

How aircraft noise impact management can improve residents' quality of life – A field study

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Introduction

Studies show that aircraft noise exposure can negatively impact people's quality of life (QoL; e.g. [1]). To address and minimize the negative effects of aircraft noise exposure, various interventions have been implemented by air traffic stakeholders such as airports. However, people's evaluations of these interventions are oftentimes unknown as well as their potential effects on people's QoL. Further, little is known about QoL in airport regions in general and which aspects are most relevant for the residents. The EU research project ANIMA (Aviation Noise Impact Management through Novel Approaches) aimed at answering these questions. Within ANIMA, the definition and framework of QoL by [2] was adopted including nine QoL dimensions: health, natural and living environment, economic and physical safety, education, material living conditions, productive or main activity, governance and basic rights, leisure and social interactions, and overall life satisfaction.

To examine QoL in an airport region and assess the potential influence of already implemented interventions on residents' QoL, four European airports were selected: Schiphol Airport (Mikroklimaat Leimuïden), Frankfurt Airport (consultation procedure), Marseille Airport (sound insulation), and Heathrow Airport (sound insulation).

The current paper focusses on the qualitative study assessing the impact of the consultation procedure around Frankfurt Airport and the re-analysis of existing quantitative data from a survey conducted around Schiphol Airport. A detailed description of the study and the results can be found in [3].

In-depth Interviews around Frankfurt Airport

In 2018, an active noise abatement program (Aktiver Schallschutz) was presented including a proposal for a flight path change. The proposal was to shift the flight path *AMTIX kurz* to the North to avoid overflying densely populated areas in the Northern parts of the city of Darmstadt. This flight path shift would reduce aircraft noise exposure in some communities but increase aircraft noise exposure for other

communities. A consultation procedure was planned as part of the decision-making process. The consultation procedure was set out to engage local communities and provide residents and representatives with the opportunity to share their opinions, concerns, and ideas. The consultation procedure took place from May to December 2018 and consisted of four components: 1) public informative events, 2) a citizen group, 3) a group with political stakeholders, and 4) a website.

In March and April 2020, qualitative in-depth telephone interviews were conducted to evaluate the consultation procedure and get an overview of how the consultation was perceived by residents and identify a potential influence on their QoL.

Method

Three study areas were selected that were all included in the consultation procedure, but that would be differently affected by the flight path change:

- Weiterstadt-Gräfenhausen (overall, no significant change in noise exposure)
- Erzhausen (increase in aircraft noise exposure), and
- Darmstadt-Arheilgen (decrease in aircraft noise exposure).

Participants were recruited via telephone. To facilitate analysis, interviews were audio recorded given the permission of participants. The recordings were transcribed according to [4] and analysed using qualitative content analysis [5]. The questionnaire covered three topics: 1) quality of life and living environment, 2) the consultation procedure, and 3) the link between the consultation procedure and QoL.

Results and Discussion of the in-depths interviews

In total, 27 people participated in the interviews.

The most important aspects for participants' QoL were health, family, and the social and living environment.

With respect to the intervention, most participants knew that a consultation procedure had been conducted in their region. Most participants did, however, not participate in the consultation procedure themselves. Most participants thought the consultation procedure aimed at reducing aircraft noise exposure for highly exposed communities by shifting the flight path accordingly. According to six participants living in Erzhausen and Weiterstadt-Gräfenhausen, the goal of the consultation was to enable the construction of new residential areas in Northern parts of Darmstadt (Darmstadt-Arheilgen), which is currently restricted due to aircraft noise exposure levels.

Different aspects of the consultation procedure were criticised. One-third of the participants did not perceive the consultation procedure as being open-ended. They had the impression that a decision to shift the flight path had already been made, before the consultation started. A lack of honesty and transparency were mentioned as negative aspects as well. The usefulness of the consultation procedure as it took place at Frankfurt Airport received mixed ratings.

Despite the negative aspects, participants liked the general concept of such a consultation procedure and rated the possibilities to participate as positive. Participants would recommend implementing such a consultation procedure at other locations as well.

When asked about the impact of the consultation procedure on their QoL, participants mentioned that the consultation itself did not have an impact. However, a flight path change would positively or negatively impact their QoL, depending on whether they lived in an area where aircraft noise exposure would decrease or increase, respectively.

These findings only give a first impression on how the consultation procedure was perceived by residents as the sample size is quite small. Further, with respect to the consultation and QoL, people might not be aware of a link or (in)direct effect.

