# Methodology Followed in the Determination of the Peak Hour Parameters for Buenos Aires City Airport

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The estimated demand used in the planning process of Buenos Aires City Airport Master Plan, developed by the Unit of Renegotiation and Contract Analysis of Public Services from Argentina, has not included infrastructure planning parameters: passenger peak hour and operation peak hour. These parameters must be determined to properly project, for the short, medium and long term development stages, the airport air-side, land-side and support elements. In order to consider infrastructure planning parameters two different methods have been used, all based in the historical data of year 2007: the peak hour movements and the airplane distribution, determined from the six peak hours; and the peak hour passenger distribution, determined from a FAA index. Also the traffic month distribution and the peak hour transit for national and international passengers for arrivals and departures have been determined. The results and conclusions of these determinations are presented.

***Key words:*** airport planning, demand, peak hour, forecast.

***Theme Area***

Air transport demand forecasting

## INTRODUCTION

Airport infrastructure should be planned according the principle of efficiency, safety, security, functionality and flexibility. The objective of the planning process is to find the balance between airport components capacities to generate an efficient system operation on any normal condition, and to satisfy the demand at a determined level throughout time. This demand is often related to a defined peak. The established design objective for the terminal and other facilities is that most of the passengers receive an adequate service levels and only a very small proportion of them experience the impact of congestion. The design level may be established through the use of indexes. There are different approaches recommended by the literature to determine the design level [1, 2]. IATA [3] recommends using the following:

- $85^{th}$ percentile of the busiest hour or day of the year.
- $40^{th}$ busy hour or day of the year.
- $30^{th}$ busy hour or day of the year.
- The second busiest day in an average week during the peak month.

These approaches are not applicable to every airport. On that way, for instance, Wang and Pitfield [4] developed an empirical approach to the determination of the design peak hour to be applied to Brazilian airports. They concluded that different design peak hours should be considered for larger and for smaller airports.

The passenger and operation peak hours must be determined to properly project, for the short, medium and long term development stages of several facilities, services and support elements of the air- and land-side of the airport. These indexes and the level of service will guide the evolution of the components of the airport infrastructure.

Finally, when planning airport infrastructures it is necessary to make forecasts of the expected traffic.

Socio-economic and technological studies are performed to determine passenger prognosis as a way to infer airport demand growth. Unfortunately in many cases the major investigative efforts are invested in studying the behavior of only the annual passenger demand, and this is incomplete information for the development of the airport infrastructure, which is the case study.

## THE CASE STUDY

Buenos Aires City Airport is the biggest domestic flights airport in Argentina in terms of passenger and aircraft movements. This airport is the usual destination for most of the domestic flights of the country. It is a hub. Its economic impact is as big as its importance in the air transport national net. The studied airport is preponderantly origin-destination in its transport net. Many of the airport operations correspond to general aviation. The airport receives a minimum portion of international air traffic.

The Buenos Aires City Airport is located 8 km of Buenos Aires city centre in Argentina. Its runway dimensions are 2,100m x 40 m with orientation 13-31. The passenger movements of year 2007 have been 5.66 million, and 81,340 aircraft movements.

In 2007 the government of Argentina, through the Unit of Renegotiation and Contract Analysis of Public Services (UNIREN), required to the airport concessionary the development of the airport Master Plan [5].

The Regularization Agency of the Airports National System of Argentina (ORSNA) established only two stages of evolution in the Airport Land Use Plan. The first finishes in the saturation of the runway, and the second at the end of the concession.

| PHASES OF DEMAND | | |
|---|---|---|
| Phase | Year | Annual passengers at the end of the phase |
| 1 | 2006 - 2014 | 8,000,000 Pax |
| 2 | 2014 - 2030 | 8,000,000 Pax |

Table 1 - Phases of demand defined by ORSNA

Performing an econometric analysis, UNIREN elaborated a passenger forecast from 2006 to 2027, taking into account the correlation between the passenger movement evolution in domestic flights and the evolution of gross domestic product (GDP). In the consignee prognosis the mathematical model of correlation and the uncertainty of the forecast were not supplied. Also, the mentioned forecast presents a saturation behavior from 2018 onwards. The prognosis is presented en Table 2.

