An Investigation of the Romanian aviation noise policy and its implementation: where is Romania placed on the European noise mitigation map?

Delia Dimitriu
Manchester Metropolitan University, Centre for Aviation, Transport and the Environment, UK.

Georgeta Dinu
Independent Communication Expert, Commercial Pilot, Romania.

Claudia Vesel
Iasi Airport, Romania.

Adina Toma
COMOTI - National Research and Development Institute for Gas Turbines, Romania.

Dan Radulescu
COMOTI - National Research and Development Institute for Gas Turbines, Romania.

Elena Narcisa Burtea
COMOTI - National Research and Development Institute for Gas Turbines, Romania.

Marius Deaconu
COMOTI - National Research and Development Institute for Gas Turbines, Romania.

Stefan Runcan
Independent Expert, Military Pilot, Romania.

Dan Tofan
Independent Expert, Romania.

Summary
Aviation noise is known as being one of the main factors that can limit the airport growth, so a wise and well-balanced policy on noise mitigation at, and around the airports is necessary, particularly in the regions with rapid growth of air traffic. Romania is such example, with a 30% increase in air traffic in the first half of 2017.
The aim of this paper is to investigate the existing gaps in implementing the aviation noise mitigation policies at Romanian airports, having END as a starting point, but considering also, and best practices from other EU airports.
A detailed research of the Romanian aviation noise policy is given, with illustration of the status of the implementation of the ICAO Balanced Approach: new operations, LUP, operating restrictions. The existing of national policy tools to minimize the aviation noise impact in airport vicinity is examined.
The main research question is: Where is Romania placed on the European noise mitigation map?
Discussion will be around gaps and barriers, to identify the best pathways Romanian airports should chose in order to design and implement a sustainable aviation noise policy.
Iasi Airport will be chosen as a case-study, having the opportunity to learn from Heathrow and Schiphol airports on how to identify & implement best practices related to airport noise management. A Framework on a national approach towards noise mitigation, including a proposed Action Plan will be designed, to be later discussed with relevant aviation stakeholders, the Romanian CAA included.
The Conclusions will be drawn and next steps proposed. The investigation for this work is realized in the frame of the ANIMA research project.

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1. Introduction

The fast-growing complexity of the International Air Traffic Management system resulted in the development of specific tools that allow the prediction of the air traffic development on different periods of time: short-term, medium-term and long-term [1]. The forecasting processes were created in order to determine the actions that have to be taken to prevent restrictions of air traffic, due to reaching its capacity limits as a result of congestions. Small or big, airports and their infrastructure provide simultaneously benefits and disadvantages for the people living in their surroundings, therefore both parties must find a way to coexist. Airports should be allowed to expand, since they are creating jobs and development opportunities for the area, while the community should be able to benefit from the "home silence" at the same time.

The aim of this paper is to investigate the existing gaps in implementing aviation noise mitigation policies at Romanian airports, having END as a starting point, together with 'best practice' examples from other EU airports. ISO standards 1999 [2], 3744 [3], 3746 [4], 1996 [5] and 20906 [6] provide procedures and guidelines for noise measurement. However, the application of the methods described in the standards to a particular situation requires careful observations of the influences of conditions pertaining to the site. At this moment, in Romania no airport has fix noise monitoring systems.

2. Material and Methods

2.1. The necessity for a well-balanced policy on noise management

Current global economic challenges within the aviation sector are highly connected with aviation noise, issue considered to be one barrier of the harmonisation between the growth of the aviation industry and the communities surrounding an airport. This topic is considered to have a high importance in the context of assessing its impact on the overall environment, specifically on the protection of human life existing in the vicinity of an airport. As a result of having no specific legal framework (legislation, policy et.al.), an uncoordinated development of the entire infrastructure of airports and their surroundings occurred. Therefore, one can observe that the areas in the proximity of an airport are becoming more populated due to heavy construction activities being increasingly conducted. These practices imply that a growing number of people become exposed to aviation noise, putting at risk not only the development of their daily activities, but also their own health state.

