

**Aircraft Noise Perception Study in Brazil: A Perspective on Airport Sustainable
Growth and Environmental Awareness**

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ABSTRACT

Aircraft noise perception is related to several variables that are tangible and objective, such as the number of operations, flight schedules. Other variables, instead, are more subjective, such as preferences. However, although their elusiveness, they contribute to determine the individuals' perception of this type of externality.

Despite 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. It has been argued that this change in noise perception has its roots on the accelerated expansion of air traffic. But, it is necessary to point out the important role played on modeling preferences, by the growing environmental conscience and the higher welfare and quality of life standards and expectations.

In that context, the main objective of this paper is to study the aeronautical noise perception in the neighborhoods of the Aeroporto Internacional de São Paulo – AISP (the biggest airport of South America). Specifically, it analyzes the relationship between aircraft noise perception and social class, which is expected to be positive.

Since noise perception is an intangible variable, this study chose as a proxy the value losses of residential properties, caused by aeronautical noise. The variable social class has been measured utilizing average per capita income of the population who live nearby the airport. The comparison of both, the lowest and the highest social class suggests that the relationship between social class and noise perception is positive in the AISP region. Moreover, it was observed that all social classes are very susceptible to aircraft noise annoyance. In fact, the magnitude of the noise perception proxy for both social classes -the residential value losses- was found to be comparable to levels encountered in developed countries.

Additionally, this paper highlights the aviation noise problem taken into account a scenario where the airport capacity may duplicate in the next 20 years. This scenario is

compounded by the paradigmatic change on environmental awareness that has emerged all over the world, as a result of the changing social and economic preferences, which favors human quality of life and a sustainable growth, in order to preserve resources endowments and quality of life for future generations. Under these circumstances, it can be foresighted that the social change is for the internalization of environmental problems, with the expected increase in the air transport sector costs.

Keywords: Aircraft noise perception; externalities; air transport.

1. INTRODUCTION

The aeronautical noise has been considered one of the most serious environmental problems of aviation, in accordance with the Report *The Full Cost of Intercity Transportation* (University of Berkeley, 1996).

Noise generated by aircraft operation affects negatively the quality of life of people living nearby airports. That notion of quality of life is a very subjective experience, as it is the aircraft noise problem (Janic, 1999). In fact, the evaluation of noise is also a subjective measure, because it depends on individual's noise perception, which depends on 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, 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. It has been argued that this change of 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 about by the institutionalization of environmental movements (Mol, 1999). Under these circumstances, the emergence of the ecological conscience has been accompanied by the emergence of higher standards and expectations about people's welfare and quality of life (Mol, 1999; Garcia, 1993). Moreover, it should be pointed out that these changes on welfare expectations have disseminated all over the world. The growing importance of such intangible factors might be credited in large measure to the web infrastructure that connected the world since the 80's and allowed access to new flows of information and knowledge created around the world.

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. This evaluation is complicated, because it involves personal attributes, such as sex, age and social class (Rogerson, 1995). Despite the difficulties associated to the noise perception evaluation, it should be emphasized the importance of obtaining an approximated measure of the externality. Thus, it would be possible to approach more adequately the problem of cost internalization. In fact, the idea is to understand the problem of noise perception in order to propose solutions that could improve human welfare and quality of life.

Additionally, this paper highlights the aviation noise problem taken into account a scenario where the airport capacity may duplicate in the next 20 years. This scenario is compounded by the paradigmatic change on environmental awareness that has emerged all over the world, as a result of the changing social and economic preferences, which favors human quality of life and a sustainable growth, in order to preserve resources endowments and quality of life for future generations. Under these circumstances, it can be foresighted that the social change is for the internalization of environmental problems, with the expected increase in the air transport sector costs.

