

Fairness perspectives of airport residents: A qualitative approach

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ABSTRACT

Long-term exposure to aircraft noise has been linked to various negative health impacts, with annoyance playing a key role in mediating stress-related health effects. Fairness can be seen as a fundamental aspect potentially reducing annoyance reactions. This study delves into the concept of fairness within airport management, drawing on research from fields such as social and organizational psychology. It specifically examines the viewpoint of noise-affected residents, offering insights into their perception of fairness in regard to airport management. The research involved focus group discussions and in-depth interviews at three different European airports in Germany and France. These sessions were transcribed and analyzed using qualitative content analysis. Participants were surveyed based on their exposure to lower (≤ 55 dB L_{den}) and higher (> 55 dB L_{den}) levels of aircraft noise. The findings indicate that distributive, procedural, informational, and interpersonal fairness are viewed as important elements for fostering a fair and neighborly relationship with the airport. Residents emphasized the importance of receiving adequate compensation for the disadvantages they incur due to their proximity to the airport, such as aircraft noise-related sleep disturbance. Additionally, residents expressed the need for earnest inclusion in the decision-making processes, as well as access transparent information. Additional focus group discussions were conducted to validate the results and to gather input from affected residents, aiming to establish a fair and neighborly relationship. Based on these insights, recommendations are formulated for airport managers from the perspective of the affected residents, emphasizing the aim of fostering a fair and neighborly relationship.

1. Introduction

Environmental noise represents one of the most important public health concerns, with its detrimental effects on human health and well-being garnering increasing attention from both the general population and policymakers in Europe (WHO, 2018). In an era of continuously growing mobility needs as well as transportation of goods, this matter is poised to assume even greater significance in the future, particularly concerning sectors such as air transportation (ICAO, 2023). Research on the effects of aircraft noise have repeatedly shown that long-term noise exposure is associated with a variety of adverse health effects, such as annoyance due to aircraft noise (Bartels et al., 2018a; Fidell et al., 1985; Guski et al., 2017; Quehl & Basner, 2006), sleep disturbance (Bartels et al., 2019; Basner & McGuire, 2018; Halperin, 2014; Smith et al.,

2022) and cardiovascular and coronary heart disease (Babisch et al., 2005; Van Kempen et al., 2018), such as myocardial infarction (Babisch et al., 2005), and hypertension (Baudin et al., 2020; Black et al., 2007; Jarup et al., 2008). Even in children and newborns, noise can have adverse effects on health (Erickson & Newman, 2017), cognition (Klatte et al., 2017) and learning ability (Klatte et al., 2013).

Annoyance is considered as one of the most important effects of noise and can occur even at lower noise levels, widely experienced in areas around airports (Guski et al., 2017). Noise annoyance can be seen as a kind of stress response to noise, that manifests in cognitive, emotional and behavioral aspects (Guski et al., 2017). Current research suggests that high levels of long-term noise annoyance can mediate adverse health-effects and is associated with a higher risk for hypertension (Baudin et al., 2020), a decrease in mental well-being (Schreckenber

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et al., 2017a), higher levels of psychological distress (Baudin et al., 2018) and medication use to treat anxiety disorders (Baudin et al., 2021). When evaluating sound as noise, stress triggers a series of responses in the human body due to the activation of the sympathetic nervous system and the release of stress hormones like epinephrine, norepinephrine and cortisol (Babisch, 2002).

Reducing annoyance is therefore assumed to be an essential factor when mitigating the negative, health-related consequences of long-term noise exposure (Guski et al., 2017; Schreckenberget al., 2022; Stallen, 1999).

Mitigating noise pollution around airports constitutes merely one facet in addressing the overall reduction of annoyance experienced by nearby residents. Research has repeatedly shown that annoyance reactions are only partly determined by the sound level itself (Guski et al., 2017). In a meta-analysis conducted for the World Health Organization's Environmental Noise Guidelines, encompassing a total of 18,947 respondents, the correlation between aircraft noise and annoyance was found to be all in all moderate, with correlations ranging from $r = 0.21$ to $r = 0.74$, and a mean correlation of $r = 0.44$ (Guski et al., 2017). In essence, only 19 % of the variation in aircraft noise annoyance (in raw scores) can be attributed to variations in the noise levels, measured in L_{den} (Guski et al., 2017). However, this study only utilizes a 24-hour L_{eq} -based indicator and not accounting for further acoustic parameters such as the intermittency of aircraft noise, a factor considered to significantly contribute to the annoyance of aircraft noise (e.g. Wunderli et al., 2016).

Over the years, there have been repeated efforts to enhance the predictability of noise annoyance through the development of better mathematical models (Fidell et al., 1991) introducing alternative metrics (e.g. the intermittency of aircraft noise) for a more accurate depiction the impact of noise exposure on individuals (Haubrich et al., 2019) and controlling other confounding variables (Bartels et al., 2022; Schreckenberget al., 2017b).

Regrettably, none of these endeavors have significantly improved the ability to predict noise annoyance.

Given that the acoustic factors alone fail to satisfactorily account for the variation in annoyance, researchers have increasingly turned their attention to non-acoustic factors (Bartels et al., 2022; Flindell & Stallen, 1999; Guski, 1999; Job, 1988; Maris, 2008; Miedema & Vos, 1999; Quehl et al., 2021; Riedel et al., 2021; Schreckenberget al., 2022; Stallen, 1999). The significance of non-acoustic factors becomes apparent in understanding annoyance as a stress response. In his theoretical model of noise annoyance Stallen (1999) points out that noise annoyance arises from the dynamic interplay between perceived disturbance and perceived control. Perceived (psychological) control in this context can arise through a variety of different means such as being able to predict future noise events (Stallen, 1999). Control in this context refers not only to influencing noise exposure directly, but also as a psychological dimension (Stallen, 1999). Similar to the concept of the 'secondary appraisal' in Lazarus' stress model (Lazarus & Folkman, 1984), perceived control is a generic term to describe a variety of mental, cognitive, or affective mechanisms when faced with a stressful situation.

Non-acoustic factors can explain a major part of the seen variations in annoyance reactions of residents exposed to aircraft noise (Bartels, 2014; Flindell & Stallen, 1999; Guski et al., 2017; Schreckenberget al., 2022). Non-acoustic factors include aspects such as trust in authorities, predictability of noise events, the feeling of having control over the noise source, and having access to understandable information (Bartels et al., 2022; Guski et al., 2017; Stallen, 1999).

Some of the non-acoustic factors mentioned here pertain to the social dimension of being impacted by aircraft noise. In contrast to natural sounds like birdsong, aircraft noise is a product of human activity, often regarded as a form of social interaction (Maris, 2008). This exposure to human-made noise is therefore commonly perceived as a social experience (Maris, 2008). For residents living near airports who endure aircraft noise, this dynamic can be summed up as "YOU expose ME" (Van

Gunsteren, 1999), with affected individuals frequently holding the airport operator accountable for their exposure (Maris, 2008). The continuous noise experienced by residents serves as a constant reminder of perceived unfair treatment by the airport, potentially triggering strong emotional reactions and contributing to protest movements against it (Rothmund et al., 2014). Thus, the experience of aircraft noise is intricately linked with human decisions and is consequently a facet of fairness.

Crucial outcomes within this context, including noise annoyance, limited acceptance of airport decisions, protest behavior, and a general sense of distrust towards airports, can, thus, partly be interpreted as indicators of a perceived deficiency in fairness regarding decision-making processes and noise management. Acknowledging this potential correlation between fairness and aspects like limited acceptance of the airport underscores the opportunity for leveraging insights from fairness research in other domains to significantly enhance various aspects of aircraft noise management. The transfer of important findings from fairness research to the context of aircraft noise issues and possible implications have already been discussed theoretically (Hauptvogel et al., 2021a).

What is lacking thus far, however, is a qualitative examination of the four dimensions of fairness within the context of aircraft noise research.

Incorporating fairness into the context of aircraft noise management has the potential to impact numerous non-acoustic factors, including predictability through informational fairness and trust through long-term truthfulness and justification as well as opportunities to enable participation in decision-making (Hauptvogel et al., 2021a). As a result, fairness can potentially have a multi-dimensional impact, reducing annoyance and ultimately increasing trust in the long-term, and thus, enhancing the acceptance of the airport and the local air traffic.

Some publications have already described aspects of fairness as essential components of sustainable aircraft noise management. These include, for example, the transparent and honest provision of information, the involvement of citizens in decision-making processes regarding aircraft noise, compensation for noise and truthful and comprehensible exchange between the airport and residents (Asensio et al., 2017; Gasco et al., 2017; Heyes et al., 2021; Woodward et al., 2009). In contrast to existing publications, this article delves into fairness research, which has been empirically studied in the fields of social, organizational psychology and legal psychology for several decades (for an overview, see Colquitt et al., 2001).

This article is a theory-based examination of a variety of fairness aspects in the context of the aircraft noise issues.

In the field of psychological fairness research, four distinct facets of fairness are commonly recognized: distributive, procedural, informational, and interpersonal fairness (for an overview, see Colquitt et al., 2001). Research on distributive fairness origins from the organizational and judicial context and suggests that fairness is assessed based on a perceived cost-benefit ratio, as proposed by Adams (1965). Seen in the context of organizational psychology, individuals evaluate the disadvantages they bear, such as time and physical effort, and compare them to the benefits they receive in the form of wages or salaries. In the context of aircraft noise research, *equity* may be perceived when there is a balance between the disadvantages associated with living near an airport (e.g., sleep disturbance or property devaluation due to aircraft noise exposure) and the benefits perceived (e.g., travel or job opportunities). Leventhal's considerations (1980) provide additional principles for distributing aircraft noise. The *equality* rule suggests distributing aircraft noise equally among all residents, regardless of other environmental stressors. Conversely, the *needs* rule advocates for protecting vulnerable groups, such as children, the sick, or the elderly, from additional noise exposure, distributing the noise over the rest of the population. Up to now, there is no answer to what distributions of noise is seen as more fair than the other (Hauptvogel et al., 2021a). However, fairness research has shown that the outcome of decisions is not the only decisive factor in whether a decision is perceived as fair or unfair.

