IMPACT ON THE LEVEL OF SERVICE DUE TO FLIGHT TRANSFERS BETWEEN AIRPORTS: CASE STUDY OF SÃO PAULO AIRPORTS

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Abstract

This work studies the impact on the level of service offered to passengers as a function of an eventual partial flights transfer from the São Paulo domestic airport (Congonhas) to the São Paulo international airport (Guarulhos). Some recent studies indicate the need of the transferring of a significant portion of the flights from Congonhas, given its lack of operational capacity, suggesting the Guarulhos airport as the main potential recipient of these transferred flights. AHP (Analytic Hierarchy Process) method was employed to obtain an overall quantitative measure of the level of service on both airports. To support the analyses, a survey has been conducted with 300 passengers and the managers of the main airlines currently operating at the Congonhas airport. Finally, an experts panel was structured, in order to consolidate the obtained information and to indicate the weights attributed to the main level of service variables and to rank the studied airports, as a function of the proposed criteria. The results indicate that the Congonhas airport is preferred by the majority of users and airlines managers, with a rating (0 to 1) of 0.801, while the Guarulhos has a rating of 0.199. The main factors determining these ratings were operational efficiency, access time, and processing time for passengers, among others.

Keywords: passenger, service, transfer, flights, AHP.

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1. INTRODUCTION

The international airport of São Paulo / Congonhas is in evidence in the international scenario as the Brazilian busiest airport (number of landings and take offs) and, according to data from CGNA – "Centro de Gerenciamento de Navegação Aérea" (Air Navigation Management Center) it operates at the limit of its capacity (48 aircrafts per hour). So, any restriction that interferes in the continuity of the operations in Congonhas will generate significant delays that will have repercussions in other airports due to the number of transferred flights, mainly at the end of the day, resulting in inconveniences to the passengers, as well as additional expenses to the airlines.

Because of the Congonhas level of saturation, some studies have been developed (Santana, 2002 and Húpalo, 2003) showing a possible reduction of the medium delays if there were a transference of a part of flights from this airport. Considering the convenient location of the Congonhas Airport and because of the infra-structure already installed by most airlines (check in, ground employees, support, etc), the international airport of São Paulo/Guarulhos has been indicated as the potential main option to absorb transferred flights, specially considering the expansion expected to be undertaken in this airport (the construction of the third landing and take off runway and the construction of the terminal 3).

The proximity of the cities of São Paulo and Guarulhos, approximately 25 km, makes possible the analysis of the airports as being inside the same zone of influence. Therefore, the group of airports can be defined as one of the ends of a pair of cities (Morrison, 2001), where airports, in the same zone of influence, dispute the costumers' preference.

In March, 2006, the accident of a BRA aircraft in Congonhas triggered a national discussion about the need of an expansion work in that runway in order to raise the safety levels. In case of an expansion, some flights would have to be transferred to other airports because the Congonhas capacity would be drastically reduced. Another issue that has been of great concern is the pressure of the airport neighborhoods, with innumerous complains about the noise generated by airplanes and the perceived risk brought by the proximity to the airplanes.

The understanding of the factors that influence the preference of passengers between the two options and the degradation of service levels due to an eventual flight transfer are very important issues to be considered. The results of this work may serve as a reference to managers in the assessment of the alternatives to lessen the impact of

flight transfers and yet to improve safety levels of the Congonhas Airport operations.

