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Airport Noise Environmental Impact Assessment Including Affected Communities Perception: Description of Social Survey on the Neighborhoods of Santos Dumont Airport - Rio de Janeiro, Brazil.

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ABSTRACT

This work is concerned with development and application of methodology including the affected communities' noise perception as a parameter for airport noise environmental impact studies. In Brazil, until now, airport noise environmental impact studies have been based firstly on Noise Zoning Plans and simulated noise contours from the Integrated Noise Model software as well as on noise measurement at external selected points aiming to characterize aircraft noise contribution related to background noise guidelines of Norm ABNT 10151 must be followed. To date, the airport noise perception of affected residents is not included as a parameter for environmental impact assessment. Since March 2009 the neighborhoods communities annoyed by the landing and takeoff noises from Santos Dumont Airport have been insisting actively joint to environmental control state institutions to solve the problem that was becoming worse due to the expansion of airport operations. At that same time this author began the implementation of noise annoyance social research on Santos Dumont Airport neighborhoods. In the first stage of the work interviews were conducted in about 70 different addresses distributed on five distinct districts as a purposeful sample of residents contacted through residents associations. The interviews were conducted by undergraduate students trained by this first author throughout 40 hours lessons course for developing field research skills. A carefully elaborated questionnaire applied during interviews and the data collecting methods are described in this paper. At the second stage of this work noise measurements at selected points will be carried out according to the noise annoyance social survey collected data results tabulation and analysis aiming to configure a complete social-acoustic survey in the near future.

INTRODUCTION

Since the noise began to be recognized as a serious environmental pollutant, numerous social surveys have been conducted to assess the magnitude of the problem especially related to the transport sector, and characterized mainly by vehicle traffic on streets, highways, railways, airways and operation of stations, ports and airports. A well-known work published by Schultz in 1978 compared the results of more than eighteen social researches on noise annoyance performed on 1960s and 1970s in a fourteen years period at nine different countries concerning different sound sources. The author translated the various degrees of noise DNL (Day Night Level) as a common measure of noise exposure.

$$DNL = 10\log\frac{1}{24}(15 \times 10^{\frac{DL}{10}} + 9 \times 10^{\frac{(NL+10)}{10}}) \qquad [1]$$

being *DL* and *NL* the average levels of noise during the daytime (07:00 to 10:00 p.m.) and night (10:00 p.m. to 7:00) (SHULTZ, 1978).

Social surveys reviewed by Schultz were undertaken in culturally diverse communities and considered results up to 14 years distant and using different noise metrics and different approaches to respondents. The distances between receiver and noise sources as well as different types of sources were considered in an indiscriminate way. Although in this study Schultz made efforts to normalize subjective and objective data at the end he used his own judgment to determine the point related to subjective parameter *highly annoyed* which was one of the causes of severe criticisms about his work besides the questioning about the scientific definition of the term. Despite the criticisms this study stimulated the appearance of several studies including noise perception related to objective measurements and resulted in a mean curve of annoyance which is still used for prediction until the present days.

Social surveys on annoyance due to airport noise are still rarely employed. On the other hand simulations performed throughout existing laboratory prediction´s models for airport noise such as the INM - Integrated Noise Model - are insufficient to establish a noise annoyance understanding. Results of simulations are rarely compared with data from noise measurement and almost never compared with data collected in noise annoyance social surveys. Besides these difficulties, in regions close to large urban center there are numerous other noise sources composing the sonorous environment such as traffic roads for example. In this case the planning of noise measurements considering airport noise contribution among

other noise sources and also the social survey data collection considering the residents` perceptions in their own sonorous environment are much more complex.

Even more recent studies on this subject are still inconclusive and some of them continue to be developed on different noise sources without discrimination. Most of the information about communities' noise annoyance sensitivity is derived from health studies which include people affected by airport noise. The arguments about negative effects of airport noise on communities are still evaluated as unconvincing to support effective measures to mitigate the problem.

