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The effectiveness of regulatory noise mitigation measures

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Abstract

The air transport growth of the last years has a negative side effect of increasing noise disturbances. A lot of airports have reacted with the introduction of an increasing number of different noise mitigation measures. This paper concentrates on the most important regulatory noise mitigation actions, not considering technical or operational procedures. These political regulations are often applied in a combined form so that it is nearly impossible to calculate their individual effects. To get an idea of their effectiveness this paper concentrates on expert interviews. Whenever the effectiveness was analysed so far, emphasis was primarily on noise effectiveness. Aim of this paper is to assess noise mitigation measures from the perspectives of different stakeholders at and around airports. In the analysis of the interviews the background of the experts will be considered to evaluate how far this will have an influence.

Keywords: regulatory noise mitigation measures; effectiveness; airport noise management; expert interviews

1. Introduction

1.1 Problem description and study aim

Except for the last 2 years, the aviation industry shows constant growth rates. In the beginning of the jet age, fascination for the new technology was predominant and people moved closer to the airports. But with increasing traffic, the annoyance due to aircraft noise increased although each new generation of aircraft engines provided significantly lower noise per movement (NASA 2007). This technical effect is not only canceled out by increasing

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flight movements but also by a rising environmental awareness. This then led to constantly increasing numbers of complaints and to increasing problems and obstacles for any expansion of airport capacity, at least in the western world.

Most airports have reacted by introducing regulatory noise mitigation measures. Technical regulations as mentioned in the Balanced Approach of ICAO (ICAO 2008) are not in view of this article since their effectiveness is less doubted and less questioned. Over the years these political regulations became more and more sophisticated and at most airports several of them were combined. The closer airports are located to the cities they intend to serve, the stricter these measures became. Totally missing in this context is an effectiveness control of the introduced mitigation strategies. Only a few articles exist, focusing merely on noise effectiveness (see chapter 2). But concentrating only on noise effectiveness would be unfair and not balancing interests of all stakeholders at airports, since under this viewpoint a ban of flights would be the most effective measure but also somewhat trivial and one-sided. Therefore, the aim of this paper is to get an overview of different regulatory noise mitigation measures and their evaluation from the perspective of different stakeholders.

Noise managers of relevant airports seemed to be the right experts for this evaluation since they act as a link between the different stakeholders. They are members of the Aircraft Noise Commissions (Fluglärmkommission) at the respective airports where they have to discuss all noise issues with representatives of the neighbors, so it can be assumed that they are able to judge the acceptance of the one or other measure by the population well; they also know about the needs of the airlines and they know about the economic relevance of their respective airport in the region. The interviews with these experts deemed to be optimal to respond to the aim of this paper.

1.2 Overview

Following the Introduction, the next chapter will provide an overview about literature dealing with noise mitigation measures. Literature about the Balanced Approach (ICAO, 2008) will not be considered since the aim of the study lies in the effectiveness control of airport specific regulatory measures. Before going into the details of the expert interviews, a methodology chapter will describe the analyzed mitigation measures, the choice of experts and the differentiation of the included airports. In chapter 4 the statistical findings will be presented, first in general, then according to different airport types. In the final discussion (chapter 5) these findings will be evaluated and matched with theoretical considerations. The paper will be finished with conclusions and some recommendations.

2. Assessment of noise mitigation measures in literature

If there is any official document giving an idea about noise mitigation, then it is the European Aviation Environmental Report 2019 (EASA et al. n.d.). It is quite remarkable that regarding noise management strategies (chapter 5.1), only the Balanced Approach of ICAO is mentioned, which became an official regulation at EU airports with entry into force of regulation (EU) 598/2014 (European Parliament, 2014). However, in chapter 5.3 this report concentrates on environmental charges, stating that 60% of EU28+EFTA airports apply them, mostly in form of noise charges. It concludes, “that it is questionable whether those charging schemes influence the fleet operating at the airports” (p.66). No reason is given, why these charges play such a big role in airport noise management, nevertheless.

