

## HOW WILL ISO 22955 AFFECT DESIGNS FOR OPEN PLAN OFFICES?

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### 1 ABSTRACT

The SARS-CoV-2 pandemic with consequential home working has demonstrated how so many open plan offices failed to support the needs of the occupants, noise being the biggest problem. This pilot study used semi-structured interviews to explore the causes of poor acoustic conditions, and potential to improve them using ISO 22955 - Acoustic quality of open office spaces, published May 2021. A purposive sample of leading acoustic practitioners from Europe was consulted, and thematic analysis was used. The key themes identified from the data included the lack of common narrative and knowledge held by stakeholders about the causes of poor acoustic conditions; the adverse effect of occupational density, currently unaccounted for in acoustic assessments; the acoustic risks of bringing the increased teleconference activity into existing office designs. ISO 22955 can consolidate understanding and offers methods to improve acoustic conditions in operation, although it should be expanded to include the personal and sociological drivers of acoustic satisfaction.

### 2 INTRODUCTION

The new standard, ISO 22955: Acoustic Quality of Open Office Spaces [1] takes a novel user-centred approach to understanding and assessing the problem of acoustic conditions in open plan offices. It builds on the foundation of ISO 3382-3: 2012, which identifies room acoustic indicators for open plan offices. The starting point is to consider the activity being undertaken. Acoustic challenges for each type of activity are identified at the workstation, between workstations, and across the floor plate. Upper limits for ambient noise (dBA) are identified as targets for different types of activity. Within the normative part of the standard, acoustic descriptors are assigned values to address the acoustic challenges for each type of activity.

There are six informative annexes that offer additional information and practical tools. One identifies the process of planning an office and how different parts of the standard can be used in each. There are three informative annexes that may be utilised when an office is in use: measurement of the ambient noise level to compare against the target values, an acoustic comfort questionnaire, and an example of an open plan office etiquette. These are tools that may be used to diagnose acoustic issues and hence improve acoustic conditions without necessarily changing the fabric of the office.

### 3 BACKGROUND

For many years noise has been reported as one of the main problems for users of open plan offices [2]. The world's largest database of employee office experience, the Leesman Index, demonstrates that from more than 800,000 responses, satisfaction with noise is rated at only 32% [3]. While there are a variety of sources of noise that frequently feature as problems, the most significant source is unwanted speech [4].

Open plan offices are frequently vilified in the media [5]. For some people they can be intolerable places to work due to the acoustic environment. Despite this, acoustic conditions can be disregarded or overlooked as a serious consideration in the design of new offices. In order to better understand the challenges of noise in open plan offices we chose to undertake a pilot qualitative study exploring what experts believe to be the barriers to achieving good acoustic conditions. Qualitative methods are rarely used in the acoustics literature despite them being well suited for exploring how people interpret the social world and their behaviours and interactions [6].

### 4 METHOD

This qualitative study used semi-structured interviews to explore in detail the perspectives of six key informants about the challenges of noise in open plan offices. In-depth interviews allow researchers to understand human contexts and to develop more complex understandings of social phenomena than is possible using quantitative methods [7]. The semi-structured interview schedule (see Appendix) was provided to respondents in advance. Written consent was sought from all the respondents and all data were handled in accordance with the Data Protection Act. Semi-structured interviews were recorded and transcribed verbatim.

Key experts in the field were identified by the research team and included stakeholders from a range of fields including: workplace design, acoustic products manufacturing, occupational health and safety, national acoustic research laboratories, and acoustic consulting. Half were on the ISO 22955 committee responsible for writing the standard. Half the sample of people has as their primary role a need to understand office users' experience. Two people have as their main role a responsibility for the design of new workplaces. Two of the sample work in national laboratories for research or health and safety. Respondents were invited to take part in the study by an email from the research team including information about the study, the interview schedule and a consent form. A reminder was sent after two weeks. One potential respondent did not reply; six respondents participated in the study.

Interviews were conducted online and transcribed using Otter software. Transcripts were checked against recordings for accuracy and to allow familiarisation with the data. Data were analysed using thematic analysis using the following stages as described by Braun and Clarke [8]:

1. Familiarisation with the data
2. Generation of initial codes
3. Search for themes
4. Review of potential themes
5. Defining and naming themes
6. Production of this paper

## 5 RESULTS

The key themes identified from the data were: causes of poor acoustic conditions for occupants of open plan offices, the impact of the SARS-CoV-2 pandemic on office design and the potential for ISO 22955 to improve acoustic conditions for occupants. Extracts from the respondents' data is presented below.