2. AIRCRAFT NOISE PERCEPTION

When considering the evaluation of aircraft noise impact, most methodologies leave out the individual perception of noise annoyance, considered to be the size of the externality. Because of the important subjective characteristics of noise perception, its study becomes more difficult. It should be remember that there is a difference between emitted noise and perceived noise. The emitted noise, more easily quantifiable, is related to factors like the technological stage of the aircraft that is in operation, climatic and topographic condition, etc. On the other hand, noise perception is recognized to be a subjective experience, determined in large measure by subjective variables, which have been associated to personal attributes, such as sex, age and social class (Rogerson, 1995).

It is important to point out that Garcia found out that noise perception varied with social class. Thus, it can be expected that people that could be classified into higher classes are, in general, more refined and have higher quality of life standards. Therefore, it can be expected that they are less willing to accept aviation noise annoyance. Conversely, the lower class people would be less susceptible to noise. This situation is confirmed in the research developed in Finland by Heinonen-Guzejev et al. (2000), where he shows results that support that the self-report of noise sensitivity does not have a positive correlation with the people noise exposure.

In this context, it is interesting to study the subjective factors that determine aircraft noise perception, in order to provide subsidies for mitigating and controlling its environmental impacts.

3. THE ECONOMIC COSTS OF NOISE ANNOYANCE

Aviation noise affects negatively welfare of people living nearby airports. These effects are considered to be economic externalities. According to Nicholson (1985), externalities happen when two or more economic agents produce effects on the activities of each other and these activities are not visible in market transactions.

When a consumer buys economic goods, he causes an increase on its price, because this action determines a demand increase of such goods. This action is harmful for the remaining consumers. These effects, which are captured by the price system, cannot be characterized as externalities, because they do not reduce the market capacity of allocating resources efficiently. The price increase of a commodity reflects the society preferences for

it. This price increase helps to recover the market equilibrium, by searching for an efficient resources allocation. Nevertheless, Nicholson (1985, pp. 285-287) states that “this is not the case for toxic chemical discharges, aircraft noise or trash.”

In such cases, the market prices (of chemical products, air transportation or trash removal) may not reflect strictly the society preferences for these activities, because they are not likely to take into account the losses caused to third parties.

As it can see in Figure 1, once an externality does exist, the production of an economic good, that generates that effect, will be represented by Q_1 . In this case, the Marginal private Benefit will be smaller than the Marginal Social Cost, generating an external diseconomy. On the other hand, when the external cost is considered, production is reduced to Q_2 , optimizing the resources allocation.

Notice that the non-internalized cost of externalities increases the quantity produced. Therefore, the air transport user receives the benefits from the supply increase, as long as the community living in the airport noise area, which, in general, does not use this service, is jeopardized by the increase in output.

The correct understanding of the aviation noise externality is a fundamental requisite for developing an efficient economic instrument, capable to internalize the external costs.

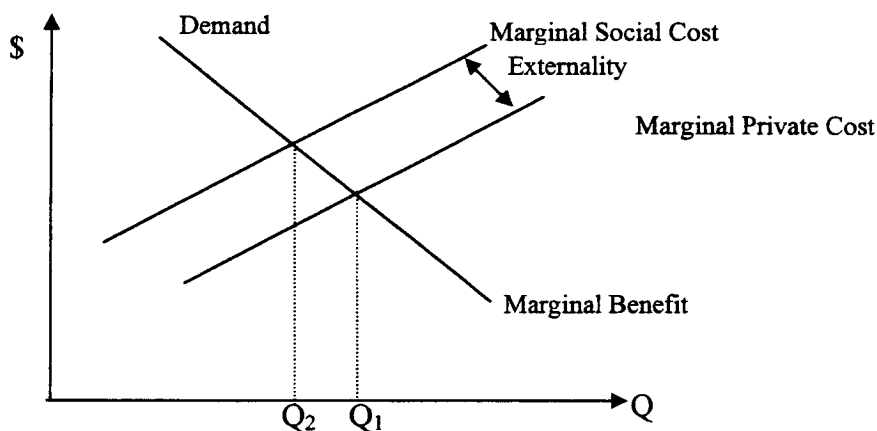


Figure 1 – Externality effect over the quantity produced

4. THE ECONOMIC REGION OF THE AISP/GRU

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, this part of the paper is devoted to describe the main socio-economic characteristics of the Guarulhos city and of the AISP/GRU.