Another official document, by a less known institution, is the report “Noise Policies in Airport Regions” by the Airport Regions Council (ARC, 2015). In a rather descriptive way, the report shows noise regulations of 16 selected airports. The description of the measures then is based again on the Balanced Approach and, within this context, some regulatory measures are briefly mentioned without any evaluation. The only point mentioned is “climate of trust between actors” as a key to success (p.91).

A final official document is the German Aviation Noise Report (“Fluglärmbericht”) 2017 of the Federal Environmental Agency (UBA, 2017). It includes at its end a longer passage about noise contingents, partially contrasted to a movement limit. Handling options are described as well as positive effects as a trade-off between industry interests and noise affected residents. In contrast to this a movement contingent is considered more critically.

In addition to these mostly rather extensive official documents there are also several scientific articles dealing with one or another regulatory noise mitigation measure. Several of them can be found in the articles of Raquel Girvin, based on her doctoral thesis (Girvin, 2006). She first realizes that “European airports tend to impose more mandatory

restrictions and take more-diverse approaches to noise mitigation" (p.11). In a broad description of several measures, she concentrates on different airports applying noise mitigation measures without an evaluation. Her descriptive part concludes in proposing Cost Benefit Analysis as a primary economic tool to evaluate them– but this is not further emphasized. She concentrates more on theoretical calculation of a socially optimal level of some of these measures. The first part of her thesis finds an updated version in 2009 (Girvin, 2009).

In her paper together with her doctoral advisor (Brueckner, Girvin, 2007) they analyze in a highly theoretical approach the effects of noise taxes – in Europe mostly noise charges are in place – and partially also of a noise cap on the reaction of passengers and airlines. Noise damage is included, but not the reaction of the neighbors of the airports. The requirements of ICAO, that charges have to be cost-based, excluding external cost, limits the application of this interesting approach (ICAO, 2013, p.78+91).

Noise charges in their differentiated form as applied by Zurich airport are analyzed in an article by Evangelinos et al. 2020. They describe the influence of the different stakeholders on setting these charges finally coming to the result that these charges are set in a way showing a political equilibrium where the interests of the airlines and those of the neighbors of the airport find a compromise. This results in some kind of symbolic policy on the one side and on the other side in an incentive to change the aircraft type to reduce emitted noise being not strong enough.

In the paper with the – for our aim – promising title "A systematic approach to assess the effectiveness of airport noise mitigation strategies" (Postorino, Mantecchini, 2016) focus is on ways to measure noise including the population density around the airport. The mitigation strategies being mentioned concentrate on the Balanced Approach of ICAO and no further regulatory measures are considered.

In their paper "Analysis of noise abatement measures on European airports" Ganic et al. (2015) present a list of 18 different noise measures with a very brief description of each. The aim of their paper is not the effectiveness of them, but the combination of measures in relationship to several criteria like the number of runways, distance to settlements, amount of population in these settlements or the GDP of the country.

Alonso et al. (2017) analyze in their paper "The efficiency of noise mitigation measures at European airports" the noise development of 6 European airports and relate this to the mitigation action taken at these airports. They do not apply their analysis to different stakeholders at the airports, neither they differentiate the effect of each individual mitigation measure.

Out of the analyzed literature it can be concluded that empirically it seems to be extremely complicated to separate the effect of a single mitigation measure, since most airports apply several of them in parallel. Therefore, the intention of this paper is to fill the research gap with expert interviews, to get a concise overview to evaluate the effectiveness of the most important mitigation measures.

3. Methodology

3.1. Choice of noise mitigation measures

This study will be limited to only regulatory political measures, whereas those taken on airport level are of main importance here. Thus, not all potential noise regulations will be considered. This means that the Balanced Approach of ICAO is not of relevance in this context, with exception of one or the other action considered as being one of the restrictive measures (ICAO, 2008). The chosen options can further be differentiated according to their noise relevance and their relevance as seen by the airport experts.

