Investigating the Effect of Indoor Soundscaping Towards Employee's Speech Privacy

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Summary

This paper presents the emerging results of a soundscape evaluation of a two open office spaces. Aims of this research is to identify sound sources within an open office space and understand if their contributions to employees speech privacy. Thematic Analysis as part of Grounded Theory is used to examine how employees perceive the soundscape of their work environment. Semi-structured interviews are conducted with 20 employees from two companies. Responses are used to create a theoretical framework that conceptualizes employee's response to the soundscape of their work environment. In order to analyze the acoustical characteristics of the office space, a combination of in-situ measurements and Odeon Room Acoustics Software are used.

1. Introduction

Open-plan offices are believed to promote communication and interaction between employees. However, these spaces are also associated with lack of speech privacy and uncontrolled sound levels. Lack of privacy and exposure to uncontrolled sound levels can cause a significant decrease in work performance and workplace satisfaction [1]. On the other hand, objective measurements of sound levels are insufficient to show the impact of sound towards employees' perception [2]. In order to develop a better understanding of this impact on employee's perception of various sound sources which affects the soundscape of his work environment should be explored.

According to Kang and Brown [3] soundscape represents both "the acoustical environment as perceived by humans" and "total collection of sounds". This approach deals with the content and interpretation of sound rather than the energy [4][5]. Over the past decade, there have been various studies examining the quality and responses of people to the soundscape of urban spaces. These studies have proposed ways to differentiate soundscapes and showed that it is not always the sound levels that matters [6].

On the other hand, very few studies are conducted to examine whether these principles of soundscape can be applied to enclosed spaces. Previous studies used combination of objective parameters, psychometric parameters and listening tests. This paper uses a subjective approach to capture the lived experience of an open office space, an approach which uses thematic analysis [4] to examine the effects of indoor soundscape quality towards employees' perception of their work environment and its contribution to speech privacy in two office spaces.

2. Method

2.1. Case Study Settings

An architecture company and an engineering company are chosen for the study. Both offices are considered medium scale offices, having between 30 to 50 employees. Architectural Company (Company A) occupies the first 3 floors of a residential building but the main office space is located at one location and all the measurements and interviews are conducted at this space. On the other hand, Engineering Company (Company E) is located in a 4 story

apartment building, with 2 floors used as an office space and rest as service and management floors. The office floors consists of; one central open office space (E1), a subspace (E2) which is the office of structural design team and rooms for project leaders. Required permissions are obtained from the relevant department of companies.

2.2. Objective Measurements

In order to analyze the acoustical characteristics of the office spaces, a combination of in-situ measurements and Odeon Room Acoustics Software are used. Measurements are done during working hours using Bruel & Kjaer Sound Level Meter type 2230. Sound level meter is placed at central locations of both offices at the height of 125cm and measured over 15 minute time intervals. Odeon Room Acoustics Software is used to measure Reverberation Time (RT) and Speech Transmission Index (STI).

2.3. Subjective Measurements

Thematic analysis, as part of grounded theory is used to create a conceptual model that reflects employee's perception of their work environment. Semi structured interviews are conducted with 25 employees from Company A with 24 employees from Company E as the collected data no longer produced significant conceptual variations [6][7]. This paper uses random sample of 10 employees per office. An interview schedule is prepared according to companies' workload. Interview process lasted for 2 working days at both companies. Interviews are held at meeting rooms and their duration varied between 6-17 minutes. All interviews are recorded and transcribed. Transcriptions are manually coded to derive themes and categories.
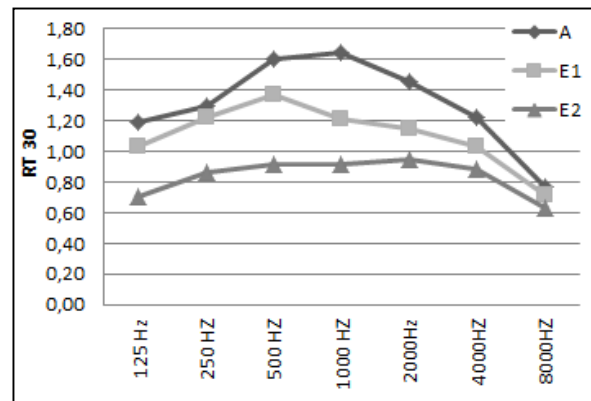

Figure 1. Reverberation times (RT30) between 125 HZ and 8000 HZ in Architecture Company (A), main office space (E1) and Subspace (E2) of Engineering Company.