2.2. The International Approach. ICAO Balanced Approach

In the situation where airports and buildings designed for living are tending towards becoming an intertwined infrastructure, specific measures have to be taken into consideration in order to prevent and mitigate any harmful impact on both human life and aviation technological and operational development. In order to ensure a proper coordination between these two main actors, ICAO proposed a "Balanced Approach to Aircraft Noise Management" (ICAO BA), having the main purpose of introducing a harmonised approach of aviation noise worldwide. The formulation of ICAO BA mainly started from the fact that the impact of aircraft noise led to operational limitations in order to preserve the environment and human life. This crucial issue, i.e. the protection of the population living in the proximity of airports, is of utmost importance, having priority before any type of action takes place. Therefore, operational restrictions have been established, limiting concomitantly the growth of air traffic and the natural economic development of the aviation sector, specifically the airports. In order to stabilise this situation without endangering the activities described within the air traffic development and management, a second issue was raised: the uncoordinated policy developments that addressed the management of aircraft noise as a threat against the economic development of aviation. These two issues determined experts to address the aircraft noise problems at individual airports, having both an environmentally responsive and economically responsible perspective [7]. In order to do so, the aim of ICAO BA was set to achieving the best possible solutions in terms of environmental benefits in a cost-effective manner, possible through the adoption of a flexible, consistent and transparent process for the assessment of both aforementioned objectives and

abatement measures. Alleviation measures vary, starting from focusing on an airport-by-airport approach and continuing with other relevant criteria: the use of objective and measurable criteria, the pursuit of a collaborative approach (i.e. consultations between all relevant stakeholders), the inclusion of adequate and timely notification of decisions, the implementation of dispute resolutions and the establishment of information exchange and dissemination [7]. The assessment of the noise situation has been determined by interrelations, with the focus on four key elements: reducing noise at source, land-use planning (LUP) and management, noise abatement operational procedures and operating restrictions on aircraft. After the identification of the noise problem and the definition of the noise objective, the proposed tools and procedures for the assessment of noise are the following: noise contours, noise index, baseline and management plans [7].

2.3. The European Approach. END

The next step towards establishing the guidelines of approaching aviation noise was set up through the EU European Noise Directive (END). This European Directive has been formulated with respect to the assessment and management of environmental noise, as the main EU instrument for identifying both the levels of noise pollution and the necessary mitigation action, at the state level and at the European level. The focus of END is oriented towards the assessment of three key actions: determining the exposure to environmental noise, ensuring the public availability of information concerning environmental noise and its effects, reducing and preventing the environmental noise in conflicting areas, respectively in areas where the quality of life is preserved. Public consultations during the drafting of Action Plans are mandatory, in order to ensure a proper collaboration between all involved parties [8].

2.4. The National Approach

In order to put in place such measures for the reduction and mitigation of aviation noise, guidelines were defined by both ICAO BA and END for the analysis and selection of measures. An individual strategy, at a national level, should aim to develop a comparative analysis on ‘best practice’ evaluation of techniques and methods (e.g. sensitivity analysis), in order to determine how to achieve a maximum environmental benefit in the most cost-effective manner. Combinations of measures should be considered and interrelations must be taken into account (e.g. between noise and emissions) in order to properly assess the efficacy and efficiency of measures within the overall strategy on environmental protection. Nor the ICAO BA, neither END have the authority to establish limits, set target values or prescribe mitigation actions to be included in the Action Plans, the Member State having the power to deal with these issues in the best way possible. Therefore, using ICAO BA guidelines and END requirements, the responsibility of legislative action upon the harmful impact of aviation noise on the communities surrounding an airport resides within the governing powers of each state, in collaboration with the relevant aviation stakeholders (airports, airlines, ANSPs et.al.).

After the analysis of the factors that act as limitations of airport growth, it has been determined that aviation noise represents one barrier that needs careful assessment. Therefore, a well-defined and balanced policy on noise mitigation both at and around the airports is necessary, especially in regions where air traffic growth is rapid. Romania is a Member State included in this category, having a 30% air traffic increase in the first half of 2017 [9].