### 5.1 Causes of poor acoustic conditions for occupants

Respondents identified a number of causes of poor acoustic conditions for occupants of open plan offices including: increasing density of office occupation, lack of understanding of the importance of acoustic conditions, the absence of a consistent narrative about acoustics in offices, lack of understanding of the activities undertaken in the office, lack of understanding of different occupants' needs and lack of guidance for the occupants (see Figure 1 for representative quotations).

The desks tend to be clustered in sixes, eights, 10s, 12, the desk sizes are smaller. So the industry standard now seems to be 1400 mm, people using 1200 mm even when the client was saying one metre is fine. So this is all increasing the density and is putting people closer and closer together with no partitioning, screens always low. (Participant 5)

The first obstacle to overcome is the level of awareness that exists, particularly among end users meaning clients, about the importance of getting a good acoustic solution... that the main drivers of poor acoustic conditions go back to lack of awareness by decision makers of the importance of it. (Participant 4)

Late consideration of acoustics in projects, which often leads to intervention once binding choices have been made or to correction, which is always difficult to do... A [lack of] multidisciplinary approach upstream, bringing together the different skills in acoustics integrated into the project, as well as in terms of activity analysis, space planning, etc. (Participant 2)

I still say there is an obstacle, with just still continuing to create a more cohesive message from the acoustic community. You talk to maybe some facilities manager that's running big, multiple projects. They don't know where to go in order to get a real clear picture of what they should be doing. (Participant 4)

I have visited and worked with more than 500 different companies...I can say with confidence that the main obstacle to good acoustics is the lack of understanding of the real activity... most of the time executives, management and designer tend to create office spaces to accommodate what they want their employees to do and not what they are really doing because of the real nature of their work.... a lot of offices are designed with collaboration in mind when in reality very little collaboration is taking place in those spaces. (Participant 1).

the personality was a much stronger variable [for predicting acoustic dissatisfaction in research about people's experience in open plan offices] than the activity. (Participant 5)

People not knowing how to behave in the spaces, I think are the key... Some countries like to work in silence, and it's not the thing to do to talk at your desks. (Participant 6)

**Figure 1. Representative quotations from participants about the causes of poor acoustic conditions for occupants**

## 5.2 Has the pandemic changed office designs?

The experience of the respondents was a range of different approaches being pursued by different parties, with some noting that activities have changed and this will have an impact on the use of offices going forwards. Representative quotations are shown in Figure 2.

...it is a little early to say. But some trends are showing a will to reduce the office sizes to cut costs... Lots of new designs were already incorporating a mix of activities prior to the pandemic but this trend will definitely pick up the pace because the office will not serve the same purpose as before. (Participant 1)

The crisis linked to covid-19 will undoubtedly change the way employees will work in the future... particularly the foreseeable development of hybrid face-to-face/remote working. Another factor ... is the relationship with digital tools. This development [will have an] impact on the use of the premises. (Participant 2)

But one of the drivers was that there were a lot of video conferences, and that is something that can be quite disturbing if you don't go aside and have that in a specific area. (Participant 3)

We're designing some offices in exactly the same way that we always did. We're designing other offices completely differently. An extreme example would be one... [company], they're moving into about 40% of the floor space that they had previously. And there there's very few desks for doing work work [sic]. The office is predominantly meeting rooms. Canvas space, social space, areas for collaboration and their view is that for their business, the future of work is that you will do your task based work at home or from another location. And that you go to the office to meet people physically and to collaborate with them physically. ...the other extreme is ... carry on as usual pretend COVID hasn't happened. And that's not necessarily driven by any sector. I think a lot of it's driven by business culture. My personal view is that COVID has probably kicked us about five years forward. It's made us realise that we can trust people. (Participant 6)

**Figure 2. Representative quotations about how the pandemic has changed office design**

## 5.3 How will ISO 22955 improve acoustic conditions for occupants?

The answers to the last two questions responded to the problems identified in the first question - in particular, for educating stakeholders, and demonstrating to facilities managers and clients what the issues may be or how they could be addressed. Representative quotations are shown in Figure 3. Respondents had very different views, and this is taken up in the discussion section.