Noise relevance is defined by three main variables influencing noise at airports, being the mass of the aircraft, the frequency of flights and the generation of the aircraft type or engine. Measures influencing these variables are taken into consideration. Noise charges as a surcharge on the landing fees intend to set an incentive to use less noisy aircraft. The way of differentiation can be based on the ICAO noise chapters (ICAO, 2022) or on classes defined by the airport itself – mostly quite more than the classes proposed by ICAO – or on measured noise of the concrete movement, so far rather seldomly applied.

A noise contingent or a noise budget sets an upper limit for the emitted noise during a defined time, mostly per night or per year. To avoid exceeding this limit an incentive is set to use less noisy aircraft, since otherwise no further growth can be accommodated. It can be defined as an area of a pre-defined noise footprint whose size is limited, or it can be defined by noise points, needed by each starting or landing aircraft.

A movement-based noise limit does not influence the total noise at an airport but sets an incentive per movement like the noise surcharge, but in this case more in a sense of using either smaller or newer planes. Setting a weight limit will also tend to influence the aircraft size, but excludes possible effects of newer and thus less noisy aircraft. A mere movement cap only targets flight frequency and not the other variables aircraft size or aircraft generation. This limitation has to be time related, it can be set per hour or per night. An extreme form of a movement limit is a night curfew or night ban. Since it forbids any traffic, it is not directed towards one of the three variables and not setting any incentive.

The last two measures being discussed with the experts are no noise mitigation actions per se. In the discussion about regulations of aviation policy the possibility of banning short haul or domestic traffic emerges from time to time. This is mainly due to aviation's impact on climate, sometimes its noise impact, more seldom to reduce capacity shortages. It was added to the analysis due to recent discussions in Germany. Communication improvements for airports towards other stakeholders is less of a mitigation measure but an adaptation strategy. Finally, the experts have the chance to add another action they regard as being successful at their respective airport but which was not listed before.

All German airports apply noise charges, so it seems to be the most relevant measure above all others. Movement limits are often discussed but seldomly introduced. Night bans are commonly required by regulatory authorities, and the number of these bans has increased over the years. Most German airports apply several measures in parallel, thus complicating evaluation concerning their individual effectiveness. This is a further reason why we contacted these experienced experts.

3.2. Expert interviews and choice of experts and categories

Expert interviews are conducted with the environmental representatives of the German airports within ADV (Arbeitsgemeinschaft Deutscher Verkehrsflughäfen / German Airports Association) in order to derive inductive qualitative statements about the effectiveness of noise measures for various stakeholders of the airports. So far 13 experts were interviewed, usually individual, in two interviews more than one expert participated. In progressing the study, more experts of more airports will be added.

The interview partners were already known to the institute from ADV committee meetings. The interviews were held in the form of video conferences and with some minutes taken. In addition, the interviews were conducted in German, just as all tables and figures, as far as used in the interview, were available in German and were only translated by the authors for publication. The interview partners were asked to rate the effectiveness of various measures in different categories (Table 1) using the Likert scale from 1 – absolutely inappropriate (hardly effective) to 6 – absolutely appropriate (very effective). It should be considered that for the categories "Regional economic impact", "Impact on Airlines" and "Impact on Airports" a high effectiveness is considered as a positive impact for the respective stakeholders, which was communicated to the interviewees accordingly in advance.

In addition, the response "no impact" was allowed for the interviewees, which is not recorded as the mean value of the scale, as it basically does not provide a direct statement on the effectiveness of a measure, but merely implies that it does not cause any change. As a consequence, "no impact" is excluded from the statistical analysis. The categories were chosen to consider the impact of aircraft noise regulations on different stakeholders, such as airports, airlines, the economy, or residents. It should be noted that not all measures are applied at every airport, and they also appear in different ways at individual airports. Other options are not implemented at any of the airports studied, but would be conceivable in principle (e.g., a ban on short-haul flights) or are applied at airports abroad. The aim of the survey is to determine how effective the respective measures are from the experts' point of view and how they impact various stakeholders in aviation.

