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Impact of Large Airport on Residents' Quality of Life

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ABSTRACT

A nearby large airport provides both positive and negative impact on nearby communities. A large airport could provide economic growth for a region near an airport, but also have negative effects on environmental and health-related impact of noise exposure and air pollution induced by the aircraft. To study the impact of a large airport on the quality of life (QoL) of residents in surrounding regions, a survey regarding nine indicators for QoL was conducted for two Dutch communities. A comparison was made between one community situated near Schiphol airport and one in Utrecht without a neighbouring airport. Results showed more aircraft noise-annoyed people living near the airport than people living further away. Using a Principle Component Analysis, the nine extracted factors supported previously theorized indicators defining QoL. Noticeable differences are found between these two communities with the airport as main discriminator. Outcomes of this study help to develop a model to measure QoL and improve the understanding of the impact of a nearby airport on people's well-being.

1. INTRODUCTION

The positive economic benefits and improved connectivity brought by large airports come together with negative effects on environmental and health-related impact of noise exposure and air pollution induced by the aircraft, or by airport-related transport or industry. For this reason, the benefits of economic growth for a region near an airport, mainly measured as a contribution to the Gross Domestic product, should be balanced against a community's quality of life (QoL).

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According to the World Health Organisation (WHO) [1], QoL is defined as "… "*individuals' perceptions of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns." It is a broad ranging concept incorporating in a complex way the persons' physical health, psychological state, level of independence, social relationships, personal beliefs and their relationships to salient features of the environment.*" QoL is a relatively new way to assess people's overall well-being, and researchers are still exploring how to measure QoL, let alone standardized ways to calculate it for a population. There is some work available to determine QoL for specific situations: for example, a model to compare a person's quality of working life [2]. A study by Steg and Gifford [3] to find QoL indicators for sustainable transport implies this requires "*balancing current and future economic, social and environmental qualities*". Other work by Botteldooren et al. [4] evaluated the relation between traffic noise and perceived QoL in neighbourhoods, and provided indications that for certain people (but not all) air or road traffic noise negatively influences QoL.

In the European project ANIMA (Aviation Noise Impact Management through novel Approaches [5] , nine indicators were identified that are relevant for measuring the QoL around an airport [6]. These are closely related to the indicators found by the European Union's EUROSTAT institute [7]:

1. Health: self-perceived health and access to healthcare.
2. Economic and physical safety: economic stability and safety from physical harm.
3. Natural and living environment: perceived environmental influences, nearby green and recreational areas, and environmental pollution.
4. Work and other main activities: paid or unpaid work.
5. Education.
6. Material living conditions: person's income and ability to buy as a consumer.
7. Leisure and social interactions: quantity, quality and access to leisure, and social activities with and for people.
8. Governance and basic rights: attitudes towards government institutes and public services, equal opportunities, and active citizenship.
9. Overall quality of life: subjective rating of life satisfaction, affects and meaning and purpose of personal life.

Up to now, no study has focused on the manifestation, the combination, and potential interrelations of all these QoL indicators near airports. Some studies were conducted on the topic of QoL around the airports of Frankfurt, Germany [8], Schiphol, The Netherlands [9], and Wellington, New Zealand [10] that focused on the negative impact of aircraft noise on health-related quality of life (HQoL). In the New Zealand study, the researchers [10] did a comparison between a group living in an area close to an airport, and another group distant from an airport. A negative relation was found between WHO-based QoL (self-reported) and living in an area close to the airport for the group of people who are (self-reported) noise sensitive. In another study by Kuhlmann et al. [12], residential satisfaction (as an outcome of the impact on the natural and living environment) was negatively correlated with the frequency of disturbances due to aircraft noise. Additionally, residents exposed to high aircraft noise exposure experienced more sleep disturbance from aircraft noise than residents without a neighbouring airport or residents exposed to railway noise. Moreover, residential satisfaction was impacted mainly by worries regarding general noise annoyance and safety. A study on airport proximity on people's subjective wellbeing (a means to evaluate overall QoL) in England [13] found no correlation between airport proximity and subjective wellbeing. Lawton and Fujiwara suggest here that *"..positive aspects of living near an airport, such as improved transport infrastructure and access to jobs, are offset by the negative aspects."* . However, in the same study a (negative) correlation was found between people living in daytime airport noise contours (at or above 55 dB) and subjective wellbeing. Similar results

were found by Tomkins, et al. [14]. In their study they provide evidence that employment opportunities are more highly evaluated by residents around airports than the negative externality effects of living in the vicinity of an airport.