... through a process of continual improvement. Making sure that when we design that we're measuring, we're monitoring and then making the right changes to be able to adapt to the needs of the people. Because we're still guessing right now... it's made great strides to convey the acoustic message in more or less layman's terms, so that the typical audience that we would be talking to can understand [it]. (Participant 4)

...it is impossible to have an international standard for office acoustic design, because there is not one set of parameters or behaviours or expectations that permeate through every member country.... I think it flies in the face of quite a few other standards and quite a few other guidance documents... Ultimately, if a client asks you to deliver a design that's compliant with BCO or BREEAM then you'll use [those]. Unless someone asks you to deliver a project to ISO 22955 then you probably won't do it because it's so different... I think there's been so many compromises in all quarters that we've ended up with a document that's probably not much use to anyone in particular. (Participant 6)

**Figure 3. Representative quotations about how ISO 22955 may improve acoustic conditions for occupants**

## 5.4 Can acousticians use tools in ISO 22955 to improve acoustic conditions in use?

Only those respondents who had been involved in the development of the Standard offered opinions on the last question. One respondent who considered that the Standard may not be useful in response to the previous question suggested here that it contains tools that may directly address one of the main problems identified by most respondents. Representative quotations are shown in Figure 4.

The acoustician could give the questionnaire as a tool to the client... you need to see if the conditions are what you expected. You can do this with a questionnaire and put it ... to the client. (Participant 3)

...there's some flow charts... they're taking people through a process of what to consider and when to consider it, that's really useful... / the questionnaire, that is the kind of thing that you can talk a lay-person through and take them on a journey of realization that acoustics are important, so there are things in there which will aid the cause of acoustics in the workplace. (Participant 6)

**Figure 4. Representative quotations from participants about using the tools in ISO 22955 to improve acoustic conditions in use**

## 6 DISCUSSION

The main themes are discussed in turn, followed by a discussion of the implications for acoustic design of offices.

### 6.1 Density of office occupation

One of the key challenges identified by respondents was the trend to increase the density of occupation of open plan offices. The facilities management industry often promotes higher densities as a cost saving for companies, disregarding the potential for adverse effects for occupants. The BCO Guide to Office Occupancy: Density & Utilisation [9] demonstrates how the space allocation per workstation has reduced over time in the UK. Current acoustic metrics do not take account of the effect of density on either potential acoustic conditions, nor acoustic satisfaction. The effect of density may be two-fold: higher noise levels, more people distracted by a person talking.

In the literature, the effect of office density, in terms of both social density (the number of occupants in a room or space) and spatial density ( $\text{m}^2/\text{person}$ ) has been investigated in various ways. Duval et al [10] carried out a literature review including 19 previous studies; they illustrate that links between density and noise have been investigated for many years, for example by Bharucha-Reid et al [11]. Duval concluded that high density offices reduced occupants' environmental satisfaction. However, there was not enough empirical evidence to determine density points above and below which occupant satisfaction is unacceptable.. Leder et al [12] investigated the effect of office environment parameters on aspects of environmental and job satisfaction and also found that density of occupation strongly impacted on users' satisfaction with acoustics and privacy.

ISO 22955 also notes that area per occupant is key in determining the ambient noise level. The indicators in ISO 3382-3 are intended to characterise the disturbance of unwanted speech in an office, but crucially, they disregard the potential number of people whose speech may be distracting. Thus two offices could achieve identical room acoustic indicators according to ISO 3382-3, and contain occupants carrying out identical activities. It is intuitive that if one office has a significantly higher occupational density than the other, disturbance by speech is much more likely. This factor could be taken into account by considering the potential number of people whose talking could be distracting, rather than evaluating room conditions regardless of density. From an occupant-centric perspective, this could mean considering the number of workstations within the comfort distance [13], for example. Alternatively, a numerical combination of the average area per occupant and the comfort distance or distraction distance could be investigated for correlation with acoustic satisfaction. This is suggested

as a subject for further research, to evaluate if the occupational density associated with the distraction or comfort distance can better predict noise disturbance than the current metrics.

## **6.2 Lack of common narrative about what constitutes good acoustic design**

During data analysis, it became clear that participants had a wide variety of ideas about the causes of poor acoustic conditions; a lack of understanding or awareness featured in many responses. The implication of the lack of awareness or understanding is that acoustic conditions are not prioritised over other design aspirations. Significant screening between teams is required to achieve the room acoustic conditions described in ISO 22955 [14], and this may conflict with the client and/ or the design team's preconception about how an open plan office should look. A design process involves identifying objectives and making use of available resources to create solutions – with better designs leading to enhanced satisfaction of the objectives. When financial decisions are made about the occupational density and hence quantity of space available, for example, the decision makers may not be aware that they may constrain the potential environmental satisfaction in the office.

Within the literature there is wide agreement that the most significant practical determinant of acoustic satisfaction is being able to hear unwanted speech [4]. Other sources of noise that are frequently noted as also leading to acoustic dissatisfaction include telephones ringing, noise from equipment (eg printers), building services noise, people passing by, or a particular colleague [15, 16]. However, there is a significant absence of a common narrative around the factors that lead to either favourable or unfavourable acoustic conditions. Rather, this debate is often polarised in the mainstream media into open plan offices vs. private offices, despite large data sets demonstrating that this distinction is not the determining factor [5]. This absence of a common narrative around the problem and potential solutions is itself noted as a central problem by one of the respondents.