Research on procedural fairness highlights that the process leading to a decision is often as important as the actual outcome of these decisions (Lind & Tyler, 1988). Procedural fairness is rooted in the notion that individuals perceive fairness when they have been given a voice or control during the decision-making process (Lind & Tyler, 1988; Thibaut & Walker, 1975; Tyler & Lind, 1992). In addition to *process* and *decision control* as important components of a fair process (Folger, 1977; Thibaut & Walker, 1975), Leventhal (1980) introduced additional principles for assessing the fairness of a procedure. These criteria include *representativeness*, where the concerns and opinions of all affected parties should be considered at every stage of the decision-making process. The *consistency* rule emphasizes the consistent application of procedures across all residents and times, while the *bias suppression* rule specifies that decisions should not be influenced by self-interest (economic reasons) but rather adopt a non-biased perspective. The *accuracy* rule suggests that decisions should be based on correct and appropriate information, with a minimum of error, and the *correctability* rule proposes opportunities for revising incorrect or inaccurate decisions. Eventually, the *ethicality* rule states that processes should adhere to fundamental ethical and moral standards.

In addition to the distributional and procedural fairness, research highlights that the interaction between the parties is also of importance in the final perception of fairness (Greenberg, 1993). Research has shown that unfairness can be perceived even if a fair decision has been made from the point of view of distributive and procedural fairness, due to the fact that this decision has not been adequately communicated with those affected by it. Research indicates that it is not enough to give individuals the opportunity to voice their concerns during the decision-making process; the decisions made need to be communicated in a fair manner as well (Bies & Moag, 1986; Skarlicki & Folger, 1997). Informational fairness highlights the importance of communicating *honestly* and *justifying* decisions in details. Interpersonal fairness suggests that airport authorities should interact with residents on a basis of *respect* and *propriety*.

To gain a comprehensive understanding of fairness in the context of aircraft noise, it is essential to actively involve residents impacted by this issue. By examining their unique experiences and interpretations through the lens of fairness research, we can identify the necessary conditions for airport management to be equitable and fair. Incorporating the perspectives and experiences of affected residents is crucial for a comprehensive understanding of fairness issues related to aircraft noise mitigation.

Up to now, qualitative research on fairness in the aircraft noise debate has been limited. However, studies such as Sommerfeld (2013) and Hooper and Flindell (2013) have shed light on residents' desires for improved communication and transparent information provision, highlighting the importance of informational fairness. Residents expressed dissatisfaction with the current state of information and felt that airports lacked genuine interest in engaging with them at eye level (Sommerfeld, 2013). In this context, 'genuine' implies that the airport is superficially displaying interest out of obligation rather than demonstrating any sincere concern for the well-being of local residents. Flindell et al. (2013) emphasized the significance of qualitative research, which revealed that residents generally exhibited tolerance towards airports and recognized that noise disturbances are sometimes unavoidable. However, to foster such tolerance, airports must actively engage with residents and establish respectful communication and information policies. This includes explaining decisions where noise mitigation is not feasible and highlighting the airport's economic and social contributions to the surrounding region, but also to be transparent about their environmental impact.

Furthermore, this research expands on prior recommendations on how to handle community reactions to aircraft noise described in the Toolkit for *Managing Community Expectations* (2009). In 2009, recommendations for best practices in communication on aviation noise issues were identified, including aspects of fairness. The work presented

here places these recommendations within a theoretical framework of fairness research and focuses on the desired aspects in the light of the four facets of fairness (Hauptvogel et al., 2021a).

In order to systematically and comprehensively grasp the aspect of fairness with all its facets from the viewpoint of noise affected residents, this paper aims to achieve three objectives:

- Determine how statements from residents impacted by aircraft noise can be categorized according to the four facets of fairness: distributive, procedural, informational, and interpersonal fairness.
- Identify which facets or subfacets are deemed particularly significant by residents, warranting special consideration.
- Exploring insights from impacted residents and gathering potential ideas for interventions to foster a more equitable relationship with the airport.

By examining these objectives, this research seeks to gain a deeper understanding of the aspects of fairness that residents value the most in relation to aircraft noise distribution.

2. Methods

The results presented here were obtained within the framework of the EU project ANIMA (Aviation Noise Impact Management through Novel Approaches). This project received funding from the EU Horizon 2020 research and innovation programme under grant agreement No. 769627. An overview of the aims of Work Package 3 and Subtask 3.2.1 in which the focus group discussions and in-depth interviews were conducted as well as further results can be found in the published deliverable (Hauptvogel et al., 2021b).

2.1. Design

The present study utilized a multicentered, multimethod qualitative study design, with data collection taking place between December 2019 and April 2020. While the focus groups near Cologne-Bonn Airport and Paris-Charles de Gaulle Airport took place prior to the implementation of COVID-19 lockdown measures, with air traffic operating as usual, interviews near Dusseldorf Airport were conducted via telephone due to contact restrictions.

To address the research questions, this study comprised two stages:

In the first stage, focus group discussions and in-depth interviews were conducted at three European airports (Cologne-Bonn Airport, Dusseldorf Airport, and Paris-Charles-de-Gaulle Airport). Specifically, four focus group discussions were conducted at Cologne-Bonn Airport, with two groups representing regions less affected by aircraft noise (≤ 55 dB L_{den}) and two groups representing regions more affected by aircraft noise (> 55 dB L_{den}). Similarly, four focus group discussions were carried out at Paris-Charles-de-Gaulle Airport. Additionally, a total of 22 in-depth interviews were conducted around Dusseldorf Airport.

The obtained data was used to categorize statements from the participants to the four fairness facets, namely distributive, procedural, informational and interpersonal fairness (research question 1) and further to identify which facets and subfacets are particularly important in the view of affected residents (research question 2).

To validate the results from this first stage and to answer research question 3, additional focus group discussions were conducted at Paris-Charles-de-Gaulle Airport. Here, the participants were presented with the results from the first stage and were asked specifically to think about potential interventions the airport could implement to foster and establish a positive relationship between the airport and the residents living near it. It should be emphasized that these are individual and subjective ideas of the people involved, rather than actual, practically implementable interventions. This stage was therefore not connected to the first stage of data collection and can be seen as an additional step to validate the results to gain a deeper understanding of what residents see

as possible and effective interventions. For the final study design, see Fig. 1.

The decision to employ a qualitative research method in this study was driven by the limited attention given to fairness within the domain of aircraft noise research, along with the scarcity of systematic work addressing this topic. Qualitative research offers a significant advantage in its ability to uncover underlying motives, attitudes, and perceptions that are not easily captured through quantitative approaches (Brüsemeister & Brüsemeister, 2008). The objective of this study was not to conduct a representative survey, but rather to gain an in-depth understanding of the experiences and opinions of individuals affected by aircraft noise. By utilizing focus group discussions as a qualitative research method, we further benefitted from the emergence of discussion topics through group dynamics, which may not have been elicited through conventional data collection methods (Krueger, 2014). This approach helps to better understand residents experiencing aircraft noise in their daily lives and gives important insights into their thoughts, motives and experiences. For determining the required number of focus groups, developing discussion guides, and planning and implementing the focus groups, Krueger's (2014) recommendations were followed.

2.2. Study sample

In the study areas surrounding Cologne-Bonn Airport, flyers were distributed and posters were displayed in local retail businesses. Special recruitment agencies were employed to handle the recruitment and participant selection around the airports of Dusseldorf and Paris-Charles-de-Gaulle.

Potential participants were pre-screened through a short questionnaire that covered demographic information such as gender and age, as well as questions related to their residential circumstances such as length of residency, and overall satisfaction with their living environment. Additionally, participants were asked about their connection to the airport, such as whether they were employed there or are an active member of a citizen organization. A complete list of the survey questions and sample composition can be found in Deliverable D3.9 of the ANIMA Project (Hauptvogel et al., 2021b). The aim here was to get a mixed group of people in the focus group discussions to stimulate discussion through the different perspectives.

All participants signed an informed consent for data collection and audio recording. The study was approved by the Ethics Committee North Rhine with the consecutive number 2019235.

2.3. Procedure

2.3.1. Noise sampling

The noise exposure of each region considered in the study was determined around Cologne-Bonn and Dusseldorf from the publicly available environmental noise maps for North Rhine-Westphalia published by the Ministry for the Environment, Nature Protection and Transport of the State of North Rhine-Westphalia (NRW) (Ministerium für Umwelt, 2017). Aircraft noise exposure was estimated for focus groups around Paris-Charles-de-Gaulle Airport through the publicly available Noise Exposure Plan (PEB) maps (République Française 2022). Care was taken to ensure that aircraft noise was the dominant noise source in the respective region.

In the study, highly exposed regions were defined as those experiencing aircraft noise exposure exceeding 55 dB L_{den} . These criteria align with the critical threshold specified by the European Environment Agency (EEA, 2014), as outlined in the 7th Environment Action Programme of the European Commission (EU, 2013). Moreover, these thresholds are consistent with the directives of the EU Directive 2002/49/EC (EU, 2002), which governs the assessment and management of environmental noise in. Low exposure was therefore defined by aircraft noise levels ≤ 55 dB L_{den} .

The selected airports were chosen based on variations in spatial and operational characteristics, aiming to capture diverse exposures for local residents. Cologne-Bonn Airport, situated 12 km from Cologne city center and 16 km from Bonn city center, serves as an international commercial airport distinguished by its cargo and night flights. With its substantial traffic volume, Dusseldorf Airport stands as one of Germany's largest international airports, situated 6 km from Dusseldorf city. Paris-Charles-de-Gaulle Airport, the largest international airport in Paris and the third largest in Europe, is located 26 km from Paris city center.

