# Occupant experience of indoor soundscapes in university office spaces

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**Summary**

For indoor soundscaping, identifying the relationship between soundscape perception and spatial experience and contributing factors is crucial. This study focuses on working environments and user interactions with the related soundscape variables, in university office spaces. Initially, a conceptual framework is established in order to evaluate the occupant's spatial experience and soundscape perception. Post-occupancy evaluation (POE) methodology is adapted for data collection and analysis. A systematical procedure of POE has been conducted to collect the data in three levels; (1) indication, (2) investigation, and (3) diagnosis. The first POE stage on indication is carried out by observations on space characteristics and measurements of the physical environment. The structure of the case study design and POE methodology is explained and the initial findings are presented as part of this ongoing study.

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## 1. Introduction

The perception of a particular space depends on an individual sense that gains on experiencing that space. Gathering the information of space is applied through five channels (vision, hearing, smell, tactility, and taste senses), which control the perception of space [1]. The individual's preference of different context of space is the important variable of their perception of space, which means that the expectation of acoustic environments for different spaces is variable [2]. There is an interaction between visual and soundscape perception that when we perceive visual information in the space it will modify the perception of the soundscape at the same time [3, 4]. Moreover, vision is different than hearing; the visual perception focuses on an object, which is influenced by the distance between the spectator and that object. On the other hand, hearing sense is multi-directional and covers all 360 degrees. Consequently, the sonic environment affects us more directly than the other factors of space experience [4]. Moreover, there is a combination between soundscape and space that means any change on space will make changes in the soundscape itself. These changes can be measured by investigating the experience of occupants in a space [5]. The combination between acoustic comfort and visual images in the same space influences the perception of soundscape and space experience. [6, 7, 8].

The aim of this study is to find out details about the factors affecting the experience of space and perception of soundscape. The overall study has been structured in three stages. The first stage involves the observations of space characteristics in the case spaces and measurements of the physical environment. The second stage involves semi-structured interviews, which are designed upon the information gathered from the observations. The third stage involves questionnaires and soundwalks and their statistical analysis that will be discussed in order to finalize the categorization of factors that were obtained from the previous studies [9].

| PHASE | POE STAGE | METHOD | TYPE OF DATA | EVALUATED SOUNDSCAPE PERCEPTION FACTOR | EVALUATED SPACE EXPERIENCE FACTOR |
|---|---|---|---|---|---|
| 1 | INDICATIVE | **Observation** | Qualitative | Spatial / Behavioral | Usage |
| | | **Measurement** | Quantitative | Sonic | Physical environment |
| COLLECTED DATA USED TO STRUCTURE 2ND PHASE | | | | | |
| 2 | INVESTIGATIVE | **Interview** | Qualitative | Psychological / Temporal | User / Social context |
| | | **Architectural survey** | Quantitative | Spatial | Architectural design |
| COLLECTED DATA USED TO STRUCTURE 3RD PHASE | | | | | |
| 3 | DIAGNOSTIC | **Sound walk** | Qualitative | All soundscape perception and space experience factors are integrated for further statistical analysis | |
| | | **Questionnaire** | Quantitative | | |

Figure 1. Previously presented study design and the considered first POE stage for this paper [9].

This paper will present and discuss the results of the first POE stage that includes the observations and measurements in order to feed the next stages. Initial observations about space characteristics and measurements of the physical environment are conducted in order to derive effecting factors to structure the second POE phase that involves interviews with the users and architectural surveying. The second and third POE stages will be presented after this ongoing study derives its results.

## 2. Methodology

Post-occupancy evaluation (POE) is the process of evaluating buildings in a rigorous manner through systematic procedures [10, 11, 12]. The POE tool, besides investigating subjective characteristics of space, deals with occupants' behaviors and their needs, at the same time, in order to reveal the results of building performance and consequences of past design decisions. The benefits of POE can be seen in three terms; the short term, medium, and the long term [10]. In order to find out the users' qualitative feedback, their experience in negative or positive aspect with the sonic environment quality should be investigated through diverse methods [13].

