Technical note

Noise abatement measures at airports: Contributing factors and mutual dependence

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Emir Ganic [a],[*], Marina Dobrota [b], Obrad Babic [a]

[a] University of Belgrade, Faculty of Transport and Traffic Engineering, Division of Airports and Air Traffic Safety, 305 Vojvode Stepe Street, 11000 Belgrade, Serbia
[b] University of Belgrade, Faculty of Organizational Sciences, Department of Statistics, 154 Jove Ilica Street, 11000 Belgrade, Serbia

ARTICLE INFO

ABSTRACT

Airports are known to cause noise-related environmental concerns, mostly because significant environmental impact correlated with operation of airports arises from aircraft generated noise. In order to address this concern, many airports have applied a variety of actions that alleviate negative effects of noise i.e. noise abatement measures (NAMs). Although there are similarities between airports applying some of the NAMs, numbers and types of applied measures are quite different among them. This paper focuses on finding statistical evidence to support the hypothesis that there is a significant correlation between applied NAMs and specific characteristics related to airports. To determine the reasons why airports apply NAMs, a logistic regression method was used on the data set for 246 European airports. As predictor variables, five specific characteristics related to airports (number of runways, number of aircraft movements, distance from the city, population of the city it serves, per capita gross domestic product (GDP) of the country an airport is located in), and ten NAMs based on their mutual dependencies were used. The results demonstrate a significant correlation between the applied NAMs and particular airport-related characteristics, but also between NAMs themselves. These findings can be used to determine the likelihood of applying a particular NAM to any airport, based on the characteristics that show a significant correlation with the corresponding NAM.

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1. Introduction

Benefits that social communities gain from major commercial airports are various [1]. Most importantly, airports provide investments, employment, increasing mobility, and high motivation to the globalization of the industry, business, and long distance tourism [2–4]. However, there are external costs associated with these benefits and any increase in aircraft movement causes adverse environmental impacts [1,2]. The most important local environmental impact related to the operation of airports is the creation of the noise generated by aircraft [5–10].

Among downsides that commercial airports cause, the literature review shows that aircraft noise causes annoyance [5,11] and various adverse health effects, such as hearing loss [12], cardiovascular diseases [13,14], and sleep disturbance [15,16]. Various organizations at the global level and different air transport system stakeholders, including airports, airlines, aircraft manufacturers, and air navigation service providers, have taken part in solving the problem of aircraft noise [1,7].

Particular efforts to achieve noise reduction have been made. The International Civil Aviation Organization (ICAO) presented the policies and programs based on the so-called "Balanced approach" to aircraft noise management [17]. These steps were taken in September 2001, within the Resolution A33-7 [18]. The balanced approach consists of identifying the noise problem at an airport and defining different measures that would reduce noise, with the goal of addressing the noise problem in the most cost-effective manner [17,18]. In the instructions for the application of a "Balanced approach", ICAO recognizes the need to discuss noise problems separately at each airport by the particular characteristics of the observed airport [19]. Even though the guidelines are general and do not require uniform application, the same solution can be applied if similar noise problems are identified at the airports [19]. The Balanced approach suggests that noise policy should not target single solutions but use the combination of solutions as the most appropriate opportunity to solve the causes of problems [7,17,20].

Noise problem has been detected on many airports, and various measures have been applied to reduce noise around those airports [21–30]. There is a valuable database developed and maintained by Boeing since 1992 [17]. Until 2010, the database has been annually

* Corresponding author.
 E-mail addresses: e.ganic@sf.bg.ac.rs (E. Ganic), dobrota.marina@fon.bg.ac.rs (M. Dobrota), o.babic@sf.bg.ac.rs (O. Babic).

updated in cooperation with the airports, thus increasing the quality of the data [17]. The database contains information about the airports and description of noise abatement measures applied at each particular airport [31].

This paper is an extension of the research by Netjasov [7] and Ganic et al. [17]. The question put in Netjasov [7] is: what are the most influential factors for introduction of certain measures? The aim of the research by Ganic et al. [17] is to find the answer to the open question above and to analyze and show whether there is a significant correlation between the number of noise abatement measures applied and specific characteristics related to airports (factors). Analysis has shown that all independent variables (five proposed factors) are statistically significant, but their association with the dependent variable (number of noise abatement measures) is weak or almost nonexistent. Based on these findings, it was concluded that it was better to pay particular attention to each measure separately, because of their specificities. In order to improve the correlation, both the type and the number of the NAMs should be considered in further research.