There are several metrics used in different countries to objectively evaluate the airport noise. Scales for subjective evaluation of noise annoyance also vary significantly. The feeling of discomfort related to airport noise depends on one hand on objective or quantifiable factors such as noise levels, frequencies of flight, flight schedule, distance between receptor location and the trajectories of flights, noise characteristics of the aircrafts, frequencies spectrum involved, etc., and moreover it also depends on qualitative factors such as education, culture, individual sensitivity and preferences, etc.

Although today there is already a consensus on using the DNL metric to assessing the airport noise levels which would facilitate the standardization of social acoustic surveys on airport noise, the values considered as limits levels are still hotly debated, and they vary widely from country to country in up to 10 dB (A) for residential areas. Moreover the laws on noise pollution use mostly based LAeq metrics. In both cases all studies generally do not consider the effect of the aircraft fly over as discrete event. The isolated event of the aircraft passage can result in much higher immission levels at the receptor position than those permitted by law. $LAeq$ can be computed by expression [2] bellow,

$$LAeq = 10\log\frac{1}{n}\sum_{i=l}^{n} 10^{\frac{Li}{10}} \qquad [2]$$

being *Li* the sound pressure level in dB(A) in fast response at 5 seconds during the noise measurement period and *n* the total number of readings (ABNT, 2000).

In Brazil, in general, the noise annoyance evaluation is not a parameter well defined in sonorous environmental impact assessment studies which are undertaken by comparing the measured noise levels and the evaluation criteria levels established in accordance with Resolution CONAMA 001 which indicates the ABNT 10.151 norm procedures (ABNT, 2000) besides the accordance to municipal laws when existing. These regulations adopt the LAeq metric to determine the environmental noise levels and assessment criteria. In the specific case of airport noise impact evaluation studies it is used the Noise Zoning Plans established in accordance with Ordinance 1141 GM5 (BRASIL, 1987) and later laws to identify permitted land uses in the noise contours areas bounded by levels established in reference to DNL metric.

The airport noise environmental impact studies performed in Brazil, so far, do not use noise annoyance social surveys as a method o assess noise perception of the affected communities. The annoyance assessment has been undertaken primarily on noise levels simulations and noise measurements carried out in accordance with the judgment and viewpoint of the consultant who carries out the impact study, contracted and paid by the polluter as determine the laws.

SOCIAL SURVEY ON ANNOYANCE DUE TO THE AIRPORT NOISE - PLANNING AND METHODS USED IN FIELDWORK

In sonorous environmental impact assessment studies for airports the community responses obtained by social survey means may reveal a different reality from that performed by simulations due to the characteristics of noise sources in flight trajectory. There are factors related to noise immission that are mostly decided not to be considered as inputs in the simulation systems despite the software facilities as an example: 1) topography; 2) urban morphology, 3) altitude of the critical receptor identified; 4) dispersion of tracks practiced by pilots from those officially determined and used in the simulations.

In this work it is understood that the first step to perform satisfactory sonorous environmental impact studies is collecting data for airport noise perceptions of inhabitants living in noise affected areas. These noise social surveys collected data may also work as parameters to be comparatively analyzed with noise measurements results. It is adopted the of Santos Dumont Airport neighborhoods affected by landing and takeoff noises as a case study. The method used to perform the noise social survey is described in this paper.

Figure 01 illustrates the position of the Santos Dumont Airport and noise affected districts participating in the noise annoyance social survey and the most practiced landing and takeoff tracks. The ends runway use depends on the wind´s orientation which predominates in South direction at the Santos Dumont Airport area. Other noise sources are dispersion routes resulting from the aircrafts conduction by pilots besides because different aircrafts maneuvers. These dispersion routes could be evaluated using radar data assessed only by control towers. Tracks in red are for takeoff and tracks in yellow are for landing. Tracks 1, 2, 3 and 4 are indicated as official and the others are practiced as alternatives.