2.5. Romania Case Study

2.5.1. National Policy Tools

The national approach of Romania from the legislative point of view starts from the implementation of the Governmental Decision (H.G.) no. 321/2005 [10], having the main purpose of transposing the END requirements into national law, for all transportation systems. In time, the Decision has undergone both modifications and completions several times, improving the clarity, quality and effectiveness of the statements. Nevertheless, a specific aviation oriented legislative act regarding noise reduction is not yet drafted. The development of noise maps and action plans are embedded within the national law, together with limiting values established for the prevention of noise exposure. Furthermore, all such actions must be monitored with the purpose of assessing their effectiveness and improve future applications and measures. Even so, there are several issues in properly understanding the proposed methodology for the application of these

requirements, considered yet incomplete. Several hierarchical schemes have been established, mainly through the Decision no. 321/2005, to ensure a proper coordination between all relevant actors involved in the processes of noise management. The framework appointing responsibilities to all relevant stakeholders (national authorities, airports, ANSP, other economic operators) in the context of noise reduction has no specific formulation specifically concentrated on aviation noise management. Therefore, the centralised data system is not complete yet and data is often not compatible (e.g. differences between the complaints on aviation noise from the official records and the community response).

From 2005 to 2016, only one airport ("Henri Coanda International Airport") has been classified as a major airport. Other existing Romanian airports with a rapid increase in air traffic were classified as urban airports under the END coverage, being required to develop Strategic Noise Maps and Action Plans. The rapid increase in the number of movements results from the fact that in 2005 and 2007 only 4 airports were considered to be urban airports; in 2012 and 2016, the number increased to 9, respectively 10 [11].

2.5.2. ICAO BA implementation level

The alignment with ICAO BA principles is under development, having already implemented SID/STAR/CDA procedures, as well as reverse thrust manoeuvres with the purpose of minimising disturbances in the areas surrounding airports. In addition, different types of methods were used in order to support the noise reduction: the use of differential maps, the prediction mapping of the noise situation, traffic planning, LUP, technical measures to reduce the noise at source, economic measures, insulation, the selection of quieter sources, the reduction of sound transmissions etc. [12]. All these actions were selected based on two criteria: the exposure of the population and the ease of implementation. This strategic decision is considered to have been made in order to act upon the aviation noise issues as fast as possible, in the shortest time possible.

All these actions should be considered as an important part of the overall strategy for the national development of the aviation transportation system integrated within the future European and International ATM system.

LUP is not specifically defined, but broadly presented in laws and strategies for urban and territorial planning that include transport networks [13]. Quiet areas are established for the protection of the population, having imposed other specific limiting values for noise. Except for the aforementioned, LUP in the context of a collaborative environment (i.e. airport-community) is not defined in any legislative document and usually not taken into consideration by real estate during decision-making processes, putting at risk the future development of the Romanian airports. As a main consequence, night time operational restrictions are imposed, together with engine run-up restrictions, APU Operating restrictions etc. [12], [13]. Relevant stakeholders, from national policy makers and real-estate agencies to aviation agents, should establish an effective management of noise by collaborating through constant communication and periodical consultations in order to ensure an effective continuous development of the entire Romanian aviation infrastructure.

2.5.3. Issues in the design and implementation of a sustainable Aviation Noise Policy

In the context of the European noise mitigation map, Romania is considered to be one of the countries actively engaged in the process of reducing aviation noise exposure through many actions. It has not exhausted all potential measures that can be implemented in order to become harmonised with the methodologies already put in place by other European airports, having the advantage of learning from 'best practice' examples such as Heathrow and Schiphol. In order to do so, the attention of national policy makers and aviation stakeholders should be directed towards the assessment of current issues, reduction/mitigation strategies and forecasting.

