OVERVIEW OF MAJOR BRAZILIAN AIR CARGO TERMINALS

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ABSTRACT

This paper brings up an overview of the four largest Brazilian air cargo terminals: São Paulo, Campinas, Manaus, and Rio de Janeiro International Airport, which processes more than 60 % of air cargo operations in Brazil. The analysis is done through three aspects: (1) an analysis of their current cargo processing capacity, (2) the current and growing demand scenario, (3) and the possible improvement alternatives. The methodology used to estimate the cargo capacity was developed by INFRAERO (federal company that manages the 67 major Brazilian airports). Data has been collected in these four airports in order to apply this methodology, including: dimensions and layout of terminal components, degree of mechanization, duration of storage, mix and flow characteristics of cargo, and general procedures. Current cargo volumes were obtained in order to evaluate the utilization of these terminals. In addition to that, official demand forecasts have been collected in order to evaluate necessary investments, if necessary. Finally, several improvement alternatives were proposed to accommodate future cargo demand at these air cargo terminals. These alternatives range from changes in lay-out, processes and procedures, to investments in new terminal areas. The results indicate that significant capacity can be added to these terminals, with little money spending; in this case, current and short term demand might be accommodated in these terminals. For future demand, however, long-term new investments will be necessary, especially for São Paulo and Viracopos Airport.

Keywords: Air Cargo Terminal, Capacity, Demand Forecast

INTRODUCTION

In order to prevent unnecessary and undesirable interference between surface access passenger traffic and land side freight movements, cargo operations are ideally well separated from the passenger terminal area. Therefore, even the frequent air traveller tends to regard the passenger terminal as the hub of all important comings and goings in the daily activities of the airport. The airport designer, however, cannot overlook air cargo, for this is an important and steadily increasing area of civil aviation (Ashford and Wright, 1992).

Traditionally, the air transport had its commercial value associated with the transport of passengers, while the other modes of transport used by humans, since animal traction vehicles to road vehicles, rail and maritime transport have always been in charge of its largest generation wealth. The air freight continued as a byproduct of the passenger transport until the mid-1970s, when it came to be seen as an independent business and profit-oriented (Chen and Chou, 2006). Nowadays, the value that combines the speed of the aircraft that can carry the load draws more and more sectors of the economy. Trade in high technology products, innovations with high value-added products with high density value, express delivery and perishable items are typical of the current air cargo (Tozi et. al., 2009).

Long-term forecasts (Boeing, 2009) indicate that world air cargo traffic will triple over the next 20 years. Air cargo grew 4.1% on the last 20 years and will grow 4.8%-6.7% per year on the next years, according to the document (Figure 1). This tremendous growth implies that airport designers and managers take necessary actions to accommodate future demand.

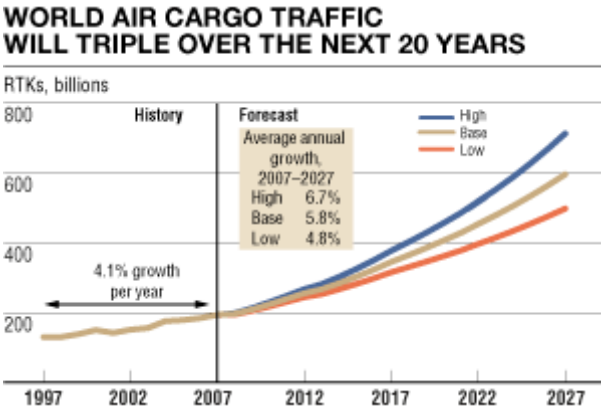

Figure 1 - World Air Cargo Forecasts (Source: Boeing, 2009).

All main Brazilian international airports have their own cargo terminals. Imported and exported processed goods at the terminals vary according to the region in which each airport is located. However, main Brazilian airports are the following: São Paulo International Airport (SBGR), Campinas International Airport (SBKP), Rio de Janeiro International Airport (SBGL) and Manaus International Airport (SBEG). All these represent over 60 % of all air cargo transported in Brazil, as seen in Figure 2.