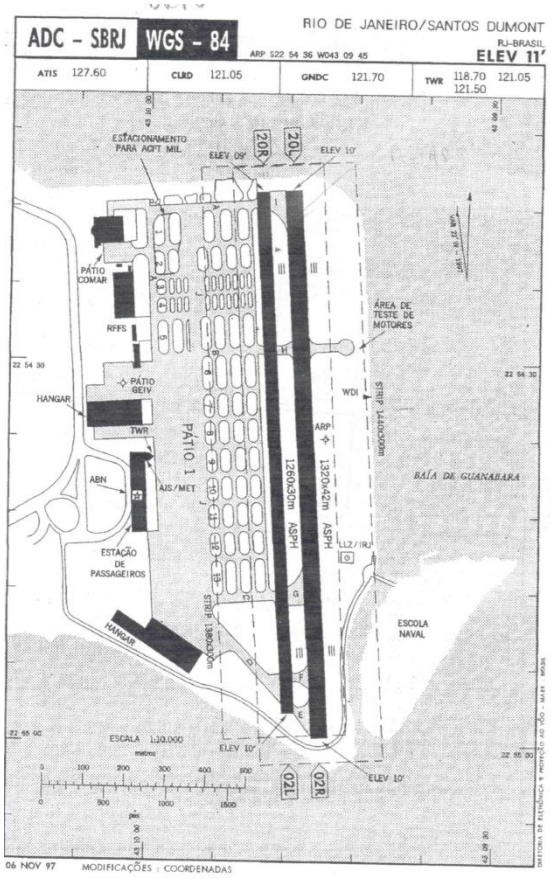
Source: Environmental Impact Study for Santos Dumont Airport (2004).

Figure 01. Santos Dumont Airport location, it's mainly tracks and affected districts.

Since April 2009 this researcher participated in several meetings related to inquiries about the airport noise study from public bodies as invited by districts associations. The negotiations resulted in the suspension of night flights which were provoking indignant reactions by affected population however there are still unresolved problems with daytime flights. Residents attribute the problem mainly to the use of Route 2 and call attention to the supervisory authorities in direction to cancel this track however this researcher has warned about

the complexity of the problem despite considering tracks restrictions possibilities.

Figure 02 shows Santos Dumont Airport layout. The runway 20L/02R (length 1350m) is mostly used and the auxiliary runway (20R/22L length1260m) is mainly used during maintenance of the main runway.



Source: Environmental Impact Study for Santos Dumont Airport (2004).

Figure 02. Layout of Santos Dumont Airport including runways.

The social survey began with noise annoyed residents identification aiming composition of *purposive sample*. These residents were considered airport noise annoyed by districts associations presidents and the residents themselves judgments. The affected districts associations contacted at the first time were from Urca, Botafogo and Santa Teresa. This researcher participated in at least one meeting with each district association to expose the survey methods and aims. The later individual contacts were made also personally by this researcher referred and introduced by presidents associations to the residents as teacher from Federal Center of Technological Education – CEFET-RJ, and researcher doctorating at Civil Engineering Program, Federal University of Rio de Janeiro – PEC/UFRJ/COPPE.

These references were important to create confidence between researcher and residents. The contacts were made carefully and repeatedly during a long period to conquest residents confidence and facilitate performing home interviews since there is wide concern about security risks and a difficulty in establishing household contacts especially in these case study areas. The contacts with residents were made intensively between April and June 2009, and the residents responses to telephone calls and e-mails came gradually. Finally a noise annoyed residents list was reached as satisfactory sample to start the fieldwork.

At the same time it was planned 40 hours courses for undergraduate students of CEFET-RJ to develop field research skills with institution´s Extension Direction support. Six students were selected and trained to apply the questionnaires in households following known techniques for social surveys. During this course held between 20 and 27 July 2009 there was a 16 hours practical part divided into two weekend days devoted to perform a household interviews campaign at Urca, Botafogo and Santa Teresa districts. The residents were contacted in advance individually and personally by telephone to confirm the interviews schedule (time and day) sand to previously identify the student's names as interviewers.