Table 1. Interview table (developed and translated by the authors)

Questionnaire on effectivity of selected regulatory measures

as part of the project FluiD-21

Deutsches Zentrum für Luft- und Raumfahrt

measure	configuration	use case, e.g.	practicability	noise effectivity	regional economic impact	impact on traffic		effectivity as residents acceptance*
						airline	airport	
noise charges	ICAO oriented							
	6 noise classes							
	15 noise classes	Frankfurt						
	according measurements	Berlin						
noise contingent	footprint oriented	Hamburg						
	noise points	Heathrow						
movement-based noise limit	max. noise level per movement							
weight limit	e.g. max. 200 t							
movement cap / contingent	max. movements per hour	Düsseldorf						
	max. movements per night	Heathrow						
night curfews	definition nighttime	Frankfurt						
short haul flight bans	e.g. < 500km							
communication								
own measure								

*only affected residents

Likert-Scale:

6	5	4	k.A.	3	2	1
absolutely appropriate (very effective)	appropriate	slightly appropriate	no impact	slightly inappropriate	inappropriate	absolutely inappropriate (hardly effective)

3.3. Sample and data processing

Overall, the sample is expected to consist of all ADV airports, which includes the German airports as well as the Austrian and Swiss airports. At present, a limited number of interviews have been conducted at various German airports, altogether with 13 experts. These will be supplemented by additional airports in the further course, which should make statistical analyses even more meaningful. Remarkably, the response for willingness so far was 100%, i.e. all requested experts agreed to be interviewed.

After the interviews were conducted, descriptive statistical analyses were performed. To investigate possible connections between the categories, a correlation analysis was performed for individual categories. As a next step, these procedures will be repeated for clustered airports. Although it was pointed out before the start of the interviews that the interviewees should be as objective as possible regarding the individual measures and categories, it became obvious that the interviewees are still influenced by the characteristics of their airport of provenance by their remarks. Therefore, differentiation for various categories of airports seems reasonable.

Airports are clustered by size (Hub vs. Non-Hub) and noise impact (number of residents affected). In our current sample, 33% of the airports interviewed to date were classified as hubs. Regarding noise pollution, the noise mapping of the individual airports is used in accordance with EU standard 2002/49/EC (European Parliament 2002). Here, the airports were divided into noise-intensive and non-noise-intensive. Threshold values are set for the individual noise categories, according to which a classification is made. Both the total number of people affected by aircraft noise and the noise intensity for the affected residents were considered (see Table 3). Since the respective experts were assured anonymity regarding both their person and their airport, and not all interviews have yet been conducted, it is not yet possible to present results for statistical analysis for the differentiation according to the noise impact. Additional interviews and data collection will be conducted in future to provide a statistical analysis for these categories as well.

4. Findings

4.1. General Findings

In the following section, the results of all interviews are outlined, regardless of the size, location or type of the airports surveyed. Table 2 shows the mean values of the categories for all experts interviewed. Here, the weight limit and night flight bans are mentioned as the most practicable instruments but lead to significant negative impacts on the economy within the region and cause severe cuts for airlines and airports. Night flight bans, however, are significantly more effective in reducing noise and are also more likely to be accepted by society than weight limits.

Table 2. Average responses for all participating experts from all kinds of airports

Measure	Practicability	Noise effectivity	Regional economic impact	Impact on Airlines	Impact on Airports	Acceptance by affected residents
Noise charge	4.7	4.2	4.4	3.6	3.8	4.2
Noise contingent	4.8	4.3	2.9	3.1	3.2	4.4
Movement-based noise limit	4.8	5.2	1.8	1.9	1.9	4.5
Weight limit	5.7	4.0	1.4	1.8	1.9	4.1
Movement cap / contingent	4.3	4.1	2.4	2.3	2.2	4.1
Night curfew	5.0	5.0	2.2	2.2	2.1	5.2
Bans on short-haul flights	4.4	3.1	2.1	1.7	1.8	3.9
Communication	4.6	3.2	4.0	4.1	4.6	5.1
Total	**4.7**	**4.2**	**2.5**	**2.9**	**2.9**	**4.3**

A ban on short-haul flights would also lead to severe economic cuts for the region, airlines and airports, but would also be difficult to implement. Communication measures, which are also practicable, are particularly positive for the economy. These are also very well accepted by residents, but, in contrast, reduce aircraft noise the least. Aggregated across all measures, a clear result can also be observed. In particular, the practicability and acceptance of the measures is quite high on average, while the impact on the region's economy and on airports and airlines tends to be more negative. In the further statistical analysis, it is noticeable that the effects on airlines and airports correlate very strongly positively and significantly at the 1% level almost linearly with each other ($r = 0.94$). The correlations between the impact on the economy in the region and the airlines ($r = 0.73$) and the airports ($r = 0.74$) is also positively statistically significant at the 1% level.