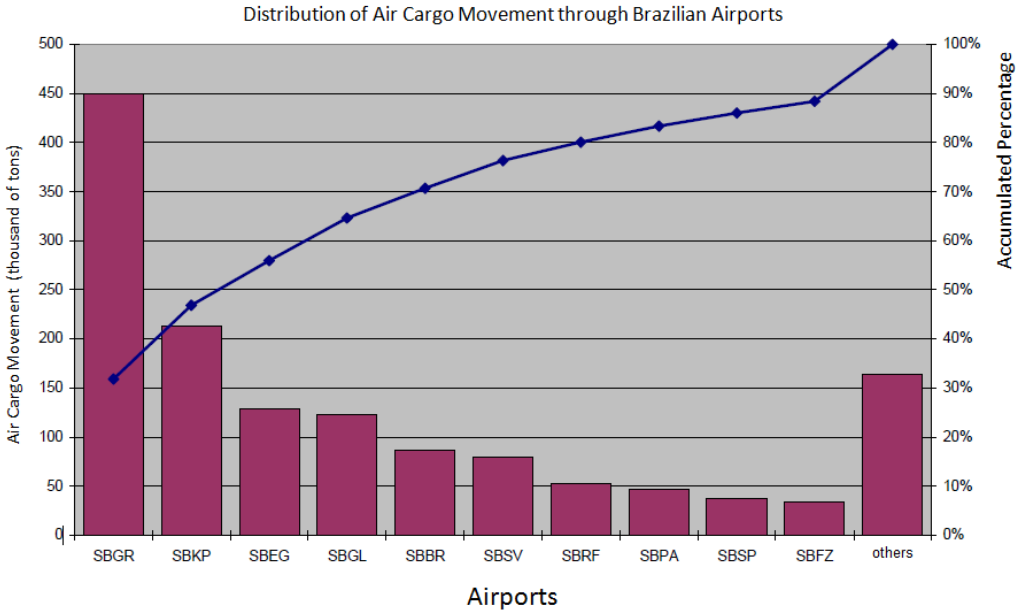

Figure 2 – Contribution of each Brazilian airport for air cargo movement (Source: Oliveira, 2007).

Considering the importance of these four airports, they will be considered for analysis in this paper. This work intends to evaluate the demand and capacity on the main Brazilian air cargo terminals, along with provide improvement alternatives to accommodate future short term growth (2009-2011).

ANALYSIS OF AIR CARGO TERMINALS

The following steps will be developed in this paper, in order to provide an overview of the main air cargo terminals:

1. Evaluate current airport cargo terminal capacities.
2. Forecast future air cargo demands.
3. Compare existing capacities and future demand.
4. Propose improvement alternatives.

Details of these actions will be presented in the next sections.

Available Infrastructure

Although most airports are capable of handling air freight in some capacity, the size and form of the cargo terminal facilities vary substantially. The degree of sophistication provided depends on the following factors (Ashford and Wright, 1992):

- The mix and flow characteristics of the cargo
- The characteristics of the surface and air vehicles

- Materials handling, documentation, and communication techniques
- Degree of mechanization

Considering these particularities, sizing an air cargo terminal is a complex task. Additionally, there is no standard methodology available at the literature; most methods are developed by consultancies, airlines or airport authorities and are used for particular situations under certain boundary conditions, which might not be geographically transferred. For this reason, we will employ a local method (Infraero, 2002) to evaluate the capacity of Brazilian cargo terminals, since it considers the reality of the terminals considered in this paper. The analysis will be done separately for export and import terminals. Capacity planning of import terminals is more complex, since they include additional components; besides that, air cargo usually remain considerable more time in these terminals, as opposed to export terminals.

Export Terminal

INFRAERO's capacity manual (Infraero, 2002) suggests that, based on observation of the Brazilian export air cargo terminals, the adequate index for area estimation would be 0.16 m^2 for each ton/year. Using this index, it is possible to develop the following equation to calculate the actual capacity:

$$C_{exp} = \frac{A_{av}}{i_{exp}} \qquad (1)$$

Where,

C_{exp} is the actual capacity calculated;
A_{av} is the available area for air cargo storage;
i_{exp} is the index provided by the capacity manual (0,16 m2 for each ton/year).

