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CAPACITY ANALYSIS OF AHMEDABAD AIRPORT- CASE STUDY

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ABSTRACT

The consistent growth of air traffic demand is causing the operational movements at hub airports to approach their maximum capacities. With this growth, delays to Aircrafts and passengers are increasing, and safety is becoming a more crucial problem. The terminal approaching and landing phases are especially important since the airspace is more crowded and operational procedures are more complicated compared with the en route phase. The paper has carried out analysis of aircraft movements to determine runway capacity using handbook approach. It gives a detailed of mix index. By using that mix index the paper find out Hourly Capacity on VFR basis and Hourly Capacity on IFR basis. By using the handbook approach to evaluate several operational scenarios, examination the runway capacity of Ahmedabad airport, is carried out.

KEYWORDS: Capacity, Runway, Airport, Ahmedabad, Aircraft.

INTRODUCTION

This paper uses AAI Flight data for analysis of airport capacity. As the cost of air travel continues to decrease, the number of people flying across the planet climbs inexorably: according to AAI Passenger Data the figure increases dramatically. Due to this passenger growth there is consistent growth of air traffic demand, the operational movements at hub airports are approaching their maximum capacities. Compared with the en route phase, the terminal area has a very complex operating environment.

The purpose of this paper is to understand the Airport capacity. That is to understand what happens to safety when throughput at an airport is increased. To do this, we first collect Aircraft movements to describe basic system characteristics and
explain the runway capacity. Then, we give a detailed of Aircraft movements and Mix Index that is calibrated to Ahmedabad Airport.

**PROBLEM IDENTIFICATION**

Looking towards the recent trends of passengers to choose the air travel for tour and travel, air traffic has increased and it will increase in future also, today many national and international air carriers have participated in India and also in Gujarat State in this Industry. Airlines have also come up with very attractive offers so that even middle class person can also afford air travel for far distances. There is very less difference in fare of upper class railway and economy class of airlines while great difference in time for travelling the same distance. The growth in air travel is outstripping the capacity of airport and air traffic control system, which results in increasing congestion and delay.

**STUDY AREA**

The Airport is spread over an Area of 1,124 acres (4.55 Km2). The S.V.P. International Airport is having single Runway (See Figure 1). Design Aircraft: B-747. Accommodate “C” and “D” type Aircraft. The main runway is 3506m long and 45m wide. (Source: Ahmedabad Airport)

![Figure 1: Google Image of Ahmedabad Airport-Runway](image-url)
OBJECTIVES

- To analyze the capacity of taxiway for aircraft movements.
- To analyze the Processing capacity of terminal building.
- To analyze Runway Capacity.
- To identify capacity shortcomings as the demand for air transportation increases in the future.

Airport Capacity Analysis Methodology

The Ahmedabad airport will face problem related to their capacity by near future. On the basis of problem identification, literature review has been done to analyze and to solve the problem. The study area details are obtained where the problem is occurring the data is collected to evaluate capacity of selected air side element. According to data collected and on the basis of data analysis the conclusions and recommendation can be drawn the study methodology adopted is shown in figure.

Figure 2 shows detailed surveys required and steps involved in the study.

RUNWAY CAPACITY

Runway capacity is defined as “the maximum sustainable throughput of aircraft operations; both arrivals and departures that could be performed during a specified time interval (e.g., 15 minutes, or an hour) at a given airport of a specific
Factors affecting Ultimate Runway Capacity

As per Horronjeff R. and Norman J. Ashford the following factors affect runway capacity:

- Ceiling and visibility condition.
- Physical configuration of the runway system
- Air traffic control system separation rules
- Runway use strategy
- Mix of aircraft using the runway system
- Ratio of arrivals to departure
- Number of touch-and-go operation
- Number and location of exits from the Runway system

RUNWAY CAPACITY USING HANDBOOK APPROACH METHOD (Source HORONJEFF R. and NORMAN J. ASHFORD)

The FAA published a comprehensive handbook containing procedures for the determination of airfield capacities and aircraft delays for purposes of airport planning. The handbook and its companion reports were based on an extensive four-year study by the FAA and a project team composed of Douglas Aircraft Company in association with Peat, Marwick, Mitchell and Co., McDonnell Douglas Automation Company, and American Airlines.