4.2. Differentiation according airport size

If hubs and non-hub airports are considered separately, it is possible to differentiate between airports according to size and hub function. 11% of German airports can be declared as hub airports. Looking at the average mean values across all categories in Figure 1, it is noticeable that the interviewees at hub airports rated the impact of the measures on the regional economy, the airlines and the airports much more positively than for non-hub airports. In terms of practicability, the environmental officers of the non-hub airports rate the measures as somewhat more practicable to implement than those of the hub airports. There is hardly any difference in the categories "Acceptance by residents" and "Noise effectivity".

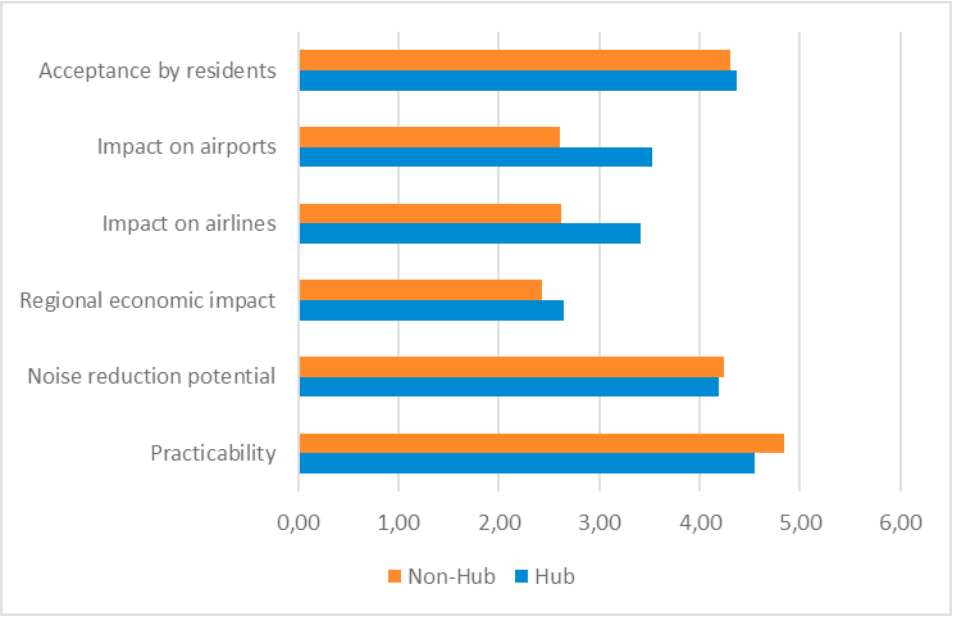

Fig. 1. Average responses of experts from Hub and Non-Hub airports

4.3. Differentiation according airport location and noise exposure

The differentiation regarding the location of the airport is also interesting, as the impact of the measures on the stakeholders can be influenced by location and resulting vicinity to residents. Location is responsible for noise dispersion in this regard. Airports located in widely isolated areas have a lower aircraft noise impact than airports located in close proximity to major cities. Since the local population perceives aircraft noise differently depending on the location of the airport, airlines and airports may have to make different individual efforts to reduce aircraft noise. As a result, the assessment of measures for these airports may vary, justifying the differentiation by location.