Import Terminal

INFRAERO's capacity manual (Infraero, 2002) proposed the following equation:

$$C_{imp} = \frac{365 \times a \times h \times A}{t} \qquad (2)$$

Where,

C_{imp} is the capacity for the import terminal;
a is the index which varies according to the level of mechanization of the terminal – 0,04 ton/m^3 without transelevator and 0,06 ton/m^3 with transelevator;
h is the average storage in the warehouse;
A is the available area in the warehouse for storage;
t is storage time;
i is the percentage of the terminal used for unclaimed cargo.

Although the percentage of terminal used for unclaimed cargo is not counted directly into the formula, it impacts directly in the capacity because it represents how much of the warehouse is being used for storage of this kind of cargo. This means that high values of **i** would decrease the value of **A**, affecting capacity.

Cargo Movement Data and Terminal Characteristics

Cargo movements have been collected for the airports of study and are presented in Table I. As it can be seen, the data for Rio de Janeiro International Airport was restricted for 2007 and 2008 since export operations has begun only on middle 2007. For that airport, 2004 and 2005 data for import movement was not available as well.

Table I – Movement for the four major Brazilian cargo terminals: SBGR (São Paulo International Airport); SBKP (Campinas International Airport); SBGL (Rio de Janeiro International Airport) and SBEG (Manaus International Airport).

Cargo Movement (ton/year)	Terminal	Airport	2004	2005	2006	2007	2008
	Export	SBGR	133,094	119,599	114,593	113,677	111,171
		SBKP	116,445	105,077	93,730	106,538	91,851
		SBGL	-	-	-	14,854	30,426
		SBEG	7,077	10,107	9,147	6,824	5,622
	Import	SBGR	97,647	98,981	111,483	129,055	130,189
		SBKP	94,884	87,350	103,158	133,435	148,287
		SBGL	-	-	22,269	28,945	33,679
		SBEG	26,375	29,520	32,786	41,689	40,721

Table II – Parameters for each studied airport's cargo terminal.

	Airports			
Parameters	SBGR	SBKP	SBGL	SBEG
A_{av} (m^2)	22,887	15,560	13,000	4,128
A (m^2)	8,802	6,062	5,272	6,000
a (ton/m^3)	0.06	0.06	0.06	0.06
h (m)	12	12	12	12
t (days)	15	15	15	8
i (%)	60	60	50	10

Available Infrastructure's Capacity

Using the data from table I and II, along the capacity's formulas 1 and 2, it is possible to calculate the available infrastructure's capacity as seen in table III.

Table III– Estimated capacity for each airport's terminal.

	Airports			
	SBGR	SBKP	SBGL	SBEG
Export (ton/year)	143,044	97,250	81,250	25,800
Import (ton/year)	154,209	106,206	92,374	197,100

Table IV presents the utilization of studied air cargo terminals.

Table IV – Utilization factor along last years for each airport.

Utilization factor (%)	Terminal	Airport	2004	2005	2006	2007	2008
	Export	SBGR	93%	84%	80%	79%	78%
		SBKP	120%	108%	96%	110%	94%
		SBGL	-	-	-	18%	37%
		SBEG	27%	39%	35%	26%	22%
	Import	SBGR	63%	64%	72%	84%	84%
		SBKP	89%	82%	97%	126%	140%
		SBGL	-	-	24%	31%	36%
		SBEG	13%	15%	17%	21%	21%

The high level of utilization factor for both SBGR and SBKP are justified by the fact that these two airports are the ones which are closer to the Brazilian largest industrial area, São Paulo, and most of all air freight in Brazil goes through them. Also, these two airports work as hub for air cargo, receiving cargo from others airports' terminals, since some flights to another countries only departure from there.

Demand Forecasts

The air freight movements is, like any economical activity, strongly impacted by external factors such as the country's Gross Internal Product growth, international economic crisis, import and export industry activity, etc. Estimating the demand growth is not always a simple task since there are several variables involved in the process. Therefore, due to the lack of a longer time series for air freight movement (only 5 years were available), it was made an estimative for growth for the next 3 years (up to 2011). This way, the many variables which impact it are less likely to change significantly, yielding a more reliable forecast.