| PASSENGER GROWTH - UNIREN | | | |
|---|---|---|---|
| **YEAR** | **INTERNATIONAL** | **NATIONAL** | **TOTAL** |
| 2008 | 6.00 % | 3.20 % | 3.53 % |
| 2009 | 5.00 % | 3.10 % | 3.33 % |
| 2010 | 4.00 % | 3.81 % | 3.83 % |
| 2011 | 3.80 % | 3.70 % | 3.71 % |
| 2012 | 3.66 % | 3.66 % | 3.66 % |
| 2013 | 3.61 % | 3.61 % | 3.61 % |
| 2014 | 3.52 % | 3.52 % | 3.52 % |
| 2015 | 3.51 % | 3.51 % | 3.51 % |
| 2016 | 3.42 % | 3.42 % | 3.42 % |
| 2017 | 3.40 % | 3.40 % | 3.40 % |
| 2018 | 0.00 % | 0.00 % | 0.00 % |
| 2019 | 0.00 % | 0.00 % | 0.00 % |
| 2020 | 0.00 % | 0.00 % | 0.00 % |
| 2021 | 0.00 % | 0.00 % | 0.00 % |
| 2022 | 0.00 % | 0.00 % | 0.00 % |
| 2023 | 0.00 % | 0.00 % | 0.00 % |
| 2024 | 0.00 % | 0.00 % | 0.00 % |
| 2025 | 0.00 % | 0.00 % | 0.00 % |
| 2026 | 0.00 % | 0.00 % | 0.00 % |
| 2027 | 0.00 % | 0.00 % | 0.00 % |

Table 2 - Phases of demand defined by ORSNA

## PROBLEM

As aforementioned, it was required to do the Master Plan for Buenos Aires City Airport, in order to fulfill quality requirements and to guide the infrastructure plan.
The historical data required to perform a detailed study of the evolution of each component of the airport was not available. As a consequence it was impossible to build a prognosis of the different demands that condition each airport component.
Particularly the peak hour parameters were required to establish capacity limits of airport components and milestones to trigger different stages of the airport construction processes.
The challenge that imposes the present constraint is to build a model, based on controllable and verifiable hypothesis that permits to elaborate a Master Plan with the available data.

## METHODOLOGY

### Available information

The available information included the historical annual passenger volume, and the correspondent prognosis. This information was supplied by ORSNA and was defined as the one that must lead the evolution of the airport.
The concessionary of the airport provided supplemental information. This information included details of aircraft movements along each day from 1999 to 2007, generated by an automatic system that registers aircraft chocks-on and chocks-off, that contains data related to flights origin-destination, main load, and other. Other information available was the monthly and daily passenger movements from 1999 to 2007.
From the information available, the year 2007 has been adopted as a reference year to determine the demand pattern. This year has been found to be representative after considering the context of economic stability of the region (4 years of positive evolution of GDP) and stability of the aviation activity.
Processing the data where chocks-on and chocks-off were registered, aircraft movements of Buenos Aires City Airport during 2007 have been classified by maximum take-off weight, according to FAA [6] criteria given by:

| Aircraft Class | Max. Cert. T.O. Weight | Number Engines | Wake turbulence Classification |
|---|---|---|---|
| A | 12,500 lbs or less | Single | Small |
| B | | Multi | |
| C | 12,500 lbs - 300,000 lbs | Multi | Large |
| D | Over 300,000 lbs | Multi | Heavy |

Table 3 - Aircraft classification - AC 150/5060-5.

The overall mixture pattern is presented in Table 4.

| Classification | Movements 2007 | Mixture factor 2007 |
|---|---|---|
| B | 5,217 | 6.41 % |
| C | 76,099 | 93.56 % |
| D | 25 | 0.03 % |
| Total | 81,341 | 100.00 % |

Table 4 - Buenos Aires City Airport movements in 2007, classified by weight.

It has been assumed that the presented mixture pattern describes the daily movements of the airport. This assumption has been validated testing the error on different days in the annual registers of 2007, showing a good agreement. This fact also gives information about the representativity of the annual averages over the daily operations.
Another way to characterize aircraft operations is by determining its main payload. Table 5 shows the result of processing the historical data classifying the aircraft operation among passenger movements, freighter movements and general aviation movement.

| Passenger aircraft movements | Freighters aircraft movements | General aviation movements and others |
|---|---|---|
| 72.22 % | 0.25 % | 27.53 % |

Table 5 - Abstract of 2007 movements according to the object of the operations.

In the same way data has been processed to classify operation by domestic flights, international flights and general aviation flights. The results are presented in Table 6.

| Domestic flights | International flights | General aviation flights |
|---|---|---|
| 63.05 % | 9.42 % | 27.53 % |

Table 6 - Abstract of 2007 movements according to the destiny of the operations.