4.1 – Guarulhos City characteristics

The city of Guarulhos is located in the State of São Paulo, in the southeast region of Brazil. It has 1.100.000 of inhabitants and has the 3rd budget of the State. Despite this favorable position in the public finance context, a study developed by the Brazilian Institute of Geography and Statistic (IBGE), point out that 22% of the population of Guarulhos can be classified under the poverty income line. Thus, they probably have no access to employment, or sufficient conditions of housing and food. The average per capita income is considered to be low when compared with the national average Gross Domestic Product - GDP. In fact, Guarulhos's average income is R\$ 500,00 (five hundred reais) by month or about US\$ 170¹, while the Brazilian average per capita Gross Domestic Product - GDP is about R\$ 420,00 per month (IBGE, 2000).

The Guarulhos' unemployment problem is the result of structural changes suffered by declining industrial regions. This decline was caused in large measure by the "fiscal war" initiated by other Brazilian regions with the objective of attracting industries. In fact, Guarulhos observed the transferring of its industries to other regions of the country, mainly the northeast, because of better fiscal conditions.

Another interesting characteristic derived from the city's historical industrial vocation is the population syndicate engagement, with popular presence in the political and classes fight. For this reason, despite the fact that the unemployment level could lead to the conclusion that people living in Guarulhos have low access to education and information, it is more probable that they 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 city is part of São Paulo metropolitan region, one of the largest cities of the world², which historically received enormous 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.

Figure 2 expresses visually the urban demographic growing vector that comes from São Paulo City to the Airport region and increases substantially the demographic density of the airport's western borders. This situation is relevant environmentally because that region is right below the flight tracks of the most occupied runways. For this reason, it is expected that as both the urban demographic density and the airport expands, the aircraft noise problem worsen.

¹ At the exchange rate of R\$2,95/US\$ 1 (O Estado de São Paulo Newspaper, www.estado.com.br, in 04/06/2003)

² 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/0006).