2. LITERATURE REVIEW – QUALITY OF SERVICE AT AIRPORTS

Several research papers evaluating the quality of airport services to passengers at airports were published during the last decade. A complete review has been presented by Correia and Wirasinghe (2005) at the national meeting of the Transportation Research Board. Mumayiz and Ashford (1986) presented a method called perception-response concept, through the analysis of graphics constructed from the passengers' opinions about the quality of service in some airports in England. Omer and Khan (1998) used the concept of utility to develop a relationship between the characteristics of a passenger's terminal – TPS (waiting time, available room) and users' opinions (0 to 1) about the quality of the services offered. Muller and Gosling (1991) used a theory called psychometric scaling technique (PST) to obtain quantitative measurement of the quality of service that could be utilized in a functional relationship similar to the one developed by Omer and Khan (1998). Seneviratne and Martel (1991) developed patterns of service quality to various components of a TPS; a selection of components of importance was based on a research about the opinion of passengers in some Canadian airports (Martel and Seneviratne, 1990), Ndoh and Ashford (1993) used perception and scale theories to evaluate the quality of access service to airports, using twelve attributes (economy of the modal, comfort of the modal, access information, etc). Park (1997) used fuzzy logic to obtain measurements of quality of service of specific components of the TPS - passenger terminal.

Yen (1995) conducted a research in the municipal airport of Austin/Texas; he used logit binary models to estimate the probability of "choice" of the quality of service indicated by the passengers. Yen et. al.(2001) presented a quantitative model to define the quality of service in a TPS. The model uses the fuzzy logic concept to relate subjunctive evaluations of the offered service with temporal measurements associated to the processing components in the TPS. Fernandes and Pacheco (2002) used DEA (Data Envelopment Analysis) to evaluate the capacity of 35 domestic Brazilian airports, based on several operational parameters (Number of ticket counters, Available room for passengers, etc).

In spite of the efforts of all these researchers and institutions, the published works focused on the evaluation of the quality of service of individual components. None of

these studies developed a global service measurement, reflecting the quality of service offered in the TPS in one single scale. That fact motivated the development of a global measurement, which is the subject of study of this paper. Correia (2005), in his doctoral dissertation in the University of Calgary – Canada, developed a proposal for a global measurement of the quality of service through the use of objective factors (processing time, available space, distance, etc) and the use of linear regression techniques. This paper intends to extend this study application to the busiest airports in Brazil:"Congonhas and Guarulhos", besides that, add subjective data to the global analysis. This way, the AHP method (Analytic Hierarchy Process) came out as the most appropriate to this analysis, as it will be presented on the following sections (Saaty, 1980; Vargas, 1990).

3. PASSENGERS PREFERENCES

In this study, we assume that a customer can make a comparison between two possibilities of consume, describing their preference. From the attributes the passenger considers to make a choice, a relation that shows the propensity of a passenger to substitute one option by another can be checked, as the attributes pertaining to each airport are altered.

This sharing relation is defined as "MSR "– marginal substitution rate, being a very important concept in the understanding of the choice of a customer in relation to the various attributes that form the two options. In Figure 1, an example of an indifference curve is presented, where groups with attributes of different value result in options that present the same level of preference to a passenger.

Figure 1 shows a hypothetical situation in which, as the airport offers more airport passenger procedures (bigger boarding time values, take off and other related procedures until the effective take off), the passenger starts to consider the proximity between the airport and its house to stay in the same level of preference.

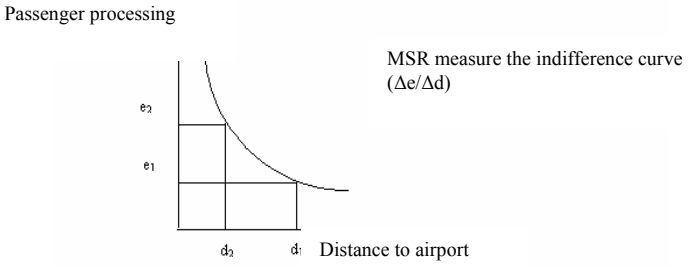

Figure 1: Indifference curve (Adapted from Varian (2003))

4. DATA COLLECTION

A wide survey divided in two parts was conducted in the airport of Congonhas with the goal of supporting the comparison among many attributes in passengers' preferences. In the first phase, professionals who have management positions in airlines (GOL, TAM, VARIG, BRA and Ocean Air) were interviewed during May 2006. These companies are directly involved with customers that use the airports in discussion and are among the main Brazilian airlines in number of transported passengers.

