

THE IMPACT OF AIRCRAFT NOISE PERCEPTION ON THE URBAN DISCOMFORT

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ABSTRACT

Noise generated by aircraft operation affects negatively the quality of life of people living nearby airports, including impacts like high blood pressure, anxiety and depression even considering that the perception of annoyance can be related to subjective factors. This paper shows the results of a survey conducted in Guarulhos, São Paulo, about the perception of aircraft noise annoyance. The results show that aircraft noise annoyance is becoming more important when compared with other sources of urban noise. Mainly the results show that night flights seem to be the major responsible for the discomfort

KEYWORDS: Airports, Aircraft noise, Land use occupation.

1. INTRODUCTION

The aeronautical noise has been considered one of the most serious environmental problems of the aviation (University of California, 1996).

Noise generated by aircraft operation affects negatively the quality of life of people living nearby airports, including impacts like high blood pressure, anxiety, depression (Kroesen et al., 2010) even the perception of annoyance can be related to subjective factors (Janic, 1999). In fact, the evaluation of noise is also a subjective measure, because it depends on individual's noise perception, which is related to both tangible factors, such as numbers of landing and take-off aircraft operations, flight schedules, climatic conditions, and intangible factors, such as environmental awareness, welfare and quality of life standards, levels of education and income (Janic, 1999; Garcia et al., 1993).

Despite of the fact that the complaints related to aeronautical noise have been registered since the decade of 50, it has been observed that the perception of noise seems to have

grown, especially since the 80's. Probably part of this change on noise perception has its roots on the accelerated expansion of air traffic. But, it is necessary to point out that the perception of noise annoyance may have grown as a result of the increasing environmental awareness brought by the institutionalization of environmental movements (Mol, 1999). Under these circumstances, the emergence of the ecological conscience has been followed by the emergence of higher standards and expectations about people's welfare and quality of life (Mol, 1999; Garcia et al., 1993).

For all these reasons, it has been observed an increasing social demand for noise reduction in the whole world. These changes on preferences have stimulated researches devoted to the evaluation of the human being perception of noise discomforts.

Thus, the main objective of this paper is to contribute to the understanding of aeronautical noise perception in the neighbourhoods of the São Paulo International Airport – AISP (the biggest airport of South America), which is located in Guarulhos, Brazil. Specifically, this study is focused on the correlation between aircraft noise perception and other sources of urban noise discomfort.

Aircraft noise perception is a localized experience. In fact, the socio-economic characteristics of the region surrounding the airport, as well as the airport's dimension, are factors that are expected to affect the perception of aviation noise discomfort. Thus, the next part of the paper is devoted to describe the main socio-economic characteristics of the Guarulhos City and of the AISP/GRU.

2. NOISE ANNOYANCE PERCEPTION

2.1 Changing Preferences

The emergence of environmental goals as values to be preserved changes undoubtedly human preferences and, consequently, a human perception about what is acceptable. Under these circumstances, airports managers have to be prepared to face an increasing social demand for reducing their environmental problems, specifically the aviation noise annoyance.

Another side effect of the new information and communication infrastructure is the access to information and knowledge. This access creates conditions for expanding people's awareness of social, political, economic and ecological issues and perception about modern welfare standards.

In 1994 Lambert et al. estimated that in the European Union approximately 77 million people (or 22% of the total population of the EU) were exposed to a transportation noise level exceeding 65 dB during the day. Hence, decision makers in airport should expect for more complaints and governments should expect for social pressure for environmental regulations.

2.2 Annoyance Perception

Noise annoyance is a personal experience. According to Vallet (2002) annoyance due to aircraft noise represents a whole synthesis of a variety of effects of the aircraft noise on the local residents. The results of surveys on dissatisfaction about this issue are being used in several European countries, both for a long term planning urban development around airports and for a practical assistance to the residents who intend to improve the insulation of their dwelling. In Brazil there are some difficulties to implement measures of insulation because they are very expensive and the major part of the population who lives in the vicinity of the airports can not afford with them.

According to Job (1996) there are considerable individual differences in reaction to noise. There are some reactions, however, that can be associated to noise annoyance, like effects on sleep and a variety of mental health effects which are observed in people living in noisy communities (especially around airports or along transportation corridors). Abey-Wickrama et al (1969) reported higher rates of mental hospital admission in high noise areas around Heathrow airport, compared with low aircraft noise areas.

Job (1996) shows that there are many possible reported effects on physical health like colds, high blood pressure and cardiovascular changes among others effects related to stress symptoms. Job affirms that it is important to point out that there are methodological concerns that limit the confidence with which these can be accepted as genuine effects of noise exposure, but others studies show the relationship between noise annoyance and physical health. Black et al. (2007) present that people chronically exposed to aircraft noise around Sydney Airport report high blood pressure, for example.