In these studies, it is shown that (aircraft) noise has an effect on people's QoL, but how they interact in the dimensions of QoL is still not fully understood. Also, the economic benefits and how they affect QoL are still unclear. Since some factors interfere and affect each other, as is the case with neighbourhood satisfaction, safety and noise exposure [15], it is of interest to investigate interactions in different quality of life indicators.

The objective of this study was to examine the impact of a large airport on nearby communities, by addressing the following three research questions: First, what is the impact of living near a neighbouring large airport on the QoL? A comparison was made between communities with and without this airport's influence on their residents' QoL. Second, which interrelations exist between the found QoL factors? And third, can the nine QoL indicators found earlier [6] be replicated by the present survey questions and validated by a factor analysis?

The pandemic outbreak of COVID-19 in March 2020 [16] provided a challenge to examine QoL near airports. A challenge as it disrupted nominal aircraft operations [17,18] due to travel restrictions to prevent the spreading of the virus and, therefore, influenced the impact of the airport on the local environment. For the present study, it also prevented the researchers to conduct a survey prior to the COVID-19 impact on aviation. For this reason, people were asked in November 2020 about their quality of life before the pandemic started and during the pandemic in November. Only the answers to the situation before the pandemic are addressed in this article.

2. METHODOLOGY

2.1 Sample

Two distinct groups of people from different areas in The Netherlands took a survey to evaluate the impact of a nearby large airport. One group lived in a proximity of 15 kilometres to Amsterdam Airport Schiphol (Schiphol-Airport) and the other group lived in a proximity of 15 kilometres to Utrecht (Utrecht-Control), a city further away (approximately 35 km) from Schiphol airport serving as a control group, see Figure 1. Both groups resided in the Randstad metropolitan conurbation and the main discriminator between the groups is distance to a large airport. In a country as densely populated as the Netherlands, the distance from home to work is approximately 15 to 20 kilometres in metropolitan cities [19]. It is therefore expected that the residents around Schiphol have more economic ties with the airport than the residents around Utrecht.

Recruitment was undertaken using a recruiting agency in November 2020. Participants answered questions on an online survey website. A total of 1024 persons were questioned for this study, of which 510 were from Utrecht area and 514 were from Schiphol area.

The groups from Schiphol-Airport and Utrecht-Control were comparable with respect to age (2% difference), gender (2% difference), family situation (2% difference), and education (3% difference). There were more deviations with respect to the time people lived in their current house between 15 and 30 years (Schiphol 28% versus Utrecht 23%) and between zero and five years (Schiphol 29% versus Utrecht 35%). Near Schiphol, more people lived in a rented house (40%) than near Utrecht (31%).