Participants were chosen from urban and rural areas, providing a diverse range of perspectives. Aircraft noise should be the main noise source; areas with highways, industries and railways were excluded.

2.3.2. Interview procedure

At the beginning of each focus group discussion, participants were welcomed and introduced to the overall procedure. To avoid influencing participants' responses, the purpose of the research was not disclosed in advance; participants received the information that the study topic was quality of life in airport regions. The discussion guide was structured with specific questions and prompts that amongst others covered the following topics:

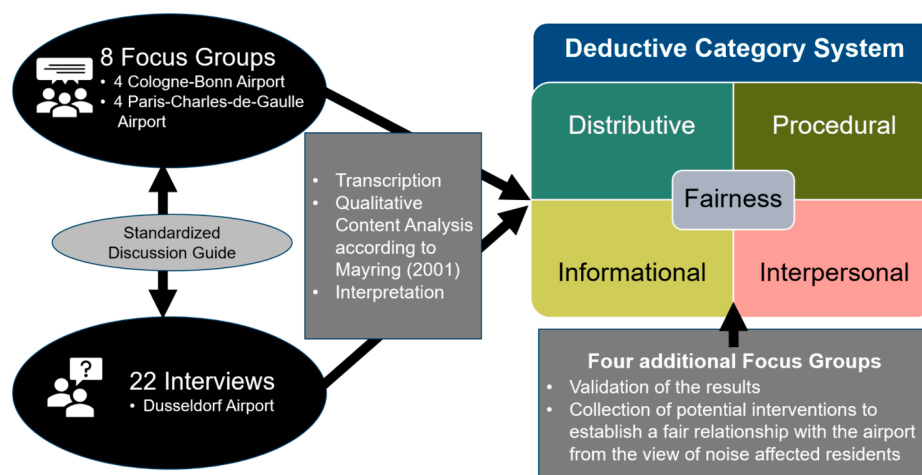


Fig. 1. Study design to investigate the four facets of fairness qualitatively in the context of aircraft noise research.

- A description of what an ideal and fair neighborly relationship with the airport would look like.
- Participants’ current perceptions of communication and information dissemination related to the airport.
- Expectations for information dissemination (e.g., what type of information is needed, who should provide it, and how the information should be provided).

The focus group discussions lasted between 1 and 2 h, and the in-depth interviews lasted on average 26 min. Participants were compensated with € 30 (Dusseldorf Airport and Paris Charles-de-Gaulle Airport) and € 50 (Cologne-Bonn Airport) for their participation in the study. Participants around Cologne-Bonn Airport received higher compensation (€50) because a pre-test indicated that offering €30 did not yield as high a response rate. To facilitate analysis, audio recordings of both the focus group discussions and in-depth interviews were made with the consent of the participants.

Additional focus group discussions

As described in section 2.1, additional focus groups were conducted to validate the results and address research question 3, focusing on collecting potential interventions for a fair and neighborly relationship with the airport from the view of noise affected residents.

The discussions began with introductory questions to understand participants’ attitudes towards the airport, such as their ideal relationship with it. The findings from the initial focus group discussions were presented to the participants to confirm the previous results and ensure their reliability. This was done using the Chinese portrait method (e.g. Maison, 2018; Wójcik, 2011), which prompted participants to associate fairness with places and objects. The goal was to emphasize fairness and prepare participants for further exploration.

The final part aimed at connecting the perception of fairness to the current airport situation. Participants were asked to envision how interventions would look like if they were to put the ideas into practice. This step required participants to apply the abstract concept of fairness to a real-world context. This comprehensive approach activated cognitive processes and aimed to achieve practical results using the implementation intentions strategy by Gollwitzer (1999). The objective was to understand how justice elements can be effectively applied in practice.

2.5. Analysis

The audio recordings of the focus group discussions and the in-depth interviews were fully transcribed. The tool “Amberscript” was used for this purpose, which complies with EU data protection regulations and was approved by the Ethics Committee (Amberscript, 2023). Furthermore, a non-disclosure agreement was signed with Amberscript. The transcribed text was qualitatively analyzed by means of Mayring’s deductive category (2015). This is a specific qualitative content analysis approach used to structure qualitative data based on predefined categories. This approach uses a-priori evaluation categories that are established based on theory, allowing for content-related structuring (Mayring, 2015).

In this study, the category system was developed based on current fairness research theories according to which were described above and consists of distributive, procedural, informational, and interpersonal fairness as the predefined main categories (Adams, 1965; Bies, 1986; Greenberg, 1993; Leventhal, 1980). The sub-categories, referred to as subfacets, are defined in Table 1, with examples provided. The examples in this table are based on an application of the fairness facets to the context of aircraft noise issues (Hauptvogel et al., 2021a). The focus group discussions and in-depth interviews were conducted in German and French, with the examples presented in this section translated into English.

Table 1

Deductive category system to categorize the statements from the participants, according to a qualitative content analysis (Mayring, 2015).

Fairness Facet	Subfacet	Description in the context of aircraft noise research
Distributive	Equity	The aircraft noise is distributed in a way that the ratio between the disadvantages and the benefits of the nearby airport are equal between all residents.
	Equality	Noise should be distributed equally over as many residents as possible, regardless of the composition of residents and other environmental strains.
	Need	Residents with special needs (e.g., children, sick or elderly) should be protected from the noise as much as possible.
Procedural	Process control	Residents have the opportunity to participate in decisions regarding aircraft noise management.
	Decision control	Residents can influence decisions regarding aircraft noise directly.
	Bias suppression	Decisions by the airport or airport stakeholders should not be taken solely for self-interest and economic reasons. For example, noise thresholds should be based on scientific knowledge of health effects.
	Representativeness	During all phases of decision-making procedures, the concerns and opinions of all affected citizens should be represented.
	Consistency	Procedures are consistent for every resident; nobody is given an advantage or disadvantage.
Informational	Accuracy	The allocative process is based on sufficient, correct, and appropriate information. In this case, e.g., noise insulation schemes should be based on the most recent scientific data about the impact of noise on health.
	Correctability	Opportunities exist to alter or reverse an inaccurate decision at various stages of a process. If decisions are made that affect the citizens concerned, they should be reconsidered and adapted accordingly in light of newer knowledge.
	Truthfulness	Communication with residents is based on honesty.
Interpersonal	Justification	Decisions are adequately explained to residents and the reasons for decisions are disclosed
	Propriety	Interaction with residents is characterized by respect and courtesy.
	Respect	Interaction is non-judgmental and courteous.

Note: Based on research by Adams (1965); Bies (1986); Greenberg (1993); Leventhal (1980).

3. Results

The results will be presented in two sections. In the first section, the analysis of the main in-depth interviews and focus group discussions are presented (research questions 1 and 2).

The second section focuses on the additional focus group discussion conducted to discern specific interventions that are desired from the perspective of noise affected residents (research question 3).

3.1. Sample description

In the first part of this sample description, the sample of the main study is described to answer research questions 1 and 2. In the second part, the smaller sample is presented, which describes the part of the study to validate the results and to answer research question 3.

3.1.1. Sample description of the main study

Table 2 shows the sample description of the focus group discussions

Table 2
Sample description of the main part of the study (N=68).

Variables	Cologne-Bonn Airport		Paris-Charles-de-Gaulle Airport		Dusseldorf Airport	
	Low exposure	High exposure	Low exposure	High exposure	Low exposure	High exposure
N	14	15	8	9	9	13
Gender	5 female 9 male	9 female 6 male	4 female 4 male	5 female 4 male	3 female 6 male	7 female 6 male
Age (M)	48,7	47,3	45,0	44,0	68,8	60,4

Note. Low exposure is defined as ≤ 55 dB L_{den} , while high exposure is defined as > 55 dB L_{den} . 'Age (M)' refers to the mean age of the participants.

and in-depth interviews to answer research questions 1 and 2. They represent the primary part of this paper. Four focus groups were conducted around Cologne-Bonn Airport, four more focus groups around Paris-Charles-de-Gaulle Airport and 22 telephone interviews around Dusseldorf Airport.

Sample of the additional focus groups

In November 2020, four online focus group discussions were conducted. The participants were residents living near Paris-Charles-de-Gaulle Airport. The total sample consisted of 20 residents, with 12 females and 8 males, ranging in age from 21 to 63 years with an average age of $M=42$ years. The sample was divided into four subgroups based on their place of residence (rural vs. urban) and their level of noise exposure (high > 55 dB L_{den} vs. lower ≤ 55 dB L_{den}). Additionally, a fifth group was formed with members of resident associations to ensure a comprehensive representation.

3.2. Fairness aspects from the view of affected residents

In the following section, the statements made by the participants in the focus group discussions and the in-depth interviews around Cologne-Bonn, Dusseldorf and Paris-Charles-de-Gaulle Airports are assigned to the respective fairness facets and then discussed (research questions 1 and 2).

3.2.1. Distributive fairness

In this section, statements from noise affected residents of all three airports are assigned to the subfacets of distributive fairness, namely *equity, equality and need* (see Table 1).

The aspect of fairness in *equity* is most commonly referred to. Participants from both Dusseldorf Airport and Cologne-Bonn Airport highlight the proximity to the airport and the convenience of travel as key benefits of living close to the airport. Additionally, the airport is recognized as an important economic factor. One participant from Dusseldorf stated, "If we ever fly away, (it is not that far) and I could well imagine that the airport is an economic factor." (high exposure group, Dusseldorf). In Cologne-Bonn, the residents stated the airport's relevance as an economic driver as well. For example, a resident of a highly noise-exposed region stated: "I would be strictly against doing something against the airport. There are people who demand a ban on flights. [...] But in general, we depend on the airport for our living in the region." (high exposure group, Cologne-Bonn). Aside from the easy access to the airport, participants in Cologne-Bonn see the airport as a personal benefit, offering shopping opportunities on Sundays and public holidays when other shops are closed. They also see the airport as an attraction for families with children, providing a chance to observe aircraft taking off and landing.