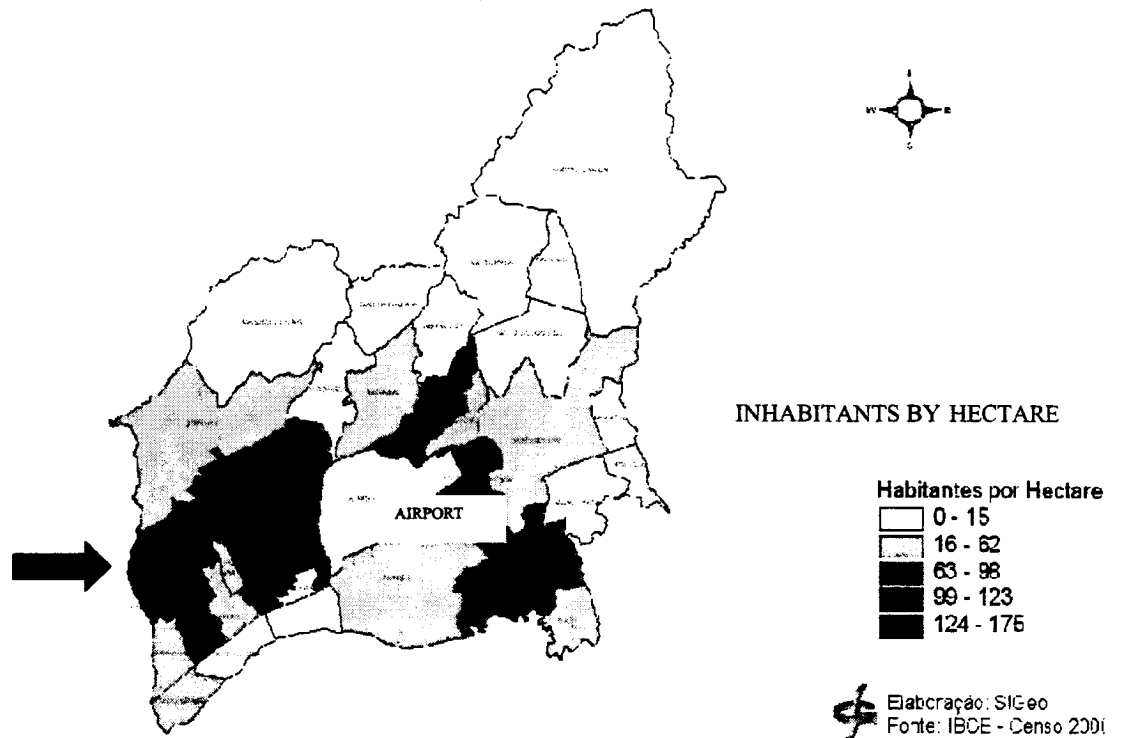


Figure 2: The urban demography of São Paulo Metropolitan Area and the AISP Region

It should be pointed out that there is a regulation designed to reduce noise problems in airport neighborhoods. Specifically, in the noise contour areas land use is not permitted without appropriate noise insulation, or even land use is simply not recommended. However, the combination of population vector growth with irregular land occupation turns noise regulations irrelevant because they are not respected. To compound this situation, there is a lack of integration between the regulation made by Brazilian civil aviation authorities (*Plano de Zoneamento de Ruído*) and the one made by the County's urban specialists (*Plano de Zoneamento Municipal*), which was more affected by population pressures than for environmental problems.

4.2 The Aeroporto Internacional de São Paulo (AISP/GRU)

The AISP/GRU, the biggest airport of South America, was inaugurated in January 20th, 1985 and has two parallel runways with its centerlines separated from each other of 375m. The airport is located in the city of Guarulhos, 25 kilometers away from the city of São Paulo. It occupies an area, of its own property, equivalent to 14 km² (fourteen square kilometers). The airport passenger's throughput (embarked plus disembarked) was 11,000,000 in round figures during the year 2002.

The airport has an average daily traffic about 500 operations, 90% of which occur in runways 09L and 09R. The airport typical aircraft fleet is classified in the Chapter 3 of the ICAO Annex 16 (IAC, 1998).

5. AIRCRAFT NOISE PERCEPTION AT THE AISP/GRU

This part of this paper is devoted to study aircraft noise perception in the vicinity of the Aeroporto Internacional de São Paulo (AISP/GRU). Initially, it is described the research methodology employed in this study. Afterwards, results are presented and analyzed.

5.1 Research Methodology

The idea is to study the aeronautical noise perception, focusing the relationship between aircraft noise perception and social class, which is expected to be positive. The problem that arises in this study is that the noise perception is intangible, difficult to quantify. Therefore, it is necessary to find a variable that expresses noise perception in a quantifiable way. Thus, this study chose the variable, developed by Eller (2000), which is the losses of value of the residential properties, caused by aeronautical noise as a “measure” of the perceived noise discomfort. The variable social class was measured utilizing the average per capita income of the people who live nearby the airport.

It is interesting to comprehend the methodology utilized by Eller (2000) to assess the impact of aircraft noise on property values, assuming that such impact is closely related to the subjective noise perception variable. Thus, it is necessary to point out that the author’s methodology was based on the ideas exposed by Frankel Marvin in a study carried out in 1991, where he interviewed real state developers in order to get the “real” market values. According to Marvin, the sample composition is important, and he recommends that qualified professionals, who have relevant market information, must be chosen to be interviewed³. Thus, Eller’s research developed questionnaires, in order to interview real state developers, who worked in the Guarulhos city area⁴.

Eller’s study focused uniquely on the value losses of residential properties, because it was considered that noise impact is perceived in a different way by owners of commercial and residential properties. This differentiated perception can be explained by the fact that commercial properties are, in general, occupied during day light hours only⁵.

