ANALYSIS OF THE ECONOMIC IMPACTS OF NIGHT CURFEWS ON AIRPORT OPERATIONS

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Abstract

Aeronautical noise is considered to be the main environmental problem derived from airport operations. It directly affects the quality of life of the people living close to airports. Generally, these are people who do not directly benefit from the airport business. As a means to mitigate the problems caused by aeronautical noise, a night curfew is often imposed on the airport activities to minimize the existing conflicts. This article describes a proposed methodology to analyze the main economic impacts derived from operational changes at the airport – namely the night curfew on airport operations. The direct, indirect and induced impacts of this curfew are considered in this proposal. This study may support future evaluation studies with a more quantitative approach.

1. INTRODUCTION

The availability of air transportation and its associated airport infrastructure constitute a significant stimulus to economic and social development, not only for the community located in neighboring areas of the airports, as well as for the region, state and the country as a whole (Silva, 1991). The airport has become a vital feature for business and industrial activities, providing the necessary access, in terms of air transportation, to firms and companies that serve markets that are competitive and in expansion. The communities served by the airports also benefit from income related to businesses generated by the airport, such as those involving the supply of goods, equipment and services (das Neves, 1995).

These expenditures represent significant, direct contributions to the productive activities of the communities served by the airport and, of course, have multiplying effects on the local economy. The airport, in turn, is a feature – normally of great size – that, for its own characteristics, distinguishes itself as an inductor of the urban development process. This fact creates many difficulties both for the communities located in the airport surroundings, and for the airport's operation and development.

With regards to the physical impacts of aeronautical noise, the airport often lacks control over its surrounding land use, in order to minimize the probability of conflicts in the process of urban development. Thus, when the land use plans initially developed are not adopted and respected by any of the parties involved in the process, the peaceful coexistence between airport and community is compromised, resulting in serious losses both to the community and the airport operations.

This work considers that the airport has attracted to its surroundings a disordered occupation, quite different from what was determined in the main plans, thus causing problems with the urban relations and leading to complains by the residents. To solve this problem, a night curfew on airport operations is proposed to reduce existing conflicts. In that respect, this article contributes to the solution of this problem by proposing directives to identify the economic impacts incurred by this curfew.

2. THE PROBLEM OF AERONAUTICAL NOISE

Aeronautical noise is regarded as one of main environmental problems generated by airport operations, because it directly affects the quality of life of a great number of people who reside in the airport's vicinity and who do not, in general, benefit directly from the airport activities. This problem is primarily related to landing, take-off, taxi and engine

testing operations. The national policy on aeronautical noise that has been developed and applied over the last twenty years can be divided into three distinct application areas: legislation applicable to the sources of noise; operational procedures of noise reduction; and land use policies.

With regards to the legislation applicable to the sources of noise, the International Civil Aviation Organization (ICAO) notes that aircraft now entering operation are approximately 20 dB less noisy than those manufactured 30 years ago. Brazil, as a signatory member of ICAO, adopts this organization's noise classification (ICAO, 1993) as the basis for its laws on gradual removal of older, noisier aircraft. The Brazilian law also disserts on the possibility of applying more severe local restrictions to reduce noise impact.

Aeronautical noise reduction operational procedures are used in Brazil and around the world to mitigate local problems. Some Brazilian airports such as Brasília, Rio/Galeão, Manaus and Londrina had their numbers of complaints reduced significantly after implementing these procedures. It is important to point out that the success of these procedures depends on several factors, such as the residents' proximity to the airport, the area's terrain and the prevalent wind direction. The level of impact of noise is directly related to the surrounding land use – some uses such as schools, hospitals and residential areas are more sensitive to noise. To avoid or prevent the use of the surrounding land for activities that are sensitive to aeronautical noise, one of the most effective policies has been land use control through zoning as function of aeronautical noise.

Brazil has adopted an extremely well defined policy on land use control in areas adjacent to airports, with hundreds of Noise Zoning Plans (NZP). The objective of these plans is to make the land use in the airport surroundings compatible with the effects of aeronautical noise, not only facilitating airport development but also reducing the impact of noise pollution on the surrounding communities.