However, participants raise a variety of disadvantages associated with living close to an airport and air traffic in general is mentioned as well. „The negative is, of course, the aircraft noise." (low exposure group, Dusseldorf). Further, air pollution due to air traffic is mentioned. It should be noted here that night flights are perceived as particularly burdensome around Cologne-Bonn Airport, due to a lack of night flight restrictions. One resident shared the following argument: "What I find particularly annoying are the cargo planes at 4 a.m., the old aircraft packed

full trying to take off." (low exposure group, Cologne-Bonn). Participants complain about the lack of parking space, as passengers of the airport often park their cars in residential areas ("In addition, there are problems for local residents caused by passengers, who park their car in the region"; high exposure group, Dusseldorf).

Sound insulation schemes are viewed as positive and necessary, but simultaneously the airport should further support residents and provide more and better sound insulation. However, some participants view the aircraft noise as being more problematic when one is outside the house ("Yes well, we have soundproof windows. But of course, that doesn't help if you want to enjoy the beautiful garden."); low exposure group, Dusseldorf). Noise protection measures (such as sound insulation) are classified here as distributive fairness, as this reduces the individual disadvantages (the noise exposure) and thus achieves a better distribution between disadvantages and benefits, in accordance with the definition of distributive fairness (Adams, 1965).

To mitigate the impacts of noise exposure, two potential compensation measures were discussed among residents living near the Cologne-Bonn Airport. It was proposed that the airport could provide residents with two free flights per year¹ and allow them to park at the airport without charge. From the perspective of the participants, this would at least somewhat compensate for the disadvantages of the airport in the region.

Aspects related to *equality* are only mentioned once both around Dusseldorf Airport and Cologne-Bonn Airport. In participants' opinion, the air traffic is already spread across different areas or flight routes are alternated to distribute the aircraft noise. Other participants think that the airport should focus more on the distribution of aircraft noise. "And yes, you can certainly consider [...] whether you change the runways more often. They are often moved from one runway to the other. Then the take-off is further north, which is more pleasant for everyone in the south, and vice versa." (high exposure group, Dusseldorf). In Cologne-Bonn, participants observed that aircrafts follow different routes on different days. They perceive this as a deliberate effort to distribute the aircraft noise among residents. One participant from the low exposure group in Cologne-Bonn commented: "And the following week, at the same time, the same aircraft comes, but it is much further over there. There seems to be quite a variety of departure routes. I suppose it's a compromise: sometimes it's more of a burden on one group, sometimes it's more of a burden on another" (low exposure group, Cologne-Bonn).

3.2.2. Procedural fairness

In the following, statements of noise affected residents are assigned to the facets of procedural fairness, namely *process control, decision control, bias suppression, representativeness, consistency, accuracy and correctability* (see Table 1).

Process control is mentioned repeatedly from the participants of all three airports. Whenever it is brought up, participants express dissatisfaction with the lack of engagement opportunities and transparency in decision-making processes. "There's no communication, there's no

¹ It must be noted that this proposal cannot be considered a long-term solution in the context of the climate crisis, but rather is perceived as a reasonable solution from the perspective of the participants of this specific focus group.

transparency. It's not announced either. It's just done that way. " (high exposure group, Dusseldorf). "You can start a "pseudo-dialogue" like that, but they're basically useless." (low exposure group, Dusseldorf). Residents near Cologne-Bonn Airport express a sense that the airport is unapproachable and indifferent to the needs of the local community. They would like to see the airport provide opportunities for affected residents to engage in dialogue and exchange ideas. "If focus groups like these could be arranged, why doesn't the airport do so? Where people can come together and voice their criticisms against the airport." (high exposure group, Cologne-Bonn). Another resident commented, "I would then feel that the airport has an open door and is making an effort to be a good neighbor." (high exposure group, Cologne-Bonn). The residents emphasize the need for improved communication from the airport, suggesting that a citizen dialogue takes place twice a year. The aspect of proactivity is of particular importance to the residents. They should not have to fight for involvement, but rather, the airport should take the initiative to seek out their opinions. One resident emphasized the feeling of helplessness in relation to the airport and stressed that if residents were given a voice, less issues would be raised. "I also see a lack of opportunity for citizen participation. [...] There's no one listening us! Only during elections, they all become active and make promises. [...] We all try to make an impact and our voices heard, but we are not listened to. You can make a point once, but three minutes later they've forgotten everything." (low exposure group, Cologne-Bonn).

The aspect of *decision control* is closely linked to the process control aspect. Although it is not frequently mentioned, it has a negative connotation when it is brought up. "Perhaps there should be a round table discussion. But everything is always decided somewhere in the city, single-handedly." (low exposure group, Dusseldorf). In regard to decision control, residents near Charles-de-Gaulle Airport point out that decisions are frequently made without considering the needs of the residents, including those with long-term impacts. "They must have involved us in the decision for instance for the terminal four extension! The project is already fixed for 10 years without considering the real impact on our quality of life!" (low exposure group, Paris-Charles-de-Gaulle). One resident acknowledged that the airport has limited responsibility for decisions, as many of them depend on various stakeholders such as the federal government, state government, local government, and airlines. Night flights at Cologne-Bonn Airport are, as mentioned previously, a key concern for residents. They are aware that decisions at the airport must balance the interests of various stakeholders. "I understand that people work there and that people want to fly. I am part of the system myself. But it needs to be discussed openly and a solution needs to be found that takes everyone's interests into account and is followed." (low exposure group, Cologne-Bonn). One resident suggested that regular meetings should be held between affected residents and representatives of citizen initiatives, so that they can represent the needs of the residents at the airport.

The aspect of *bias suppression* is another issue raised by the residents with regards to the airport's practices. They contend that the airport does not provide impartial information and that airport expansions are executed without sufficient environmental impact assessments. This raises concerns about the prioritization of the economy over the environment, and the fairness of putting financial profit ahead of the quality of life of affected populations. The less impacted communities demand greater transparency and action to mitigate the negative effects of airport operations on their health and well-being. A resident from Paris-Charles-de-Gaulle Airport emphasized this point by stating, "The airport always prefers the economic decision rather than the ecologic one, they never take into account the ecological issues in their decision." (low exposure group, Paris-Charles-de-Gaulle). This highlights the importance of fairness in considering the impact of airport operations on local communities and the environment.

The significance of considering the perspectives and needs of local residents into the decision-making process, the *representativeness*, is a recurring theme among participants. It is crucial to consider residents' needs and engage them in airport-related processes and decisions. "I

think, if the airport approaches (the residents) and that one mutually tries to understand the situation and the needs of the other, then (that would be good)." (high exposure group, Dusseldorf).

The issue of consistency was raised by residents with regards to the airport's sound insulation scheme policy. "However, within a street, for example, (one house gets the soundproofed windows and another house does not). Although they are just as annoyed, there were some limits or boundaries drawn. And I found that very unfair." (high exposure group, Dusseldorf). Specifically, they express concerns regarding the enforcement of the night flight ban and limitations on airport expansion. "We have a night flight ban, if I know correctly. [...] And there are exceptions constantly. When there are charter flights in the summer, the ban is somehow increased to 11 or 12 o'clock. I don't think that's good" (low exposure group, Dusseldorf). Furthermore, residents living around Cologne-Bonn Airport expressed the need for consistency regarding the information provision online, as well as for engagement opportunities in airport-related processes and decisions.

According to participants, the airport should measure the air pollution and regularly evaluate the protection zones in order to meet the fairness aspect of accuracy. "These zones are also checked regularly. Not every week, but every 2 or 3 years to see if anything has changed." (high exposure group, Dusseldorf). Additionally, residents should be provided with accurate information about noise distribution, changes, and improvements being made at the airport, which is particularly relevant for property purchases and decisions. Furthermore, participants felt that the maximum nighttime exposure for aircraft noise should be redefined based on the findings of scientific human research, with the health and well-being of residents taking priority over economic interests in air traffic. Participants expressed their disbelief in the airport's disregard for expert opinions which prove the harmful effects of night flights on health. "For me, it is incomprehensible why the airport does not recognize these expert opinions?" (low exposure group, Cologne-Bonn).

The concept of *correctability* was only indirectly referenced. Residents near the Cologne-Bonn Airport expressed their dissatisfaction with the night flights in the area and strongly advocated for a night flight ban. This indirectly alludes to the idea of correctability, as the residents were well aware that they have no means to challenge or change this decision.

3.2.3. Informational fairness

Thirdly, statements are assigned to the respective subfacets of informational fairness, namely *truthfulness* and *justification*.

Truthfulness is a recurrent theme among participants, who indicate a lack of informational fairness on the part of the airport. Some participants do not view information originating from the airport as impartial and truthful, but rather as being embellished by the airport to promote its own objectives. Residents living near Cologne-Bonn Airport have expressed their dissatisfaction with the fact that they are unable to obtain answers to their questions in a manner that is consistent with informational fairness. It is particularly striking for residents that there is no ban on night flights at Cologne-Bonn Airport, which elicits confusion among residents who do not receive any explanations. One resident commented, "How come Dusseldorf has a night flight ban and Cologne-Bonn Airport does not. I suspect or I fear that nothing will change in the foreseeable decades." (high exposure group, Cologne-Bonn). Another resident emphasized the significance of open communication, stating, "For me that would already be a neighborly relationship, if the other person answers me." (high exposure group, Cologne-Bonn).