There are several demand forecast methods available at the literature, including the following: delphi, regression analysis, econometric models, and time-series analysis. Due to

its simplicity and usefulness, time series will be employed in this paper. The time series analysis combines the variations of demand, as follows (Ballou, 2003):

$$F = T \times S \times C \times R \qquad (3)$$

Where

F = forecasted demand
T = trend level
S = seasonality index
C = cyclical index
R = residual index

Cyclical and residual index is considered as 1.00 in this paper. Most probably, the cyclical index would not impact a short term forecast, like the one developed in this paper. Trend levels are evaluated as follows:

$$T = a + b\,t \qquad (4)$$

Where

T = time in years

and

$$b = \frac{\sum D_t(t) - N(\overline{D})(\bar{t})}{\sum t^2 - N\bar{t}^2} \qquad (5)$$

$$a = \overline{D} - b\bar{t} \qquad (6)$$

where

N = number of observations used for development of trend level
D_t = current demand in time *t*
D = average demand in *N* periods of time
$\bar{t}$ = average of *t* throughout *N* periods of time.

Seasonality will not be considered in our model, since we are using yearly data. Additionally, air cargo seasonality of demand usually occurs within a year period.

In order to build the time series forecast, we used the LOGWARE software, which is a free software used by logistics students around the world. The input for each forecast are similar for all airports: it was used the air cargo demand data inside table I, the number of years to be forecasted, the number of periods which will used to compute the error (for all cases it

was used to series) and the number of periods used to model initialization (in this case it was 2 periods). Due to scarcity of data, it was not possible to do a reliable forecast for Rio de Janeiro International Airport.

São Paulo International Airport

According to Figure 3, the trend for export demand in SBGR is decreasing for the next years. The decreasing of export for the last years can be explained by the fact that Brazilian currency has been increasing over the U.S. dollar. That is, Brazilian products are being less competitive for international trade. Table V presents the forecasted values for the next 3 years. For this series estimation, the values of mean absolute deviation (MAD) and root mean square error (RMSE) are respectively 3,190.22 ton/year and 3,268.16 ton/year.

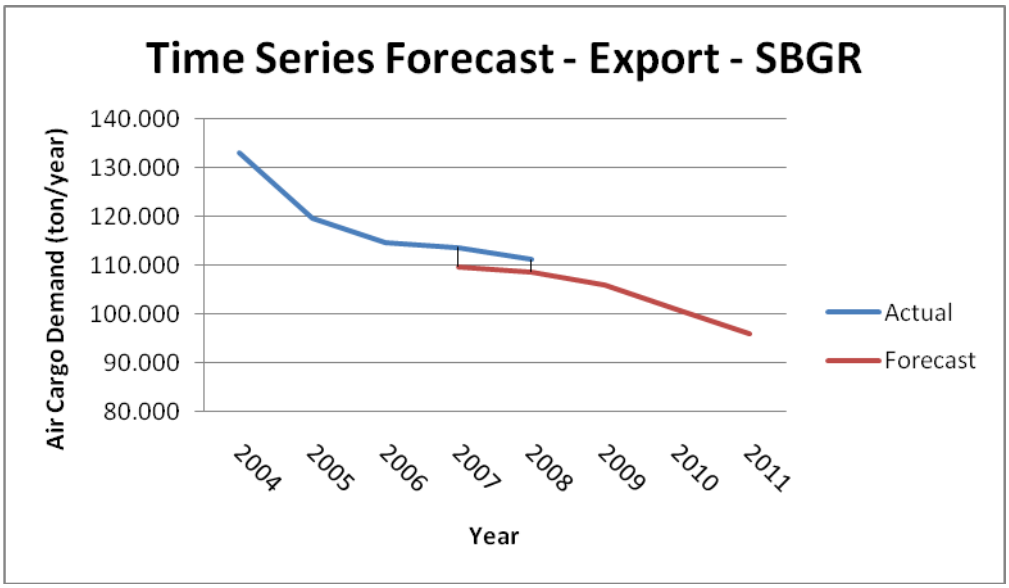

Figure 2 – Time Series Forecast for export demand in SBGR.