3. Results and Discussion

3.1. Objective Results

In order to get clear results from ODEON Room Acoustics Software, Company E's office space is divided into two separate models. One model for the main open office space (E1) and the other for the subspace (E2). Reverberation times for all spaces can be seen at Figure 1 and STI values can be seen at Figure 2. Mean Continuous A weighted sound levels (Leq(A)) are 0,54 dBA at Company A, 0,58 at main office space of Company E (E1) and 0,64 at subspace of Company E (E2). These results are used to give an idea about the acoustical characteristic of office space which can help with the comparisons of two offices.
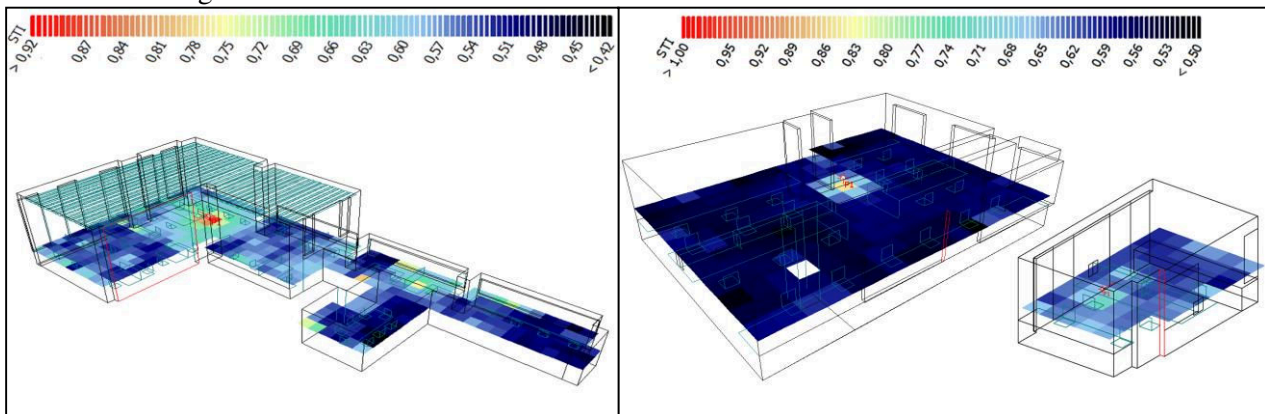