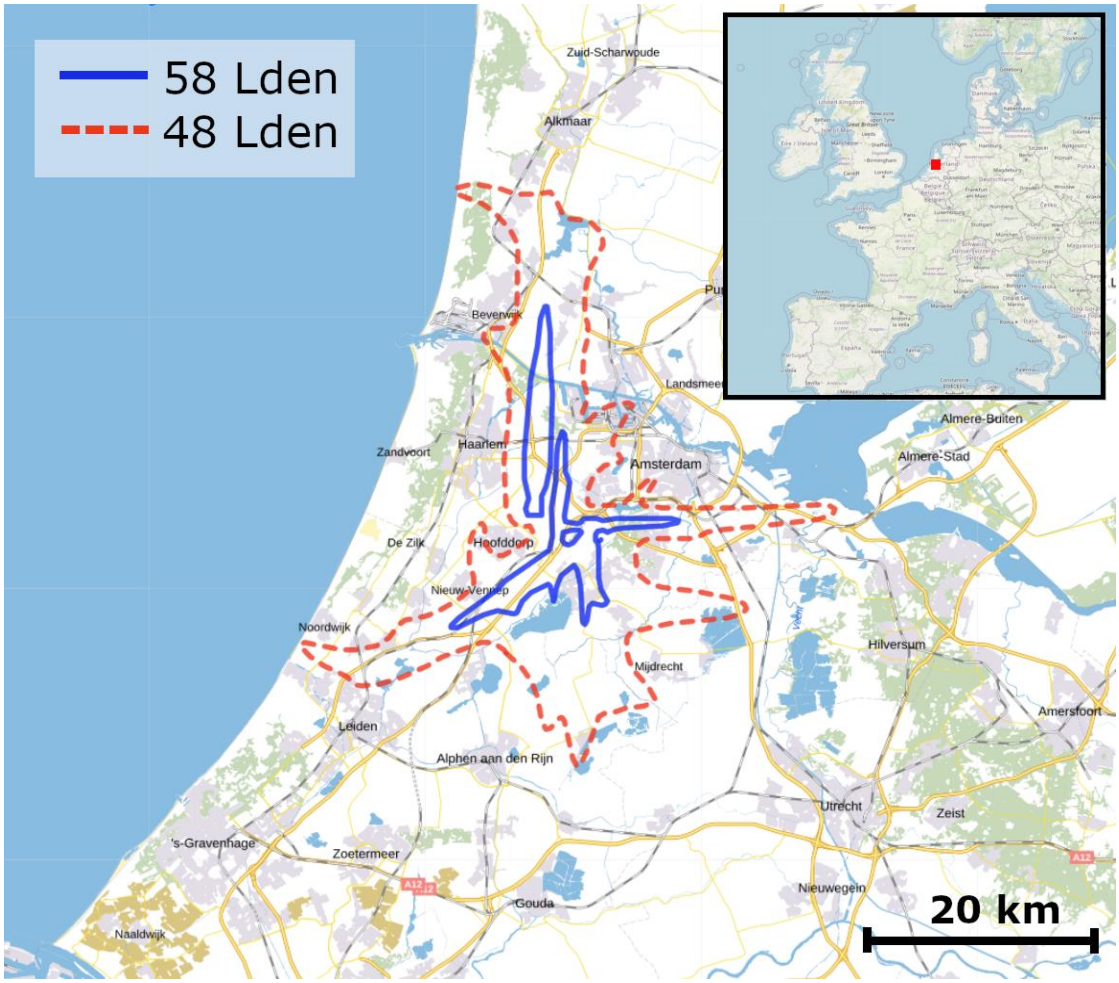

Figure 1: The noise contours for (the inner) 58 Lden and (the outer) 48 Lden around Schiphol airport. The red rectangle in the inset in the top-right shows the location of the considered area in a map of Europe. These noise limits correspond closely to the yearly noise exposure for the year 2019. Schiphol is located in the centre of the 58 Lden contour. The city of Utrecht can be found on the lower right outside both contours (Map background copyright OpenStreetMap).

2.2 Material

An online survey study provided the participants with questions on their quality of life. The questionnaire, asked in the local Dutch language, contained a total of 59 questions. The survey contained seven questions related to participant's age, their house ownership situation, family situation and education. Twenty questions of the questionnaire were related to the weight or important of certain aspects of their life (not evaluated in this study). The participants answered thirty-two paired questions (before and during COVID-19) about their quality of life situation, See Table 1 for the questions before COVID-19. Each of those questions could be categorized into one of the earlier identified QoL indicators. As an example, the paired questions "*Did you have financial concerns before the Corona outbreak (before March 2020)?*" and "*Do you have financial concerns since the Corona outbreak (since March 2020)?*" are part of the QoL indicator "material living conditions". The questions were answered on a 5-point Likert scale. Again, only the questions answered before the Corona outbreak are addressed in this article.

2.3 Statistical analysis

First, two-way repeated measures ANOVAs calculated differences in aerospace related questions and aspects of QoL for the Schiphol-Airport and Utrecht-Control regions. Additional t tests and correlation tests measured differences in other QoL questions for these two

regions. These results provide answers about the influence of the airport on specific questions.