The NZP's consist of noise level contours and land use restrictions. The Airport Noise Weighted Index (ANWI, the method used in Brazil for creating the contours), corresponds to the average noise level generated by the aircraft, incremented by 10 dBA during the night period (22:00h – 7:00h) to compensate for the residents' increased sensitivity to noise during the night. The contours are generated by connecting the points with equal levels of ANWI, and the values of 75 ANWI and 65 ANWI are used to define the contours for

noise levels 1 and 2, respectively. From these contours, three areas – named I, II and III – are defined. In each of these areas, land use restrictions are established as a function of the noise level to which they are exposed. In cases where urban occupation already exists in those areas – especially with residential occupation – the expected reactions of the communities are listed, as shown in Table 1.

Table-1 - Values of ANWI and Community Reactions

Value of the ANWI	Reaction of the Displayed Community
Below 65 (Area III) – little noisy environment	- no claim is expected.
Between 65 and 75 (Area II) - medium noisy environment	- great volume of claims from the residents is expected.
Above 75 (Area I) - extremely noisy environment	-claims generalized from the residents are expected. - it is possible that appears communitarian action in favor of the noise reduction.

Source: Federal Interagency Committee on Urban Noise (1980).

Restrictions on land use are established as a function of the noise level to which each area is exposed. In Brazil, those restrictions are set out by the local (municipal) authorities. Since the NZP's are defined by the federal government through the Civil Aviation Institute, it is critical that they be developed in collaboration with the local planning agencies to ensure their effective implementation.

3. OPERATIONAL RESTRICTIONS AS A SOLUTION

As mentioned previously, aeronautical noise is considered the main environmental problem generated by airport operations. Primarily, this problem is related to landing, take-off, taxiing and engine test operations. As a secondary factor, the noise generated by the ground support equipment can also be included, even though they affect more directly the airport workers. Thus, the choice of measures to be taken to solve the problems associated with aeronautical noise, existing options must be considered. In the specific case of a community that occupied improperly the areas adjacent to the airport, the following alternatives can be considered:

- acquisition of lands affected by the aeronautical noise, especially those located in Area I of the respective Noise Zoning Plan;
- relocation of the airport;
- changes in the aircraft operational procedures;
- restricting the airport's hours of operation.

Since the most noise-sensitive period for the residents is the night, most claims are made about nocturnal airport operations. Thus, to mitigate the noise problems generated by the airport, one of the possible measures consists

of imposing a night curfew on the airport operations. The analysis of this impact will be evaluated in this article. This analysis is also important for a comparison with the cost of land acquisition and relocation of the population currently within the limits of the NZP and affected the noise generated by the airport operations. This analysis can be used be the authorities as a tool to better evaluate the issue.

In regards to the night curfew, even though Brazilian regulations determine it to be between 22:00h and 06:00h, for the purpose of this article it will be defined as the period between 23:00h and 7:00h. This period has been used in practice for night curfews. As an example, São Paulo/Congonhas airport operates with the latter.

These restrictions on airport operations bring a great benefit to the airport's neighboring community by eliminating the aeronautical noise generated by them. However, they also cause significant economic impacts not only on the local community, but also on other sectors of the economy associated with the air transportation activities. The airport, the airlines, the state's economy and the national airport system will all be affected by such restrictions. Therefore, it is necessary to evaluate this new situation and identify the principal economic impacts incurred by this mitigating measure.

4. ECONOMIC IMPACTS OF THE OPERATIONAL RESTRICTIONS

As mentioned in the previous section, the economic impacts of night curfew on airport operations are many and very complex. Therefore, the main impacts on the various sectors affected by this measure must be evaluated. The impacts on the airport business vary with the operational development alternatives adopted. However, in general these effects arise from the reduction in employees, passenger traffic, aeronautical and non-aeronautical revenue, cargo and all other factors associated with in the number of flights. Additionally, there is also the need to adjust the airport to the change in the hours of operation, which can potentially lead to its physical and operational saturation and congestion during the times immediately before and after the curfew.

The majority of the impacts on the airlines are related to the cost of changes in schedules, both in terms of routes and departure times; and changes in cargo and mail logistics. Decreases in revenue due to a decrease in the number of passengers carried are also possible due to the changes in routes and schedules.