Vallet (2002) adds that noise sensation can be caused by high sensitiveness but it is possible that some people present high excitability of the nervous system because noise annoyance configures a continuous stimulus which makes people anxious and presenting sleep disorders.

All the problems could be addressed in a market-based approach. The Future Noise Policy report (European Commission, 1996) points out that the studies in general aimed to evaluate economically the effects of noise taking into account the factors as follows:

- a. the individual willingness to pay for silence;
- b. the costs of mitigation measures;
- c. the costs of preventing noise;
- d. medical care costs and production interruption costs;
- e. properties market value changes (hedonic prices).

However, the study developed in the University of California (1996) pointed out that all these impacts are reflected by the diminishing value of properties located in the noise impact region no matter what methodology is employed to evaluate these environmental costs.

So "real state owners are very concerned about a possible drop in the value of their property such as will be disclosed only when the actual sale will take place, yet the annoyance itself is quite real". (Vallet, 2002).

Any measure to face the problem by means of internalization of the external cost and/or by means of diminishing the number of the operations can affect the airport efficiency.

2.3 Noise annoyance and time of the day

Considering that urban noise (traffic road noise, machines on the street, people talking) use to be reduced during the night, it is expected that complaints about aircraft noise annoyance increase during this time of the day because this noise is more strongly perceived. Further, during the night people are usually at home and residences do not have sound insulation in the same way of commercial buildings. So, nuisance can impact people at home while they are watching television or talking on the phone, for example.

Hume et al. (2003) show that there are a relationship between specific noise complaints and the hour of the day. In their study with data from Manchester Airport, they found out that there are on averaging nearly five times more complaints during the night (23h to 06h) when comparing with the rest of the day (06h to 22h59).

3. GUARULHOS CITY

Guarulhos City is located in the State of São Paulo, in the southeast region of Brazil. It has approximately 1.300.000 of inhabitants. Despite of the favourable position in the public finance context, a study developed by the Brazilian Institute of Geography and Statistic (IBGE), point out that part of the population of Guarulhos can be classified under the poverty income line. The inhabitants' average per capita income is considered to be high when compared with the Brazilian one. In fact, Guarulhos's average income was approximately US\$ 11,100 a year while the same indicator for Brazil was US\$ 6,852 in 2007. Guarulhos' Gini Coefficient was 0.4 in the same year. (IBGE, 2010).

The city has some social characteristics derived from industrial area. For example, it can be observed people's syndicate engagement, which could explain why low income does not mean low information level in Guarulhos. People have conditions to understand the social and economic processes that affect them. Thus, it is possible to expect them to organize themselves in order to fight for higher quality of life standards.

Guarulhos is part of São Paulo metropolitan region, one of the largest cities in the world¹, which historically received immigration flows. In that context Guarulhos is a suburban area, which has been characterized for receiving part of those immigrants, especially from the poorest parts of the country, with the consequent irregular occupation. Also, even considering the fact that São Paulo's immigration flows have decline in intensity overtime, currently Guarulhos urban density is affected by São Paulo's own vegetative population growth, which pressures suburban areas. Table 1 shows Guarulhos population in the last years:

¹ São Paulo metropolitan region is estimated to have around 18 million inhabitants (IBGE, in http://www6.prefeitura.sp.gov.br/secretarias/planejamento/sp_em_numeros).

Table 1: Population of Guarulhos

YEAR	POPULATION OF GUARULHOS
1991	787.866
1996	972.197
2000	1.072.717
2005	1.251.179
2006	1.283.253
2009	1.299.283

Source: IBGE (2010)

Population increased more than 60% in the last 18 years. The fast and disordered urbanization process impacted people’s quality of life. The urban diseconomies have generated costs to the population, mostly related to noise, emissions and congestion. But people are still going to the cities because of the economies of agglomeration that are still perceived, sometimes more than diseconomies. It is difficult to the authorities to have a satisfactory control of the land occupation.

The population increased more strongly after the Airport has started to operate, in 1985. Although the major part of the population came from other cities seeking for employment and characterizing external flows, more recently it was verified some internal flows, mostly to poor areas of the city with environmental degradation process. In fact, the regions that are still more crowded are those located right below the flight tracks of the most occupied airport runways. So, the aircraft noise annoyance could be worse since airport operations increase.