The graphs in figure 3 & 4 account for the effect of the following variables

Source: FAA Advisory Circular AC: 150/5060-5 year: 1983
Figure 3: Hourly capacity in VFR for runway operations

Source: FAA Advisory Circular AC: 150/5060-5 year: 1983

Figure 4: Hourly capacity in IFR for runway operations

1. Aircraft Mix
2. Runway serving both Arrivals and Departure
3. Touch-and-go operation
4. Different exit taxiway configuration
5. Environmental condition (VFR, IFR)
6. A variety of runway configurations uses

The graphs employ a “mix index,” (MI) which is determined by the percentages of aircraft in classes C and D:

\[ MI = \left( \% \text{ aircraft in class C} \right) + 3 \times \left( \% \text{ aircraft in class D} \right) \]

As a result of extensive research conducted to determine the capacity of runway system, the FAA has published a series of charts to determine runway capacity. The Runway capacity (C) is determined as, \( C = C_b E T \)

Where \( C \) = hourly capacity of the runway-use configuration in operations per hour
\( C_b \) = ideal or base capacity of the runway-use configuration
\( E \) = exit adjustment factor for the number and location of runway exits
\( T \) = touch-and-go adjustment factor

Figure 3 and 4 shows the VFR and IFR Chart

The Aircraft Mix is expressed in terms of four aircraft “classes” is shown in Table 1
Table 1 the Aircraft Mix

<table>
<thead>
<tr>
<th>Aircraft class</th>
<th>max. Cert. Take Off weight (Kg.)</th>
<th>Number of engines</th>
<th>wake Turbulence Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5663 or less</td>
<td>Single</td>
<td>Small</td>
</tr>
<tr>
<td>B</td>
<td>Multi.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>5563-135900</td>
<td>Multi.</td>
<td>Large</td>
</tr>
<tr>
<td>D</td>
<td>Over 135900</td>
<td>Multi.</td>
<td>Heavy</td>
</tr>
</tbody>
</table>

Source: FAA Advisory Circular AC: 150/5060-5 year: 1983

DATA DESCRIPTION

Aircraft Movement increases as the movement of passenger Demand increases. Aircraft Data was collected from airport time schedule for 24hr for a week. This data was analyzed by their category to determine Mix Index (MI). The past data was collected of passenger movements to compare with present to know the growth. Figure 6 shows the passenger movements growth.

(Source: www.aai_news.com)

Figure 6: Passenger Growth at Ahmedabad Airport
The increase in passenger movements is the reason for the increase in aircraft movements at the Airport. Figure 7 shows the Aircraft movements growth.

![Growth in Aircraft Movements (2001-2011)](Source: www.aai_news.com)

Figure 7: Aircraft Growth at Ahmedabad Airport

**Runway Capacity**

The data was collected of Flight at workdays in the year 2013: for 7 days 24hr data. The recording period in each day was 7:00 through 24:00 (local time).

The recorded Flight Arrival and Departure time for each aircraft, and then calculated total number of flight with their Take-off and landing weight to classify the Aircraft category. Tables 1 show the Aircraft Mix.

The Aircraft data are classified according to their Weight and category on the basis of data collected. The data are then classified and calculated to Mix Index. Table 2: Shows the Mix Index of collected data.

Table 2 Aircraft Mix Index at Ahmedabad Airport

<table>
<thead>
<tr>
<th>Category</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of Aircraft</td>
<td>4</td>
<td>0</td>
<td>761</td>
<td>273</td>
<td>1038</td>
</tr>
<tr>
<td>% of Aircraft</td>
<td>0.38</td>
<td>0</td>
<td>73.32</td>
<td>26.3</td>
<td>100%</td>
</tr>
</tbody>
</table>

C=73.32% for aircraft of C type

D=26.3% for aircraft of D type

Therefore MI=C+3D

\[
= 73.32 + 26.3 \times 3
\]

=152.22

Say MI=152

Hourly Capacity on VFR

Touch and go factor for 152 Mix Index=1.00

C=CbET
Cb=72 from VFR for 50% arrival, 152 Mix Index
E=0.98
T=1.00
C=72*1*0.98
=70.56
Say 70 operation per hour in VFR

Hourly Capacity on IFR
Touch and go factor for 152 Mix Index=1.00
C=CbET
Cb=60 from IFR for 50% arrival, 152 Mix Index
E=1
T=1
C=60*1*1
=60
Say 60 operation per Hour in IFR

Gate Capacity
The term “gate” designates an aircraft parking space adjacent to a terminal building and used by a single aircraft for the loading and unloading of passengers, baggage, and mail or a remote parking stand on the apron where passengers and baggage are transferred to the terminal building by apron vehicles.

