DARK CLOUDS AHEAD TO THE BRAZILIAN AIRPORT SYSTEM

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Abstract

This article establishes a relationship between the required capacity for the forecast demand to 2015 and the installed capacity of the twenty largest Brazilian airports. This capacity was estimated using current available techniques in the literature. These techniques are been used for organizations involved with the planning and operation of the airports. The studied airports were the largest ones with respect of the movements of passengers in Brazil. For the analyzed airports, the following factors were taken into consideration: runway system, apron system and the passenger terminal building complex. This analysis is focused on the areas where INFRAERO is planning expansion works or planning phases. The observed results show us mainly a critical situation to the passenger terminal buildings system.

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1. INTRODUCTION

The growing demand has been requiring improvements in the airport capacity systems. The construction of new airports or to enlarge the existing ones is not a simple task. There are many environmental, economical and political restrictions to be considered. INFRAERO, the governmental company that manages the majority of the Brazilian airports, has adopted procedures aiming to minimize problems generated from the traffic jam of the main operational centers of the Brazilian air transport network: Sao Paulo and Brasilia. Many projects are in place, some of them proposed by experts but not necessarily essential. We can see congested airports, others under utilized, and others less important being modernized.

Serious studies to evaluate the real situation of the Brazilian airport system capacity, the identification of the main clogs, are extremely important. They are subsidies to studies and to decision makers involved in this problem solving.

2. THE CURRENT METHODOLOGY

The current methodology takes into consideration the following systems: runways, aprons, and passenger terminal building complexes. The employed models had been selected from the literature [18]. The 2012 demand data was supplied by the Civil Aviation Institute (IAC) [15]. These projections considered three sceneries of growth: pessimistic, ordinary (medium) and optimistic.

2.1 Measures of Required Runway Capacity

The model used to evaluate the runway capacity was the same adopted by INFRAERO [1] and IAC [2]. This model is an adaptation of the contents from the Advisory Circular (AC) 150/5060-5 - Airport Capacity and Delay, of the Federal Aviation Administration - (FAA) [3]. It has listed the aircraft fleet of each studied airport. The 2015 fleet projection was based on the IAC demand studies [15].

This IAC classifies the aircraft in different categories, thus making necessary to establish a criterion to sort them out: INFRAERO, IAC and FAA. See Table 1. The criterion takes into consideration the number of seats in the aircraft and the maximum takeoff weight (MTW).

Table 1 – Relationship between Aircraft Categories

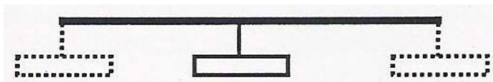
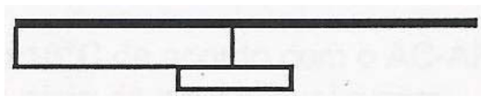
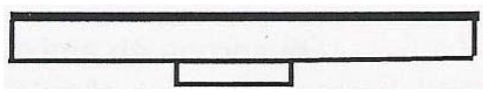
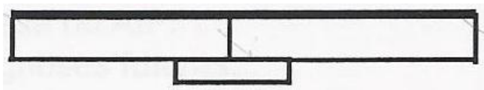
INFRAERO			*IAC*		*FAA*	
Category	*Passengers*	*MTW (kg)*	*Category*	*Passengers*	*Category*	*MTW (kg)*
R1	12 to 25	5,600	F1	8 to 18	A	Below 5,675
					B	
R2	25 to 35	19,000	F2	19 to 30	C	5,675 to 136,200
R3	35 to 60	20,600	F3	31 to 60		
A1	90 to 130	60,550	F4	61 to 130		
A2	130 to 170	78,267	F5	131 to 180		
A3	170 to 300	273,288	F6	181 to 260	D	Above 136,200
A4	300 to 450	394,625	F7	261 to 450		
A5	above 450	-	F8	above 450		

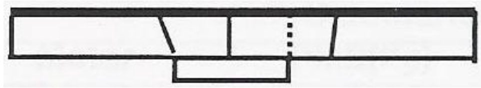
Source: Albuquerque, 2005 [4]

For this application is also necessary to know the configuration of the runway system, the number and the localization of the runway exits. For this section, it was utilized data from satellite images [5], aerial photos [6-9] and the procedures of approaching and landing (Instrumental Flight Rules -IFR and Visual Flight Rules – VFR) provided by Air Navigation Management Center (CGNA) [10].

In accordance to the INFRAERO manual [1], for Brazilian airports, the hourly and annual capacities of the runway systems must be evaluated considering factors available in the AC, as presented in Table 2.