Various issues have been identified during the assessment of the Romanian proceedings on aviation noise. Firstly, the lack of a stable budget supporting the development of Strategic Noise Maps and Noise Action Plans often results in delays for their preparation. Transparency in decision-making is conflicted by the absence of available data justifying the choice of specific decisions and trade-offs in the favour of economic gain. Secondly, there is a limited number of specialists for strategic noise mapping and action planning, for assessing the noise situation at the airport/ regional/ national level, as well as for ensuring a proper management of noise, moderating consultations between all relevant stakeholders. Thirdly, delays frequently emerge

from the absence of an efficient information exchange system, causing difficulties in collecting data for strategic noise mapping, thus furthering delays in drafting action plans. Furthermore, data provided for strategic noise mapping is not in a GIS format, extending their period of preparation.

2.6. Performed studies international and national level

Between 1961-2014 numerous studies have been performed. A review of most of them has been presented by Bassarab et al. (2009) [14]. Key data on 43 surveys of aircraft noise has been compiled by Fidell et al. (2011) [15], centralizing articles of research and results being published during time [16], [17]. Except for the aforementioned, other studies being performed at the moment, including the research started in 2015 in Romania, having the Iasi Airport case study. In the "MANAGING AVIATION NOISE IMPACTS. MAPPING FUTURE RESEARCH PRIORITIES" workshop, held in Iasi, Romania, in May 2015, the subject of annoyance was highly discussed. It was brought to attention then the increased interest for the subject, in the past years. Before 2015, in Romania were identified only 4 studies performed on annoyance, out of which only one is related to airport noise and one methodology that allows a unified approach to assess the effects of noise. The first one can be found in EUROCONTROL Experimental Centre report "Attitudes to Aircraft Annoyance around Airports (5A)" published in 2002 [18]. The report presents three case studies: Manchester, (UK), Lyon (France) and Otopeni (Romania), where the attitudes of residents living near airports were assessed. For Otopeni it was concluded that "the effect of removing the airport would be to deny opportunities for economic development, remove much needed jobs, and although people might perceive improvements in air quality, the noise is far less of an issue because of ambient noise from road traffic and other sources" and that „In Romania, increases in air traffic are associated with better economic fortunes". During 2001-2013 three studies were performed in Cluj, to determine the population awareness, regarding the urban acoustic environment and estimation of effects and disturbance. The surveys were conducted in 2001, 2009 and 2013, the results being presented in „Monitoring the Reaction and Response of People to Urban Noise" [19] and „Urban Noise Annoyance Between 2001 and 2013 – Study in a Romanian City" [20]. In this case, none of the studies aimed airport areas. A study financed by the Ministry of Environment and Forests was performed in 2012, „Study for the development of guidelines to determine dose-effect relations for assessing the annoyance on population, due to the noise from traffic" and briefly presented during the workshop from Iasi, May 2015. The study identified and developed a methodology that allows a unified approach to assess the effects of noise from road, rail and airport on the population. The objective was to determine dose-effect relations that can be used to establish the degree of population discomfort and annoyance created by transport noise. Having in mind the studies performed until now, it is clear that further research is needed, especially in Romania, where it can be considered that knowledge and data are incomplete/absent.

3. Results and discussions

3.1. ABC for airport noise monitoring – Iasi Case Study

The objective of this ABC procedure is to specify the minimum requirements and to present the necessary steps needed to be performed in order to have a trustable and unified airport noise monitoring system. The normative reference documents used for noise monitoring [5], [6], [21] are a compilation of ISO standards relevant for Romania that enable a proper noise assessment of the airport surroundings. The quantities to be measured and reported are: A-weighted sound pressure levels of the total sound in the form of time-series of 1s; Sound exposure level; Maximum sound pressure level; Event sound pressure level; 1hour A-weighted sound pressure level, Lday, Levening, Lnight, Ldn and Lden. The equipment to be used for airport noise monitoring must follow the requirements specified in IEC 61672-1 (19) for a class 1 sound level meter. The sound monitor shall provide measurements of A-weighted measurement quantities in 1/3 octave band spectrum. The entire microphone assembly as used in normal operation (microphone, preamplifier, rain protection, windscreen, microphone device support, anti-bird devices, lightning conductor and any calibration device) shall fulfil the following requirements: the lightning conductor shall be at least 0,5 m from the microphone; all other devices shall be at least 1 m below the microphone and at least 1,5 m