The impact on the airport system is associated with adjustments that must be made to other airport schedules, in order to accommodate the changes in routes and

schedules and the corresponding changes in demand profiles. In this context, it is very important to take into account the possible failure to serve the part of the demand that cannot be served under the new restrictions. As to the state, there will be several indirect impacts such as reduced employment and commercial and industrial activities. In summary, the indirect reduction in state revenue and outcome due to the change in the airport activity patterns, as well as social issues, must be taken into account. However, before all these economic impacts can be evaluated in more detail, it is necessary to define them. For this reason, the main definitions and methodologies for economic evaluation and quantification of benefits of airports to the community will be presented next.

The Federal Aviation Administration (FAA, 1992) establishs a distinction between benefits and economic impacts. These are the two main indicators that can be measured and used as evidence of the economic importance of an airport. Thus, to better analyze this issue, one must first define these two indicators:

- **Economic Impacts**: defined as the local or regional economic activities, employment and tax revenues that can be attributed, directly or indirectly, to the operation of an airport in one given region. Through the evaluation of these impacts, it is possible to measure the importance of aviation as an industry, due the level of service it provides and the goods and services it consumes.
- **Benefits**: the services that an airport makes available to the region it serves. The two main benefits are: the time savings and the reduction in user costs. They also include other advantages, such as access to the national airport system, convenience and security. The benefits are a measurement of the improvements in the standards of transportation provided by the airport and, consequently, reflect the immediate goal of a community in a operating a public airport.

Since the airport is the main link between communities and even between countries, the determination of its economic impacts is of considerable importance. The economic impacts can be divided into three categories: direct, indirect, and induced (FAA, 1992). To each of these economic impacts are associated specific indicators, with the purpose of evaluating its magnitude. Variables or indicators can be defined as units of measurement of level of socio-economic

impact. In general, variables that can represent changes in the level of economic development of the region as a consequence of an airport construction, operation and/or expansion are used.

According to the FAA (1992), the direct impacts are a consequence of the economic activities developed at the airport by the airlines, the airport administration, airport operators and other activities directly involved with aviation. Labor, local goods and services used in the construction of an airport, as well as financial investments, are examples of airport activities that generate direct impacts. Some direct impacts such as the number of jobs generated by the airport activities occur within the airport borders. Others such as the production of local goods and services used by the airport can occur outside of the airport site. The element that really identifies a direct impact is the direct consequence of an airport activity.

In summary, the direct impacts must represent economic activities that would not exist in the absence of the airport and its operation. Jobs that would exist somewhere else in the same area if the airport did not exist are not considered a contribution from the airport to the local economy. Expenditures by the airlines, airport operator and tenants generate direct impacts, but only those that generate local economic activity are relevant to the region. The same applies to retail, restaurants and other concessions, as well as airport construction and capital investments.

The indirect impacts are derived, initially, from the economic activities outside of the airport site that are associated with the airport's presence. These activities include services rendered by travel agents, hotels, restaurants and car rental agencies, for example. These companies, like the airport, employ local people, consume local goods and services and make capital and financial investments. However, the indirect impacts are distinguished from the direct impacts by the fact that they occur outside of the airport site.

Like the direct impacts, the indirect ones must, at least in theory, represent the economic activities that would not exist in the absence of the airport. For this reason, it is necessary to distinguish between the visitors who would not have traveled to the region without the air transportation activities and those who would have traveled anyway, using some other transportation mode. Unfortunately, in most cases this distinction is difficult to accomplish. As a result, the impacts from the expenses by visitors who arrive through the airport can be

overestimated, especially in areas that have easy access by train, bus and automobile. Therefore the main indirect activities derived from the presence of an airport are: the increase in tourism and business activities, land value, tax revenue and new investments.

The induced impacts consist of the combined multiplying effects of the direct and indirect impacts, namely the increase in employment and revenue derived from the successive spending cycles. For example, in most cases, the salaries earned by airport employees are used for basic living expenses in the region where they live (Pitfield, 2000). Much of those expenditures turn into income for local service providers. Some will return to the local economy and turn into income for retailers and small businesses and their employees. Therefore, a part of this income cycle is also spent in the region, thus becoming income for other individuals. These successive revenue cycles generate additional economic activities and income.