Figure 2. Odeon simulation showing the STI values of Architecture Company (A) , main office space (E1) and Subspace (E2) of Engineering Company.
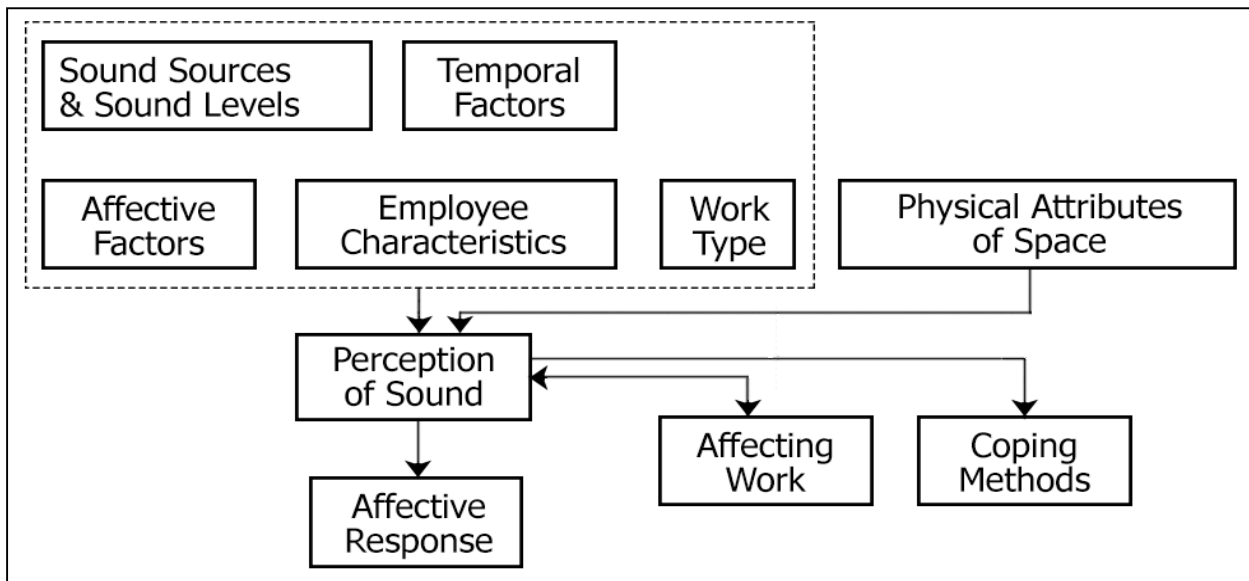
Figure 3. Conceptual Model shows the patterns between themes

3.2. Subjective Results

Interview transcriptions are analyzed to derive themes. These themes are searched for patterns which rearranged the themes into Main themes and categories. During this process irrelevant themes are eliminated. Based on the patterns, a conceptual model is created which is used to understand employees' perception of his workspace and its effects on speech privacy.

Study aimed to compare two open offices spaces and construct a conceptual model for each one of them as they were expected to be different from each other. However, analyses of the data showed similar patterns for both of the offices. Therefore one conceptual model is generated for both cases (Figure 3). This analysis of data revealed 10 themes (Table 2) which are divided into 29 categories.

3.2.1. Auditory Perception of Work Environment

In order to investigate the soundscape quality of their work environment employees of both companies are asked what they expect to hear and briefly list the sound sources within their work environment. These sound sources can be seen at table 1.

Employees answers revealed that the most frequently perceived sound sources are different for offices both offices. Employees of Company A reported phone conversations to be the most frequent sound (n=6) while employees of Company E reported Group Conversation (n=8). At this point it should be added that, recently there have been a new

seating arrangement at Company E which placed relevant departments together, such as structural engineering and design departments. Some employees reflect that with this recent change people started to engage in group conversation much more often. Even though this rearrangement seemed to be done to increase efficiency, due to the probable increase in sound levels, employees who prefer silence reflected negative feelings about it.

Employees of Company E also reported that conversation sounds coming from the meeting rooms and the management floor to be most dominant sound (n=7). It has been observed that employees expressed this regardless of their location and proximity to the meeting rooms. When they were asked, what they expect to hear in their work space most of the employees said that they expect to hear speech. From this point on, discussion will include direct quotations from employees' responses, to show their perception explicitly

A (Employee of Company A): I don't know what the ideal is but I think I expect to hear human dialogue, which is the ideal sound for me, not a printer sound.

Interviews showed that second most frequent sound sources are mechanical sounds such as computer fans and printers. As it was expected, all employees seated near the printer room at Company E reported that they expect to hear the sound of printer while those seated away from the printer room barely mentioned about it.

E (Employee of Company E): As the printer is right around the corner its sound is associated with office in my mind. When I don't hear the noise of printer I'm thinking if it's broken or something.