Table 2 – Configuration Factor Utilized to Brazilian Airport Runway Capacity

Runway System	***Runway System Sketch***	***Factor***
Only one runway exit in any runway part		0.30
Only one runway exit and taxiway connecting one threshold		0.50
Parallel taxiway connecting both thresholds		0.70
Parallel taxiway connecting both thresholds and an other connection to the runway		0.88
Parallel taxiway connecting both thresholds and two or three others connections to the runway		0.94

Runway System	*Runway System Sketch*	*Factor*
Parallel taxiway connecting both thresholds and more than three others connections to the runway		1.00

Source: INFRAERO,2002 [1]

Table 3 – Installations Factor

Installations/Navaids	*Factor*
Radar, ILS, ALS, VOR, DME, NDB (optional), PAPI ou VASIS	1.00
ILS, ALS (optional) ou Radar, VOR, DME, NDB (optional), PAPI ou VASIS	0.96
VOR, DME (optional) ou Radar, NDB, PAPI ou VASIS	0.90
VOR ou NDB, PAPI ou VASIS (optional)	0.87
VOR ou NDB	0.85

Source: INFRAERO, 2002 [1]

Others factors must be considered and are dependent on the available level of service in terms of installations and Navaids. Table 3 shows us these factors. The used data about navaid are in the book ROTAER (Air Routes Manual) edited by Air Space Control Department (DECEA) [11].

2.2. Measures of Required Apron Capacity

The required apron capacity was obtained from INFRAERO [1]. In this model the capacity is estimated from the position of the gates in the apron (stands) for each kind of aircraft category. Table 4 shows the relationship between number of seats (Aircraft Size - TAMAV) and passenger capacity per year.

Table 4 – Passengers per Gate to Aircraft Category

Category	*Passengers*	*Pax/year/gate*
R1	12 to 25	70,000
R2	25 to 30	100,000
R3	35 to 60	130,000
A1	90 to 130	200,000
A2	130 to 170	250,000
A3	170 to 300	300,000
A4	300 to 450	400,000
A5	above 450	500,000

Source: INFRAERO, 2002 [1]

The process consists of dividing the total number of passengers embarked and disembarked in the year of study for the number of passengers embarked and disembarked for position in accordance to the TAMAV of each airport.

2.3. Measures of Required Passenger Terminal Capacity

The utilized method for evaluating the Passenger Terminal Building Complex (PTB) was developed by Medeiros [12]. This approach mixes techniques for dimensioning specific airport components, with adjustments for the Brazilian context. The data was found in sites sponsored by INFRAERO.

Some considerations: 50% of the passenger movement during peak-hour is in arrival or in departure procedures; it is assumed that 2/3 of the peak-hour movement is concentrated in the critical half hour. Level of service, according to Horonjeff and Mckelvey [13], is related to dwell time, processing time, walking distances, people agglomeration, availability of concessions and convenient amenities. This work has regarded the service level as "*good*". The average processing time in check-in counter was considered 1.5 minutes per domestic passenger and 2.0 minutes per international one. For greeters and meters were defined 0.5 person per passenger and 10% of total passenger movement like visitors. These people are not considered in some areas (departure lounge, bags reconciliation etc).

2.4. Selected Airports

The Brazilian airport system controls some airports with movement sufficiently reduced. As of 2004 INFRAERO's data, [16], only the 20 largest Brazilian airports had carried more than 90% of the total regular passengers, as showed in Figure 1. This fact justifies a detailed study on this group of airports.