Source: Researcher personal archive. Photo by Livio Bruno (2009).

Figure 03. Researcher and graduating students at CEFET-RJ for 40 hours Extension Course. July, 2009.

The students went to fieldwork with shirts specially created for identification during social survey and also presented their credentials at each household interview. An aircraft flying over affected region photo was drawn on the shirts. This type of identification is part of the mostly accredited social survey procedures and helps to establish a satisfactory trust degree between interviewer and interviewee. The students were orientated through the Extension Course on proper behavior during interviews as physical posture, vocal intonation, and length of stay in the respondent´ residence. The completion of the questionnaire was also simulated during the Extension Course to determinate the correct time of the interview as well as to familiarize the interviewers to questions content.

Source: Researcher personal archive. Photo by Livio Bruno (2009).

Figure 04. Researcher and graduating students at fieldwork during Extension Course. Santa Teresa` District. July, 2009.

In the following months other districts became interested to participate in the survey and interviews were also performed for Laranjeiras district at interviews campaign previously

wide propagated and held on 29th and August 30th, 2009 at district association headquarters. Later interviews were made also for Flamengo district residents. It was observed that the household interviews were more productive then that performed at associations headquarter. After much effort almost 70 questionnaires were completed by one informant per household reaching almost 350 people affected considering informers co-inhabitants. The continuity of social survey became slower because the difficulties in maintaining the necessary human and material resources.

Source: Personal researcher achieves (2009).

Figure 05. Art for shirts used by graduating students in Interviews campaigns. July, 2009.

In October 2009 a roundtable meeting was held with residents associations presidents of Urca, Botafogo and Santa Teresa districts at the CEFET-RJ Week Extension. It was an opportunity to submission the research project progress and to discuss the residents expectations about actions to mitigate the airport noise problem.

Source: Researcher personal archive. Photo by Raoni Cordeiro (2009).

Figure 06. Roundtable meeting with Districts Associations presidents at CEFET-RJ Extension Week. Left to right: Mr. Paulo Saad from AMAST/Santa Teresa, Mrs. Celinéia Ferreira from AMOUR/Urca, Mrs. Regina Chiarardia from AMAB/Botafogo, Rita Nogueira (the first author) and Mr. Licínio Rogério representing FAM Rio – South Regional Residents Associations Federation. October, 2009.

Questionnaire

The questionnaire was carefully developed for several months after studying various different models used in social surveys and subjected to criticism from some selected people with different education levels. The questions were formulated to identify the various noise sources as perceived by respondents apart from aircraft noise so to enable a more accurate understanding of resident's sonorous perception at their own home environment. The questionnaire was designed to be administered by interviewers already trained on field research skills in about approximately 20 minutes and to facilitate disarticulated tabulation of results. The questions were divided into nine distinct blocks defined and organized according goals to be filled during interviews, as described following.

Source: Photo by Rita Nogueira (2009).

Figure 07. Graduating Students during Extension Course visiting Civil Aviation Exposition at Santos Dumont Airport. Left to right: Guilherme de Almeida, Raíssa Torres, Saulo de Araújo, Livio Bruno Peixoto, Álvaro da Silva and Liliane da Silva. July, 2009.

Source: Photo by Rita Nogueira (2009).

Figure 08. Interviews Campaign at Laranjeiras District Association Headquarter (August, 2009).

Source: Researcher personal achieves (2009).

Figure 09. Interviews Campaign at Laranjeiras´ District Association Headquarter (August, 2009).

Block 01 - Survey control and questionnaire identification

Blanks - District, interviewer's name, begin and end interview times, interview duration, date and interviewer name.

Objective - Control and identification.

Block 02 - Household characteristics

Blanks - Home type, home position in relation to the access street, total residents by sex and age, existing animals by type and household function, family income by three distinct bands and the option of not disclosing income.