There is a wide body of work around office design and outcomes for the occupants. There has been a marked increase in interest in occupants' wellbeing over recent years, reflected in the uptake of the WELL™ Standard [17]. The determinants of wellbeing are acknowledged to extend beyond the physical environmental conditions, with WELL Concepts extending to Mind, considering individuals' cognitive and emotional wellbeing, and Community, concerning wider aspects of health and social connections. Given that one of the most significant impacts of noise disturbance is annoyance, it can both have an adverse impact on both these aspects of wellbeing, as well as being determined by them. Consequently, there is an opportunity to improve acoustic satisfaction by approaching the problem from a psycho-social or psycho-acoustic perspective [18].

Over the last two decades, there has been a significant international effort to link room acoustic measures to acoustic comfort or satisfaction [19]. While this approach has demonstrated some success, it has also highlighted the need to consider additional factors beyond the room acoustic parameters. For example, VDI 2569 [15] suggests that only approximately 30 % to 40 % of the annoying effect resulting from noise can be explained by technical-acoustic factors. The predominant portion originates from so-called moderators of annoyance. The moderators of annoyance are indicated to include personal control, attitude, predictability, sensitivity and activity profile, as well as organisational structure and identification with the business. Workload and other environmental factors (eg light, thermal comfort) are also mentioned.

Hanc [20] describes the gap of knowledge between the environmental and social sciences approaches: the environmental sciences perspective emphasises the role of the physical workspace environment on productivity and wellbeing. In contrast, the social sciences approach focuses on the psychosocial processes in the workplace. Considering the physical and psychosocial determinants as independent from each other leads to an incomplete understanding of workspace productivity and wellbeing. This is especially so when considering noise, which is overwhelmingly treated as a physical factor of the workplace environment. One definition of "noise" is sound which the recipient does not wish to hear. The lack of control is implicit in the word "noise". People's relationship with the environment can be more important than its physical characteristics; this implies that the human factors determining acoustic satisfaction should be given more attention.

Leaman and Bordass [21] demonstrate how perceived productivity is strongly and significantly correlated with perceived comfort. Control is described as the "killer variable" for comfort and satisfaction with the physical environment in buildings. A sense of control is also much more than just a moderator of response to one's physical environment. Leotti et al [22] explain that belief in one's

ability to exert control over the environment and to produce desired results is essential for an individual's wellbeing. Perception of control is not only desirable, but is also probably a psychological and biological necessity.

Thus conferring opportunities for personal environmental control is an end in itself, as well as increasing satisfaction with environmental conditions. Evidence for the value of control is only just emerging for acoustic comfort, as reported by Harvie-Clark and Hinton [23], and Haapakangas et al. [24]. Lee and Aletta [25] have taken a more holistic approach to understanding acoustic comfort and conclude that the most important factors for acoustic comfort are acoustic space planning and occupant control. While ISO 22955 offers a method to undertake acoustic space planning systematically [26], it does not identify any performance standards to be achieved; neither does ISO 22955 take any account of the extent of control that the occupants may enjoy.

A process of acoustic design occurs within a context that in itself implies a change for the occupants. A perception of influence or control in the process is also an important determinant for the outcome, although this aspect is often neglected in workplace design. Hongisto et al [27] note that environmental and job satisfaction can be improved in an open-plan office if the refurbishment addresses issues that employees have identified, there is professional change management, and the employees are involved with planning the change. The importance of the change management process is often underestimated or entirely neglected, and can be especially important for aspects such as the acoustic environment, over which people may feel they have little control.

Thus the current focus on room acoustic parameters may actually be a distraction from the more significant determinants of acoustic satisfaction. There are actually so few examples of offices with documented high levels of acoustic satisfaction [19, 3], that the combination of characteristics that reliably yield high levels of acoustic comfort are neither well understood nor known. In this context, it is not surprising that experts in the field have such wide ranging opinions as to the causes of poor acoustic conditions.

### **6.3 Has the pandemic changed office designs?**

The respondents note a wide range of responses within the industry, with some companies continuing with their previous workplace strategies, and others making very significant changes to the office accommodation. One respondent notes this is driven by individual company culture rather than sector. Some respondents note that activities have changed - there is a lot more teleconference activity for most office workers - and as such, simply returning to the old office environment represents a significant risk for a worse acoustic environment. The Leesman Workplace 2021: Appraising future readiness [28] suggests that it is imperative that organisations re-evaluate and re-purpose their accommodation to adapt to their employees' evolved needs. One respondent notes that in expanding economies, employees have more options and therefore more power to choose an employer that offers the experience they seek. Thus there may be both a business advantage by offering a more attractive and flexible workplace strategy, and a business cost in not doing so.