In the second phase, the survey was directed to the users of air transport through a random poll including 300 passengers who boarded in Congonhas in May 2006, with 3 interviewers trained and qualified. In this phase, a questionnaire of preferences that tried to approach the most relevant aspects related to the quality of service in these airport was used. The poll was conducted only in Congonhas, for the passengers who use this airport are the main goal of study of this work; this way, a poll with passengers in Guarulhos seemed unnecessary.

Table 1 presents the order of priorities that determine the choice of the passenger according to the point of view of the airlines management teams. The attributes presented to the interviewee were selected from a panel indicated by specialists in air transportation.

Table 1: Priority of attribute in the choice of an airport

Companies	Attribute (More important → Less important)			
TAM	Efficiency	Passenger processing	Time	Cost
VARIG	Passenger processing	Efficiency	Time	Cost
GOL	Cost	Time	Passenger processing	Efficiency
BRA	Efficiency	Time	Passenger processing	Cost
Ocean Air	Time	Cost	Efficiency	Passenger processing

Figure 2 represents the percentages of the attributes related by the passengers; the definition of each attribute (time, efficiency, passenger processing, cost and distance) is presented in item 4.2 of this article, which has the denominated title of "Methods application". The attribute "Others" refers to the criteria of frequency of flights to the destination place.

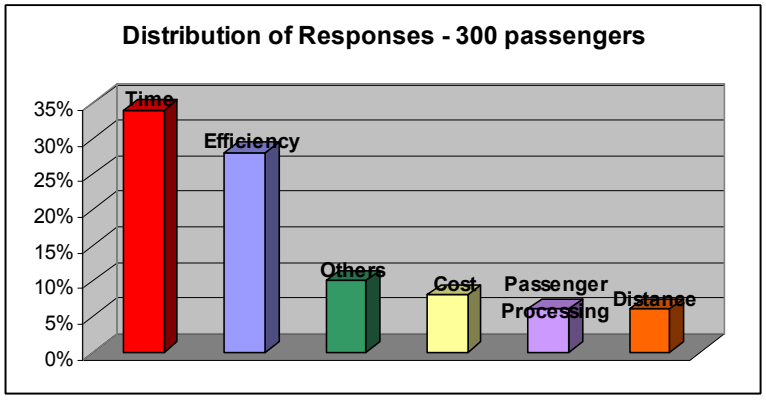

Figure 2: Passengers' preferences

With the numbers obtained in the two steps of the poll, a value adjustment to the fundamental scale (Saaty, 1980) will be made. Based on the sampling (users and managers of airlines), a panel of researchers and specialists in air transportation indicated the value of the attributes. On this way, the criteria to the structuring of the tree attributes was defined with higher level of consistency. The description and the formulation of the method will be presented in the following sections.

5. THE METHOD – ANALYTIC HIERARCHY PROCESS

5.1. Description

The AHP method has as one of its goals to represent the models of decision as realistically as possible, including all the important measures achievable or unachievable, quantitatively measurable and / or qualitative factors (Saaty, 1980). The method consists of four basic steps: (1) development of the levels of hierarchy decision of the inter-related elements, (2) determination of preferences through comparisons on the same level, (3) synthesis and determination of relative priority or value of each element of decision in a certain level using the method of self-value or another approach method and (4) the adding of the relative priorities to the final choice (Jansen, 2004). The scale of comparisons on the same level to the AHP is presented in Table 2.

Table 2: Fundamental scale of Saaty (1980)

1	Same importance	Both activities contribute equally to the goal.
3	Little importance of one over the other	Experience and judgment favor one activity in relation to the other.
5	Great or essential importance	Experience and judgment favor one activity strongly in relation to the other.
7	Very big or demonstrated importance	One activity is strongly favored in relation to the other.
9	Absolute importance	Evidence favors one activity in relation to the other, with the highest level of safeness.
2,4,6,8	Intermediate values	When a condition of commitment is searched between the two definitions.

As mentioned before, the AHP method has been chosen because it is the method whose characteristics are adequate to the analysis of the impact of the quality of service to passengers. Although the method has its classic application concerning the decision-making, it also showed good application in the analysis of preference.