horizontally distant from the microphone support. In order to identify the aircraft noise events, the noise monitoring systems is needed to be equipped with virtual radar. In addition, a wireless router or a local connexion must be provided in order to transmit the acquired noise data to the central unit. All equipments must have access to a power supply system and have a backup in case of main line electricity interruption. The noise monitoring system must have the possibility to export the noise signal in 'txt' format or other files in order to store them into a database, perform the signal processing, identify the aircraft and their noise data and print a report for all the noise parameters. Sites for unattended measuring microphones shall be chosen to minimize the effect of residual sound (the maximum sound pressure level of the quietest aircraft to be detected is at least 15 dB greater than the residual long-term-average sound pressure level). Typical sources of residual sound can be main roads, factories, air-conditioning equipment, pumps, trees that rustle in the wind and attract birds and metal roofs during rain or hail.

The noise monitoring station (NMS) site selection is determined by the existence of airport noise contours and furthermore, if those are calculated based on real flight tracks. The NMS can be fixed or mobile. The aircraft detection must be performed based on the following aspects: the sound is not steady, but also not impulsive, i.e. its duration lies within specified limits; the sound level exceeds a threshold level by at least a specified amount; when an event terminates, the sound level does not rise again above a specified level within a specified time. Data storage and transmission must be performed using a VPN secured connexion. This process can be performed daily, weekly, monthly, quarterly or annually.

3.2. Questionnaire construction

When a questionnaire is developed, the first thing one has to establish is which attitudes, needs, or behaviours wanted to be identified. The questionnaire developed for the Iasi Airport case is a noise perception questionnaire aiming at identifying first the attitude and second the behaviour toward airport-generated noise. Another important aspect is to assure the right dimension of the questionnaire (number of questions and estimated answering time). Designing it too long or very complex will decrease the chances of receiving a response. So, a long questionnaire may determine the respondent to lose patience and stop answering or give indifferent answers, neither of the cases being wanted. Firstly, the more answers you get, the better your statistics are. Secondly, avoiding neutral answers decreases statistical errors. If the questionnaire is too complex, i.e. the respondent cannot understand what is being asked, the same negative results can be obtained. In the best case, one will stop answering, while in the worst case one will provide answers based on inaccurate understanding of the questions, resulting in erroneous leads for painting the real overall picture of the issue. In addition, another decision is the way on how the questionnaire will be collected: face-to-face, mail or by telephone. When a survey is prepared, the questionnaire that will be used has to go through several steps integrated in a complex procedure. Figure 1 provides a set of questions that are suited for survey purpose. Therefore, the purpose of the questionnaire has to be defined, followed by the area and the respondent category. Several items are then selected and first version of the questionnaire is drafted, which enters next into a validation process. This validation process consists of a small/well dimensioned data collecting campaign, followed by data analysis. Its purpose is to check if the items are easy to understand, if they are understood as as intended and how people react at them. Data analysis helps with refining the questionnaire which is further used in the research study. The questionnaire proposed to be used in the annoyance study in the area of Iasi Airport was built in partnership with a psychology team from Psychology Faculty of the Bucharest University and Iasi Airport. The two noise annoyance questions given by ISO 15666 [22] were integrated in a quality of life survey questionnaire, after a proper Romanian translation of the questions. The translation procedure was developed by an ICBEN Working group and has been published by Fields et al. (2001) [23]. The questionnaire was constructed based on the brief versions of The World Health Organization Quality of Life (WHOQOL) [24] in the context of assessing perception of noise and its associations with different dimensions of quality of life. In order to differentiate between different sources of noise, items were added that assess not only noise annoyance related to air traffic, but also related to other sources, like road traffic, railway, industrial and commercial units. For validating the questionnaire, data was collected from 408 participants, out of which 90 (22.1%) were males

and 318 (77.9%) females, aged between 19 and 75 years old, with a mean of 24.99 and a standard deviation of 9.23. Regarding the level of education, 1 participant (0.2%) graduated primary school, 240 (58.8%) graduated high-school, 118 (28.9%) with university studies and 49 (12%) with post-university studies.