### **6.4 Can ISO 22955 help improve acoustic conditions for occupants?**

There was a strong consensus that some of the informative parts of the standard - especially the noise comfort questionnaire [16] - could be very valuable tools to help educate stakeholders. This addresses one of the biggest constraints noted for good acoustic conditions – the lack of awareness of the problem.

One respondent suggested that they would not use the standard unless specifically requested, because it is different to other current guidance. This suggests that either the normative requirements of ISO 22955 are considered unnecessary to achieve good acoustic conditions, or a reluctance to take on the difficult task of conveying requirements that may be in conflict with other designers' - and the client's - expectations for an open plan office design. ISO 22955 compliance is likely to require high screens across an open plan office such that it is much less open than typically expected in the UK, for example. It is not clear from this respondent's response, however, whether they believe that better acoustic conditions would be achieved or not, were the Standard implemented. They make a reference to BREEAM, which is an environmental assessment tool that refers to criteria in other published standards. As there are no acoustic performance requirements within the BCO guide

relating to acoustic conditions in open plan offices, the new international standard - adopted as a British Standard - may fill this gap in the UK. In which case, fit-out projects may be required to meet BS ISO 22955 if they seek those particular credits at some point in the future. Some countries already have national standards for open plan offices, in which case ISO 22955 is unlikely to be simply adopted. In these cases, it may offer an opportunity to reevaluate the national standard.

One respondent suggested that an international standard for office design may be paradoxical, because culture around conduct and behaviour in the office varies so much globally. This emphasises the need for a holistic understanding of the determinants of good acoustic conditions, so that individual office design approaches can be developed for a particular company culture within the wider cultural landscape.

## **6.5 Qualitative approach to understanding acoustic conditions in open plan offices**

One limitation of this pilot study was that the sample size was small and data saturation may not have been reached. However, the richness and depth of data from this limited study suggests that there is much potential for further investigation to reveal additional findings. As qualitative research does not seek statistical significance, a small number of participants is not a limitation in itself. A second limitation is that all respondents were working in a western European context; thus the results may not be generalisable to other geographic areas or cultural contexts. Thirdly, the respondents were all known to the interviewer or person seeking a response to the questions posed. The interviewees may respond differently to their peers compared with a neutral observer, as they may use short-hand answers with their peers, assuming a degree of common knowledge. Within this pilot study, there were insufficient resources to analyse data as data gathering progressed, and adapt questions or probe further those areas of either agreement or disagreement. This could lead to a greater depth of data in future studies.

## **7 CONCLUSION AND FURTHER WORK**

Excessive density of occupation was frequently cited by respondents as a cause for poor acoustic conditions, but density does not currently feature in the indicators of ISO 22955. Further work should investigate how occupational density has a quantitative effect on acoustic satisfaction; it is suggested that it may be suitably combined with a room acoustic parameter such as the comfort distance or distraction distance, to determine a number of people impacted by speech, for example.

This pilot qualitative investigation has revealed the importance of generating a shared narrative around acoustics in open plan offices, so that design and operational decisions can be made with the knowledge and understanding of the opportunity and implication for acoustic satisfaction. The data and discussion demonstrate that there is a wide body of stakeholders, including the occupants, who between them are responsible for creating the conditions for acoustic satisfaction or dissatisfaction. However, there is little shared understanding or common narrative of the range of factors that contribute to outcomes for acoustic satisfaction, nor of the relative importance of each. Further work could identify acoustic risks and opportunities for different design approaches in different contexts, for example, beyond the current scope of ISO 22955. A deeper qualitative investigation could significantly improve accessibility to a common narrative, and thereby strengthen cohesion around suitable design responses. ISO 22955 offers an opportunity to consolidate this narrative, and should be expanded to include the personal and sociological drivers of acoustic satisfaction.

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## 10 APPENDIX

The following questions were put to interviewees:

1. What do you see as the obstacles to good acoustic conditions for occupants of open plan offices? What are the main drivers of poor acoustic conditions for occupants of open plan offices?
2. How has the Covid-19 pandemic changed the way that people want to design offices? Are people designing offices for a different mix of activities?
3. How will ISO 22955 assist clients / designers / consultants / facilities managers to improve acoustic conditions for occupants?
4. Can acousticians use the tools within ISO 22955 to help educate FMs on opportunities to improve acoustic conditions in OPOs, on an ongoing basis - not just at the point of office redesign?