This research focuses on finding statistical evidence to support the hypothesis that there is a correlation between airport-related characteristics and applied NAMs. Another aim of this study is to investigate the mutual dependence between NAMs and determine whether there is some significant relationship between pairs of NAMs applied at European airports.

This paper is organized as follows. Section 2 describes problem defining and the methodology; Sections 3 and 4 present the results and discussion; Section 5 implies concluding remarks.

2. Defining the problem and methodology

Even though there are 18 different noise abatement measures (NAMs) [7,31] according to previous research [17], the following ten NAMs were used for this research:

1. Noise Abatement Procedures,
2. Engine Run-Up Restrictions,
3. Preferential Runways,
4. Airport Curfews,
5. Noise Charges,
6. APU Operating Restrictions,
7. Noise Level Limits,
8. ICAO Annex 16 Chapter 3/Chapter 2 Restrictions,
9. Operating Quotas,
10. Noise Budget Restrictions.

As defined in the previous research [1,17], according to Boeing's database, 630 airports around the world have been applying some of the NAMs until 2010 [17]. Fig. 1 shows the distribution of the number of airports in various regions that have applied some of the NAMs in the years 2009 and 2010. Comparison of frequency of applied NAMs at airports in various regions in the year 2010 is given in Fig. 2. The most common NAMs applied at the airports are Noise Abatement Procedures (517 airports) followed by Engine Run-Up Restrictions (414 airports). Only 14 airports in the world have applied Noise Budget Restrictions.

It was also observed that the largest number and the widest variety of NAMs were applied at Northern American (289 airports) and European airports (246 airports) [7]. The number and type of applied NAMs differ among airports [1].

2.1. Assumptions and hypotheses

Before answering the question about the dependencies between airport-related characteristics and applied NAMs, it is important to know whether every airport can apply any measure. Even if sometimes certain conditions are necessary for introduction of a particular NAM, the general conclusion is that in the largest number of cases, any airport can apply any measure in one or the other way.

However, the question that we strive to answer is: on what basis can one decide which airports will apply what NAM? This also implies the following questions:

- Does introduction of a particular NAM lead to introduction of other NAMs?
- Can a particular NAM be a precondition for introduction of other NAMs?
- Is there a relation between implementation processes for different measures?

Every airport has the flexibility to apply any measure or combination of the measures to address the noise concerns in the most cost-effective manner. It should be noted that cost-benefit analysis for a particular measure is not the same for every airport, due to different airport-related characteristics (fleet mix, traffic volume, surrounding population, etc.). On that basis it was presumed that airports would apply a similar measure or a combination of measures when they had similar airport-related characteristics (and similar noise problems assumed).

Various airport-related and land-use characteristics have been considered and described in the literature to determine impacts
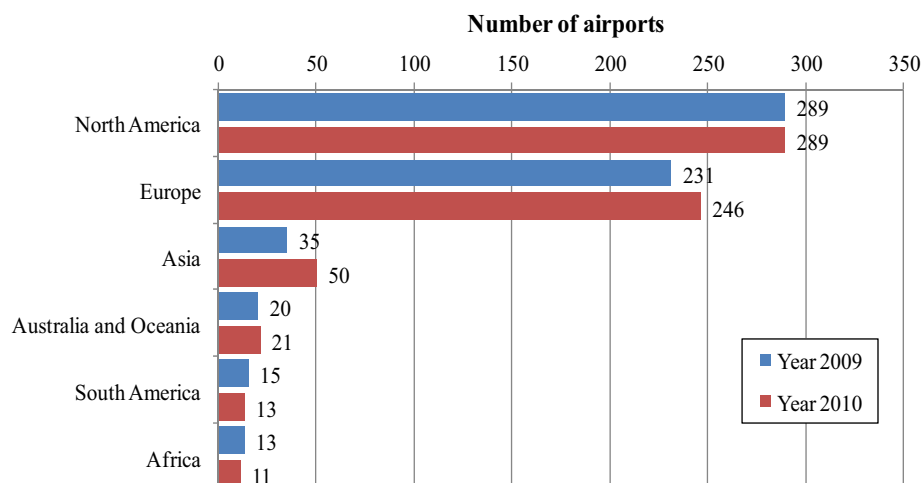

Fig. 1. Number of airports in various regions that applied some of the NAMs in years 2009 and 2010.