Objective - Characterize the informant domestic environment

Block 03 – Residents profile

Blanks - First name of each resident, family status or position, gender, age, city of birth, residence period in the same household, education level, work type, locomotion way, survey informant indication.

Objective - Establishing an individual profile of each resident living in the household and distinguishing the informant position in the family or household, identifying factors possibly related to demand on sound perception.

Block 04 - Health condition

Blanks - General health in one field and eleven fields for different common health problems which could be associated or increased with noise annoyance as insomnia, stress, depression, problems with cholesterol, diabetes, digestion, respiration, pressure, heart, vision, hearing.

Objective - Trying to assess possible association among physical symptoms and annoyance due to high noise levels.

Block 05 - Informant activities at home

Blanks - Rest, watch TV or DVDs, using Internet, using computer for other purposes, reading, studying, working, doing physical activities, performing household tasks, talk, hearing sound or radio, playing an instrument.

Objective - Identify the activities performed by the informant at home possible to be affected by high noise levels immission and to associate these activities to responses for other questionnaire blocks aiming better understanding of the informant in relation to noise annoyance.

Block 06 - Music preferences

Blanks - 24 (twenty four) different musical styles.

Objective - Verifying the validity to associate music requirements to noise annoyance sense through certain music styles as references.

Block 07 - Informant permanence at home

Blanks - five different time periods in a day on weekdays and weekends.

Objective - Identify most time periods of informant permanence in residence and try to associate it with domestic habits and different noises sources perceptions.

Block 08 - Noise perception

Blanks - 35 different types of noise sources identified as characteristics for analyzed districts.

Objective - Identify intensity and frequency for informant perception related to listed noise sources.

Block 09 – Informant relationship with Santos Dumont Airport and the aircrafts flying over their households

Blanks - This block was opened to writing answers by the own informant about frequency in visiting the airport, using Airport facilities or services, as well as subjective responses to the interviewee's feelings about the airport and aircraft flying over residences.

Objective - Enable freer expression of the interviewee on the airport noise problem, identifying subjective traces on relationship with the airport as urban equipment and aircrafts as a means of transportation beyond as noise sources. Identify also the respondent interesting to having his residence as measurement noise point.

Expected results and next steps in research

The tabulation of social survey collected data is underway and results will be announced after noise measurements and comparative analysis to configure this work as social acoustic-survey. It is expected that noise measurements will be performed in July 2010. As all of residents participating in this social survey were identified as annoyed by aircraft noise is expected to establish a relationship between the noise annoyance sense and airport noise levels also to other subjective factors.

The difficulties in undertaking this work were many despite the positive response from the residents associations contacted and interested in completing work. Despite the support from residents associations and the efforts by their presidents to facilitate contacting residents the interviews happened slowly and demanded a personal effort by this researcher as person indicated nominally as survey coordinator to contact people. Scheduling difficulties of residents and unavailability of trained students to continue in the research project also contributed to limit the work. Dozens of electronic correspondences were exchanged and dozens of telephone calls were made to reach the necessary confidence from residents. It shows the importance to correctly introduce the responsible researcher and staff for the social survey success.

The issue of Santos Dumont Airport noise effects on communities and their reaction to it took up considerable space in the media in recent months and residents associations considered the recent guarantee to night flights suspension as being a partial victory. However there are still complains and the research is still open to apply social survey methods including new residents interested to participating in it up to complete the acoustical part.

An expectation from residents associations was created on the contribution of this presented work for their causes and it is believed that the results of this study will help finding

more satisfactory solution of the airport noise problem. The authors hope that this work will really contribute to a better understanding of Santos Dumont Airport noise perception on affected neighborhoods and appropriated noise annoyance assessment for future sonorous environmental impact studies.

Source: Photo by Rita Nogueira (2009).
Figure 10. Original picture from aircraft landing flying over Santos Dumont Airport neighborhoods. (April, 2009).

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