Another aspect relates to transparency. One resident noted, "I think the airport is also a neighbor with closed doors, that's how it looks to me." (high exposure group, Cologne-Bonn). This resident stresses that a fair, neighborly relationship could be established, if the airport was more transparent, if information was more freely available, and if there was a greater willingness to engage with noise affected residents. Residents living near Paris-Charles-de-Gaulle Airport have suggested the use of a mediator: "We need some neutral mediator to communicate with us. Even if airport managers present data, we are not sure that this data is true." (low

exposure group, Paris-Charles-de-Gaulle). This highlights the issue of the airport not being perceived as truthful, and residents distrusting the airport's information and systematically questioning it. One participant noted that honesty could be a quick way to overcome this issue, "This could be overcome relatively quickly if I feel that the airport [Cologne-Bonn] is telling the truth, the whole truth, and that it takes me seriously and sticks to agreements." (low exposure group, Cologne-Bonn). Other participants added aspects that, according to them, are often overlooked, such as the airport highlighting the positive aspects of its operations. For example, one participant stated that noise is an inherent part of an airport and that it is important to acknowledge that thousands of rescue flights are also handled and that goods are supplied that are bought in the supermarket every day. In this way, the positive aspects of the airport should be emphasized, thereby contributing to a more positive and complete picture of the airport.

Residents living near Cologne-Bonn Airport have criticized the airport's justification for allowing night flights, and have expressed the opinion that the decision should be explained in detail. "I don't know what legal or other agreements there are. The fact that there is a ban on night flights in Frankfurt and Cologne can't manage it...". "In all these years, I have never once heard why a night flight ban is not possible in Cologne-Bonn. And that's where I have a problem" (high-exposure group, Cologne-Bonn). The airport is generally perceived as being uncommunicative. "I would give it an "A" in compartmentalization." (low exposure group, Cologne-Bonn). Residents suggest that the airport should be more proactive in reaching out to them and providing information about its plans and decisions. "What I miss is [...] that the airport approaches the affected residents and asks, "well, are you doing well? what do you think? We'll have an information event that day and we'll tell you what we're going to do and how terrible or how good it is" (high exposure group, Cologne-Bonn). Further, it is important for contact persons to be adequately qualified to provide information. "If you want to reach [...] someone, you never know if the person is even qualified to answer the question." (high exposure group, Cologne-Bonn) The need for informational fairness to be established in the long term was emphasized by saying "I think the airport has it really hard. I firmly believe that the airport is acting out of self-interest with its actions. The airport has to communicate with me in a very transparent way for a long time for me to believe that" (low exposure group, Cologne-Bonn). Residents desire information about the night flight ban, noise protection zones, and flight routes. Information about the night flight ban and future plans are viewed as desirable as well as justifications on the noise protection zones ("Whether (the zones are still correct)?"; high exposure group, Dusseldorf) and the flight routes ("Otherwise, the transparency of the airport in that direction is missing. Because there are definitely flight routes that are more bearable"; high exposure group, Dusseldorf).

3.2.4. Interpersonal fairness

Lastly, to answer research questions 1 and 2, statements are assigned to the subfacets of interpersonal fairness, *respect* and *propriety*.

Regarding interpersonal fairness, residents hold different perceptions. Some residents living around Cologne-Bonn Airport and Dusseldorf Airport view being responsive to neighbors as part of a fair and neighborly relationship. "For me that would already be a neighborly relationship. If the other person replies to me." (high exposure group, Cologne-Bonn). This refers to the aspect of *proactivity* as well. One resident criticized that the airport is always pressured into action. "It has to happen on its own initiative, not under pressure [...]. People complain to each other and that doesn't achieve anything, but the airport has to take care of it, it has a responsibility to take care of it!" (high exposure group, Cologne-Bonn).

The obligation of the airport to care for residents due to the health effects of long-term aircraft noise is recognized by the residents as well. Residents in the Cologne-Bonn area in particular see a ban on night flights as necessary in order to feel respected. "There is a basic alphabet of decency. I would say that a ban on night flights and appropriate sleeping hours are part of that!" (high exposure group, Cologne-Bonn). A resident

formulated a respectful approach as follows: "I think it's a nice idea to imagine that you really are a neighbor. Then you make sure that you can sleep at night alongside your neighbors or that you are considerate. If you throw a party, you inform them or invite them over." (high exposure group, Cologne-Bonn).

One participant sees no neighborly relationship between the airport and the residents at present. This is commented on by another participant: "We knew when we moved here that the airport was here, we knew what we were getting into. You always have something [environmental pollution] somewhere. But regarding neighbors, I don't turn up my radio at night until the neighbor falls out of bed and then say that's not that bad, you'll get used to it. At least a period of five or six hours where there's really no noise, that would be great."²(high exposure group, Cologne-Bonn). Another resident stated that he had the feeling that the fronts were hardened, but that there was a general willingness to cooperate: "The attitude is partly hardened and also partly resentful. I think it's like talking in a marital dispute, the willingness to talk mitigates that a little bit. That is, of course, completely lacking." (high exposure group, Cologne-Bonn).

Other residents, especially those with low levels of noise exposure, see noise reduction as the only viable option for dealing with each other in a respectful manner. "A ban on night flights would be great, and perhaps the provision of sleeping quarters, so that they are sealed off somehow, so that you can sleep in peace." (low exposure group, Cologne-Bonn). Residents around Paris-Charles-de-Gaulle mentioned that for now, the only strategy that was put forward by the airport is to relocate residents. However, it is a strategy that ignores the problem as opposed to solving it. Residents undoubtedly prefer strategies that aim at the source of the problem in order to tackle it. "We, as citizens, are forced to be compliant, if we are not happy they will say move out" (low exposure group, Paris-Charles-de-Gaulle). Another aspect refers to the parking situation that arises due to passengers. "(Passengers) (use) [...] the parking space of the residents. Of course, the airport does not try to solve such things in any way by saying, okay, I'll create more parking capacity." (high exposure group, Paris-Charles-de-Gaulle).

It is difficult to distinguish between the aspect of propriety and aspects that were previously assigned to the category of respect. Statements from participants refer to general aspects that participants describe as respectful interaction, for example "What I miss, now that I think about it. If I want to be a good neighbor, then I am first of all friendly to people and talk to them. Family Day, making the airport open, showing how everything works. In fact, it's totally exciting what's happening there!" (low exposure group, Cologne-Bonn).

3.3. Results from the additional focus group discussions around Paris-Charles-de-Gaulle airport

In this section, the results from the additional focus group discussions around Paris-Charles-de-Gaulle Airport are presented, conducted to validate the results from the main focus group discussions and in-depth interviews conducted at the three European airports and to specifically ask residents about interventions to create a fair, neighborly relationship with the airport, answering research question 3 (see Section 2.1). These interventions are to be understood as ideas considered relevant from the perspective of the affected residents. Whether and how they are actually implemented must be discussed in the future.

In these additional focus group discussions, participants were specifically asked about interventions to establish a fair and neighborly relationship. It is important to note that these results are separate from

² It should be emphasized that even at airports where general night flights are prohibited, exceptions are still possible. At Frankfurt Airport, for example, a general ban on night flights has been established, but an annual average of up to 7.5 landings between 11p.m. and midnight is still permitted (Frankfurt. (2023). <https://frankfurt.de/themen/umwelt-und-gruen/umwelt-und-gruen-a-z/laerm/fluglaerm/nachflugverbot>).

the previously presented findings and serve to reinforce the conclusions from the first phase.

Participants affected by aircraft noise shared their ideas to enhance the relationship with the airport. The affected residents proposed concepts that integrate the fairness facets of distributive, procedural, informational, and interpersonal fairness.

Residents prioritize appropriate interventions to address *distributive* fairness, focusing on reducing noise and implementing financial solutions to balance advantages and disadvantages. They seek a reduction in noise as a core element of fair and neighborly coexistence. Regarding compensation for noise, residents desire improved employment opportunities for young residents, affordable airport parking, flight discounts,³ tax benefits, simplified noise abatement procedures (particularly in remote areas), and free medical examinations to assess noise and air pollution impacts.

Other aspects related to the airport's presence were also mentioned, including efforts to address traffic congestion, improve road conditions and public transport cleanliness, increase security with police presence, and enhance tourism in the airport vicinity (e.g., upgrading the airport shopping center to attract tourists).

There is a notable difference between the association group and the rural high-exposure group regarding noise distribution. The rural group believes that adding more flight routes to disperse noise would reduce annoyance, while the association group considers reducing the number of people potentially affected by noise by decreasing flight routes to be more relevant.

Residents put forth ideas for interventions that align with aspects of *procedural* fairness. Some participants suggested establishing intermediary mediation services for local residents to facilitate processes that are considered fair by affected residents.

Residents expressed a desire for increased involvement in airport processes and the ability to communicate their wishes, views, and concerns. They proposed sharing their thoughts through questionnaires, surveys, polls, or direct contact in meetings with a neutral third party. They also recommended establishing organizational elements like users' committees, municipal representatives, general assemblies, and representation in airport decision-making. Involving the city and implementing interventions in schools, such as career forums and parent-child workshops, were also suggested.

The resident association group expressed additional viewpoints compared to other groups. They disagreed with the current measures, arguing that mere discussions are insufficient, and residents are not offered suitable job opportunities. Instead, they advocated for imposing stricter sanctions on airports or airlines that exceed noise limits and designated time frames.

Regarding communication and informational fairness, participants across all groups expressed a need for more information about health risks, pollution, and the airport's efforts to reduce noise impact. To address this, they suggested various communication channels, such as newsletters (both email and paper), websites, mobile applications, and monthly public meetings.

One common sentiment among all groups (rural, urban, and resident's association) was feeling excluded from discussions on airport noise exposure. They emphasized the crucial role of real information and complete transparency from the airport to foster inclusivity in the decision-making processes.