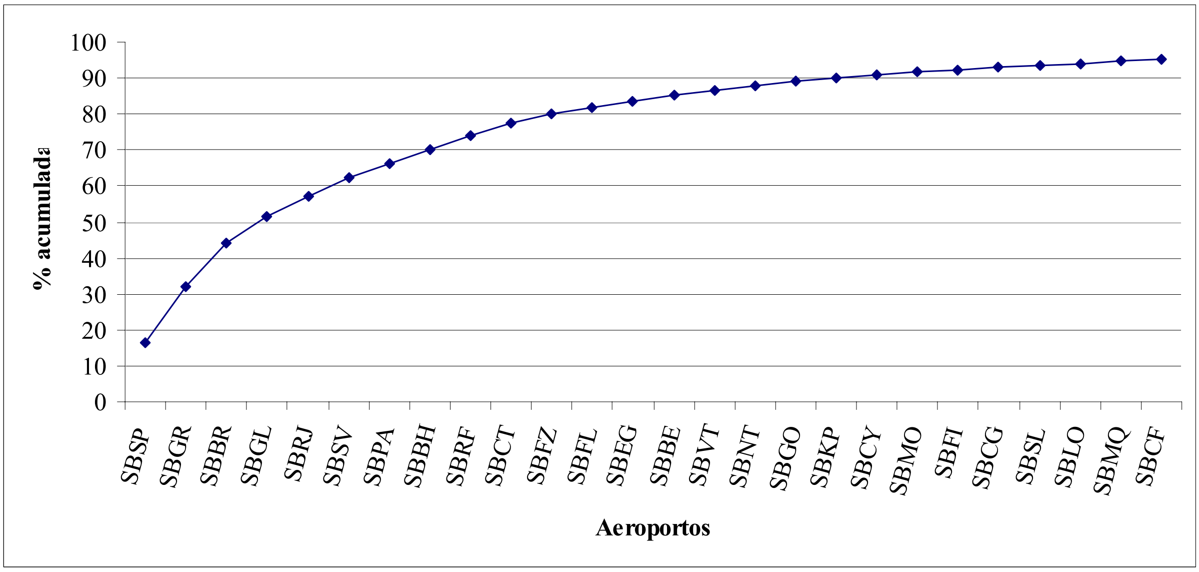


Figure 1 – Airport Participation in Passengers Movement (2004)
Source: INFRAERO [16]

To make possible a comparative analysis of the results, the airports had been grouped in accordance to its quantitative and qualitative characteristics of the aircraft movement. For the 20 airports in study, 5 groups had been established:

- Group I: Predominantly domestic airports (less than 5 % of international passengers), in 2004, low aircraft movement (less than 30,000 landing and taking-off) and less than 1.3 millions of passengers/year. They are: Maceio (SBMO), Cuiaba (SBCY), Campinas (SBKP), Goiania (SBGO) and Vitoria (SBVT).
- Group II: Domestics airports, with short haul flights and localized in urban areas. In this group, two airports: Pampulha (SBBH) and Santos Dumont (SBRJ).
- Group III: International airports with moderate aircraft movement (30,000 to 100,000) and less than 7 millions passenger/year in 2004. This group congregates a large number of the studied airports: Natal (SBNT), Belem (SBBE), Manaus (SBEG), Florianopolis (SBFL), Fortaleza (SBFZ), Curitiba (SBCT), Recife (SBRF), Porto Alegre (SBPA), Salvador (SBSV) and Rio de Janeiro (SBGL).
- Group IV: Great international airports where occurs concentration of aircraft movements (above 100,000), known like hub airports. Includes: Brasilia (SBBR) and Sao Paulo/Guarulhos (SBGR).
- Group V: Only destined to the Congonhas Airport (SBSP), that possesses characteristics of central airport (Group II) and huge concentration of flights (Group IV).

2.5. Demand and Capacity

CGNA [10] outlines suggests that a runway operating at 60% of its capacity should trigger, a detailed study of the airport in question. If the operational level reaches the 80% of the capacity, a constant and controlled management must be put in place, turning conditional the implementation of the ATS slot police. In this work was considered a warning situation, when the runway is operating at more than 80% of its capacity. This work also took into consideration the possibility of the runway to work at above 100% of its capacity, a critical situation, with high level of lost quality-of-service, long delays, near a collapse!

3. RESULTS

3.1. Prognosis

The 2015 projections are shown in Tables 5 and 6, in three sceneries of demand growth. Warning situations are for percentages of utilization between 80% and 100%. Serious problems will be observed in the airports with percentages of utilization above 100%. In this case, we are close to an operational collapse.

Table 5 – Required Capacity to 2015 in Runway and Apron Systems [18]

Airport	*% System Utilization - 2015*					
	pessimistic		*average*		*optimistic*	
	R/W	*Apron*	*R/W*	*Apron*	*R/W*	*Apron*
SBVT - Vitoria Airport	49	135	59	162	76	**193**
SBGO – Goiania Airport	33	75	46	94	65	118
SBKP – Campinas Intl Airport	21	101	26	122	32	146
SBCY – Cuiaba Intl Airport	36	23	50	28	69	34
SBMO – Maceio Intl Airport	10	28	12	34	15	41
SBRJ - Santos-Dumont Airport	52	**184**	67	**218**	86	**257**
SBBH – Pampulha Airport	48	19	64	22	84	26
SBGL - Rio de Janeiro Intl Airport	55	118	67	141	80	**168**
SBSV - Salvador Intl Airport	12	118	69	141	82	**166**
SBPA - Porto Alegre Intl Airport	41	143	51	**171**	63	**204**
SBRF – Recife Intl Airport	38	87	49	106	63	128
SBCT - Curitiba Intl Airport	45	118	54	140	65	**166**
SBFZ - Fortaleza Intl Airport	34	125	44	**153**	54	**186**
SBFL - Florianopolis Intl Airport	47	**167**	59	**200**	73	**238**
SBEG - Manaus Intl Airport	30	79	41	96	53	115
SBBE – Belem Intl Airport	33	92	42	109	54	**129**
SBNT – Natal Intl Airport	10	36	13	45	17	55
SBGR – Guarulhos Intl Airport	81	143	98	**170**	119	**198**
SBBR - Brasilia Intl Airport	58	**216**	74	**256**	92	**302**
SBSP – Congonhas Airport	**150**	**510**	**186**	**607**	**231**	**718**