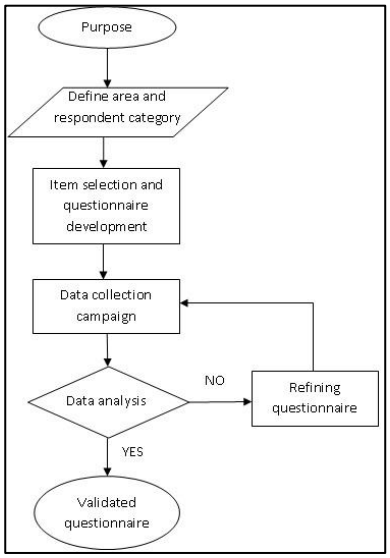

Figure 1. Questionnaire development procedure.

After analysing the responses and validation of the questionnaire, questions were rearranged, while some of the items were dropped out and developed new one. The final form of the questionnaire was used in a data collecting campaigned performed in Valea Lunga and in Aroneanu, two villages positioned very close to Iasi Airport, data that had to be analysed.

3.3. Method to determine the community noise annoyance

The method proposed by the research team can be presented as a succession of steps that Airports/ Competent Authorities should accomplish, apart from airport noise monitoring and how to do it. At the same time, there are two main directions that have to be developed in parallel, merging in the end: one regarding noise measurements and monitoring and another with respect to social surveys in the airport area (Figure 2). The first direction, put into practice through Activity 1 and 2 returns the noise map of the airport together with precise noise values in points determined after the data from the social survey (activity 3) is analysed and critical areas are identified (activity 4). Activity 1 is performed in order to identify the affected area and how many people are exposed to aircraft noise. In parallel, Activity 3 is developing (if not developed yet) the questionnaire that will be used during the social survey and the survey is performed. At the end, it returns an Annoyance map that is used to identify the locations for the punctual measurements. This is very useful because the specification in END allows the formulation of some assumptions and hypotheses, like uniform distribution, which does not give the accurate number of people affected by the aircraft noise. Activity 2 analyses the noise activity with punctual values so that it makes possible the assignment of noise levels to the identified annoyance level. Activity 5 compares the data obtained from the Annoyance map with the theoretical number of people exposed to noise (from the noise contours). Activity 6 will further identify win-win situations, for both the community and the airport.

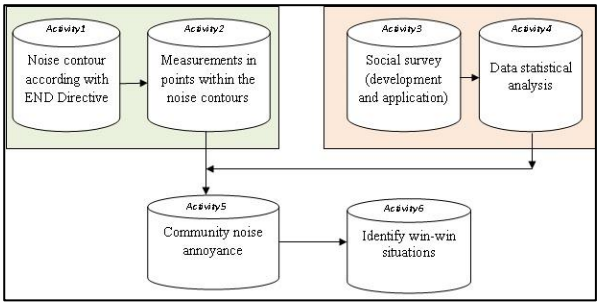

Figure 2. Method to determine the community noise annoyance.

4. Conclusions

The previous research on the Romanian Aviation Noise Policy determined that future priorities of the Romanian approach on reducing aviation noise are currently oriented towards the optimisation of the on-going methods and methodologies. If the presented method is applied, the current noise situation is identified and then if repeated periodically, the noise perception can be observed over time, identifying trends in community annoyance. The data evolution analysis will provide sufficient data to develop future action plans suited for the community, while data monitoring will permit the identification of necessary adjustments so that they work properly.
The method developed to determine the community noise annoyance presented within the paper returns data comparable with data available at international level. This will facilitate the integration of results from the research group in meta-analysis studies of the annoyance. Such studies will allow the verification of the effectiveness of global proposed solutions at a

local level. The lack of an existing background of airport noise actions related to annoyance in Romania, determines difficulties for airport authorities to conduct individually such kind of research. Therefore, having a uniform method to determine the community noise annoyance and an ABC procedure for airport noise monitoring will make a difference, supporting airport authorities. In the same time, the wider public, represented by the communities from airport vicinities, will benefit from awareness campaigns promoted by airports and other responsible authorities.

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