Table V – Demand Forecasted for export in SBGR.

Year	2009	2010	2011
Forecasted Demand (ton/year)	106,070	100,970	95,870

As it can be seen in Figure 4, on the other hand, the trend for import demand in SBGR is increasing for the next years. The increasing of import can be explained by the same reason of decreasing in import. The Brazilian currency increasing its value compared to the U.S. dollar has the opposite effect for importation. International products get cheaper in Brazilian internal market due to this fact, turning them more attractive than national products. Besides that, the Brazilian economy has been increasing on the last years, except by 2009, which was affected by the global crisis. Table VI brings the values forecasted for the next 3 years.

For this series estimation, the values of MAD and RMSE are respectively 8,537.11 ton/year and 8,542.89 ton/year.

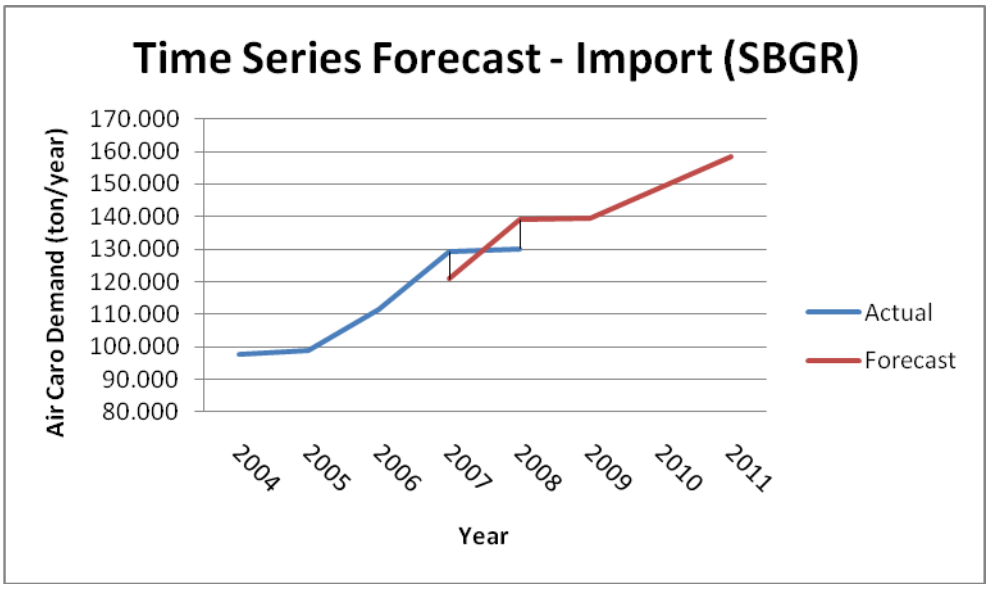

Figure 3 – Time Series Forecast for import demand in SBGR.

Table VI – Demand Forecasted for import in SBGR.

Year	2009	2010	2011
Forecasted Demand (ton/year)	139,539	148,888	158,238

Campinas International Airport

Analogously to SBGR, SBKP follows the same trend for both importation and exportation. It is interesting to note that there a little peak for export air cargo in 2007, as shown in figure 5. This value can be explained by the entrance of more air cargo carriers operating in that airport. After that, the trend continues to fall up to 2011. Importation has the same trend as SBGR's for all years as shown in Figure 6. Both forecasted demands are seen in tables VII and VIII. For export, the values of MAD and RMSE are 13,329.39 ton/year and 13,869.63 ton/year respectively while for import, the values are 8,684.85 ton/year and 11,597.94 ton/year respectively.