Table 5 – Group 1 shows that we have apron restrictions for the airports of Vitoria, Campinas and Goiania The runways in these airports are not a problem though. Group II, shows an almost collapse in the Santos Dumont apron system for any scenery. Group III shows no problems for the runway systems. The Natal apron system is the exception, all others aprons have shown limitations. More critical situation is observed in aprons of Florianopolis, Porto Alegre, Fortaleza, Rio de Janeiro and Curitiba. For Group IV, the major problem is in the Brasilia apron system. Congonhas, in Group V, shows a chaotic situation, impossible to be managed. The location site of this airport does not permit any kind of expansion and probably part of this demand will be transferred to other places (Rio de Janeiro, Guarulhos or Campinas).

Table 6 - Required Capacity to 2015 in PTB System [18]

Airport	*% System Utilization PTB - 2015*		
	Pessimistic (m^2)	*Average (m^2)*	*Optimistic (m^2)*
SBVT - Vitoria Airport	78	91	106
SBGO – Goiania Airport	57	68	80
SBKP – Campinas Intl Airport	100	113	128
SBCY – Cuiaba Intl Airport	94	108	126
SBMO – Maceio Intl Airport	95	106	118
SBRJ - Santos-Dumont Airport	69	80	92
SBBH – Pampulha Airport	**455**	**521**	**597**
SBGL - Rio de Janeiro Intl Airport	59	69	81
SBSV – Salvador Intl Airport	111	130	**151**
SBPA - Porto Alegre Intl Airport	119	139	**162**
SBRF – Recife Intl Airport	122	144	**171**
SBCT – Curitiba Intl Airport	133	**153**	**178**
SBFZ – Fortaleza Intl Airport	132	**156**	**184**
SBFL – Florianopolis Intl Airport	**382**	**436**	**497**
SBEG – Manaus Intl Airport	70	80	92
SBBE – Belem Intl Airport	98	111	126
SBNT – Natal Intl Airport	**271**	**320**	**373**
SBGR – Guarulhos Intl Airport	142	**167**	**194**
SBBR - Brasilia Intl Airport	**190**	**222**	**260**
SBSP – Congonhas Airport	**324**	**384**	**452**

A preliminary analysis discloses that practically in all passenger terminal buildings there will be restrictions in 2015. In some cases, independently of the group, it will be necessary some kind of expansion. Brasilia, Natal and Florianopolis are in this critical situation. Pampulha and Congonhas, due to their geographic positioning, will have to limite the number of flights ant to deviate them to Confins and Guarulhos.

3.2. Some Expansions in Place

INFRAERO's site informs the expansions in place and or being planned. In Group I, expansion works in the passenger terminal buildings have been initialized: Vitoria (the capacity will be expanded in four times), Goiania (to increase threefold the current capacity), Cuiaba (the capacity will be doubled), Campinas (a threefold increase) and Maceio (an increase of 100% of the capacity).

All, therefore, are in process of expansion. The deadline varies from the end of 2005 to the beginning of 2008.

Group II required a different solution. For Santos-Dumont, in Rio de Janeiro, a major expansion work (almost to triple the current of 3.2 to 8.5 millions passengers/year), Pampulha, in Belo Horizonte has already transferred the majority of the flights to Confins (with no expansion work been planned).

For Group III, despite the critical situation at the terminals of Florianopolis and Natal, and the warning situation at the terminals of Curitiba and Fortaleza, there is no information about expansion projects in these places.

In Group IV, Guarulhos and Brasilia, with both terminals in precarious operational conditions, developments are in place and new improvements in their capacity must take place to satisfy the forecasted passenger demand.

In Group V, in Congonhas, the recent reforms undertaken are not enough to improve the situation and there is no available area for future expansion.