The tool Expert Choice version 11.0 (www.expertchoice.com) was used to the dynamic analysis of the results, which consisted in the manipulation of value of the attributes as to easy the visibility of the impact of each one in the preference of the passengers.

5.2. Method Application

The problem decision criteria were formalized in:

- cost conditions; and
- comfort conditions

Cost conditions wise, two main attributes incorporated in the final fares were determined:

1. *Length of ground operation*, which involves operational cost since the moment when the engines of the aircraft are started until its take off; and
2. *Aairport fares,* which are the take off fare and the boarding fare charged against the airlines.

Comfort conditions wise, four attributes were considered:

1. *Distance* between São Paulo downtown and the airport;
2. Airport *passenger processing*, which comprehends the time passengers spend in the procedures prior to the take off of their aircrafts (parking their cars, check-in, the time they wait to be attended and other necessary procedures);
3. *Transportation Efficiency*, which represent not only the diversity of accesses like subway, bus and taxis, but also how frequently they are available; and
4. *Time* of journey to the airport.

The attributes described above refer to the predominant characteristics of passengers who use the airport Congonhas, the so-called business travelers. These users, in general, are not much price sensitive. Time length between their moving to the airport and the effective take off of the airplane is the main concern. In the adaptation of the problem, two possibilities were admitted by the users, which are the airports of Congonhas – CGH and Guarulhos – GRU.

The AHP method consists in a squared matrix n x n, where the lines and the columns correspond to the n criteria analyzed to the

problem in matter. This way, the value aij represents the relative importance of the criteria of the line i compared to column j. As this matrix is reciprocate, only the main diagonal gets values equal to 1.

With the hierarchy built, the dominant matrixes can be filled, in which the alternatives in relation to each criterion are compared two by two and the criteria of a specific level in relation to the criterion of the immediately superior level (Gomes et al, 2004). The formulas that follow make the considerations to each evaluated criterion:

$$\varpi_i(C_i) = \frac{C_{ij}}{\sum_{i=1}^{m} C_{ij}} \qquad (1)$$

e

$$\varpi(C_i) = \sum_{j=1}^{m} \frac{\varpi_i(C_i)}{m} \qquad (2)$$

where j = 1, …, m; w = vector; C = criterion; m = number of criteria of one same level.

The paragraphs that follow present the values attributed to each one of the criteria and sub-criteria, which were indicated by the group of specialists, based on passengers and airline managers' opinions.

In the second level criteria, the comfort conditions are at major importance in relation to the cost conditions, according to the opinions of users and managers, in special, the total minimization of the passenger's time until the effective take off. This way, Table 3 presents the respective matrix of criteria comparison:

Table 3: Second level criteria comparison matrix

	Comfort Conditions	Cost Conditions
Comfort Conditions	1	7
Cost Conditions	1/7	1

According to Equations (1) and (2), we get the following numbers: 0,125 to cost conditions and 0,875 to comfort conditions, that is, comfort conditions are strongly favored in comparison to cost conditions.

For the sub-criteria of the first level of cost conditions it's known that the time on the ground has absolute importance in relation to the fee, as exposed in Table 4:

Table 4: Matrix of comparison of cost conditions sub-criteria

	Ground Time	Airport Fee
Ground Time	1	5
Airport Fee	1/5	1

According to the Equations (1) and (2), we get the following numbers; 0,833 to ground time and 0,167 to airport fee, which shows a higher degree of importance to the ground time attribute.

For the sub-criteria of the first level of comfort conditions, the relation between the attributes may be summarized by Table 5:

Table 5: Matrix of comparison of comfort conditions sub-criteria

	Efficiency	Distance	Passenger processing	Time
Efficiency	1	5	4	1/3
Distance	1/5	1	1	1/7
Desembaraço	¼	1	1	1/4
Time	3	7	4	1

According to the Equations (1) and (2), we have the following numbers: 0,538 for time of access to the airport; 0,249 for the efficiency of means of transportation; 0,093 for airport disembarrassment and 0,075 for the airport distance.