Clustering into noise-intensive and non-noise-intensive airports is based on noise mapping according to EU directive 2002/49/EC (European Parliament 2002). This indicates the number of residents exposed to a certain noise level. Airports with more than 50,000 aircraft movements per year are obliged to report this noise mapping for different sound levels every five years. A distinction is made between the weighted average sound level for day, evening, and night (L_{DEN}) and the sound level at night between 10 p.m. and 6 a.m. (L_{Night}). The results of the latest 2017 noise mapping for individual airports, where legally required due to their amount of aircraft movements, are shown in Table 3. The values for the individual airports are taken from the websites of the airports and the national, regional and municipal ministries of transport and information offices, as these results are published individually. Six airports, included in this study, have less than 50.000 movements p.a. and do not report the noise mapping and are accordingly assigned to the non-noise-intensive airports. To perform clustering, thresholds are defined to consider both the total number of residents affected by aircraft noise and the noise intensity. In this process, airports are classified as noise-intensive if they exceed the threshold values of the total number of affected residents or if they exceed the threshold value in three of the four sound level categories (L_{DEN} or L_{Night}). In doing so, the thresholds were set to allow good separability between noise-intensive and non-noise-intensive airports for L_{DEN}. The threshold value for L_{Night} equals one quarter of the threshold value for L_{DEN}, in each case, to account for the increased sensitivity of residents to aircraft noise at night. Overall, 26% of German airports are thus classified as noise-intensive, which will also be statistically investigated in further data collections.

Table 3. Affected residents according to the noise mapping of 2017 at German airports with more than 50,000 movements p.a.

Airport	L_{DEN} (55-60 dB)	L_{DEN} (60-65 dB)	L_{DEN} (65-70 dB)	L_{DEN} (>70 dB)	**Sum_{DEN}**	L_{Night} (50-55 dB)	L_{Night} (55-60 dB)	L_{Night} (60-65 dB)	L_{Night} (>65 dB)	**Sum_{Night}**
BER	31,070	12,879	510	0	**44,459**	13,919	509	12	0	**14,440**
BRE	16,005	2,960	100	0	**19,065**	1,540	30	0	0	**1,570**
CGN	83,650	17,102	614	4	**101,370**	42,443	10,364	270	4	**53,081**
DRS (2012)	8,570	1,070	20	0	**9,660**	1,020	10	0	0	**1,030**
DTM	1,060	0	0	0	**1,060**	0	0	0	0	**0**
DUS	37,065	16,209	2,363	1,000	**56,637**	7,213	2,610	0	0	**9,823**
FRA	170,882	18,310	34	17	**189,243**	36,347	280	25	0	**36,652**
HAJ	14,800	4,500	200	0	**19,500**	7,600	1,600	0	0	**9,200**
HAM	41,100	12,800	3,800	200	**57,900**	7,900	1,600	200	0	**9,700**
LEJ	7,964	2,645	17	0	**10,626**	6,021	2,076	14	0	**8,111**
MUC	10,700	2,700	100	0	**13,500**	3,400	200	0	0	**3,600**
NUE	10,200	1,800	100	0	**12,100**	4,100	200	0	0	**4,300**
STR	31,000	4,500	0	0	**35,500**	1,700	0	0	0	**1,700**
Threshold	40,000	15,000	1,000	500	**50,000**	10,000	3,750	250	125	**12,500**

5. Discussion†

Regarding the results of chapter 4, differences between individual measures as well as between individual airport types can be identified and discussed. Although mass limits for airports can be implemented in a similarly practicable way as night flight bans, residents clearly prefer the limitation of movements by the latter. Night flight bans have the advantage that the absence of aircraft is directly noticeable by affected residents during nighttime. A mass limit, however, does not directly reduce the number of aircraft movements as it only impacts the noise level of single noise events. Flight movements could even increase as long as mass limits are adhered to. Such a limit might even be counterproductive considering that in several cases newer aircraft type with a new generation of engines emits less noise, but has a higher mass.

Interestingly the evaluation of the effect of noise charges on noise differs between the experts and a more theoretical analysis. It is obvious that airports tend to set incentives to promote the usage of less noisy aircraft, and also to avoid night times. However, calculating the impact these costs have on the total operating cost especially for long haul flights on the one side, and limited chance of airlines to change between different aircraft types on the other side, it becomes understandable that real noise reduction potentials can only be limited. Therefore, the potential of this measure is more focused on the residents, it has more of a symbolic effect.