The variable property value losses, chosen as a proxy of aircraft noise perception, was related to a variable that expresses social class. The social class variable requires also the choice of a “proxy” measure. Thus, this study chose the average per capita income as an

³ Additionally, the use of a sample of real state professional is considered to be appropriate due to the fact that other methods of assessing properties values –like researching official statistics or interviewing the properties owners – could fail to estimate these values, because they can incorporate other factors, not necessarily related to the airport influence (e. g., cemeteries, schools, highways and personal impression.)

⁴ Eller’s research developed Non Personal interviews made by means of questionnaires sheets, sent by postal shipment. This method is considered appropriated by Breen & Blankenship (1991), who recommended 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. It has to be pointed out that the method chosen by Eller allowed to previously identify the entire interviewed public, as well as to know in advance their postal addresses.

⁵ Two factors that recommend the commercial properties exclusion from the sample refer, on one hand, to the fact that this type of property have a functional noise background that minimize the perception of the environmental noise, along with the fact that it can be easily insulated acoustically. The other factor that supports its exclusion is the expectation of oversized market values for commercial properties, due to their closeness to the airport area (this situation would typically affect business related to airport activities, like warehouses).

expression of social class. It could be argued that this variable is not the best to assess economic and social welfare, because those are elusive factors⁶. Despite these factors, this study assumes that average per capita income of the population who live nearby the airport is an appropriated measure of social class. There were utilized four social classes, based on published data.

It was necessary to remember that, among the questionnaires properly answered, there was not any of them that pointed out losses in property value from regions which average per capita income below the average of the city. It is explained by the fact that the poor regions of the city are located out of the aircraft noise impacted area, as it was already shown.

5.2 Results Analysis

The results⁷ obtained by Eller (2000) were separated by property's value losses intensity, and for region. Thus, it was possible to associate each real state business region with its property's value losses intensity⁸. Afterwards, it was identified average per capita income for each real state business region. Therefore, it was possible to associate value losses intensity with social classes, as shown in Table 1.

Table 1: Properties market losses due to aircraft noise related to the average per capita

AVERAGE PER CAPITA INCOME (Reais)	PROPERTIES MARKET LOSSES			
	BELOW 10%	BETWEEN 11 AND 20%	BETWEEN 21 AND 30%	HIGHER THAN 30%
500-1000	0	50	50	0
1000-2000	0	33	35	32
2000-3000	0	33	25	42
>3000	6	30	23	41

income

⁶ It could be argued that economic and social welfare could be better expressed by a measure of the income purchasing power, however, due to the data scarcity this study chose a simple measure. Another variable that could be used is the educational level of people living nearby the airport, because there is a close relation between social class and human capital accumulated, but the data is not sufficiently discriminated.

⁷ In this study, the results selected, corresponding to 99% of the responses, showed market losses above 11%.

⁸ All the real state market regions were identified and, after that, the corresponding average per capita income of each region was found.

Considering that the “really” poor people do not live nearby the most noise-affected area, the lowest level of income selected was R\$ 500 (five hundred Reais) per month, which is equal to the average income of the Guarulhos City.

The sample was classified in four income classes, and the people belonging to each social class was separated utilizing the noise perception criterion, as shown in Table 1. There, it can be observed that all social classes had losses of value estimated to be above 11% of the market value of a similar residential property located in an area not affected by noise. Moreover, between half and two thirds of the people, classified in each social class, had residential value losses greater than 20% of the market value of similar houses, located in a noise-free area. In fact, for income levels above R\$1000, around 67% of the income level sample group declares residential value losses of more than 20%. It is interesting to note that people classified into the lowest income class registered substantial losses of value in their residential properties. However, as expected, the highest income class had more residential properties losses, indicating that their noise perception was greater.

Table 1, also, shows that for the lower noise perception level, there were reported only 6% of the sample groups earning above 3000. Another interesting feature of the sample is that people classified into the lowest income class registered intermediate levels of noise perception, as approximated by the range of residential value losses between 11% and 30%.

Also, it is possible to observe, in the second column of Table 1, that all social classes earning above R\$1000 registered around a third of the group sample on the intermediate noise perception levels, reporting properties market losses between 11% and 20%. On the other hand, for the subsequent intermediate noise perception level, it was observed that the proportion of the sample that reports between 21% and 30% declines as income increases. However, as expected, for the higher noise perception level, the proportion of people affected, in each social class, increases as income increase.