6. RESULTS OF THE NORMALIZED COMPARISON OF THE CRITERIA

For each airport (CGH and GRU), there are the priority vectors of the alternatives, according to each criterion, which were calculated applying the following formulas:

$$v_i(A_j) = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} \qquad (3)$$

e

$$v_k(A_i) = \sum_{j=1}^{n} \frac{v_i(A_j)}{n} \qquad (4)$$

where: i = 1, …, n; j = 1, …, n; v = value of impact; A = matrix of decision; n = number of alternatives or compared elements.

Based on this information and with matrixes of comparison of the alternatives of each criterion, it is possible to calculate the vectors of priority of the airport alternatives. The matrixes are represented in Tables 6 and 11. The punctuations of the airports because of each pre-established criterion were defined by the group of specialists, based on real quantitative data related to the two airports. This real data was obtained from a measurement conducted in 2004 on both airports, according to what is related in Correia (2005). This research aimed the identification of the quality of service in these airports related to airport access, efficiency in the passengers' terminals and boarding and landing procedures.

Table 6: Matrices of comparison of the alternatives

	1		2		3		4		5		6	
	CGH	GRU	CGH	GRU	CGH	GRU	CGH	GRU	CGH	GRU	CGH	GRU
CGH	1	4	1	3	1	4	1	5	1	3	1	1
GRU	1/4	1	1/3	1	1/4	1	1/5	1	1/3	1	1	1

Comparison 1: efficiency of the means of transportation
Comparison 2: distance to the airport
Comparison 3: time of access to the airport
Comparison 4: passenger processing
Comparison 5: ground time
Comparison 6: airport fee.

The values attributed to the criteria and the alternatives through the classic AHP method are presented in Figure 3:

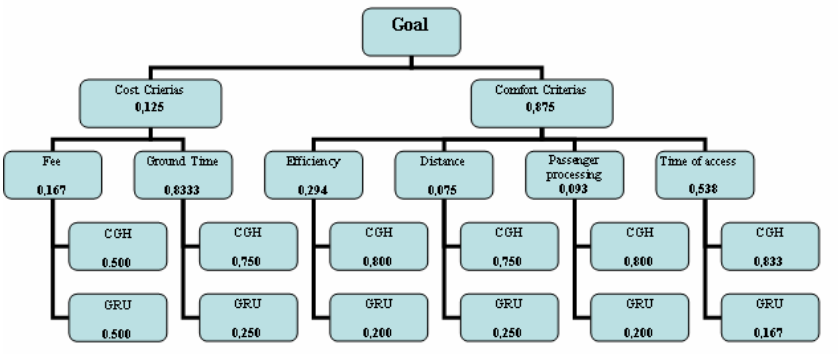

Figure 3: Values obtained in the choice of the airport

To obtain the final values of each alternative, the Equation (5) offers a process of aggregation that makes it possible to generate the final values of the alternatives:

$$f(A_j) = \sum_{i=1}^{m} \varpi(C_i) x v_i(A_j) \qquad (5)$$

where: j = 1,…, n; n = number of alternatives; v = impact value; A = matrix of decision; w = vector; C = criterion.

Therefore, with the Equation (5), it's possible to multiply the values obtained in each step and add the results of the different steps. Table presents the final punctuations for each airport:

Table 7: Final punctuation of each airport

Congonhas's Poctuation CGH	=	0,125 x 0,167 x 0,500 + 0,125 x 0,833 x 0,750 + 0,875 x 0,294 x 0,800 + 0,875 x 0,075 x 0,750 + 0,875 x 0,093 x 0,800 + 0,875 x 0,538 x 0,833 =	= **0,801**
Guarulhos' Ponctuation GRU	=	0,125 x 0,167 x 0,500 + 0,125 x 0,833 x 0,250 + 0,875 x 0,294 x 0,200 + 0,875 x 0,075 x 0,250 + 0,875 x 0,093 x 0,200 + 0,875 x 0,538 x 0,167 =	= **0,199**

Observing the results we see that the priority of alternatives is: Congonhas, Guarulhos.