Although most of the induced impacts occur locally, some are noticed outside of the airport region, as a result of the purchase of local goods and services. Thus, the induced impacts are typically measured by multiplying the sum of the direct and indirect impacts by some factor. The factors attributed to the several multipliers reflect the unique characteristics of the region where the airport is located, especially its degree of self-sufficiency. The total impacts correspond to the sum of the direct, indirect and induced impacts. It is important to note that the definition of these concepts is of utmost importance for the analyses of economic impact of airports. In order to judge the most adequate procedure to be taken by the airport administration on operational changes or land acquisition for the purpose of expansion, the quantification of the total economic impact of airport operations and activities becomes critical.

5. MEASURING THE ECONOMIC IMPACT OF OPERATIONAL RESTRICTIONS

To identify the economic impacts on the various civil aviation system links, an analysis is proposed based on the formulation of three air traffic development scenarios under the night curfew on airport operations:
Scenery a) moving the flights scheduled during the night curfew to other times;
Scenery b) moving the flights scheduled during the night curfew to other airports;
Scenery c) canceling the flights scheduled during the night curfew, which implies leaving the demand for those flights unsatisfied.

For each scenario, a simple analysis of the situation must be done, considering mainly

the impacts on air traffic, infrastructure and the economy.

It is important to note that, from these air traffic development scenarios, a hypothesis can be formulated on the airport operation. The hypothesis considered for the analysis of the economic impacts must, therefore, take into account various combinations of the aforementioned scenarios. That way this analysis can serve as a reference for future quantitative analyses.

5.1 Air traffic

The air traffic profile during the night must be taken into account. It is important to categorize the flights according to their markets: international, domestic, cargo, transfer and in transit. Other important factors are the number of aircraft movements, aircraft size, flight type (schedule vs. charter), etc.

5.2 Demand

The changes in the airport's flight schedule must take into account the issues related to the demand for these services. Although this factor is of great importance as demand is very sensitive to flight schedules, it will only be significantly affected if a large portion of the daily flights occur during this period. Therefore the most critical issue associated with the demand is the changes the night curfew may impose on other airports, especially for connections with international flights. The air transportation user is very sensitive to changes in flight origins and destinations and to travel times. Therefore the portion of the demand that will stop flying due to the potential changes in flight origins and destinations is a more significant issue. In addition, there is a need to synchronize flights to provide for transfers. Some characteristics of the different flight types can be mentioned: a) Since domestic flights are more sensitive to the origins and destinations served, they will most likely be re-scheduled or cancelled. b) International flights will have two choices: re-scheduling or moving to another airport:

- **re-scheduling:** the definition of this alternative requires the analysis of the flights that occur until one hour after the closing of the airport and until one hour before the opening of the airport to the air traffic. Therefore, taking the type of operation and the viability of changes into account, the flight arrival and/or departure times can be moved outside of the night curfew period.
- **change of airport:** international flights are normally very inflexible with their schedules, so a change of airport for the international flights affected by the night curfew can be expected. This inflexibility is due to airline operational restrictions, such as route planning, aircraft maintenance,

aircraft overnight stays, etc.

c) Cargo flights are often scheduled during the night. Therefore, it can be expected that these flights will need to be relocated to another airport.

5.3 Capacity of the aeronautical infrastructure

The physical and operational capacity of the aeronautical infrastructure may be a significant limiting factor for re-scheduling and relocation of flights.

The adjustment of the aeronautical infrastructure must take into account the cost of physical changes (aprons, terminal area, ground support, etc.) and operational changes (air traffic control, etc.) needed to serve the demand relocated/re-scheduled. This impacts both the airport and the airlines, as it can affect the construction of new facilities to process passengers, baggage and cargo. Besides these factors, the basic infrastructure and its access must also be evaluated, for they can also be of vital importance to quantify indirect costs incurred by changes in the road system to adapt it to the new traffic profile.

5.4 Staff adjustments

Any reduction in staff that will result from the night curfew must be quantified. In case of flight re-scheduling, this impact may not be so great since it may be possible to also assign the same staff to work on the services associated with those flights, compensating the negative impacts of this change. In the case of flight relocation to other airports, however, that compensation will not be possible.

Airport operations involve a great number of staff for take-off and landing procedures (air traffic control), aircraft taxiing and parking, aircraft ground services, passenger and cargo loading and unloading, baggage handling, passenger check-in and many others that are critical to the full processing of passengers, baggage, cargo and aircraft. However, quantifying the number of staff involved with this operations and the policies associated with each service are beyond the scope of this work.