Additionally, it is possible to look at Table 1 from a diagonal perspective, so as to allow both noise perception and social level to increase. Thus, it is observed that higher income levels reported a substantial proportion of people (around 40%) very much affected by aircraft noise. As commented above, results for one of the intermediate levels, again, do not follow the expected pattern. However, observing results for social classes that earn more than R\$1000 and comparing both the more susceptible group and the lower intermediate level, it can be clearly perceived a positive relationship between noise perception and income class.

Thus, it was observed that the lowest income class registered substantial losses of value in their residential properties. Also, as expected, it was observed that the higher income class had proportionally more reports of residential properties losses, indicating that their noise perception was greater. Thus, the comparison of both, the lowest and the highest social class suggests that the relationship between social class and noise perception is

positive in the AISP region. However, since part of the sample, reflecting one of the intermediate noise perception levels, did not behave as expected, it is recommended to pursue this study, in order to better support the conclusion that social class determines aircraft noise perception. Additionally, an important result obtained by this study is the fact that all social classes are very susceptible to aircraft noise annoyance. In fact, the magnitude of the noise perception proxy for both social classes -the residential value losses- was found to be comparable to levels encountered in developed countries.

Thus, the results obtained in this study highlighted the change on the behavioral pattern, since both, the lower and the upper, social classes perceived noise as a serious problem. These modifications on perception could be attributed to a change on social preferences caused by the emergence of new global vision of what is a good quality of life.

6. ENVIRONMENT AWARENESS AND AIRPORT SUSTAINABILITY

This part of this paper is devoted to study the evolution of environmental awareness over time, as supported by the new information and knowledge economy, and its expected impacts on the AISP/GRU expansion plans.

6.1 Expected AISP/GRU Growth

As mentioned above, the AISP/GRU, the biggest airport of South America, was inaugurated in January 20th, 1985 and has two parallel runways. According to Infraero (Apud Lorenço, 2003, 44), these two runways support around 14 million passengers annually.

Table 2 shows that airport has already reached its full planned traffic capacity. Thus, it is expected an airport expansion, as was planned by the Infraero Director Plan⁹.

Table 2: Annual Movements of Passengers (embarqued + desembarqued) at the AISP/GRU

YEAR	TOTAL
1995	10.704.421
1996	14.032.208
1997	14.407.036

Font: IAC (Apud Lorenço, 2003, 44)

In fact, nowadays there is a project to build the 3rd runway. This runway is planned to allow movements of 12 million passengers annually. Thus, the AISP/GRU full capacity will reach 26 million passenger movements per year.

Lorenço (2003) estimated that the AISP would reach full capacity of the three runways close to 2014. Thus, table 3 shows his estimates, which were based on other Brazilian studies, focused on projecting the airport capacity demand, under alternative scenarios. There were chosen two year bases in order to avoid any abnormal situation.

⁹ Infraero is a government agency responsible for Brazilian airports management.

Table 3: Alternative Scenarios for Annual Movements of Passengers at the AISP/GRU

SCENARIO	PROJECTED DEMAND	YEAR (Base: 2002)	YEAR (Base: 2000)
Infraero IAC- Mean	26.034.000	2014	2012
IAC – Pessimistic	26.727.000	2015	2013
PDDT – Pessimistic	26.315.000	2014	2013

Font: Lorenço (2003, 50)

The relevant aspect of this discussion is that in the next decade the AISP/GRU will duplicate its capacity in around one decade, and that situation will have a very important impact on the environment.

6.2 Preferences Changes And Environmental Awareness

Airports managers have to be prepared to face an increasing social demand for reducing environmental problems, specifically the aviation noise annoyance. That change in social demand could be attributed to the emergence of a more susceptible environmental awareness, in large part because of the changing preferences in a global scale. Such changes favor human quality of life and a sustainable economic development, in order to preserve resources endowments for future generations. Thus, these new set of social and economic preferences configures itself in a new paradigm¹⁰, because it brings new values and perceptions about what is acceptable, about what brings welfare.

