Journal of Air Transport Management 34 (2014) 49–56

Contents lists available at ScienceDirect

Journal of Air Transport Management

journal homepage: www.elsevier.com/locate/jairtraman

Assessment of land use compatibility and noise pollution at Imam Khomeini International Airport

Maryam Kiani Sadr [a,*], Parvin Nassiri [b], Mohsen Hosseini [c], Masoud Monavari [a], Alireza Gharagozlou [a]

[a] Department of Environmental Science, Science and Research Branch, Islamic Azad University, Tehran, Iran
[b] Department of Occupational Health, Tehran University of Medical Sciences, Tehran, Iran
[c] Department of Forestry, Tarbiat Modares University (TMU), Jalal Ale Ahmad Highway, Tehran, Iran

Keywords:
Airport noise pollution
Imam Khomeini International Airport
Noise prediction model
Integrated Noise Model

A B S T R A C T

This study aimed to investigate land use planning around airports, by employing Remote Sensing (RS) and Geographic Information Systems (GIS), in conjunction with an optimization algorithm using an Integrated Noise Model (INM) software, to establish the potential effects of aircraft noise at Imam Khomeini International Airport (IKIA) in Tehran. We also checked for land use compatibility with the noise levels around IKIA and the residents' reaction to the noise. The research was carried out in three stages: a) the establishment of Strategic Noise Map (SNM) scenarios of the airport operation in the years 2011, 2020 and 2030 using the INM software; b) the assessment of the results with emphasis on the study area land uses and application of RS and GIS and the exposure of residents at different levels of environmental noise; and c) the assessment of the intensity of aircraft noise annoyance at various times of day and night. The results indicated that developing IKIA together with the residential development will increase airport noise. Hence proper management and control of noise at IKIA is essential.

1. Introduction

Airport noise pollution is one of the main environmental problems that limit the efficient use of airport capacity. The main focus of this paper is based on the discussion of an aircraft noise prediction model, namely the Integrated Noise Model (INM), and using Remote Sensing (RS) and Geographic Information Systems (GIS) software to establish the various potential effects of aircraft noise, together with the response from the neighboring communities concerning noise annoyance.

Aviation has grown tremendously since the 1970s. Yet, due to the introduction of new aircraft technologies, noise exposure patterns surrounding the airports have greatly reduced in size (Fleming et al., 2008). In the future, however, less is expected from new technology and as a result, the number of exposed people is expected to grow. So, aircraft noise is considered as an important issue in deterring the efforts being undertaken to develop the capacity of airports.

In fact noise considerations have played an important role in recent decisions in preventing airport expansion and in supporting costly relocations (Girvin, 2010). Exposure to aircraft noise can negatively affect health, which ranges from subjective and behavioral effects like annoyance or sleep disturbance (Miedema, 2007) to physical effects such as high blood pressure (Babisch, 2006). Chronic psychological strain, along with physiological stress reactions to noise exposure, may increase the risk of health problems, in particular cardiovascular diseases and mental disorders (Schreckenberg and Meis, 2010). Recent epidemiological studies on the relationship between transportation noise (particularly road traffic and aircraft noise) and cardiovascular effects have been carried out on adults and on children, indicating a positive association (Vogiatzis, 2012). Several studies have found links between residential satisfaction and noise annoyance (Kroesen et al., 2010). Van Kamp studied the role of stressors (noise) and coping with noise for the prediction of health complaints (Van Kamp, 1990). Also Stallen pointed out the importance of the social aspect of noise on perceived control and, thus, on annoyance and source-related attitudes (Stallen, 1999).

As regards airport noise management, this includes noise exposure simulation, noise annoyance control, environmental regulations, land use planning, noise monitoring, and air traffic control. In order to reduce the negative effects of aircraft noise exposure, the US Federal Aviation Administration (FAA) for instance, has mainly concentrated on the source with sequentially

* Corresponding author. Tel.: +98 912 818 7223.
E-mail address: Mkianysadr@gmail.com (M. Kiani Sadr).

0969-6997/$ – see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.jairtraman.2013.07.009

severe certification standards for new aircraft. More recently policies have also developed other tools to reduce exposure to aircraft noise. For example, the ICAO's balanced approach, which focuses on land use planning, noise abatement operational procedures and aircraft operation restrictions (ICAO, 2004). Generally noise mapping is an important tool for supplying the necessary relevant information for both global and local action plans (Klæboe et al., 2006; WG-AEN, 2006).