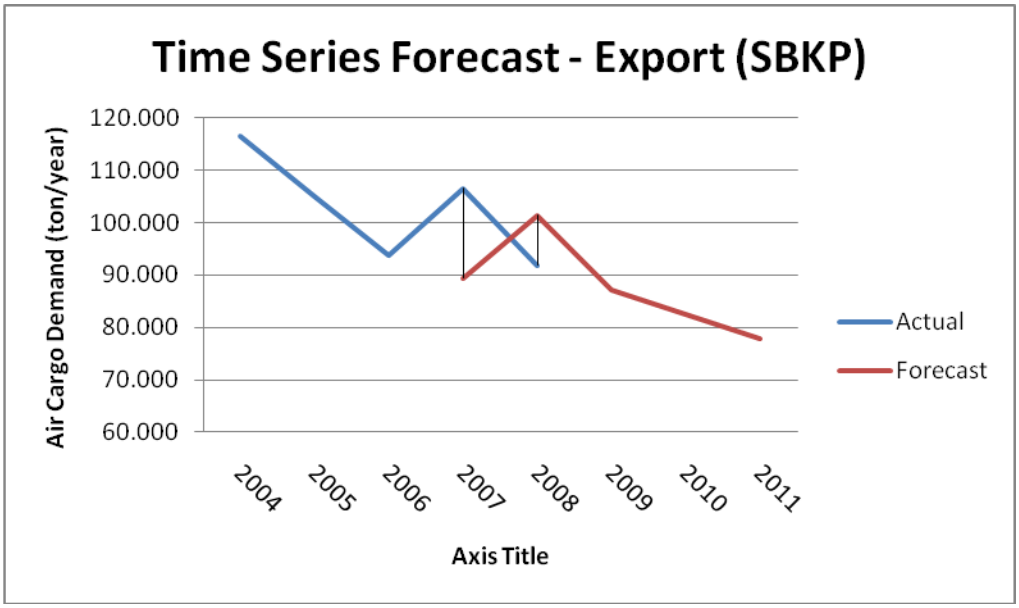

Figure 4 – Time Series Forecast for export demand in SBKP.

Table VII – Demand Forecasted for import in SBKP.

Year	2009	2010	2011
Forecasted Demand (ton/year)	87,146	82,442	77,737

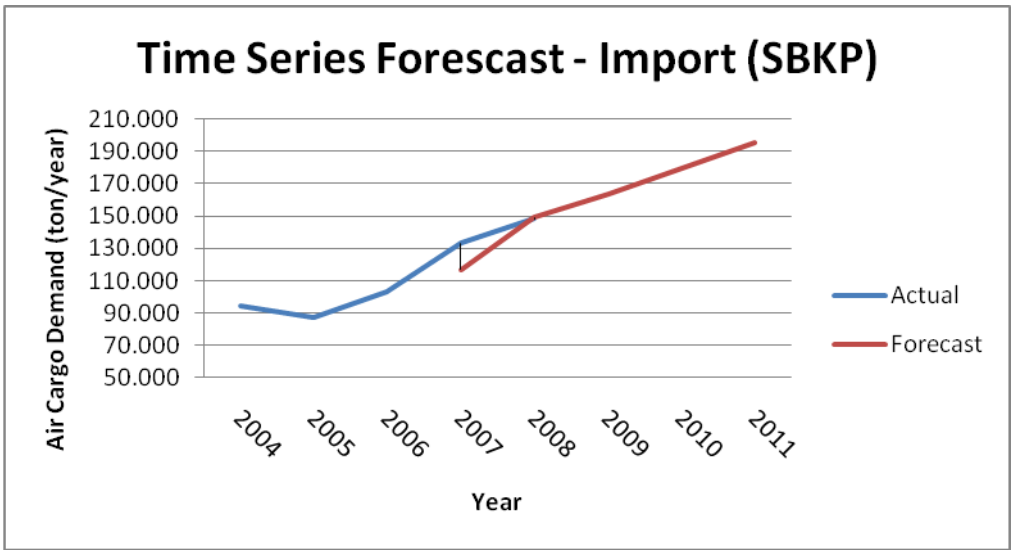

Figure 4 – Time Series Forecast for import demand in SBKP.

Table VIII – Demand Forecasted for import in SBKP.

Year	2009	2010	2011
Forecasted Demand (ton/year)	164,031	179,775	195,519

Manaus International Airport

As expected, this airport follows the same trend as the other previously ones as can be seen in Figures 7 and 8, also in table IX and X. For these export series forecast the values of MAD and RMSE are 1,101.18 and 1,205.85 ton/year respectively while for import series forecast the values of MAD and RMSE are 5,201.54 and 5,205.93 ton/year, respectively.