The POE process can be applied systematically in three levels:

1.The first one is an indicative level that can be conducted to find out an indication about the characteristics of space and sound sources. The method that can be used at this stage are observations and measurements (sound level, temperature, humidity, and lighting).

2.The second level is investigative; it is more reliable than the indicative level. This level investigates more details with more accuracy about the space. The researcher can use methods by making direct contact with the users of space such as interviews and conduct architectural surveying.

3.The third phase is the diagnostic POE stage. This POE stage involves comprehensive investigations, that includes more accurate methods such as, questionnaires and sound walks, to find out the final evaluation and feedback to future design. [9, 14, 15, 16].

Each stage expands upon each other by passing on data to the following stage from the gathered information of the last stage. Along these lines, it

is recommended that the information gathered from the indicative stage will be assessed and the data from the investigated information will be passed on to the improvement of the interview content. Correspondingly, information gathered from the interviews will be used for the design of the questionnaires in the diagnostic level [9].

### 2.1 Conceptual framework

Previously, two different aspects of soundscape perception and space experience were presented in a framework [9]. It is based on applying a proper tool to evaluate the relationship between these two concepts, namely perception and experience, in order to assess the relationship between the main concepts regarding the variation of physical elements and social differences that are considered under each variable. The crucial point in this framework is how to categorize the factors and how to collect data from the users and from space and environment. This framework is aimed to form an integrated evaluation guide that would feed the future design projects [9].

### 2.2. Case Space Selection and Characteristics

The case study spaces are the offices of the instructors in the Faculty of Architecture at Çankaya University located in Çankaya, Ankara, Turkey. The University complex is surrounded by 2 parks in the north and east direction, and other school buildings in south and west direction. The Faculty of Architecture is located on B-Block in the Balgat Campus. It is surrounded by roads and car parking. There are 38 offices in different floors with various orientations, where every office has its specific characteristics, and these offices are linked by small corridors that open to the main corridor.

### 2.3 Data collection

The survey of POE in this study will start with general questions, and move towards more specific questions within the method (identification and evaluation). The general goal of this survey is to cover issues and topics that are discussed or discovered in the literature review and to find their impact on the users of the chosen case space. However, the identification survey can reveal the hidden characteristics of spaces by following observation and interview methods, which can help a researcher to structure the next step of the survey to analyze the data more rigorously.


Figure 2. First floor plan of the case spaces.


Figure 3. Second floor plan of the case spaces.

The data collected by the observation of 38 offices, which is based on documenting notes about the space characteristics such as space size, colors, orientation, furniture, and finishing materials. Moreover, sound sources and physical environment in every space separately are noted. Physical environment variables (temperature, sound level, humidity, and lighting) have also been measured at each case room during observations. These documentations have been used to structure the interview questions in more details for the nest phase. All of the observation documentation was made by the researcher. On the other hand, in the second phase the interviews are conducted in 20 offices based on the results of the observations. The interview questions are designed to identify more details about space characteristics and space environment from the user's point of view.

## 3. Findings

### 3.1 Observations

The results of the observations lead to initial indications about the differences and similarities between space variables, which will later feed the

interview questions. Through such analysis, the variables are grouped into seven categories, (1) sound sources, (2) orientation, (3) daylight access, level of luminance and lighting type, (4) furniture style, material and color, (5) building finishing materials on walls, ceiling and floor, (6) space shape and dimensions, and (7) level of privacy. The observation findings are presented in Figures 4-10.

Consequently, the observation analysis shows that there is a relationship between variables related to the similarities between spaces and other related factors. For instance, some spaces have enough luminance while other spaces do not because of the variance in orientation of the space. The south oriented spaces have good lighting, but the north and west oriented spaces have less day light during the day. 26 out of 38 offices have good natural light all daytime, and have white color painting on the walls.