A second analysis investigated the structural validity of the concepts of quality of life differentiating between several indicators using a Principle Component Analysis (PCA). A PCA is commonly used as a factor analysis in social sciences and therefore selected in this study. Also, the general goal of a PCA is to simplify the dataset by deriving a linear combination of smaller components in a large list of items, whereas in a common factor analysis it is expected to have a latent construct connecting all the items together [20]. In this dataset, it was not expected that a latent construct among all the items would be found (resulting in a better fit for a PCA), but to test and confirm the actors found in the previous study [6]. Two PCAs included the sample living around Utrecht and around Schiphol.

Table 1: Survey questions asked and evaluated in this study.

Identifier: Question (Translated from Dutch)	**Response category (lowest/highest)**
Social: How many social contacts did you have in your free time during the 12 months before the Corona outbreak (before March 2020)?	None at all / Very much
Going out: How often did you go out to musea, dining out, visiting the zoo, cinema, or family during the 12 months before the Corona outbreak (before March 2020)?	Not at all / Very much
Education: How often did you follow an education or course before the Corona outbreak (before March 2020)?	Never / a number of times a week
new-education: Were you interested to re-educate or start a new education before the Corona outbreak (before March 2020)?	Not at all / Very much
Health: How satisfied were you with your health before the Corona outbreak (before March 2020)?	Not at all / Very much
health-activity: How often did you go out to exercise (sports, walking, cycling, etc.) before the Corona outbreak (before March 2020)?	Not at all / Very much
Air travel: How often did you make use of air travel for holidays or work before the Corona outbreak (before March 2020)?	Never / a number of times a week
Aircraft noise: Did you feel annoyed by aircraft noise in your living environment before the Corona outbreak (before March 2020)?	Not at all / Very much
aerospace-perception: How do you view aviation for 12 months before the Corona outbreak (before March 2020)?	Very positive / very negative
government-trust: Did you trust the government before the Corona outbreak (before March 2020)	Not at all / Very much
financial-worries: Did you have financial concerns before the Corona outbreak (before March 2020) ??	Not at all / Very much
Buying luxury items: Did you buy luxury articles (brand clothing, electronics, premium products instead of discount products or 2nd hand) before the Corona outbreak (before March 2020) ?	Not at all / Very much
voluntary-work: How much voluntary work did you do before the Corona outbreak (before March 2020) ?	None / 36 hours or more

Work: How much paid work did you do before the Corona outbreak (before March 2020) ?	None / 36 hours or more
neighbourhood trouble: How much were you bothered by nuisance neighbours, youth on the street and/or drugs use the 12 months before the Corona outbreak (before March 2020) ?	Not at all / Very much
personal-safety: Did you worry about your personal safety the 12 months before the Corona outbreak (before March 2020) ?	Not at all / Very much

3. RESULTS

3.1 Differences between regions

The question results for each of the two regions are presented in Table 2 and Table 3.

3.1.1 Main effects region

To examine the impact of living near a neighbouring large airport on the QoL (research question one) two-way repeated measures ANOVAs were performed. Results showed a significant main effect of region on noise annoyance scores, ($F(1, 1049) = 33.88$, $p < .001$), as seen in Table 3. Here, aircraft noise annoyance scores were higher around the Schiphol-Airport region compared to the Utrecht-Control region. Region also had an effect on air travel ($F(1, 1049) = 4.57$, $p = .033$), as residents around Schiphol reported to generally make more use of air travel for holidays or work. The residents around Schiphol also had a more positive perception of aerospace than residents around Utrecht ($F(1, 1049) = 12.58$, $p < .001$).

Further two-way repeated measures ANOVAs showed that the region had an impact on neighbourhood trouble ($F(1, 1049) = 6.35$, $p = .012$) and social contacts ($F(1, 1049) = 4.04$, $p = .045$). Residents around Schiphol reported more neighbourhood trouble (M = 1.75, SE = .04) than the Utrecht residents (M = 1.62, SE = .04). Furthermore, residents around Utrecht reported to have fewer social interactions (M = 1.62, SE = .04) than the Schiphol residents (M = 1.75, SE = .04), controlled for by socioeconomic indicators: education level and type of house, either bought or rented. Here, type of house had an impact on neighbourhood trouble in both the Utrecht and the Schiphol region. In the Schiphol region, more houses were rented (44.2%), than bought (55.8%), compared to the Utrecht region, were 31.8% reportedly rented a house and 68.2% bought a house.