3.1 São Paulo International Airport

Urban noise is one of the most serious problems of the big cities and the aircraft noise makes the urban discomfort worse. The objective of this paper is to show how people from Guarulhos City in Brazil perceive the aircraft noise annoyance among general urban noise. The city shelters São Paulo International Airport, which presented approximately 200.000 flights and more than 20.000.000 passengers in 2009. The movement of aircraft and passengers in the airport has grown, as it can be seen in the Table 2:

Table 2: Movement in the São Paulo International Airport

YEAR	AIRPLANES		PASSENGERS
	DOMESTIC	INTERNATIONAL	
2003	77.122	61.916	11.581.034
2004	85.042	64.455	12.940.193
2005	84.585	69.774	15.827.708
2006	88.335	66.613	15.689.302
2007	113.910	74.050	18.795.596
2008	119.928	74.256	20.400.304
2009	135.970	73.666	21.727.649

Source: Infraero, 2010

Table 2 presents the evolution of the movements of airplanes and passengers at the Airport, which has an average of 500 movements a day. It is important to notice that the Airport has night flights that include freight aircraft, which use to be noisier.

3.2 - Aircraft noise annoyance in Guarulhos

Al-Harthy and Tamura (1999) affirms that noise and noise annoyance are not confined to the industrialized societies, but are quickly increasing in cities in developing countries.

Eller et al. (2002) found out that residences in the vicinity of the Guarulhos Airport could lose more than 30% of this market price just because of the aircraft noise annoyance. The study shows the results from 228 questionnaires applied to the real states in the city. They said that just after the airport starts to operate the prices increased because of the improvement in the urban condition. But since the traffic and the population increased continuously the prices start to decline relatively to residences located in other areas not affected by the aircraft noise.

On the other hand, Scatolini and Eller (2009) present a study about real state market around Congonhas Airport, the second in movements and passenger in Brazil. Their results show there are no losses of market value for these residences probably because that airport does not operate at night.

Note that, in Brazil, the major part of the residences around airports has no insulation measures.

According to Nykiel (2009) about 15% of the operations in São Paulo International Airport correspond to night flights. During the night the urban noise diminishes. Thus, the nuisance from the aircraft operation can be more perceived. The study takes into account the population living in the vicinity of the airport, the number of night flights and the length of area impacted by at least 65 dB show that São Paulo International Airport presents the more critical situation about noise annoyance in Brazil. (Nykiel, 2009).

4. METHODOLOGY

The method used to perform this research was personal interviews made by means of questionnaires sheets. This method is considered appropriated by Breen & Blankenship (1991), who recommend that the research universe should be homogeneous and small, as well as the subject of investigation should be presented, in an identical and simple way, to all the interviewed people.

The questionnaires were developed based on the idea of knowing the personal profile of each person and its perception about the noise annoyance. They were built based on the Likert Scale, which associates quantitative and qualitative criteria and assesses the aircraft noise nuisance participation between other urban noises. People were chosen randomly while walking on the streets in the vicinity of the São Paulo International Airport.

In the first part of the questionnaires the interviewed was asked to answer about some personal data, like age and time of living in the noise area. In the other parts questions

focused on the perceived noise annoyance from three different sources: urban traffic, other urban noises (like machines on the street, for example) and aircraft noise. For each source the respondent should indicate how much feels annoyed among the possibilities: not at all; weakly; reasonably; strongly and extremely. They were also asked about how much they were annoyed by the aircraft noise in five periods of the day. The sample was 250 questionnaires. The results are showed in the next part.

5. RESULTS

The results show that even traffic and others urban noises cause discomfort in the population who lives in Guarulhos, the impact of aircraft noise is remarkable, as presented by Figure 1.