In addition, observation notes were taken by the researcher in order to get initial indications about the space characteristics as listed below;

1. The offices have different facades with different orientation and views.
2. The offices that have south orientation have good natural light during the day.
3. Some occupants use a disk light at afternoons (low luminance).
4. Most of the spaces have indirect link to the main corridor.
5. Most of the spaces have similar furniture types and same furniture that are provided by the university (regarding material, style and color).
6. In all offices the finishing materials on walls and ceilings are water based white paint.
7. Some of the offices are occupied by more than one user (less privacy).
8. In 32 offices furniture does not fit to the space because of space size limitations and proportions in the room creating a less spacious working environment.
9. Observed sound sources are various, coming from outside or inside the building mostly dominated by sounds created by people and their activities.

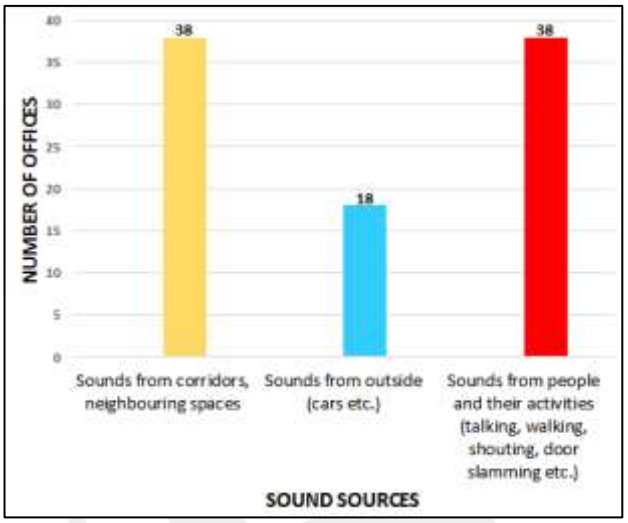


Figure 4. Sound sources that are observed to be affecting at the case spaces.

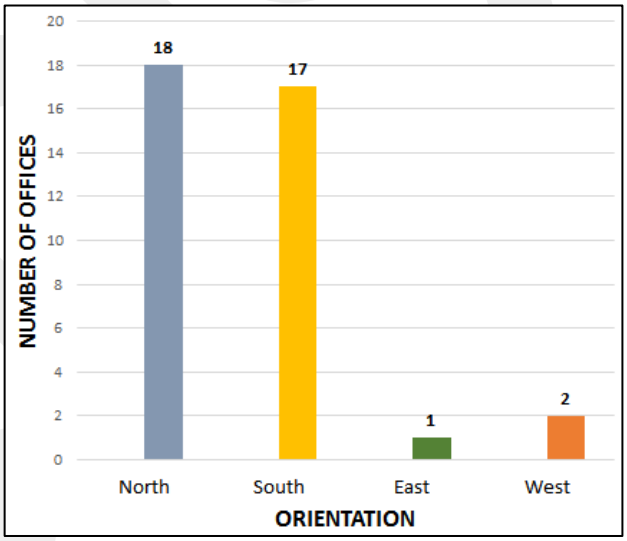


Figure 5. Observed orientations of the case spaces.

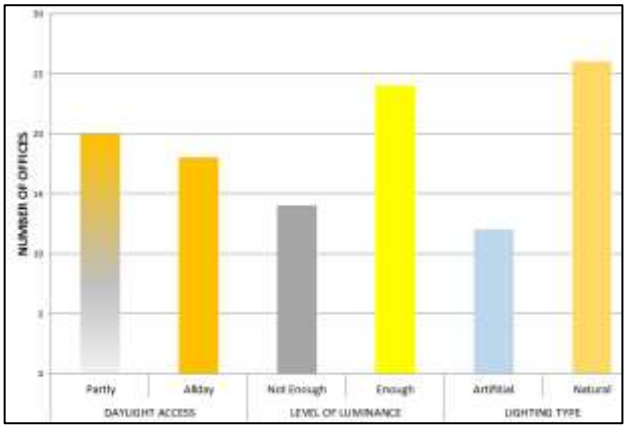


Figure 6. Observed daylight access, level of luminance and lighting type.