This research considers noise issues at Imam Khomeini International Airport (IKIA). This airport is located about 30 km (19 miles) southwest of Ahmadabad city near the localities of Robat-Karim and Eslamshahr. It was designed to replace Mehrabad International Airport, which is in the west of Tehran, now inside the city boundaries (IKIA, 2012). The total airport site is about 13 500 Ha, which is divided into two parts (northern site and southern site) separated by an important spine road connected to Tehran. Today, only the northern site of the airport is developed. The large wide areas surrounding the airport offer an important development potential in order to turn IKIA into the main prestigious gateway to Iran (IKIA, 2012). IKIA is accessible from Tehran by car, taxi, and bus via the Tehran-Qom freeway. An airport access road connects the freeway to the airport terminal, continuing to serve Robat-Karim city via an interchange with Saidi highway. An extension to the southern part of Line 1 of Tehran Metro for IKIA airport is currently under construction. There is also a plan to have Line 3 of the Tehran Metro to reach its southern terminus at IKIA in future. One runway has already been built and the closest taxiway to the runway was built to be used as an emergency runway, but it has not yet been authorized to be operational.

2. Methodology

2.1. Noise exposure maps

Noise exposure maps (NEMs) are designed to identify an airport's present and future noise patterns as well as land uses which are not compatible with those noise patterns. An airport's NEM serves as a standard reference to its existing and future noise impacts for anyone proposing sensitive development in the vicinity of the airport. This scope of work consisted of the production of NEMs by using the FAA's Integrated Noise Model (INM), recognized as a renowned device amongst noise modeling specialists. Countries that use the INM include Australia, Belgium, Greece, Hong Kong, Spain and USA. Other countries use variants of the INM; for example, Denmark and Finland use their own model, DANSIM, with the INM database (Trani, 2008). The INM is a computer model that assesses the effects of aircraft noise in the area exposed to the airport traffic and surroundings. It applies Noise–Power–Distance (NPD) data to evaluate noise according to the specific operation mode, thrust setting, source–receiver geometry, acoustic directivity, and other environmental factors. Furthermore, the INM can make noise contours for an area or noise level at pre-selected locations. The noise output can be exposure-based, maximum-level-based, or time-based. In the United States, the INM is considered as a most favored model in air pollution issues; it is typically used for FAR Part 150 noise compatibility planning as well as for FAA Order 1050 environmental assessments and environmental impact statements.

The INM Version 7.0c is the most recent release of the INM, which was used in this study (FAA, 2012). To improve computational accuracy it requires average meteorological data including temperature, humidity, pressure and wind speed (Kreshover et al., 2000). This data for the study week were obtained from the airport's meteorological office. The other inputs to the INM were as follows: airport characteristics (runways, orientation, etc.), approach and departure profiles (procedural or aerodynamic based profiles, and fixed-point profiles), flight tracks (approach, departure, touch-and-go, circling and over-flights), flight operations (numbers of aircraft assigned to each track, percentage of aircraft operations assigned to each track, run up or engine test operations) and noise metrics.

For this research, the noise exposure contour sets were developed for three time frames detailed in Table 1. Based on these, three scenarios (in the years 2011, 2020, and 2030) were developed to evaluate the airport noise impact on the surrounding communities and the future airport city. The scenarios were based on the mid-term and long-term air traffic predictions in the IKIA's development plan. Different runway layouts were used in each scenario. Aircraft operations are expected to be accommodated on a single runway oriented east/west in scenario 1. An additional staggered parallel runway is planned to be constructed in scenario 2. The ultimate phase presents long-term development at the airport, which would comprise two pairs of closely spaced parallel runways with a mid-field terminal.

For all the scenarios there was an analysis of the following.

(a) Aircraft traffic per day/runway/flight path.
(b) The distribution of aircraft types in categories per day hour/runway/flight paths in the three partial periods (day–evening–night).
(c) Aircraft operations per period of the day (Table 2) and by ICAO aircraft code (Table 3).
(d) Runway utilization: At IKIA, 60% of the landing and take-off procedures will be operated to the west on the runways 29L/R and 30L/R.
(e) Aircraft fleet mix: The fleet mix was defined according to the mid-term and long-term air traffic predictions in the IKIA's development plan. An INM aircraft-specific code was then assigned to each aircraft, reflecting the current or future engine types used by the airlines expected to be accommodated at IKIA.

The number of operations per runway, aircraft types and time period for each scenario were then computed by multiplying the number of operations per period of the day and runway by the percentage of aircraft movements by the INM code. The last step before using the INM was to assign each aircraft operation to a specific departure and approach procedure. The exit radials were

Table 1
Characteristics of the three scenarios.

Scenario 1 (In 2011)			Scenario 2 (In 2020)			Scenario 3 (In 2030)		
Runway	Annual passenger traffic	Average daily aircraft movements	Runway	Annual passenger traffic	Average daily aircraft movements	Runway	Annual passenger traffic	Average daily aircraft movements
11/29	12 Mpax	290 movements	11L/29R 11R/29L	27 Mpax	580 movements	11L/29R 11R/29L 12L/30R 12R/30L	92 Mpax	1705 movements