## Model

The challenge of the present case is to establish the pattern of the demand traffic for the airport. To do this, a set of data of a representative airport activity year has been selected to build parameters that describe the pattern of demand. These indexes permit infer from the passenger prognosis, for the same annual distribution pattern determined for the representative year (2007), the demand of airport facilities.
The hypotheses considered are: the overall characteristics of the position of the airport in the transport net remain the same over time, there will not be any drastic change in air transport technology and the traditional airlines keep their typical operation unchanged. To validate the model the historical data have been used.
To have a measure of the peak hour aircraft movements pattern, the annual absolute peak hour has been taken into account. For the presented case, during year 2007 Buenos Aires

City Airport had 26 operations in the peak hour. To consider a group of peak hours to have an average of patterns, all the hours of the year within a 10% margin of the peak hour movements have been considered. Specifically, the year had 6 days with a peak hour with the mentioned characteristics, corresponding to the days: 20th September, 17th August, 29th December, 28th December, 23rd February, and 25th January. Based on the registers of these cases the pattern of the peak demand has been determined.

The peak hour movements data have been processed to characterize the operations in terms of different classification criteria, such as:

- Aircraft class (Table 7).
- Passenger aircraft/freighter/general aviation movements (Table 8).
- Commercial/private operations (Table 9).
- Domestic arrival/departure (Table 10).
- International arrival/departure (Table 10).
- Used runway (Table 11).

| Peak hour | Aircraft class B | Aircraft class C | Aircraft class D |
|---|---|---|---|
| Sep 20 (18:00-19:00) | 4 % | 96 % | 0 % |
| Aug 17 (18:00-19:00) | 16 % | 84 % | 0 % |
| Dic 29 (11:00-12:00) | 21 % | 79 % | 0 % |
| Dic 28 (16:00-17:00) | 13 % | 87 % | 0 % |
| Feb 23 (15:00-16:00) | 29 % | 71 % | 0 % |
| Jan 25 (18:00-19:00) | 8 % | 92 % | 0 % |

Table 7 - Classification of peak operations according to weight class.

| Peak hour | Passenger aircraft | Freighter aircraft | General aviation |
|---|---|---|---|
| Sep 20 (18:00-19:00) | 65 % | 0 % | 35 % |
| Aug 17 (18:00-19:00) | 64 % | 0 % | 34 % |
| Dic 29 (11:00-12:00) | 67 % | 0 % | 33 % |
| Dic 28 (16:00-17:00) | 67 % | 0 % | 33 % |
| Feb 23 (15:00-16:00) | 46 % | 0 % | 54 % |
| Jan 25 (18:00-19:00) | 67 % | 0 % | 33 % |

Table 8 - Classification of peak operations according to payload class.

| Peak hour | Total operations | Commercial | Private |
|---|---|---|---|
| Sep 20 (18:00-19:00) | 26 | 73 % | 27 % |
| Aug 17 (18:00-19:00) | 25 | 64 % | 36 % |
| Dic 29 (11:00-12:00) | 24 | 71 % | 29 % |
| Dic 28 (16:00-17:00) | 24 | 67 % | 33 % |
| Feb 23 (15:00-16:00) | 24 | 46 % | 54 % |
| Jan 25 (18:00-19:00) | 24 | 67 % | 33 % |

Table 9 - Classification of peak operation according commercial/private criteria.

| Peak hour | International arrivals | Domestic arrivals | International departures | Domestic departures |
|---|---|---|---|---|
| Sep 20 (18:00-19:00) | 5 % | 53 % | 5 % | 37 % |
| Aug 17 (18:00-19:00) | 12 % | 44 % | 0 % | 44 % |
| Dic 29 (11:00-12:00) | 0 % | 41 % | 12 % | 47 % |
| Dic 28 (16:00-17:00) | 6 % | 62 % | 6 % | 25 % |
| Feb 23 (15:00-16:00) | 0 % | 55 % | 9 % | 36 % |
| Jan 25 (18:00-19:00) | 19 % | 31 % | 6 % | 44 % |

Table 10 - Classification of peak hour operations according to domestic/international and arrival/departure criteria.

| Peak hour | Runway 13 | Runway 31 |
|---|---|---|
| Sep 20 (18:00-19:00) | 100 % | 0 % |
| Aug 17 (18:00-19:00) | 100 % | 0 % |
| Dic 29 (11:00-12:00) | 83 % | 17 % |
| Dic 28 (16:00-17:00) | 100 % | 0 % |
| Feb 23 (15:00-16:00) | 96 % | 4 % |
| Jan 25 (18:00-19:00) | 100 % | 0 % |

Table 11 - Classification of peak operation according runway header criteria.