Table 2: Calculated mean and standard deviation of results for both regions.

	Schiphol region		Utrecht region	
	M	SD	M	SD
Aerospace perception	2.72	0.94	2.84	0.91
Aircraft noise	2.01	1.16	1.55	0.91
Air travel	2.19	0.88	2.04	0.83
Buying luxury products	2.37	1.00	2.24	0.91
Education	2.06	1.56	1.97	1.06
Financial worries	1.52	0.84	1.50	0.81
Going out	3.28	1.00	3.21	0.98
Government trust	2.83	0.95	2.95	0.96
Health	3.32	1.00	3.36	0.92
Health activities	3.31	0.99	3.33	1.03
Neighbourhood trouble	1.72	0.95	1.57	0.82

Starting new education	1.81	1.15	1.72	1.09
Personal safety	1.57	0.84	1.49	0.76
Social contacts	3.46	0.93	3.54	0.85
Voluntary work	1.67	0.99	1.73	0.94
Work	3.27	1.66	3.18	1.67

Table 3: Test results two way repeated measures ANOVA for both regions.

Dependent variable	Main effect region		
	df error	df factor	F
Aircraft noise	1049	1	**33.88**
Air travel	1049	1	**4.57**
Aerospace perception	1049	1	**12.58**
Buying luxury products	1049	1	3.09
Education	1049	1	0.56
Financial worries	1049	1	0.87
Going out	1049	1	1.40
Government trust	1049	1	3.45
Health	1049	1	1.99
Health activities	1049	1	0.68
Neighbourhood Trouble	1049	1	**6.35**
New education	1049	1	1.85
Personal safety	1049	1	0.21
Social contacts	1049	1	**4.04**
Voluntary work	1049	1	0.35
Work	1049	1	0.28

3.2 Correlation between individual questions

To examine interrelations between QoL factors (research question two), a Pearson correlation coefficient was calculated for the combined regions to examine the differences between the two regions. The results, presented in Table 4, show nine questions that have at least a moderate correlation ($|r| \geq 0.30$). The correlations in this table were as expected, with the strongest correlation between those with more social contact and those more active in going out. There were also relations with regard to people's economic situation, such as buying luxury goods and how much people worked, and likewise for personal security between financial worries and personal safety. There was a (moderate) correlation between aircraft annoyance and the perception of aviation, where a higher level of annoyance correlated positively with a negative perception of aerospace. Additional analyses on aircraft noise annoyance shows a weak (r = .26) but significant correlation between aircraft noise annoyance and neighbourhood trouble (nuisance). A similar result was found between aircraft noise annoyance, personal safety (r = .29) and financial worries (r = .28).

A comparison was made between the differences in correlated questions between the Schiphol-Airport region and Utrecht-Control region (Table 5). A stronger significant relation is found between work and air travel in the Schiphol region (r = 0.40) than in the Utrecht region (r = 0.24). A stronger correlation was also found between work and health around the Schiphol region (r = 0.25) than in the Utrecht region (r = 0.09).

Table 4: Correlation for both regions combined (|R| > 0.3).

Question A	Question B	correlation
Social contacts	Going out	**0.48**
Education	Starting a new education	**0.42**
Neighbourhood trouble	Personal safety	**0.42**
Financial worries	Personal safety	**0.37**
Health	Engaging in health activities	**0.35**
Education	Air travel	**0.32**
Air travel	Work	**0.32**
Buying luxury items	Work	**0.32**
Aircraft noise	Aerospace perception	**0.31**

Bold = significant value <.005

Table 5: Differences in correlation (>0.15) for the questions between the Schiphol-airport and Utrecht-control region.