Survey in Schiphol Airport Region

To examine one aspect of QoL in an airport region, i.e. the natural and living environment, existing data from a survey conducted around Schiphol Airport was re-analysed. The survey was commissioned by the Community Council Schiphol and conducted by the company Team Vier from November 2018 until October 2019. The questionnaire assessed topics such as residential satisfaction, sleep disturbance and aircraft noise annoyance as well as worries about, e.g. noise annoyance and pollution (<http://www.belevingsthermometer.nl/#/>).

Method

Three study areas with different noise exposure levels were selected to examine the potential effect of aircraft noise exposure on various variables. These three study areas are:

1. Inner area (58 dB L_{den}),
2. Outer area (48dB – 57 dB L_{den}),
3. Area outside noise contour (< 48 dB L_{den}).

In total, 1,216 people participated in the survey (response rate of approx. 14%).

The following variables were measured: age, sex, duration of residence (years: 0-5, 5-10, 10-20, 20-30, >30), residential satisfaction (answered on a 5-pt scale: 1 = *very satisfied* to 5 = *very unsatisfied*), noise annoyance and sleep disturbance due to different noise sources, such as road and air traffic (answered on an 11-pt scale: 0 = *not at all* to 10 = *extremely*; [6]), comparison between previous and present experience of aircraft noise annoyance (answered on a 3-pt scale: 1 = *increased*, 2 = *stayed the same*, and 3 = *decreased*), expectations for future aircraft noise annoyance (answered on a 3-pt scale: 1 = *have increased*, 2 = *have remained the same*, 3 = *have decreased*), how often aircraft noise disturbances occurred in the past month (answered on a 4-pt scale: 1 = *often* to 4 = *seldom or never*), and worries regarding different topics such as pollution and noise annoyance (answered on a 3-pt scale: 1 = *a lot of worries* to 3 = *no worries*). In addition, items asking at which days or times of a day aircraft noise is most annoying. If a specific day or time of a day was mentioned, three follow-up questions were asked (n=749).

For all variables, descriptives (incl. means and standard deviations) and correlations were calculated. A regression analysis was done to assess which variables have an impact on residential satisfaction. An ANOVA was performed examining whether participants' responses differ significantly between the three groups. A Tukey post-hoc analysis was done to identify between which groups the significant differences are. SPSS 27 was used for analysis.

Results of the survey in the Schiphol Airport region

In total, 1,212 participants (55% female) were included in the analyses. Participants' age ranged from 18 to 87 years with a mean of 58.2 ($SD=13.6$). Residential satisfaction was, on average, high ($M=1.85$, $SD=.87$). Annoyance due to aircraft noise was higher than annoyance due to any other noise source, but still relatively low ($M=4.52$, $SD=3.35$). Aircraft noise annoyance seems to be especially prominent on the weekends (18.6%) and to a lesser extent on weekdays (13.4%; 100% equals the subsample of n=749). With respect to a certain time of the day, aircraft noise annoyance seems to prevail around noon (19.5%).

Correlations were calculated to explore the relationships between the different variables. There is a significant positive relationship between residential satisfaction and sleep disturbances and annoyance due to all seven noise sources. The highest correlations were found between residential satisfaction and annoyance due to loitering teenagers ($r=.28$, $p < .01$) and road traffic noise-induced sleep disturbances ($r=.27$, $p < .01$). In addition, a higher frequency of aircraft noise disturbances during the past month ($r=-.20$, $p < .01$), and the expectation of an increase in future aircraft noise annoyance ($r=-.10$, $p < .01$) are associated with less residential satisfaction.

A regression analysis was performed to examine the influence of noise annoyance and sleep disturbances due to different noise sources and worries about various topics on residential satisfaction. Age and sex were included in the analysis as

well. The variance in residential satisfaction explained by the model increased from 14.5% to 19% (adjusted $R^2=.181$; $F(13,1190)=21.425$, $p < .01$), when aircraft noise annoyance and aircraft noise-induced sleep disturbances were added to the model. This corresponds to a moderate goodness-of-fit of the model [7]. The largest effect on residential satisfaction is found for worries about noise annoyance, followed by worries about safety (Table 1). Noise annoyance due to road traffic noise-induced sleep disturbance and loitering teenagers have a significant impact as well. Aircraft noise annoyance does not significantly influence residential satisfaction.

Table 1: Results of the regression analysis

Predictor	Parameter			Lower	Upper
	B	SE	p		
Intercept	2.137**	.189	.000	1.767	2.508
Sex	-.003	.046	.955	-.093	.088
Age	.003*	.002	.043	.000	.007
Road traffic noise annoyance	-.005	.011	.674	-.026	.017
Neighbour noise annoyance	.036**	.010	.000	.016	.055
Aircraft noise annoyance	-.016	.010	.116	-.036	.004
Industry noise annoyance	.048**	.014	.000	.021	.075
Construction and demolition	.003	.010	.728	-.016	.023
Loitering teenagers	.052**	.015	.000	.023	.081
Sleep disturbance road	.048**	.015	.001	.019	.077
Sleep disturbance aircraft noise	.020*	.011	.053	.000	.041
Sleep disturbance teenagers	.000	.018	.985	-.035	.036
Worry safety	-.131**	.035	.000	-.199	-.064
Worry noise annoyance	-.162**	.040	.000	-.240	-.084

*= significant at .1; **= significant at .05; ***= significant at .01.