Company A		Company B	
Human Generated Sounds:	**Mechanical Sounds:**	**Human Generated Sounds:**	**Mechanical Sounds:**
Face to Face Conversation	Keyboard & Mouse	Face to Face Conversation	Keyboard & Mouse
Group Conversation	Printer/Plotter	Group Conversation	Printer/Plotter
Phone Conversation	Computer Fan	Phone Conversation	Computer Fan
Rattling Noise	Air Condition	Rattling Noise	Phone (Ring)
Footsteps	Phone (Ring)	Footsteps	Paper Towel Dispenser
	Phone (Notification)		
	Phone (Vibration)		
Outside Sound Sources:	**Entertainment:**	**Outside Sound Sources:**	**Entertainment:**
Nature	Music	Nature	Music
Animal		Animal	
Mechanical		Signal Sounds	

Table 1. Sound sources perceived by employees

E: This is a planning office there should be a buzzing sound, for example computer. There should be background sound, printers or plotters should work.

When they were asked to differentiate sounds as positive and negative, some employees of Company E reported ringing of a certain telephone to be the most disturbing sound within their work environment.

E: There is a phone here which has a different sound then others. Its sound is the most disturbing thing ever.

E: Well I don't get annoyed by sounds easily but there is this telephone whose sound is quite annoying. This doesn't ring very often thankfully.

As it can be seen from these examples, sound of this phone is perceived as same as the way signal sounds do which is introduced by Schafer [8].

An interesting finding is employees from both offices listed the sound of keyboard and mouse as positive sound (n=4) and said that they expect to hear it within their work environment (n=6). Employees expressed that the sound of keyboard and mouse means that they are working at that moment, there are other people around, they are not working alone and not working overtime. An employee even said that it motivates her.

E: Well as for the positive ones, keyboard sound doesn't affect me negatively. It shows that there is work. Sometimes when I slow down it even motivates me.

On contrary, two employees reflected negative feeling about this source. But it also shows that there is an underlying theme beneath their perception of this source. For example:

A: The colleague working next to me uses the keyboard very roughly. He types like he is punching the keyboard which disturbs me a lot.

E: When someone is typing an angry email or trying to rush a job, they type really really hard which breaks all my concentration.

These examples indicate some of the factors that affect employees' perception of sound sources. Regular typing sound is perceived positive or neutral, but when it is combined with affective factors such as anger or rushing the job it can be perceived as negative. Same situation applies to other cases also. Employees of both offices consider speech as positive (n=7) or neutral (n=4). But when speech becomes a group conversation or yelling at each other, it becomes negative source. Unfortunately, some of the employees of Company E associated yelling with their work environment.

E: When I think about this space, yelling is the first thing that comes into my mind. This is tense environment.

E: When people at meeting rooms or the upper floor (management floor) yell at each other we can directly hear it.

*A: Conversations disturb me. Sometimes 3-5 people gather around and start talking which disturbs me. A **thing that you don't participate tends to disturb you.***

Sound Sources: Sounds that contribute to soundscape	
Affective Factors Emotional Factor that affect employees perception	
Temporal Factors Comments about duration or frequency of actives	
Perception of Sound Employees perception of sound sources	
Employee Characteristics Comments regarding personal preference or behavioral tendency	
Coping Methods Comments related to coping methods developed by employees	
Affecting Work Performance Comments showing effect of sound towards work performance	
Job Type Employees comments regarding his work	
Physical Attributes of Space Physical features of space affecting employees perception	
Affective Response Employees emotional response to soundscape	

Table 2. Themes derived from the interviews.

When they are asked what they prefer to hear, vast majority of employees from both offices said that they prefer to hear music (n=17). However, using music as source of background sound is a problematic situation. Company E already has central music broadcast available but even though employees preferred to hear music in theory, they do not prefer to do so in practice. They do not use the central broadcast system unless they leave their workstations for lunch. Some of the new employees are not even aware that there is a music broadcast.

*E: I would prefer music but I don't know if it would work. I think it's really hard to implement because **it's very hard for people to find a common ground.***

Reponses indicate that the main reason why people don't want music broadcast is because it is very hard to find a music genre that everybody would appreciate, even impossible. Employees say that genre of the music is very important; if it is something they don't like music becomes a major negative sound source.