4. CONCLUSIONS

This article aimed, with the utilization of a conservative methodology, to identify and to quantify the operational level of the main Brazilian airports in the next years. The investments announced by INFRAERO seem to be not enough to face the challenge. It is necessary to conduct new studies to search for better solutions for the forecast over crowding. Time is crucial: the process of conception, construction and operation of a new airport takes 3 to 4 years. During this period, the demand will increase and more people will be affected.

The conservative methodology used appoints to no substantial changes in the operational procedures. With the development of technologies and the aggravation of the relationship between demand and capacity at the Brazilian airports, maybe will trigger the necessary political motivation to revert the situation, not considered in this study.

The scenario revealed by this study supports the projects that INFRAERO has already implemented or is planning to, due to the projected demand growth. However, it points out to many capacity problems in 2015.

In summary: the runway system are in good conditions, some apron systems require updating and a lot of work at the passenger terminal buildings is required in order to face the urgency of the traffic demand. By the way things are being managed; we foresee trouble waters for the Brazilian Airport network management.

REFERENCES

[1] INFRAERO – **Manual de Critérios e Condicionantes de Planejamento Aeroportuário.** Superintendência de Empreendimentos de Engenharia – DEEE, April 2002.

[2] INSTITUTO DE AVIAÇÃO CIVIL (IAC) – **Manual de Capacidade para a Infra-Estrutura Aeroportuária**. DPT. Rio de Janeiro, January 2005.

[3] FEDERAL AVIATION ADMINISTRATION (FAA) – **Airport Capacity and Delay**, Advisory Circular Nº 150/5060-5, Washington, DC, September 1983.

[4] ALBUQUERQUE, R. M. – **Um Estudo da Malha Aeroportuária Brasileira**. Trabalho de Graduação, ITA, São José dos Campos, 2005.

[5] GOOGLE EARTH **- A 3D Interface to the Planet - Explore, Search and Discover.** 2006. Available in:< http://earth.google.com/download-earth.html>. Access 09/02/2006.

[6] SBSV – **Aeroporto de Salvador**. Available in: <http://www.aeroportosalvador.hpg.ig.com.br/ principal.htm>. Access 02/14/2006.

[7] SBRF – **Aeroporto Internacional do Recife.** Available in: <http://www.sbrf.hpg.ig.com.br/ index.html> . Access 10/19/2005.

[8] SBCT – **Aeroporto Internacional de Curitiba**. Available in: <http://www.pr.gov.br/aeroportos/ afonso.html>. Access 02/09/2006.

[9] SBPA – **Aeroporto Internacional de Porto Alegre**. Available in: <http://paginas.terra.com.br/lazer/ sbpa/aeroportos/palegre>. Access 02/09/2006.

[10] CENTRO DE GERENCIAMENTO DA NAVEGAÇÃO AÉREA (CGNA) – **Aeroportos – Capacidade**. Available in: <http://www.cgna.gov.br/aeroportos/ aeroportos.htm>. Access 10/19/2005.

[11] DEPARTAMENTO DE CONTROLE DO ESPAÇO AÉREO (DECEA) – **ROTAER Brasil** – Manual Auxiliar de Rotas Aéreas, Rio de Janeiro, 3rd ed., November 1999.

[12] MEDEIROS, A. G. M. – **Um Método para Dimensionamento de Terminais de Passageiros em Aeroportos Brasileiros**. MSc Dissertation, ITA, São José dos Campos, 2004

[13] HORONJEFF, R. & MCKELVEY, F. X. – **Planning and Design of Airports**. McGraw-Hill, New York, 4th ed., 1993.

[14] ALVES, C.J.P. – **Terminal de Passageiros**. Available in: <http;//www2.ita.br/~claudioj/mod07.htm>. Access 11/29/2005.

[15] INSTITUTO DE AVIAÇÃO CIVIL (IAC) – **Demanda Detalhada dos aeroportos brasileiros 2005**. Preliminary Version. Rio de Janeiro, 2006.

[16] INFRAERO – **Relatório Anual 2004**. Brasília, March 2005. Available in: <http://www. infraero.gov.br/ upload/arquivos/inst/relat_anual_2004.pdf >. Access 03/14/2005.

[17] CENTRO DE GERENCIAMENTO DA NAVEGAÇÃO AÉREA (CGNA) – **Aeroportos – Conceitos**. Available in: <http://www.cgna.gov.br/aeroportos/ conceitos.htm>. Access 05/10/2006.

[18] CARVALHO, B. G. – **Uma metodologia para obtenção de um diagnóstico dos principais aeroportos no Brasil através da avaliação da relação demanda e capacidade**. MSc Dissertation, ITA, São José dos Campos, 2006.