When comparing the three groups, results show that participants in the high exposure group score worse on all aircraft noise-related variables (see Table 2). For example, they report more aircraft noise annoyance and aircraft noise-induced sleep disturbances, being more frequently bothered by aircraft noise in the past month and expect an increase in aircraft noise annoyance in the future.

Table 2: Results of the ANOVA analysis

Variables		Inner area	Outer area	Outside noise contour	F(2,1207)	p	
Residential satisfaction		2.05 (1.02)	1.83 (.85)	1.73 (.75)	8.62	.000	
Noise annoyance	Road	2.93 (2.83)	2.51 (2.72)	2.64 (2.95)	2.06	.128	
	Neighbours	1.71 (2.48)	1.97 (2.57)	1.90 (2.50)	.92	.399	
	Railway	.17 (.86)	.50 (1.44)	.71 (1.76)	9.28	.000	
	Aircraft	6.61 (3.11)	4.30 (3.20)	2.97 (2.99)	86.61	.000	
	Industry	.88 (1.82)	.67 (1.74)	.76 (1.98)	1.32	.268	
	Construction	1.46 (2.46)	1.74 (2.46)	2.01 (2.78)	2.95	.053	
Sleep disturbances	Loitering teenagers	1.15 (2.17)	1.28 (2.27)	1.29 (2.42)	.35	.708	
	Road	1.18 (2.10)	1.04 (2.08)	1.06 (1.93)	.44	.644	
	Neighbours	.55 (1.56)	1.02 (2.08)	1.09 (2.00)	6.09	.002	
	Railway	.05 (.37)	.23 (1.04)	.26 (1.12)	3.80	.023	
	Aircraft	4.35 (3.64)	2.28 (3.07)	1.26 (2.42)	66.75	.000	
	Industry	.35 (1.23)	.29 (1.19)	.32 (1.22)	.26	.770	
	Construction	.51 (1.64)	.61 (1.56)	.59 (1.56)	.38	.684	
	Loitering teenagers	.66 (1.74)	.76 (1.82)	.80 (2.01)	.42	.658	
	Development of aircraft noise annoyance		1.32 (.52)	1.59 (.59)	1.65 (.57)	24.02	.000
	Frequency bothered by aircraft noise past month		2.21 (1.12)	2.96 (1.08)	3.35 (.89)	75.81	.000
Expectations aircraft noise annoyance		1.43 (.54)	1.65 (.54)	1.67 (.50)	16.52	.000	

M= mean, SD= standard deviation

Discussion of the Schiphol Airport survey

Overall, the survey results show high residential satisfaction in the Schiphol Airport region. Nevertheless, participants living in the inner area (i.e. high exposed area) report significantly less residential satisfaction. Additionally, they are more annoyed and disturbed by aircraft noise annoyance and expect their aircraft noise annoyance to increase in the future. Participants from the high exposure group reported significantly less sleep disturbances due to neighbours and railway noise but more aircraft noise-related sleep disturbances. One explanation could be that aircraft noise is the most prominent noise source and other noise sources, such as railway noise, fade into the background and are less noticeable.

Results of the regression analysis indicate that worries about noise annoyance and safety in general have a larger impact on

residential satisfaction than aircraft noise related variables other than annoyance. It is important to note that the study was conducted in the course of a year, thus including summer and winter season. Therefore, results on annoyance might differ between the different seasons, as noise annoyance is typically higher during summer as people tend to spend more time outside [8].

Conclusions

In this paper, we presented results of two evaluative analyses of the impact of living near an international airport on residents' quality of life (Mikroklimaat Leimuïden Schiphol Airport) and on the effects of a consultation process concerning the shift of a flight route on citizens of the airport region (consultation process at Frankfurt Airport).

The qualitative in-depth interviews at Frankfurt Airport give a first impression on people's perception of a consultation procedure and indicate which issues could arise. Results of the survey data collected around Schiphol Airport imply that in an airport region, other, not aircraft noise-related aspects, have a larger impact on residential satisfaction than, e.g. aircraft noise annoyance. Future research should further assess QoL in airport regions and the impact of noise management and noise mitigating interventions on QoL of surrounding communities.

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