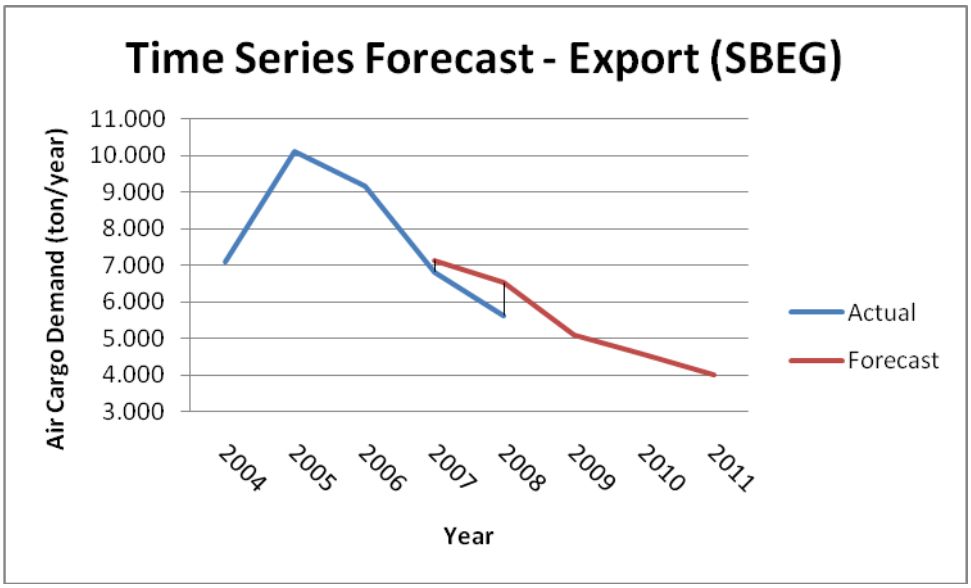

Figure 6 – Time Series Forecast for export demand in SBEG.

Table IX – Demand Forecasted for import in SBEG.

Year	2009	2010	2011
Forecasted Demand (ton/year)	5,088	4,553	4,019

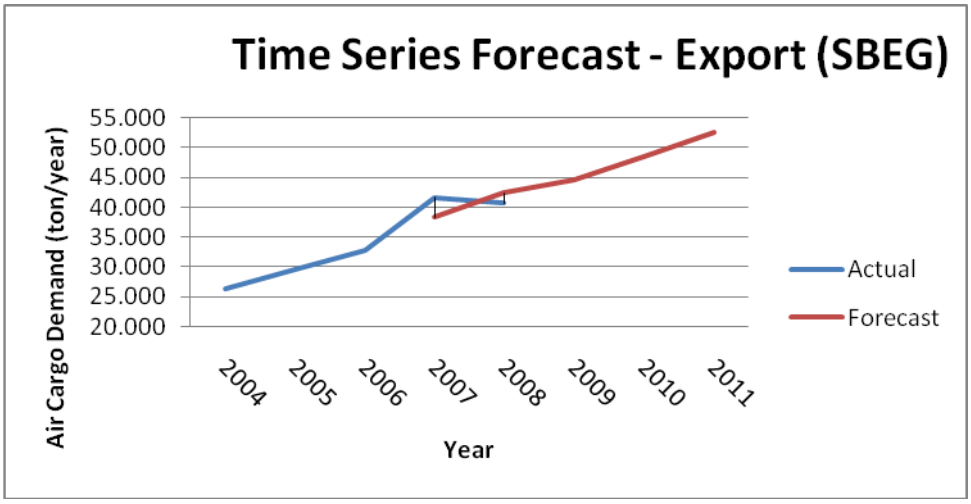

Figure 7 – Time Series Forecast for import demand in SBEG.

Table X – Demand Forecasted for export in SBEG.

Year	2009	2010	2011
Forecasted Demand (ton/year)	44,646	48,571	52,496

Demand/Capacity Analysis

Table XI presents the utilization index (demand/capacity) of the three studied airports.