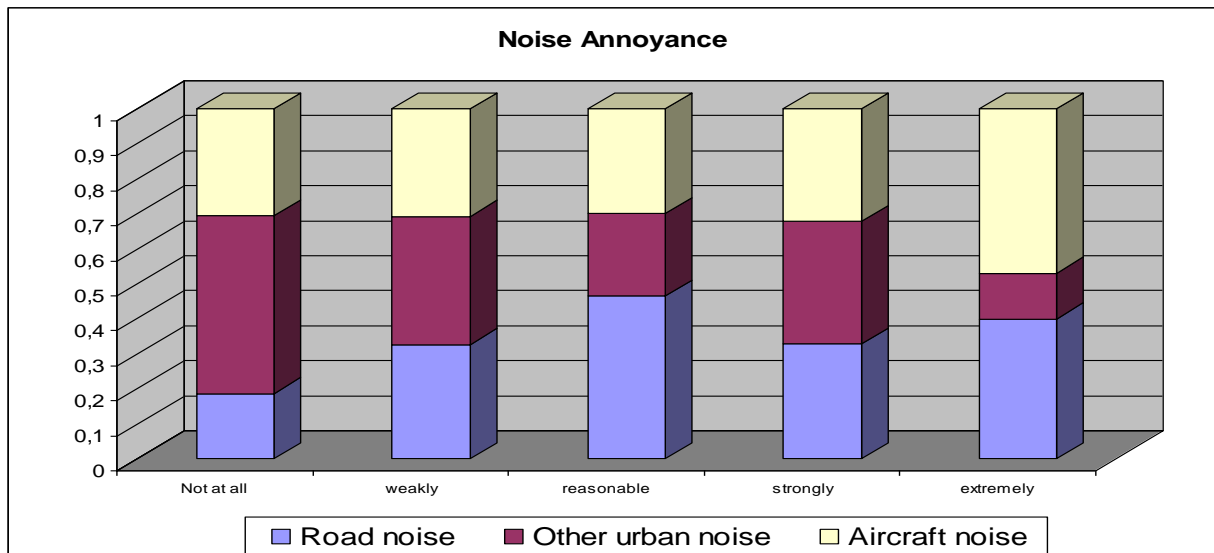


Figure 1: Urban noise annoyance from three different sources

It is demonstrated by the number of responses that report people strongly or extremely annoyed by the aircraft noise. It should be considered that airport vicinity is densely town with important bus and car traffic.

When considering only the aircraft noise annoyance the respondents were asked about what time of the day they perceived more discomfort. It was presented to them five periods of the day: from 06h to 10h, from 10h to 14h, from 14h to 18h, from 18h to 22h and from 22h to 06h. The number of responses for strongly and extremely annoyed indicates that people are more sensitive to aircraft noise annoyance during the night, as presented in the Figure 2.

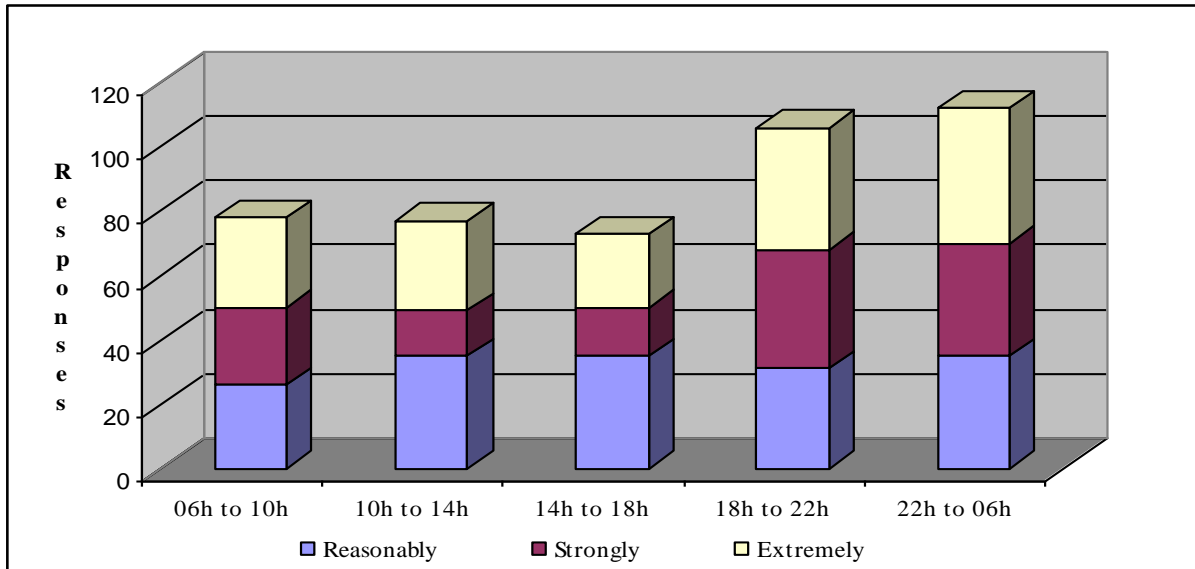


Figure 2: Aircraft noise annoyance by hour of the day

Aircraft noise is becoming more important when compared with other sources of urban discomfort. In Guarulhos, negative environmental impacts caused by the aircraft operations are enhanced by the lack of integration between Noise Zonings Plans and Municipal Urban Zoning Law. The land occupation is out of the boundary of the legal instruments, part because there is a conflict between federal and municipal laws, part because there is a lack of alternatives to control the aircraft noise. There are no noise surcharges and night flights seem to be strongly responsible by the discomfort.

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