Practicability of all actions is relatively high within a rather small range. The only exception being a ban of short haul flights. This is due to a high probability that this measure needs a lot of exceptions before it can be introduced, e.g. PSO routes (public service obligations) have to be allowed, as well as services to islands, since they don't have train connections, and finally acceptance of feeder services for hubs have to be discussed, if they are included or whether the airport provides a good rail connectivity or not at all.

Potential negative impacts on the region's economy or transport modes could be caused by measures either aiming at reducing the supply of air traffic (e.g. night flight bans, short-haul bans) or at compliance with standards, which are associated with high costs due to technical innovation or charges for airlines. Both leads to reductions in supply and

† This chapter needs a revision once all interviews are performed; probably the one or other evaluation might change.

thus also to adverse effects in the airport's and the region's economy. But it should also be noted that several experts surprisingly concluded that these measures would not have any impact on the region's economy.

At the same time, acceptance of residents as well as practicability to implement the measures are high on average. This does not show that policy regulations are effective in protecting the local population from aircraft noise, but that they increase the acceptance of the airport. Especially in cases where the effect on noise reduction differs from the effect on acceptance of residents we can state that these measures might have a more symbolic value.

Regarding the correlation analysis, it can be observed that impacts on traffic are mostly reflected on both, airlines and airports. In addition, impacts on the region's economy are also closely related to those of the transport providers, suggesting that the impacts of aircraft noise measures are similar for these three stakeholders. Practical solutions do not usually elicit the highest acceptance from residents and vice versa, which explains the correlation of these categories with each other.

With respect to the differentiation between hubs and non-hubs, it is noticeable that the economic impact is stronger at smaller airports than at large hubs. The reason behind this might be that the traffic changing at the hub does not affect the region of the airport. The fact that practicability is slightly higher at non-hubs than at hubs could be related to the fact that hub operations are significantly more complex than at smaller airports, thus reducing practicability of these measures at hubs.

Concerning the results of the differentiation regarding noise exposure it can be expected that the acceptance of residents for the measures will increase on average for airports where the threshold values are exceeded, since residents around these airports should react significantly more sensitively to aircraft noise due to higher noise exposure. In particular, regulations that are considered very strict, such as night flight bans, should elicit greater acceptance by residents at these airports. For example, according to our analysis, 80% of German airports classified as noise-intensive have night flight bans in place, while only 43% of non-noise-intensive airports do. At these airports, other business models, such as transport of air freight at night, may have become more established, which would have to be abandoned with introduction of a night flight ban.

6. Conclusions

A lot of airports apply a set of regulatory measures to achieve the requirements of the Balanced Approach, setting incentives or even forcing airlines to serve this airport either with less noisy aircraft with newer technology, by changing their operations or by restricting their services. It is surprising that airports rarely show results of their noise mitigation strategies, at least not specifically to the applied measures. It is the intention of this paper to fill this research gap by interviewing airport experts who have to find compromises between the interests of the different stakeholders at the airport as their daily business. All approached experts so far agreed to participate in the interviews.

There was no measure which was evaluated as being totally inappropriate to affect noise as seen by the experts. This might be surprising since the one or other action was highly criticized, which shows that the effect on other stakeholders play an important role. It could be shown that if these measures affect the regional economy, their effect is negative. Another, more surprising result is the fact that effectivity of noise reduction does not highly correlate with the effect these strategies have on the acceptance of the airport. Only in one case, when it comes to noise effectivity of noise charges, there is an obvious disagreement between the evaluation of the experts and the theoretical analysis. It could be a topic of further research if – confronting the experts with the theoretical results – they would change their evaluation. Another topic of further research could be to interview members of anti-noise groups at the same airports and to compare their results with those of the different experts.

As a recommendation for regulators – since all measures proposed by the airport's management have to be accepted by the respective regulator – it can be concluded to consider the effects of each regulation not only from the noise mitigation perspective, but more by the acceptance of residents and resulting effects on other stakeholders in order to achieve a fair balance between all stakeholders.

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