the allocated check-in area for ANA. The airline management controlled the congestion caused by the arriving passengers in the check-in area by limiting the number of passengers entering the queuing area every several minutes. The tendency was that the arriving passengers bound for check-in piles up at the common/waiting area of the airport, as seen in Figure 5.

Figure 5.Check-in Counters B16-B23 during the Morning Flight of ANA.

This was due to inadequate number of check-in islands and consequently, inadequate check-in queuing area available to accommodate the passenger demand of the airline. There were only 8 check-in counters for ANA, but setting a 30-minute maximum queuing time in the IATA standards results to a required number of check-in counters to 18 check-in counters. Moreover, though there were 6 other available check-in counters at Island B16-B29 during the congested period experienced by ANA, these counters were not utilized since they are allocated for Cebu Pacific flights and during that time, no flights were accommodated in check-in counters B24-B29.

Imbalance in Check-in Island Utilization. As previously mentioned, the check-in island distribution within the Terminal is airline-specific. Though this is the case, all the data from the most congested hours were initially integrated solely dependent on the passenger arrival rate, regardless to which airline or check-in island these data belong to. An in-depth analysis was performed to determine the LOS during peak hour to assess what level of service is rendered to the passengers during this high level of congestion. Furthermore, B16-B29 and D16-D29 were clearly highly congested among the others, and their LOS cannot be explicitly determined by just mere ocular observations. The other check-in islands were not experiencing heavy congestion, and this premise was supported by the data that the peak hour did not occur in these check-in islands. Furthermore, some of these check-in islands are occupied by airlines handling few daily non-overlapping flights. There were instances where check-in islands such as D16-D29 were heavily congested and experiencing LOS D to LOS F, but the other check-in islands were either not in use or experiencing light to no congestion. In connection with this, all highly congested check-in islands were observed but there was no need for close scrutiny to those that clearly experienced a level of service higher than LOS C, since high level of congestion is least expected to occur, and the behavior of the passenger flow will be maintained throughout the day. Specifically, these check-in islands are occupied by Cathay Pacific, Singapore Airlines, Delta Air Lines, Air Asia and Philippine Airlines. The summary of an estimation of the LOS per check-in island based on the observed airlines during data gathering is shown in Table 3.

Table 3. Level of Service as Observed per Check-in Island.

CHECK-IN ISLAND	AIRLINE	LEVEL OF SERVICE (LOS)
A01-A15	Cathay Pacific	LOS A
A16-A29	Cebu Pacific	LOS B to LOS C

Table 3 continued…

B01-B09	Air Asia/Singapore Airlines	LOS A to LOS B
B10-B15	Singapore Airlines	LOS A
B16-B23	All Nippon Airways	LOS D to F
C01-C15	Delta Air Lines	LOS A to LOS B
C16-C29	Cebu Pacific	LOS B to LOS C
CHECK-IN ISLAND	AIRLINE	LEVEL OF SERVICE (LOS)
D01-D15	Cebu Pacific	LOS B to LOS C
D16-D29	Cebu Pacific	LOS D to LOS F
E01-E15	Philippine Airlines	LOS A to LOS B
E16-E29	Philippine Airlines	LOS A to LOS B

Capacity Assessment. Determination of the capacity of the existing area is important to assess the maximum threshold it can hold. The capacity determines passenger volume that the area can accommodate by taking into consideration the dwell time of the passengers and the area provided for each person in the queue.

The maximum capacity of the available area for Check-in Island D16-D29 during peak hour was computed based on the total available queue area, the space standard based on LOS C, and the dwell time of the passengers. Considering the dwell time from the time block concept, the computation show that the maximum capacity to achieve LOS C should only be 530 passengers/h, while considering the dwell time derived from the actual video recording, the maximum capacity should only be 446 passengers/h. It is evident again that the value from the time block concept yield a larger capacity, a manifestation of its underestimation of the actual conditions. However, the actual capacity occupied by the peak hour passenger volume was found to be 544 passengers/h. Thus, the actual operating capacity during peak hours already exceeds the maximum capacity of the required area.

5. CONCLUSION

The 10 different check-in islands at NAIA Terminal 3 showed different levels of service (LOS) at any given time. The peak hour island occurring at Island D16-D25 had LOS D to LOS F while most of the check-in islands were performing approximately above LOS C. This is due to the large number of overlapping flights handled by D16-D25 during peak hours operating at inadequate standards. D16-D25 experienced a maximum queuing time of 32 minutes which is longer than the passengers' maximum tolerable waiting time of 25 minutes according to previous studies. Furthermore, for the check-in island to operate at LOS C, the dwell time of the peak hour passengers should only be approximately 17 minutes. This could be achieved by adjusting the service rate to approximately 1.61 min./passenger. It was also found that the available effective area of 275.4m^2 used for queuing of the check-in passengers is inadequate by approximately 60m^2 for the system to operate at LOS C. In connection with this, the Airline had a tendency of limiting the queuing area only across the active servers, thus, analysis with this limited area showed that it is inadequate by approximately 100m^2 to operate at LOS C.

In terms of the passenger capacity, the passenger arrivals during the peak hour occupied a capacity of 544 passengers/h. However, for the queuing area to operate at an optimum LOS C, it should only be handling approximately 446 passengers/h. This exhibits an inadequacy of approximately 98 passengers/h. To accommodate this passenger demand during the peak hour based on the observed average service rate currently rendered by the system, there should be 29 active check-in counters based on the computation using IATA standards. For Economy Class passengers, 24 check-in counters should be allotted, while 5 check-in counters for the Business Class passengers.

International Air Transport Association (IATA, 2004) has proposed that airport passenger terminals should be designed at LOS C because at this level, it renders good levels of service and comfort at economical costs. Overall, all the analyzed parameters had been inadequate for achieving the IATA recommended minimum of LOS C upon analysis of the established peak hour during the peak month. To increase the LOS rating during peak hours, values for different parameters were suggested in this study for NAIA Terminal 3 check-in area to achieve at minimum of LOS C during peak hours. To increase the rating to LOS C, it is suggested to adjust at least one of the following: a minimum of 1.6 min./passenger processing service rate, increase the queuing area to $336m^2$, and increase the active check-in counter to at least 29 during peak hour. It is highly recommended to for airlines with fully-booked and overlapping flights to request for more check-in counters especially during peak hours. This solution is feasible since it was also observed that several check-in islands assigned to airlines with fewer flights for the day were either not in use or experiencing LOS A, whereas other airlines were experiencing up to LOS F (i.e. Cebu Pacific and ANA).

Apparently, check-in island distribution was airline-specific, thus airlines handling few flights within the day had under-utilized check-in islands, while those with several (and often fully-booked) flights suffered congestion. Clearly, there is an imbalance in the utilization of the five check-in islands (i.e. A, B, C, D and E) in NAIA Terminal 3. Thus, by equalizing the distribution and utilization of the check-in islands at the NAIA Terminal 3, the LOS of the Terminal could be improved significantly.

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