4. Discussion

This qualitative study delves into the four dimensions of fairness, which have been empirically validated and explored in the realms of

social, organizational and legal psychology, in the context of aircraft noise research. By bridging the theoretical groundwork laid out by Hauptvogel et al. (2021a) with the real experiences and subjective perceptions of residents impacted by aircraft noise, this research addresses an important gap in understanding fairness perceptions of affected residents. Furthermore, the study investigates the preferences of affected residents regarding potential interventions aimed at fostering a neighborly relationship with the airport, within the broader context of fairness research.

4.1. Discussion on distributive fairness

The aspect of distributive fairness plays a recurring role for the residents concerned in the focus group discussions and the in-depth interviews. *Equity* in the sense of the relationship between the cost or in this case disadvantages and the benefits from the airport in the region is a highly relevant topic from the perspective of the participants. There are also positive aspects that are associated with the airport in the region, such as short distance to the airport, the shopping opportunities or the important economic relevance in the region. However, most of the statements refer to the disadvantages living near an airport. For example, residents perceive the noise from the aircraft and the air pollution as negative aspects. Residents in the vicinity of Cologne-Bonn Airport see the noise during the night hours as particular burdensome and unfair. *Equality* was mentioned only rarely by affected residents. However, it should be emphasized that residents around Dusseldorf Airport and Cologne-Bonn Airport are aware that the airport systematically varies the noise exposure in order to reduce the impact on different residential areas at different times. However, this variation was hardly intended to distribute the noise among residents as an intentional act by the airport and is most likely a wind-dependent change of operating directions. The *needs* approach aspect was not mentioned by any of the participants. This may be due to the fact that the residents interviewed here, focus on their personal perceptions and their personal burden. The *needs* approach in this context would mean that residents who already have other sources of noise in the neighborhood or belong to a vulnerable group (children, the sick, the elderly) are especially protected from noise.

The results indicate that distributive fairness makes an essential contribution to the perception of fairness in the context of aircraft noise. Although the negative aspects predominate, positive perceptions were nevertheless expressed by the participants. It can be seen around Cologne-Bonn Airport, as well as at the other airports, that residents are aware of the relevance of the airport as an economic factor in the region and also of other positive aspects. As a negative aspect, night flights should once again be highlighted here, which are seen as particularly unfair by participants at Cologne-Bonn Airport. The aspects of equality and need are less strongly represented. Therefore, no statement can be made on the basis of this study as to which distribution of noise in the region is perceived as particularly fair.

In regard to potential interventions focusing on these aspects, two aspects should be highlighted. Firstly, efforts should continue to be made to mitigate individual noise exposure, especially at night. On the other hand, in the sense of establishing a fair disadvantage-benefit ratio, ways should also be sought to compensate residents or municipalities for the burden the airport causes in regard to noise exposure. During the focus group discussions and in-depth interviews, residents voiced their preferences for different compensation options. These suggestions offer a valuable chance to explore and refine these ideas, ultimately incorporating them into concrete intervention plans. For instance, rather than granting tax benefits to individuals, the airport could engage in supporting local projects or allocate financial resources to communities for free disposal services. It is essential to emphasize that such initiatives should not be seen as an attempt to "buy off" the airport's responsibilities towards the well-being of affected residents. Instead, they should complement efforts to alleviate the burdens and ensure a

³ As mentioned earlier, it must also be emphasized here that, within the context of the climate crisis, measures leading to an increase in flight movements cannot be considered a long-term solution.

reduction in the overall impact on the community. It is essential to reiterate that the interventions discussed here represent ideas put forth by residents, with the aim of potentially improving the neighborly relationship with the airport, as seen from their perspective. This study does not assert that these interventions comprehensively address all the adverse health-related consequences of aircraft noise.

4.2. Discussion on procedural fairness

While prior research on procedural fairness (Leventhal, 1980) proposes a distinction between process control and decision control, it is not feasible to make such a differentiation in this particular context. The primary concern for residents affected by noise was their general involvement in the decision-making process. Residents do not voice a clear distinction between participating in the process and actually influencing decisions at the airport. This lack of distinction may stem from the residents' perception of being currently excluded entirely from the decision-making process at the airport. It is possible that if they feel they are involved in the decision-making process, they pay more attention to whether their involvement is merely procedural or if they can actually impact the decisions. Regarding the airport's decisions, it is important to note that residents are well aware that those decisions are made based on the interests of multiple stakeholders. The residents have indicated the aspect of bias suppression, although it is more about decisions being made without considering the residents' quality of life. This aspect of bias suppression is intricately connected to both process and decision control, as it entails integrating residents' concerns into the decision-making process. In the present scenario, accuracy entails decisions being consistently assessed using up-to-date and correct information. As suggested by Leventhal (1980, p. 41), accuracy pertains to information and opinions being "gathered and processed with a minimum of error". Additionally, accurate communication of information is essential from the view of affected residents to perceive the airport as fair. This aspect can also be associated with bias suppression and is relevant to informational fairness as well. To summarize, residents perceive low levels of process and decision control across all airports. They view the airport as non-transparent, unapproachable, and indifferent to the local community's needs. Proactivity plays a significant role in this context. Residents expect the airport to proactively engage with affected individuals and involve them in processes and decisions. The reason for this could be that the residents are constantly exposed to aircraft noise and therefore also expect the noise emitter to act. Residents emphasize their desire to be engaged and not presented with a fait accompli. They suggest focus group discussions or round table talks as suitable methods for involvement. Particularly, they stress the importance of being part of the decision-making process before final decisions are reached. Participation in decision-making is a top priority for residents, with a focus on ensuring procedural fairness by addressing bias suppression, representativeness, consistency, accuracy, and the ability to correct errors.

As indicated by (Woodward et al., 2009), airports might struggle to effectively communicate with the public if they rely solely on "one-way" communication methods. This study highlights the importance of adopting a two-way communication approach that actively engages with the public, which is essential for cultivating long-term trust. Considering this perspective within the framework of research on procedural fairness provides further context. This research lends support to the recommendations outlined in the Toolkit for *Managing Community Expectations* (2009), integrating them into the realm of social justice research. The recommendations provided, such as strategies for comprehending public concerns and fostering two-way communication with the public, are categorized here as procedural fairness research. This qualitative study acknowledges these recommendations as essential steps that are also actively sought after by the residents affected by aircraft noise.

In regard to potential interventions derived from these results,

residents suggest to establish an intermediary mediation service to facilitate fair processes and offer the ability to express their wishes, views and concerns (through questionnaire, surveys, polls or, more preferably through direct contact, assisted by a neutral third party). In terms of procedural fairness, they also highlighted the establishment of committees, where different stakeholders are representing different groups in the decision-making process. These findings support prior qualitative studies seeing procedural fairness being important for residents (Liebe et al., 2020; Sommerfeld, 2013). Noise affected residents, especially in the vicinity of Cologne-Bonn Airport, are also demanding the possibility to revise what they consider to be wrong decisions on e.g. night flights. One possibility here could be to ensure that decision-making processes are made in accordance with a scientific advisory board to ensure that, for example, night flight permits are evaluated at regular intervals with regard to scientific findings on their effect on health. This also requires the possibility to revise decisions, which goes hand in hand with the aspect of correctability and accuracy from procedural fairness research (Leventhal, 1980).

4.3. Discussion on informational fairness

Informational fairness seems to be an important factor for residents. In contrast to the perspective put forth by Bies (1986), the current reality often involves an indirect interaction between the airport and residents due to noise-related impacts. However, it is crucial to acknowledge that residents wish for a direct and meaningful interaction, allowing for an exchange of information. Despite the prevailing indirect interactions in the current situation, there is a strong desire among residents to establish a direct channel for communication with the airport. This direct interaction would facilitate a more transparent and informative relationship between the two parties. Furthermore, in the present context, informational fairness closely intertwines with procedural fairness. It revolves around the understanding that effective participation opportunities for residents can only exist if the information shared by the airport during these interactions is both truthful and transparent. Therefore, the aspects of informational fairness are intricately linked to the bias suppression in procedural fairness. In this context, bias suppression refers to the airport making decisions not based solely on their own economic interests but in a fair and impartial manner, while also taking empirical findings into account. Regarding justification, it is essential for residents to be informed when airport decisions are detrimental to their well-being. Establishing a long-term, honest relationship and providing transparent information are crucial in this regard. Overall, the aspects of informational fairness play a significant role in cultivating a fair and neighborly relationship, serving as the foundation for building trust between the airport and the residents. The airport's lack of transparency and inadequate explanation of its decisions have created a perception of dishonesty among the residents affected by the airport. One particularly contentious issue is the night flights at Cologne-Bonn Airport, which significantly burden the local residents. These residents consistently express their frustration and inability to comprehend the necessity of these flights. They believe that a neutral mediator is essential to facilitate communication between the airport and the community. The residents' statements clearly indicate a lack of trust in the airport's actions, resulting in a general skepticism towards the information provided. Rebuilding this trust will undoubtedly require a considerable amount of time and effort. These findings align with the research conducted by Sommerfeld (2013), highlighting that residents desire comprehensive, transparent, and honest communication from an airport.

Elements of informational fairness, such as transparent and easily understandable information provision, have previously been identified as crucial measures to enhance residents' acceptance of decisions and mitigate nuisance, as discussed by Heyes et al. (2021); and Woodward et al. (2009). The results of this study reinforce these recommendations and classify them within informational fairness as a fundamental factor.

Based on the wishes and demands of the residents affected by noise, it can be said that the airport should provide information in a truthful and direct manner in the future in order to establish a fair and neighbourly relationship with local residents. This research confirms the already recommended strategy that information communication should be clear and honest (Woodward et al., 2009). In the present study, however, it is categorized within the framework of informational fairness, which provides the necessary theoretical framework for this recommendation and is further supported by the qualitative work. The results regarding the other fairness facets on distributive and procedural fairness indirectly demonstrate further that informational fairness is an important issue. For example, participants repeatedly expressed incomprehension about noise protection regulations and emphasized that they did not know that there were contact points at the airport. A resident at Cologne-Bonn Airport pointed out that he did not know for sure whether and how a ban on night flights was established there. These aspects, assigned to other fairness facets, also underline the relevance of informational fairness in this context.