This paradigmatic change in human preferences could be attributed to the important spaces opened in economic life of modern societies, by the ecological movements that initiated during the 70's. According to Mol (1999), the old radical movements have transformed into institutionalized movements, which have a saying in economic decisions that affect environment. Mol calls this process of ecological modernization.

The ecological modernization brought about the institutionalization of environmental regulation and control. Thus, they participate in environmental negotiations and obviously have left behind their radical positions, accepting some environmental losses in exchange for ecological advances, when internalization costs were too heavy.

Ecological movements have contributed to create a new ecological conscience all around the world. In fact, the global emergence of environmental awareness was expressed in the World Summit of Rio de Janeiro in 1992. The idea was to define an agenda in order to avoid ecological risks and environmental deterioration. Thus, this first meeting can be seen as the foundation of a world movement that supports the preservation and recuperation of the environment.

It is necessary to point out that the perception of noise annoyance may have grown as a result of the increasing environmental awareness. Thus, these considerations may shed

¹⁰Paradigm can be defined as the set of values that defines the perception and the vision of the world (Capra, 1982).

a light on the results obtained in this study, which showed that noise perception intensity was not differentiated by social class. In fact, both the higher and the lower income classes perceived aircraft noise as a negative externality.

6.3 The Knowledge Economy and Environment

The growing importance of environmental factors in determining human preferences and welfare standards might be credited in large measure to the information and communication technology innovations implemented during the 90's, in a worldly scale. In fact, in this period the world became connected by a digital web, which allowed to accessing the flows of information and knowledge created around the world.

These new communication technologies had a very important impact on the rate of innovation generation and adoption by the productive sector of the economy. The access to enormous flows of new knowledge contributes itself to generate new ideas, new knowledge. In fact, this times are inaugurating a new economic paradigm, where the main factor in the production function is new knowledge, which itself helps to generate the most valuable type of products –knowledge-intensive goods and services.

Some of these innovations could alleviate environmental problems, such as the developments of less noisy aircrafts turbines. These innovations might be the result of changing world preferences toward higher standards of life. One indication of the importance of these social pressures in molding entrepreneur's decisions could be found in the NASA strategic planning for the next 25 years. Thus, in the strategic goals roadmaps developed by Nasa, the third goal that guides their long run investment decisions is noise reduction. Specifically, the goal is to reduce the perceived noise levels of future aircraft by 1/2 (10dB) from today's subsonic aircraft within 10 years, and by 3/4 (20dB) within 25 years. Consequently, efforts will be devoted to develop technology to reduce community noise impact (www.nasa.gov).

Another side-effect of the new information and communication infra-structure that links the world is the fantastic access to information and knowledge it provides. This access creates conditions for expanding people's awareness of social, political, economic and ecological problems. Under these circumstances, the civil sector can be mobilized by Non Government Organizations in order to fight for their rights or their welfare.

The growing expansion of the third sector could be seen as a result of the strengthen communication web, which reduced enormously the costs of informing and contacting people. As an example of this potential for people mobilization created by today's technologies, it can be pointed out the case of pacifists movements that have spurred all around the world recently.

As pointed out above, noise perception intensity is considered to be related to quality of life expectation, which is highly influenced by people's information/education level. In the case of AISP/GRU, which is located in a region, where people have more access to information because of their presence in the political and classes fight, the social demand for quality of life is expected to be stronger, even from people with low income. In these circumstances, results obtained in this study support the recommendation that government and airport authorities change the idea that poor people are less sensitive to

annoyance. Nowadays, as a result of higher access to information, the social demand for welfare is expected to increase, with the consequent development of a new relationship between airport and society.

6.4 The AISP/GRU Sustainable Growth

The emergence of new environment preferences supported by strengthen Non Government Organizations could be seen as a signal that airports managers would be, more and more, required to face pressures to reduce environmental externalities, which would require the adoption of measures that would increase airports costs.