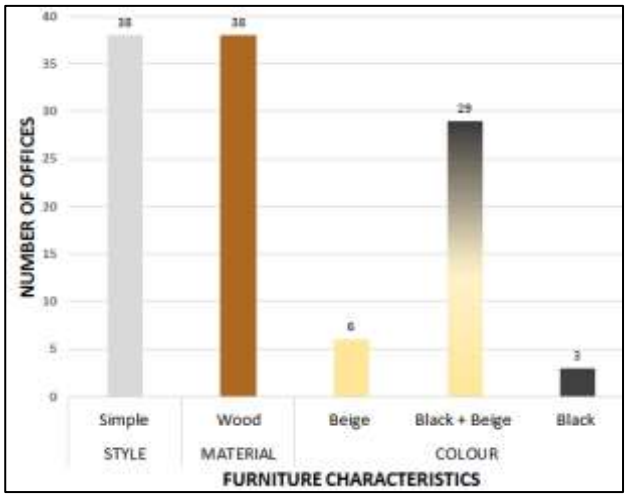


Figure 7. Observed furniture characteristics in the case spaces.

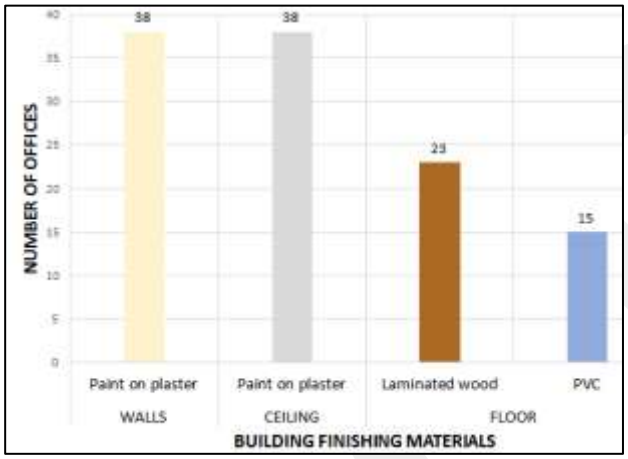


Figure 8. Observed furniture building finishing materials.

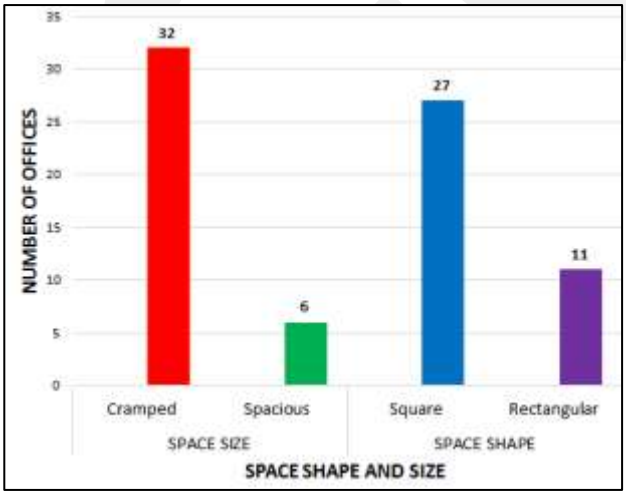


Figure 9. Observed space shape of the case spaces.

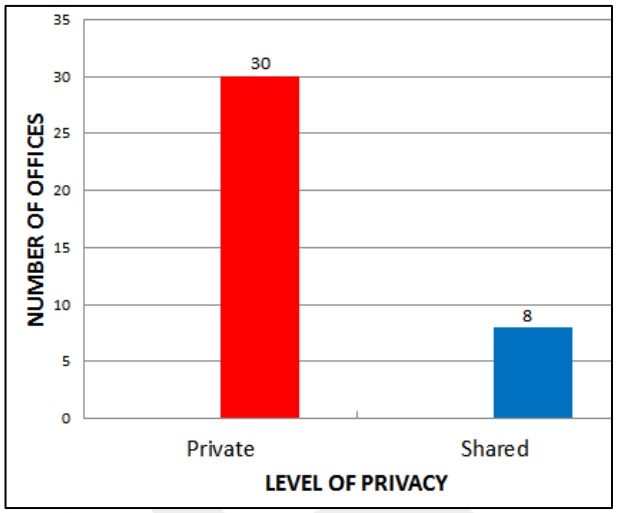


Figure 10. Observed level of privacy at the case spaces.