*A: It is very important what is playing. **If it's something I don't like, it's better to have no music at all.***

Further investigation of this situation revealed that when employees said they preferred music, what they actually meant was, they preferred hear their own music. 18 out of 20 employees said that they are using earphones while they work. Responses indicate that using earphones is much more than just listening to music. Employees are using earplugs to isolate themselves, to cope with speech interference, to cope with high sound levels and even with low sound levels. In some extreme situations it has been stated that employees leave their workstation in order to avoid the sound levels.

A: Sometimes it gets so noisy that I feel like just to go and get a tea just to avoid exposure to sound for a while.

A: Sometimes this place gets very noisy, but we deal with it using earphones. Sometimes I keep them on even without music.

E: When it gets really silent it bothers, it feels like there is a distance between us and everything I do is creates a noise. It bothers me so much that I put on earphones.

Results showed that employees use earplugs for two main reasons; to isolate themselves from their workplace and when they want to listen to music. It has been also found that employees tends to react more positively towards semantic sound sources, such as music and speech, when they are performing visual based tasks. On contrary, employees performing semantic tasks stated a negative attitude towards nearly all kinds of sound sources and preferred absence of sound.

Findings indicate that, other than some behavioral tendencies, employees are uncomfortable with low sound levels nearly as much as they are with high sound levels. Due to lack of background sound, employees often expressed concern during silent periods which indicates problems with privacy. It has been mentioned that employees tend to reduce their voices in order to avoid disturbing others and due to speech privacy issues. Those who were working there for a shorter period of time are more concerned with speech privacy but in time they habituate and become far less concerned about it.

E: At the beginning I was bit concern. But after sometime I got used to it and started talking without being concerned about what third person would think.

In general employees are not very concerned with speech privacy other than private conversation. In both offices, employees answer private phones in a location other than their workstation. In Company A, employees go outside to answer their phones, while in Company E there is a special room meant for this activity. The important point here is, in Company A, employees came up with this method of making private phone calls at outside. For Company E, it is a company rule to make every single private phone call at the telephone room and they express discomfort about it (n=7). On the other hand, only 2 employees, from Company A expressed discomfort. They did not express need of a telephone room also. This is very likely that it is their method of coping with lack of speech privacy as there is not enough background sound and has a fair STI (μ=0.54). It should also be noted that when Company E dictates a special place to talk to phone, it is received more negatively than the actual problem, which is speech privacy. Responses imply that people like to have the freedom of answering their phones in their workstations regardless of speech privacy.

E: It times you want to answer the phone without changing location. For example my mom calls, it could be an emergency, but the telephone hangs off before I get to the phone room.

Even though, they are not as concerned with speech privacy as it was anticipated, they still expressed a need of background sound. As it was stated previously, too low sound levels cause concern and anxiety on employees. One employee from Company E explained this situation as:

E: When its silent it feel like people are not bonding with each other, it feel like there is a conflict. If people don't communicate with each other it means there is no teamwork.

At the end of the interview, employees are asked whether they are satisfied with the acoustical performance of their work space and if not why? 8 out of 10 employees working at Company A sated that even though there are some issues they are happy with the acoustics. Employees of Company E on the other hand, are very unsatisfied with their company's acoustics and concerned with privacy

E: I am not really sure if it only occurs during quite moments but when you talk with someone it can be head from all around the office.

Half of the employees of Company E stated that they are unhappy with acoustic. Their dissatisfaction are associated with materials and distribution of spaces. Observations also confirmed that there are very few absorbent surfaces. 10 cm plasterboard walls and door materials are very vulnerable to speech transmission. Even employees that are seated further away from the toilets said that they can hear the sound of paper towel dispenser which makes them feel like anyone can keep track of who goes to toilet. This situation causes both distraction and privacy concerns.

4. Conclusion

Study successfully created the lived experience of open-planed offices. Results confirm that auditory environment of a workplace cannot be properly evaluated by only using objective measurement. Responses of the employees indicate that there various different factors affecting employees' perception of soundscape. Among all these factors, employees' mood has significant effect on perception of soundscape. Further studies should be conducted to investigate this relationship which could lead to increased workplace satisfaction, work performance and even a more positive mood in general.

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