Question A	Question B	Utrecht Correlation (r)	Schiphol Correlation (r)	Difference
Financial worries	Voluntary work	0.04	**0.23**	**0.19**
Air travel	Work	**0.24**	**0.40**	**0.16**
Starting a new education	Voluntary work	0.04	**0.20**	**0.16**
Health	Work	0.09	**0.25**	**0.16**
Education	Buying luxury items	**0.10**	**0.25**	**0.15**

Bold = significant value <.005

3.3 Principle Component Analysis (PCA)

To validate earlier found QoL indicators (research question four), multiple PCAs were performed for the different regions and time periods.

3.3.1 PCA around Utrecht and Schiphol

The Schiphol sample was acceptable for analysis with a KMO of 0.81, which could be considered meritorious [20,21]. The Utrecht sample, however, is still acceptable for analysis but could be considered middling due to a lower KMO of 0.78 [20,21]. Using the Kaiser criterion [22], we considered 10 factors for the Utrecht sample (which explained 61.2% of the variation). We found nine factors for the Schiphol sample (which explained 57.5% of the variation).

3.3.2 Differences between Utrecht and Schiphol sample

Oblique (direct oblimin) rotation method showed that the factors extracted from the Utrecht and Schiphol sample, overlapped with the previously theorized factors about QoL. It is noticeable, however, that a separate factor about financial/safety related worries was extracted in the Schiphol sample. The same items in this factor were included in 'health' and 'local environment' in the Utrecht sample. Correlations between the factors showed this separate 'worries' factor had the highest correlation with the aerospace environment around Schiphol (r = .22). Also, 'local environment (neighbourhood safety)' was extracted as a different factor around Utrecht, while the questions in this factors were merged in the Schiphol sample into 'worries (financial / safety)' and 'governance / neighbourhood'.

4. DISCUSSION

A survey has been conducted on aspects of QoL to compare a group of people living close to a large airport with a similar group living further away from this airport. As the survey took place during the COVID-19 pandemic, participants were asked to answer questions with regard to their life before the break-out of the pandemic.

The groups can be compared with respect to gender, age, education, family situation, and education, with only a moderate difference in house ownership situation. The group near the airport was more annoyed by aircraft noise. Results also showed that people who were more annoyed by noise, also experienced more neighbourhood nuisance, financial worries and worries about personal safety. These results indicate a relation between stressors someone experiences and the experience of aircraft noise annoyance. This could partly explain the variability in noise perception between individuals. It should be noted that even though these correlations were significant, they were considered weak ($r < .30$) and no causality could be determined, meaning that neighbourhood with more nuisance could be situated closer to the airport and experience more aircraft overflights. Also, only an effect was found on these three stressors and further research could include other worries, such as on health, as no relation was found between health satisfaction and noise annoyance in this research.

The group near the airport also made more use of air travel, meaning that people take an airplane more often, possibly due to work, e.g. as pilots or flight attendants, who are expected to live closer to the airport. Perception of aviation was more negative in the Utrecht-Control group than near Schiphol-Airport. It can be expected that the group living further away from the airport is receiving fewer benefits from the airport, similar to what was suggested by Lawton and Fujiwara (2016) on subjective wellbeing and airport proximity. A conclusion can be made that people living closer to the airport are more affected, both positively and negatively. For those living further away from the airport, the airport plays a less important role in their daily life. There is an opportunity for the airport to build upon the positive aspects of the airport on people's life for those who live close by. It should also be noted that this study included communities in The Netherlands and around Schiphol Airport, and outcomes may differ for other (airport) regions.

These results are also supported by the correlations between the individual QoL questions for the two regions. Here, the main differences between the Schiphol-Airport region and Utrecht-Control region (Table 5) can be attributed to people that make more use of air travel and work for the airport in the Schiphol region than in the Utrecht region. Also, a stronger correlation was found between work and health in the Schiphol-Airport region than in the Utrecht-Control region, possibly due to the health concerns of the neighbouring airport. It should be noted however, that even though these correlations were significant, they were still considered weak ($r < 0.30$).