### 3.2 Measurements

Four types of measurements (sound level, temperature, humidity, and lighting) have been applied at the case spaces to find an initial indication about the physical environment by using DT8820 multi-function environment meter. The measurements were taken in seven locations in the building of faculty of architecture as shown in Figure 1 and 2, during three times a day (morning, noon, and afternoon) at each location to present an overall indication regarding the physical conditions. The measurement points were established in accordance with the orientation of the space and the spatial variation of the sound sources in the last observation of the case space. The overall measurement time at each location is approximately 5 minutes. The measuring device is located at 1.2 m from the ground.

Case spaces that M1, M3 and M6 measurements were taken are overlooking to inner atrium and M5 overlooking to parking area towards north direction. Case spaces that M2 and M7 measurements were taken are overlooking to the neighbouring restaurant block and M4 overlooking to parking area towards south direction.

Table I shows the measurements of sound pressure level in the observed spaces, which are higher than the standard levels [17]. Whereas, the temperature, lighting, and humidity levels are found to be within the standards' range [18].

Table I. Measurement results at the case spaces and related standard value ranges.

| Measurement No | SPL dB(A) | Regulations dB(A) | Temperature C° | Standards C° | Humidity % | Standards % | Lighting Lux | Standards Lux |
|---|---|---|---|---|---|---|---|---|
| **1** | 42.5 | **<35 dB(A)** | 24 | **Winter: 20-24 C° Summer: 22-27 C°** | 39 | **≈34%** | Nat:440<br>Art: 857 | **>500 lux** |
| **2** | 48 | | 26 | | 36.9 | | Nat:407<br>Art: 1120 | |
| **3** | 48.6 | | 26.5 | | 35.5 | | Nat:128<br>Art: 1361 | |
| **4** | 51 | | 26 | | 35 | | Nat:320<br>Art: 535 | |
| **5** | 43 | | 25 | | 34 | | Nat:272<br>Art: 741 | |
| **6** | 44 | | 25 | | 33.5 | | Nat:383<br>Art: 813 | |
| **7** | 47 | | 23 | | 35.5 | | Nat:196<br>Art: 618 | |

As a result, in order to feed the next method (interview), the observations and measurements are reviewed and factors are indicated to be included in the interviews as shown in Table II. All of the items that are observed are planned to be considered in the interviews with the addition of other related factors that have been previously presented in the literature review section, in order to achieve a detailed scope.

## 4. Conclusion

A detailed identification of affecting space experience and soundscape perception factors is very important. The first stage of the previously developed and presented acoustical POE methodology is applied and presented as part of an ongoing study. In this stage of the study, the results of the observations and measurements are presented in detail that comprises the first POE stage on 'indication'. Categorizations and related obtained data is produced in order to build database for future study of POE process. The influence of sound environment and relevance of soundscape with the quality of space will be assessed in the ongoing study.

Preliminary investigation of space environment has been applied by observing different case spaces. As a result of the first POE indicative stage, observations have led to the formation of seven categories that are, (1) sound sources, (2) orientation,(3) lighting and luminance, (4) furniture (style, material, color), (5) building finishing materials (walls, ceiling, roof), (6) space shape, and (7) privacy. In addition, the physical measurements of the environment have shown that only the sound levels are above the standards.

The indication about the space characteristics and sound sources will help to design future interview questions. These questions will help to obtain further details about space characteristics and space environment by involving occupants in order to feed the evaluation stage in the third phase of this study.

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