5.5 Airline's route planning

This impact is strongly associated with the airlines, cargo dispatchers and others who must change their plans and logistics to make the changes in schedule and/or relocation to other airports possible. Special attention must be given to route planning, since rescheduling and relocation to other airports may significantly affect the airlines' route network. Some of the economic impacts incurred by these changes are: changes in routes due to re-scheduling and changes in the destinations served; relocation of staff; costs associated with relocation to other airports, including possible higher fees charged by the other

airports. Airlines are most qualified to analyze these impacts.

5.6 Employment generated off the airport site

The issue of off-airport employment will not be of great importance if the indirect and induced economic impacts of night operations are not significant. Hotels located near the airport usually serve the traffic associated with the 19:00h-22:00h period. Therefore, night flights can be served by the existing infrastructure, and their re-scheduling and/or relocation will have virtually no effect on the hotel industry.

5.7 Aeronautical and non-aeronautical revenue

Re-scheduling will not significantly affect aeronautical and non-aeronautical airport revenue, as airport fees do not currently vary with time of day. Variations in aircraft ground time can have some impact on airport revenue, but its quantification is beyond the scope of this work. On the other hand, relocation of flights to other airports will most certainly cause a loss of revenue for the airport. According to studies by Infraero, the state-owned company that manages and operates most Brazilian airports, aeronautical fees collected during the night make up 12.7% of an airport's revenue. This impact will be even more significant because most flights scheduled during that period use large aircraft, for which the fees are usually higher. If those flights are to be relocated to another airport, the reduction in revenue will be significant.

With regards to retail revenue, this could be more significantly impacted since this sector has gradually acquired great importance at airports in Brazil, now responding for approximately 40% of the total revenue at the country's largest airports. A great part of the international traffic occur during the night period, so a relocation to another airport would significantly affect the retail revenue associated with those flights, such as duty free shopping. Revenue generated by air cargo is also of importance to the airport, and most cargo flights are schedule for the nighttime period. However, only a small portion of all air cargo processed at the country's airports is transported on all-cargo aircraft (around 15%).

In summary, this analysis must look into the various types of aeronautical fees, as well as the impacts on the airport operator and the airlines. Therefore, the analysis can be divided into two parts:

a) Impacts on the airlines: include the costs associated with the aircraft operators, such as landing, apron and hangar fees.

b) Impacts on the airport operator: includes the loss of aeronautical revenue.

Finally, besides the impacts identified here, many others are of importance to the airport operator, the airlines and the local community. Special attention must be also being given to:

- Airport operation suppliers: baggage handling, catering, safety and ancillary service providers may be significantly affected by flight relocations. Local and state authorities will also be impact by loss of tax revenue.
- Civil aviation system: the potential cancellation of flights can result in reduced revenue from air traffic control fees. This will indirectly affect other airports in the system, as in Brazil this revenue goes to a fund used for improvements to airports.
- Remote customs units: these services depend directly on air cargo operations at airports. If the cargo operations are transferred to another airport, all this infrastructure becomes obsolete.

5.8 Selection of a new airport

The relocation of flights to another airport must consider the compatibility with the type of traffic at the new airport. This means the selection of a new airport to which the flights will be relocated is almost exclusively a function of the type of traffic.

6. CONCLUSIONS

The establishment of an airport is most often a response to the demand for air transportation. However, this establishment brings not only benefits to the community and the region it serves, but also environmental impacts that can negatively affect the development of both the community and the airport.

The establishment of airports and its operations serve as an inductor to land occupation around the airport site and the development of the adjacent communities. However, airport operations negatively impact the environment, especially in the form of aeronautical noise. Aeronautical noise is the main cause of complaints by the surrounding communities. This article has discussed the identification of the main economic impacts caused by the implementation of noise mitigation measures affecting the airport operations and the adjacent communities.

The measure analyzed in this article is the night curfew on airport operations. A wide range of economic impacts (direct, indirect and induced) from this operational restriction were discussed. In this context, it can be concluded that when airport development plans – including the Noise Zoning Plans – are followed, the economic impact on the state is reduced. Therefore, as the main result, one must always remember that the impacts of

changes in the operation of an airport are not limited to the airport operator: they will also affect the national airport and civil aviation systems; the local, state and federal governments; the airlines; and the local community.

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