A similar result was found with the factor extraction from the PCA. Here, we found an extra factor related to 'economical safety/worries' in the Schiphol sample. This could be explained by airport-related work, since the highest correlation was this 'safety/worries' factor found with the factor 'aerospace environment'. People living around Schiphol could have more worries related to their jobs in/around Schiphol airport. This also overlaps with the findings from the Pearson correlation analysis, which shows a high correlation between financial worries and air travel for the Schiphol sample. It should be noted though that only the pre-COVID-19 questions were included into this analysis, but asked during the COVID-19 pandemic. This may possibly influence people's economic worries around Schiphol airport, since air travel has been limited during this pandemic. It would also explain the extra factor found in the Schiphol sample for economic safety/worries Also, health concerns were generally higher during this time period, which could have a large impact on the health aspect of QoL (hQoL).

This could also be considered the main limitation of this study, since these answers could have been guided by commonly used mental shortcuts, such as an anchoring heuristic. With an anchoring heuristic, an individual relies on an initial point to make an estimation or decision [23]. This means that participants rely on their current view of the pandemic, coherent with the local measures at that moment, to answer questions about the pre-COVID-19 situation. Participants decision-making could also rely on their nostalgia of the pre-COVID-19 situation, where the pre-COVID-19 situation might have looked better or worse than how it was experienced in reality. Since nostalgic memories often include friends and family, increasing the feelings of social connectedness [24], pre-COVID-19 memories might be recalled as more pleasant. It would be interesting to test these same questions again after aerospace recovery of the COVID-19 pandemic, with similar air travel as before 2019 and with lower general health concerns.

Another limitation of the study is the selection of the questions for QoL. They were selected based on the earlier study by [6] and the EUROSTAT's QoL model [7]. Although this was a thorough research, questions were asked related to these indicators, and possible additional indicators that were considered not to be related to the airport, may still have had some influence on overall QoL. In this study, the questions asked on the weight of the QoL factors were not yet addressed. They may give indications about how important certain factors of QoL are perceived. Additional study of the data can therefore also help to develop a model to measure QoL and improve the understanding of the impact of a nearby airport on people's well-being.

5. CONCLUSION

In this study the impact on QoL of a large airport in the vicinity of one's living environment was measured, as well as the interrelation between QoL factors. This paper also validated earlier theorized QoL indicators by Roosien et al. [6]. Results show that living in close proximity to a large airport (Schiphol) has an effect on the use and perception of the aerospace environment (noise, perception and air travel), social interactions and perceived neighbourhood trouble. Noise annoyance was higher amongst those living in close proximity of Schiphol-Airport area. This could be explained by the more significant impact of noise from overflights. However, people who are more noise annoyed also experienced more financial stress, nuisance from neighbors and worried about personal safety, indicating a more complex relation between noise exposure, noise annoyance and other (major) stressors.

Furthermore, those living in close proximity to the airport reported a more positive perception of aerospace. This finding could highlight the economic opportunities offered by the airport [25]. People who live close to an airport are more negatively, but also more positively affected by the airport than people living further away. This outcome confirms results from Lawton and Fujiwara [13] on subjective wellbeing and airport proximity as well

as the results from Tomkins et al. [14] on employment opportunities and negative external effects from living in the vicinity of an airport.

The analysis of the survey questions shows that people who live around the area of Schiphol generally have more social contacts, but also more nuisance in the neighbourhood. However, these differences can not only be ascribed to the nearby airport, but also possibly to demographic or landscape differences in these areas, as, for example, the percentage of reported rental houses instead of bought houses is higher in the area around Schiphol, compared to the Utrecht region. Living near an airport does not have an impact on other aspects of QoL, such as work, education, health, government trust, etc.

The components from the PCA overlap with the previously theorized components [6,7]. The factor financial/safety related worries were extracted from the Schiphol sample that had the highest correlation with the aerospace environment. It should be noted, however, that this correlation was still low.

All in all, this study showed that local aviation in airport regions considerably affects residents' quality of life, both negatively and positively. Residents perceive both, the adverse as well as the beneficial impact of the airport's activity. It is worthwhile for airport management to put efforts on learning what impact the airport has on the quality of live in communities in airport regions. This may be different from airport region to airport region. Moving on in working on the improvement of the positive side of the quality of life of residents living in airport regions, whilst continuing to mitigate the adverse effects of local aviation, is a way forward for airports to improve their relationship with neighbouring communities and, thus, advancing in receiving the societal licence to operate.

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