4.4. Discussion on interpersonal fairness

Interpersonal fairness at its core entails that the interaction between the parties involved is conducted in a respectful manner. Within the context of noise research, interpersonal fairness and general respect is closely tied to the notion of taking residents' needs seriously. In this regard, being proactive is crucial, as the airport should actively engage with residents and inquire about their situation. At Cologne-Bonn Airport, residents view the absence of a night flight ban as a concern in terms of respectful interaction. They hold the belief that implementing a night flight ban would be a respectful measure, considering the adverse impact of nighttime flights on their sleep. Residents draw a comparison between the airport and a considerate neighbor—one that genuinely cares about its neighbors, prioritizes their well-being, and treats them with respect. It is challenging to separate the fairness facets *respect* from *propriety* commonly seen in research (Bies, 1986) in this context, as it primarily reflects the airport's underlying attitude that shapes the principles of a fair coexistence.

4.5. Summary

In summary, we conclude that in distributive fairness, the aspect of equity is particularly relevant in the context of noise research. Here, residents perceive an imbalance between the disadvantages they experience and the benefits they notice from the airport. First, interventions to mitigate the noise from source would be essential to reduce the negative aspect of the airport. A provision of noise-free times, also called respite, could also be established in consultation with the affected residents. Here, arrivals and departures at the airport would be systematically varied in order to relieve some residents at certain times, while other residents would receive more noise during this time (Porter, 2017; Schreckenberger et al., 2016).

In this context, the findings build upon prior research on interpersonal fairness. Residents impacted by aircraft noise, particularly those affected by night flights at Cologne-Bonn Airport, perceive certain airport actions as lacking respect. They view a prohibition on night flights as a gesture indicating regard for the community. This underscores the airport's imperative to cultivate respectful engagement with residents on a broader scale.

Another aspect, which has already been published as a recommendation, is that employees at airports should have "people skills" in addition to technical skills. This means that the people who are in contact with the affected residents should be sensitive. This aspect is also embedded here in the empirical context of interpersonal fairness and could be analyzed.

While certain publications have highlighted the importance of fairness in interactions with affected individuals, this recommendation has

not yet been integrated into a social-psychological framework. Questions such as "How do affected residents perceive fairness?" remained unanswered. Additionally, grasping the connections between fairness, acceptance, and aircraft noise annoyance is imperative for ensuring the efficacy of future interventions. This qualitative study aims to address these questions by leveraging insights from social justice psychology and incorporating them into the four empirically studied facets of fairness within organizational psychology, which have been explored for many decades (see e.g. Colquitt et al., 2001).

To sum up, this paper thus fills an important gap in the research on non-acoustic factors by firstly highlighting the relevance of fairness in the context of aircraft noise annoyance and aircraft noise management and describing the different fairness aspects with their respective characteristics from the residents' perspective. Few studies have directly surveyed airport residents about their perceptions, expectations and current views on neighborly relations with the airport. Sommerfeld (2013) qualitatively investigated the relationship between noise annoyance and other variables such as attitudes and sense of community, and highlighted desires for change in the sense of a neighborly relationship with the airport. In another study residents were asked about measures they would like to see from the airport operator (Haug et al., 2003). Based on this, a citizens' hotline was set up where residents affected by aircraft noise could contact the airport. The findings of these studies suggest that residents want an open and honest information policy (Maziul & Vogt, 2002), characterized by mutual consideration and tolerance in combination with good communication. In the work of Sommerfeld (2013), residents expressed the desire for more information and explanations, which should also be provided in a comprehensible form.

The summary of the results under the aspect of fairness in connection with its subfacets distributive, procedural, informational and interpersonal fairness now offers the advantage that the concerns of the residents found can be classified in terms of scientific concepts allowing a more systematic planning of aircraft noise management strategies (for an overview, see Colquitt et al., 2001).

This qualitative study offers valuable insights into the actions required, according to the perspectives of affected residents, to foster a more amicable relationship with the neighboring airport. By delving into the experiences and viewpoints of those living in the vicinity of the airport, the research sheds light on potential measures and initiatives that could enhance a sense of community and improve interactions between residents and the airport. These findings not only contribute to a deeper understanding of the current dynamics but also offer valuable recommendations to promote a harmonious coexistence and address any existing challenges. As such, the study serves as a significant resource for stakeholders, policymakers, and airport authorities seeking to implement effective strategies to create a more neighborly environment for everyone involved. While recommended practices for airports already cover some of the recommendations postulated here (see Woodward et al., 2009), this research is able to classify the qualitative findings from the perspective of the affected residents from the viewpoint of social justice research and, thus, form a theoretical framework in which these findings can be organized (see Hauptvogel et al., 2021a). Furthermore, the results of this qualitative work lead to hypotheses and research questions for follow-up quantitative research in order to explore the four facets of fairness in the context of the aircraft noise topic more fundamentally.

5. Recommendations for a fair, neighborly relationship

As part of this qualitative study, the residents surveyed made a number of suggestions and wishes as to how a more neighbourly relationship can be established between those affected and the airport. Embedded in the context of research on social justice (see also Hauptvogel et al., 2021a), these ideas are summarized in Table 3 and assigned to the fairness facets (see Chapter 1). This simplified synthesis of the

Table 3

Recommendations for fair and community-oriented airport management from the perspective of affected residents impacted by aircraft noise, categorized to the four facets of fairness elucidated in Chapter 1.

Letter	Description	Implementation	Fairness facets
F	Feedback: The airport should have an open ear for feedback from residents and address their concerns and complaints. It is important that residents feel heard and understood and facilitate open communication. Feedback from residents should be taken seriously and be able to revise decisions made if, after review, they are found to be wrong.	Establishment of a citizens' hotline or contact form to enable residents express their concerns, wishes and complaints, ensuring their feedback to be heard. One example could be Cologne-Bonn Airport, which allows under the term "Let's Talk!" to organize expert talks through video or telephone, answering questions concerning noise, noise protection and other relevant topics.	Procedural Fairness
A	Active: The airport should actively seek residents' input and feedback.	Personalized letters, news provided via local radio and e-mail newsletters could inform affected residents about certain changes and ask for their opinion. Public participation could also be planned at regular intervals, for example in the form of open dialogue or focus group discussions, or periodic surveys.	Procedural Fairness
I	Information Provision: Information regarding noise (changes) or future plans of the airport should be communicated timely, truthfully, directly and transparently to all affected residents. This is about telling the truth to all affected residents and not sugarcoating the details. Further, the information from the airport should be accurate and provide information on noise distribution, changes and improvements at the airport, especially regarding property purchases and decisions.	For example, an app could be created, a website or personalized newsletters. Furthermore, information provision in form of open meetings could be arranged. One example could be the Noise Platform provided by the ANIMA EU-Project, which offers transparent and understandable information regarding aviation noise, implementing a noise intervention and experience from other airports.	Informational Fairness
R	Respect: To build a fair and respectful relationship with the community, the airport operator should engage with community members in a respectful and considerate manner.	This includes engaging with community members in a respectful and open manner, acknowledging and addressing community concerns and complaints, and demonstrating a willingness to listen and learn from community feedback.	Interpersonal Fairness
N	Noise Mitigation: Fairness also means that the airport should	The airport should consider the impacts of nighttime operations	Distributive Fairness

Table 3 (continued)

Letter	Description	Implementation	Fairness facets
		actively work to mitigate noise impacts on nearby residents, recognizing that excessive noise can have negative health and quality of life effects.	
		on nearby residents, recognizing that nighttime noise can have particularly significant effects on sleep quality and overall well-being. This may include implementing curfews, respite or restrictions on nighttime flights, or investing in noise-reducing technologies to minimize the impacts of nighttime operations.	
E	Engagement: The airport should engage residents in meaningful dialogue and decision-making processes, recognizing the importance of building trust and fostering collaboration.	This may include establishing formal community advisory boards or committees, hosting regular public meetings and forums, or conducting surveys and other forms of community outreach. These involvement processes should be initiated before decisions are being made.	Procedural Fairness
S	Sound Exposure Compensation: For many homeowners and residents, the negative impacts of aircraft noise can have significant financial consequences. The airport should ensure that the negative impacts on individual residents are compensated for.	To compensate for the disadvantages, measures could be taken, such as the airport's participation in local projects. Here, the municipalities in consultation with affected residents should decide how the money generated by the airport's profits is to be used.	Distributive Fairness
S	Science: Decisions on noise distribution or noise protection zones should be updated at regular time intervals in the light of new scientific findings on the long-term effects of noise on health.	Noise protection measures at the airport must be evaluated transparently and impartially in order to ensure the protection of the population. To this end, processes at the airport must ensure that new findings from research are regularly incorporated into airport operations.	Procedural Fairness

findings does not claim to be a complete catalogue of how aircraft noise should be managed fairly, but is intended to summarize the participants' opinions and wishes identified in this qualitative study. Furthermore, its practicability must be investigated in future research.

4. Strengths and limitations

The present study has certain strengths and weaknesses. Qualitative studies are often criticized for their relatively small sample size compared to quantitative studies, which limits their generalizability. However, the aim of a qualitative approach is typically not to achieve generalizability. The aim of qualitative studies is to delve into the nuances of human experiences and perceptions, prioritizing depth over breadth. Unlike quantitative research, which often seeks generalizability through large sample sizes, qualitative studies focus on

generating hypotheses and uncovering insights into participants' perspectives (Namey et al., 2016). Therefore, there is no fixed recommendation regarding the number of focus groups needed for qualitative studies. We conducted two focus groups for each key characteristic, considering the degree of noise exposure as a pivotal factor. Through the application of well-established qualitative methods and a standardized analysis protocol as well as careful consideration of sample size, we believe our study has provided valuable insights into the complex issue of residents' perception of fairness aspects regarding communication and measures for noise mitigation. However, future studies should also explore specific socio-demographic differences in perceived fairness within the context of the aircraft noise debate through qualitative research. Different groups may have distinct thought patterns and reasons, which could be valuable in this context and should be considered when designing measures to address the needs of the entire population. Following quantitative research on a larger scale may then help understanding the nature of such personal factors, i.e. whether they act as moderating or rather mediating factors. For instance, such knowledge may become relevant in evaluating the success of intervention measures in different groups of the population.