Table 3

<table>
<thead>
<tr>
<th>Aircraft Class</th>
<th>Mix (%)</th>
<th>Average occupancy time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.38</td>
<td>15</td>
</tr>
<tr>
<td>B</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>C</td>
<td>73.32</td>
<td>40</td>
</tr>
<tr>
<td>D</td>
<td>26.3</td>
<td>60</td>
</tr>
</tbody>
</table>

Assume that each gate is available for all aircraft

The gate capacity for a single gate is given by

\[ C = \frac{1}{(0.038 \times 15) + (0.73 \times 40) + 0.26 \times 60) \]

C=0.03 Aircraft/min/Gate.
Arrivals and Departure (Using SPSS SOFTWARE) at Ahmedabad Airport Time Schedule Data Collected from Airlines at Ahmedabad Airport. Aircraft Movements are obtained from Schedule. O-D of Aircraft Movement is done with the help of SPSS software. Table 4 shows Different origins of aircraft to Ahmedabad Airport and Table 5 shows the destination to Ahmedabad.

Table 4 Different Origins Arriving at Ahmedabad Airport

<table>
<thead>
<tr>
<th>ORIGIN</th>
<th>AMD</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abu Dhabi</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Bangalore</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>Bhopal</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Bopal</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Chennai</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Delhi</td>
<td>114</td>
<td>114</td>
</tr>
<tr>
<td>Doha</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Dubai</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Goa</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Hyderabad</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Hyderabad</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Indore</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Jaipur</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Kolkata</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Kuwait</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Mumbai</td>
<td>157</td>
<td>157</td>
</tr>
<tr>
<td>Pune</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Sharjah</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Singapore</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>469</td>
<td>469</td>
</tr>
</tbody>
</table>

Table 5 Different Destination from Ahmedabad Airport

<table>
<thead>
<tr>
<th>ORIGIN</th>
<th>Abu Dhabi</th>
<th>Bangalore</th>
<th>Chennai</th>
<th>Delhi</th>
<th>Doha</th>
<th>Dubai</th>
<th>Goa</th>
<th>Hyderabad</th>
<th>Jaipur</th>
<th>Kolkata</th>
<th>Mumbai</th>
<th>Pune</th>
<th>Sharjah</th>
<th>Singapore</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AMD</strong></td>
<td>7</td>
<td>35</td>
<td>14</td>
<td>97</td>
<td>7</td>
<td>18</td>
<td>14</td>
<td>24</td>
<td>13</td>
<td>7</td>
<td>162</td>
<td>13</td>
<td>7</td>
<td>9</td>
<td>427</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>7</td>
<td>35</td>
<td>14</td>
<td>97</td>
<td>7</td>
<td>18</td>
<td>14</td>
<td>24</td>
<td>13</td>
<td>7</td>
<td>162</td>
<td>13</td>
<td>7</td>
<td>9</td>
<td>427</td>
</tr>
</tbody>
</table>
Desire lines using Trans CAD software

Desire lines are plotted to Find Busy Routes using Trans CAD software.

Figure 8: Desire lines for Ahmedabad Airport using Trans CAD

**Passenger Terminal Building Capacity**

Layout of terminal building

- Passenger walking distance should greater than 180m from the surface transport to their boarding in the aircraft.
- Passenger should be able to check in without waiting maximum check in time not greater than 3 minutes.
- The Airline passenger should not have to carry the baggage or hire the carrying of baggage by more than 22m from the road transportation to the check-in point.
- On the arrival of aircraft, the baggage delivery speed should correspond to the walking time of passengers from the aircraft to the claim or custom area.
- Maximum carrying distance from the custom or baggage claim area to the road transportation not is greater than 22m.
Figure 9: Function Performed by/for departing Passenger

Figure 10: Function Performed by arriving Passengers

**Passenger Movements (2012)**

Domestic = 3327547 = 3.32 million

International = 610788 = 0.6 million

Peak hour Passenger = 3.32*10^6 * 0.03/100

Domestic(Arr.+Dep.)= 996 passenger/hr

Peak hour Passenger = 0.6*10^6*0.05/100

International(Arr.+Dep.)= 300 passenger/hr
CONCLUSION

- The increase in aircraft movement is growing consistently.
- It shows that the demand will soon be reach to the capacity of runway at Ahmedabad airport.
- The area for expansion for runway is not enough at airport.
- Looking towards the last few years data of aircraft movement, the growth trend is inconsistent. In last few years only the policy is changed and more airlines are entering in the aviation sector.

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