As a consequence of the study of the cases we may build an operational environment that represents an extreme case of demand.
Averaging the selected hours, the design hour will then have the following characteristics:

- 100 % of operations are performed on runway 13.
- 55% are arrivals.
- 26 peak hour operations.
- 85% Class C aircraft and 15 % Class B aircraft.

A number of indexes have been defined to describe the demand pattern over the time, inferred from the typical year 2007.

$$PHAO = \frac{Peak \quad hour \quad operations(2007)}{Total \quad annual \quad operations(2007)}$$

$$APAO = \frac{Annual \quad passengers(2007)}{Annual \quad operations(2007)}$$

Under the hypothesis presented to infer the peak hour operations in the *n* year, posterior to 2007, the following expression has been used:

$$Peak \quad hour \quad operations(n) = Total \quad annual \quad passengers(n) \times \frac{PHAO}{APAO}$$

The uncertainty associated with this method depends on the temporal distance to the year where the index has been taken and the stability of the national macroeconomic indicators and the air traffic pattern.
With the peak hour operations in the *n* year, introducing the percentages of the design peak hour, we infer the pattern of the future peak hour. Then it is possible to design different airport areas/facilities/services & components; and it is possible to establish a relation between the growing of different areas of the airport. In other words, making a prognosis of the passenger demand based on parameters associated with the growing of

social and economic activity, we may infer the capacity requirement associated with each airport area.
To have an alternate measure of peak hour passengers, the method proposed by FAA [7], that recommends computing it, for 8,000,000 annual passengers, as 5/10,000 of the total passenger movements, has been adopted. The passengers per aircraft come from computing the peak hour passengers over the peak hour movements.
The FAA suggests computing as passenger movement in peak hour 5/10,000 of the total passenger annual volume. However, it has been assumed that peak hour operations have an occupancy level equal to APO. In the example showed in Table 10 both are shown and it may be seen that the error between them is about 3%.

## RESULTS

To sum up, Table 10 shows an example of extending de passenger prognosis and current airport characteristics to a future point.

| Parameters | Source | Quantity |
|---|---|---|
| Year passengers (2007) | Registers | 5,665,808 PAX |
| Passenger per year prognosis (2018 onwards) | Various | 8,022,442 PAX |
| Annual operations (2018 onwards) | APO index | 90,351 MOV |
| Peak Operations (2018 onwards) | PAO index | 37 MOV |
| Peak passenger movements (2018 onwards) | APO index | 3,286 PAX |
| Alternative peak passenger movements (2018 onwards) | FAA suggestion | 4,011 PAX |
| Operations from 13 runway during peak hour (2018 onwards) | Reference peak hour pattern | 100 % |
| Arrivals during peak hour (2018 onwards) | Reference peak hour pattern | 20 MOV |
| Class C aircraft during peak hours (2018 onwards) | Reference peak hour pattern | 32 MOV |
| Passenger movements during peak hours (2018 onwards) | Reference general pattern | 27 MOV |
| Domestic flights during peak hour (2018 onwards) | Reference general pattern | 24 MOV |

Table 12 - Peak hour operations related to passenger prognosis in year 2020.

## DISCUSSION

For establishing the pattern of the demand traffic for the airport, a set of data of a representative airport activity year has been selected. These indexes have enabled infer from the passenger prognosis the demand of airport facilities. To have a measure of the peak hour aircraft movements pattern, the annual absolute peak hour has been taken into account. To consider a group of peak hours to have an average of patterns, all the hours of the year within a 10% margin of the peak hour movements have been considered. Averaging the selected hours, the design hour has been determined. A number of indexes have been defined to describe the demand pattern over the time, inferred from the typical year 2007, and then the pattern of the future peak hour has been inferred.

Summing up, on the basis of a hard work to process data from the aircraft movement program, the planning parameters have been obtained. Comparing the results with the FAA estimation method, they have been validated for the case study.

The absence of a plan for obtaining data and preparation of reliable statistics of certain necessary planning indexes for airport development involves an additional engineering cost and time for the master plan development.

Finally, considering the estimation of demand and infrastructure planning would enable to form the economic equation of the project. All foreseeable factors should be analyzed to avoid financial inaccuracy for over or under estimation of the demand.

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