Under this scenario, the AISP/GRU growth plan would be very much attacked by social and ecological movements, because it would worsen the already critical aircraft noise perception problem. Moreover, as the airport expands to double its current capacity, also the urban demographic density will increase in the regions nearby the airport. Thus, it can be expected that the perception of noise discomfort would become so relevant that may initiate social and political pressures that may limit AISP/GRU expansion. In fact, airport growth has to be sustainable in the long-run¹¹, so as to preserve environment. Under these circumstances, airport managers would have to deal with the internalization of the noise negative externality. That situation, besides increasing airport costs, would reduce its rate of growth because the social optimum airport capacity is below the private one.

This scenario could be attenuated by the expected technological advances devoted to aircraft noise reduction. However, airport expansion strategic planning can not omit environmental issues. In fact, as it can be foresighted that the social change is for the internalization of environmental problems, managers have to be prepared to deal with the expected increase in the air transport sector costs.

In this context, the implementation of isolated control/mitigation measures to deal with specific environmental problems may not avoid future social demands that might impair airport growth. Thus, it is suggested the development of a managerial program for dealing with environmental problems at the AISP/GRU.

8. CONCLUSIONS

The last decade was characterized by the emergence of worldwide webs that linked the world and allowed to accessing enormous flows of information and knowledge. Under these circumstances, citizens of the world are more conscious of the serious implications of neglecting environmental impacts on the world ecology sustainability. As a result, during the last years, a new approach toward these problems has resulted in social pressures to develop regulation and to implement measures designed to mitigate/control environmental damages on social and economic welfare, caused by economics activities. This situation demands that airport managers and aeronautical engineers take into account possible environmental negative impacts, when they develop airport expansion projects. Moreover,

¹¹ Sustainable growth is the kind of growth that is compatible with the preservation of the ecology and of the resource endowments for the use of future generations. In other words, sustainable economic growth does not compromise future generation's economic growth (Seroa da Motta, 1997). In this case, sustainable growth is associated to the microeconomic growth decisions that are compatible with social demands for the preservation and recuperation of the environment, in the long-run. Under these circumstances, firm's economic growth decisions do not compromise the long-run expansion path of the firm.

it is expected that managers develop a more systemic view of the relationships between airport and society.

In this context, the main objective of this paper was to contribute to the understanding of environmental problems in the Brazilian air transport sector. In this context, this study analyzed aeronautical noise perception in the neighborhoods of the Aeroporto Internacional de São Paulo – AISP (the biggest airport of South America). Specifically, it focused on the relationship between aircraft noise perception and social class, which was expected to be positive.

This work contributed to show that Brazilian preferences support the reduction of environmental negative impacts, caused by aircraft noise. Thus, it was observed that the lowest income class registered substantial losses of value in their residential properties. As expected, the higher income class had more residential properties losses, indicating that their noise perception was greater. Thus, the comparison of both, the lowest and the highest social class suggests that the relationship between social class and noise perception is positive in the AISP region. However, since part of the sample, reflecting one of the intermediate noise perception levels, did not behave as expected, it is recommended to pursue this study, in order to better support the conclusion that social class determines aircraft noise perception. Additionally, an important result obtained by this study is the fact that all social classes are very susceptible to aircraft noise annoyance. In fact, the magnitude of the noise perception proxy for both social classes -the residential value losses- was found to be comparable to levels encountered in developed countries.

Moreover, this paper highlighted the aviation noise problem taken into account a scenario where the airport capacity may duplicate in the next 20 years. This scenario was analyzed taken into account also the paradigmatic change on environmental awareness that has emerged all over the world. Thus, social and economic preferences favor human quality of life and a sustainable growth, in order to preserve resources endowments and quality of life for future generations. Therefore, it can be foresighted that the social change is for the internalization of environmental problems, with the expected increase in the air transport sector costs.

Under these circumstances, airport expansion strategic planning can not omit environmental issues. Moreover, the recommendation is for the development of a managerial program, capable of dealing with environment problems in a systemic way, so as to allow a sustainable airport growth in the long run.

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