Moreover, it should be noted that the quantifiability of the findings is a significant limitation in this study, as well as in most qualitative studies. This is due to the nature of focus group discussions, where it was often challenging to determine the frequency of certain statements since they were discussed multiple times by different individuals, with others agreeing. Whether the results of qualitative studies are quantifiable or not is discussed frequently in qualitative research (Vicsek, 2010). A basic misconception that arises from quantification is the generalization of the findings to the general population (e.g. Krueger, 1998). In the current paper we have adopted the recommendation of Krueger (1994), who recommends that no quantification of the results should be carried out. The decision has the disadvantage that the results are not easy to interpret, as the relevance of aspects cannot be determined on the basis of numbers. Quantification would also have been problematic as it would not have illuminated how important individual aspects are. Aspects that were mentioned less frequently could often be of enormous importance for affected residents, which is why a quantification might lead to incorrect conclusions. Moreover, the basic aim of qualitative studies, including the one presented here, is to gain a deeper insight into the thinking of the people concerned. We believe that quantification would distort the focus of this paper.

The participant selection process was carefully executed to ensure that areas with aircraft noise as the primary noise source were included in the study. Additionally, data collection occurred at multiple airports in two countries to assess potential country-specific differences. The results do not indicate a difference between the study sites: residents from all airport regions consistently mentioned similar aspects related to cultivating fair and neighborly relationships with the airport, suggesting that fairness might be an important factor to all airport residents.

Another limitation, as described in Chapter 2.1, is the study's timing coinciding with the implementation of COVID-19 measures, resulting in restricted air traffic during the research period. Consequently, individuals interviewed near Dusseldorf Airport experienced notably reduced air traffic compared to participants of the focus groups, which were conducted prior to COVID-19 measures. While this circumstance could potentially influence local residents' reactions and perceptions of the airport, analysis of the study findings did not uncover significant differences in discussed topics. Thus, we conclude that the imposed flight restrictions did not tangibly impact the study outcomes. Moreover, this suggests that local residents' perceptions may be of a long-term nature, unaffected by short-term changes, in their assessments of the airport's fairness.

Another limitation of this study is the involvement of different interviewers or focus group discussion leaders in the data collection process. This may have introduced unconscious biases and prejudices that could have influenced the direction of the discussions. To ensure the

objectivity of the research results in this study, all researchers strictly followed the discussion guideline that was prepared beforehand. To establish reliability, the categorization of statements was thoroughly discussed and transcripts were analyzed by two researchers followed by a discussion of the categorization. The categorization of statements into predefined categories was similar between researchers. Categorized statements were also checked by other researchers to ensure reliable classification. Methodological weaknesses were additionally treated by triangulation, which involves combining two methodological approaches (in this case focus groups and in-depth interviews) to compensate for the weaknesses of individual approaches (Valenci & Mercedes, 2022). This improves furthermore the reliability of the results.

Another limitation is the categorization of noise exposure. In this study, noise exposure was classified according to the EU Directive 2002/49/EC as high (>55 dB L_{den}) and low (≤ 55 dB L_{den}). It should be noted, however, that an exposure of 56 dB L_{den} is not necessarily high, just as 54 dB L_{den} is not necessarily low. While we carefully selected study areas to ensure a significant difference between high and low exposure levels, future studies should consider a more nuanced approach by introducing additional exposure classes where appropriate.

Lastly, fairness is a complex construct, and it is crucial to acknowledge the subjectivity inherent in this concept, particularly when applied to the context of aircraft noise. The diverse range of stakeholders involved, each with their unique perspectives and interests, renders it impossible to establish a one-size-fits-all approach. The primary objective of this study is not to prescribe universal actionable steps but rather to illuminate the varied perspectives of affected residents concerning the four facets of fairness. Our goal is to contribute to a nuanced understanding of the complexities surrounding fairness in the context of aircraft noise, advocating for collaborative efforts among stakeholders to develop inclusive solutions that respect the diverse notions of fairness held by the community.

The primary strength of the study relates to the theory-based analysis of the aspect of fairness in the context of aircraft noise research. An initial theoretical transfer has already been carried out and potential implications analyzed (Hauptvogel et al., 2021a). A qualitative investigation of the four facets of fairness, distributive, procedural, informational and interpersonal fairness. Therefore, social justice research should also be seen as an overarching theory that supports and at the same time enriches existing recommendations (such as Asensio et al., 2017; Gasco et al., 2017; Heyes et al., 2021; Woodward et al., 2009). Derived from the recommendations of social justice research (e.g. Bies, 1986; Bies & Moag, 1986; Bies & Shapiro, 1988; Colquitt, 2001; Colquitt et al., 2001; Colquitt et al., 2013; Leventhal, 1980; Thibaut & Walker, 1975, 1978) and the theoretical model of noise annoyance (Stallen, 1999), the findings provide a theoretical link to the stress-based health consequences of long-term noise exposure.

This study possesses a notable strength that deserves special recognition within the field of aircraft noise research. The study's distinctive approach is commendable for its constructive examination of the elements requiring modification to foster a fair and amicable neighborly relationship. Unlike previous research in this domain (e.g. Bartels et al., 2018b), which has predominantly centered on negative aspects, this paper offers a valuable contribution by adopting a more positive perspective, making it a valuable addition to the existing body of work in this area.

Another strength of this study lies in the established validity of the results, as they align with the categories proposed in theory. Previous research has highlighted the significance of procedural fairness in aviation noise research, which is consistent with the themes identified in this study (e.g. Liebe et al., 2020; Maris, 2008; Maziul & Vogt, 2002; Suau-Sanchez et al., 2011). Similar themes have also emerged in other qualitative studies on residents impacted by aircraft noise (Sommerfeld, 2013).

A further significant strength of this study lies in its practical

orientation. The action recommendations presented in Table 3 aim to be implemented in airport and aircraft noise management practices, with the goal of making a tangible difference in the lives of affected residents and improving their quality of life. However, it is essential to emphasize that the efficacy of these recommendations should be evaluated through systematic assessments and feedback from both residents and airport authorities. This evaluation process will help refine and optimize the proposed actions, ensuring their effectiveness and long-term impact on creating a more harmonious relationship between airports and the communities.

Moreover, the evaluation should also consider the potential effects of implementing fairness measures on various aspects, such as noise annoyance and acceptance. Understanding how fairness interventions can influence these factors will provide valuable insights into the broader implications of the proposed actions and aid in developing more comprehensive and targeted strategies for improving the overall airport-resident relationship.

5. Conclusion

Fairness is a complex concept. What is fair depends on the perspective, and the definition of fairness varies from person to person or institution to institution. Although airports, airlines and affected residents naturally have very different interests and interpret fairness in their own way, it seems essential to us to take the perspective of the people who are negatively affected by airport operations: the residents.

In conclusion, this qualitative study aimed to gain insights into the experiences and perspectives of residents affected by aircraft noise in their respective regions, with the focus on fairness related aspects. The findings indicate that aircraft noise poses a significant burden for these residents. Participants from all three study areas expressed criticism towards the airport, specifically highlighting a lack of perceived fairness. This encompassed issues related to noise distribution, compensation for noise impacts, as well as opportunities for participation in processes and decisions. Additionally, residents emphasized the importance of proactive, transparent, and truthful communication that is respectful and inclusive.

The findings from this study suggest that many previously researched non-acoustic factors such as trust, attitudes, predictability, and expectations could be influenced by aspects of fairness (Sommerfeld, 2013). As can be seen from the discussions, attitudes towards the airport are not generally negative. Residents are aware of the airport's relevance and would not want to abandon the airport in general. However, it will take work to ease the partly hardened fronts and to establish a neighborly relationship.

The airports should strive to implement the action recommendations outlined here. It is crucial to acknowledge that noise reduction still remains essential and necessary, and effective communication alone cannot entirely eliminate annoyance among residents. However, fostering mutual understanding, improving acceptance, trust, and attitudes through fair communication can significantly contribute to mitigating annoyance and establishing a more positive airport-resident relationship in the long term.

Improved communication and noise reduction should not be seen as separate endeavors. Instead, fair communication should complement and support the ongoing technical efforts to reduce noise. An open and transparent dialogue between the airport and the affected residents can facilitate the development of collaborative solutions and address potential conflicts between noise reduction and quality of life in the airport region. By integrating both aspects, a long-term and sustainable improvement in the relationship between the airport and the community can be achieved.

CRedit authorship contribution statement

Dominik Hauptvogel: Writing – review & editing, Writing – original

draft, Visualization, Validation, Software, Project administration, Methodology, Investigation, Conceptualization. **Julia Kuhlmann:** Writing – review & editing, Writing – original draft, Validation, Project administration, Investigation. **Isabelle Richard:** Writing – review & editing, Writing – original draft, Validation, Investigation. **Camille Emanuely:** Writing – original draft, Validation. **Dirk Schreckenberger:** Writing – review & editing, Writing – original draft, Validation, Supervision, Resources, Methodology, Conceptualization. **Julia Quehl:** Writing – review & editing, Writing – original draft, Validation, Project administration, Investigation. **Tobias Rothmund:** Supervision, Methodology, Conceptualization. **Susanne Bartels:** Writing – review & editing, Writing – original draft, Validation, Supervision, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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