7. ANALYSIS OF THE RESULTS

Through the application of the sensitivity analysis by Expert choice 11.0 (Figure 4), we verified the following results:

- Taking under consideration a hypothetical sampling that would not worry about comfort, but high cost sensitivity, the airport of Guarulhos would have an score improvement from 19,9 to 26,4%.
- **Taking a sampling opposite to the previous one, that is, focused in comfort, Guarulhos would have a decrease in its punctuation of only 19,9% to 20,1%.**

In this way, we realize that the Congonhas passenger is more concerned in comfort items. The sensitivity analysis also shows that the impact of a lower service quality may be smoothened through the following actions:

- Priority of flight transfers to the ones with fewer *business* passengers;
- Cost reduction strategies for domestic flights with operation in Guarulhos; and
- Restructuring of patio and runway accesses of Guarulhos airport with the goal of speeding the aircrafts operation.

Because of the larger preference of passengers to depart from the Congonhas airport, even with the application of some of the strategies mentioned above, the impact would only be smoothened, not eliminated.

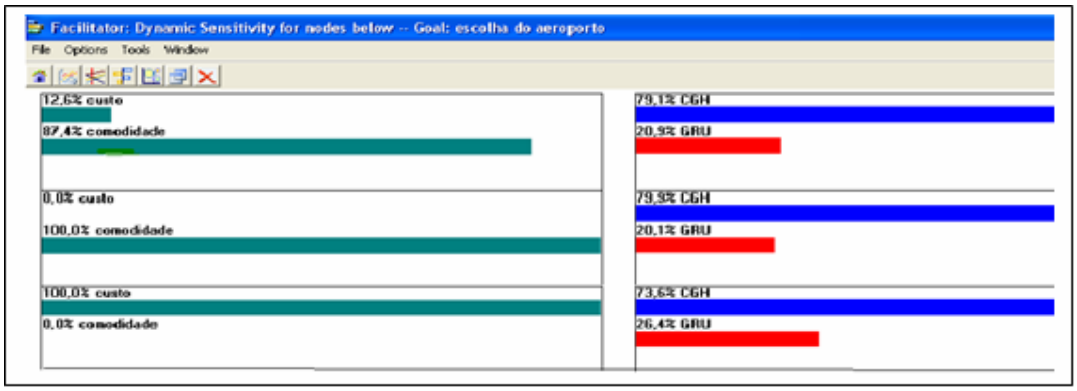

Figure 4: Analysis of sensitivity

8. CONCLUSIONS

The results point to a preference of passengers to depart from the Congonhas airport. So, in case of flight transferences to GRU, client satisfaction would be reduced.

The results seem strongly connected to the Congonhas' passengers profile, the so-called business travelers, which are mainly concerned to the commuting time to the airport. In a lower degree of preference,

transportation availability (subways, busses, and taxis) as well as their frequency also ranked at the top of at passengers' preference.

The attribute airport passenger processing obtained a relatively low score, considering the characteristic of the passengers of Congonhas. This fact can be related to the difficulty of many passengers in identifying their priorities, considering the waiting-factor generated by the usage of a busy airport.

The small score contribution of the cost criteria also reinforces the characteristic of the passengers of Congonhas, not being prince-sensitive.

Data also showed that the airport's relative distance is not relevant to most passengers, considering the fact that greater distances may not reflect in longer commuting time, due to the efficiency of the transportation available.

Through the sensitivity analysis performed with the Expert Choice version 11.0 software, it was verified that the maintenance of the service quality may be achieved with improvements in the transportation systems to the Guarulhos airport. This solution provides score increments for the GRU in the attributes of efficiency and dislocation time, resulting in a smaller impact in the quality of service caused by flight transferences.

However, a refined study of costs of the different improvements in transportation to Guarulhos must take place in order to perfect the application of resources.

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