Table XI – Utilization factor for each forecasted demand.

		Airport	2009	2010	2011
Utilization Factor (%)	Export	SBGR	74%	71%	67%
		SBKP	90%	85%	80%
		SBEG	20%	18%	16%
	Import	SBGR	90%	97%	103%
		SBKP	154%	169%	184%
		SBEG	23%	25%	27%

As it was expected, the utilization factors for export terminals are getting lower as years pass by. Since the time series forecast showed a decreasing trend for exportation, these results seems more than obvious. Table IV showed that both the most critical airports are SBGR and SBKP, which are close to saturation degree. However, as forecasted demand showed, these two terminals will take advantage of demand reduction in the years to reduce their utilization factor.

On the other hand, the condition for import terminals seems quite critical for the next years. Both for SBGR and SBKP, the utilizations factors show that the available capacity will not be enough to absorb the growing demand. For SBKP, the necessary capacity in 2011 will be almost twice bigger than current one. This situation could lead to many unwanted situation like lows levels of service, loss of credibility for the terminal's administration and, certainly, revenue losses.

Possible Improvements

Usually, the most common way of increasing capacity in the terminal would be building a new warehouse. However, this alternative would be probably the most expensive one since sometimes a new area is not always easily available at the airport site, which is the case at São Paulo and Campinas International Airport. In this case, the obvious solution is improving efficiency, if possible.

Firstly, as seen in table II, the storage period for all four airports' terminals are about 15 days. The long period is caused mostly due to bureaucratic processes though the terminal. A solution for this problem could be implemented through coordination and agreements between the airport administration, freight forwarders, federal police and customs, which could lower the storage period inside the terminal. This action could be easily accomplished in a short-term period and would significantly impact their capacities.

Another way of incrementing the terminals capacity is decreasing the percentage of unclaimed goods. This improvement could be reached through changes in Brazilian laws, which rule this kind of cargo. Nowadays, any cargo which is not claimed by its owner in 90 days is set to the condition of unclaimed cargo. Then, the airport administration is given the responsibility to keep the product until customs suggests a final destination for it (perishable products are destroyed, otherwise it is auctioned). This period, which the airport has to storage this kind of good, generates great losses for the terminal because storage area for other goods which will be turn into revenue are unavailable for storing the unclaimed cargo. Unlike the reduction of storage period, this action would be more difficult to implement due to necessary legal actions to change laws and regulations, which regulate the unclaimed cargo conditions.

It is important to notice that both São Paulo and Campinas airports are equipped with modern technological storage facilities, which presents efficiency similar to any international air cargo terminal. Obviously there is room for efficiency improvement, but their gains are not able to accommodate future short term demand, especially for Campinas. In this case, necessary actions should be undertaken at Campinas in order to prevent a critical capacity bottleneck, which could cause significant damage to the local and national economy.

REFERENCES

Ashford, N & Wright (1992). Airport Engineering. 3rd. Edition, John-Wiley & Sons Inc., New York.

Ballou, R. (2003). *Business Logistics: Supply Chain Management*. Prentice Hall, 5th. Edition.

Boeing (2009). World Air Cargo Forecast. www.boeing.com/commercial/cargo/01_06.htm

Chen, C.H. and Chou, S. Y. (2006) Framework for Air Cargo Terminal Design: Procedure and Case Study. Journal of Industrial Technology, v. 22, No. 1.

INFRAERO. (2002). Handbook of Criteria and Conditions for Airport Plannning – "Manual de Critérios e Condicionantes de Planejamento Aeroportuário". Internal Publication.

Oliveira, D. S. (2007). Operational Performance Study of Brazilian Airport Cargo Terminals - "Estudo do Desempenho Operacional dos Aeroportos Brasileiros relativo ao Movimento de Cargas". Aeronautics Institute of Technology, Msc Thesis.

Tozi, L. A., Correia, A. R., Müller, C. and Mendes, D. S. (2009). Verification of Determinant Factors of Decision for Customers of Air Cargo Terminals. *Journal of the Brazilian Air Transportation Research Society, v. 5, No. 1, pp. 1-24 (In-press).*