An Analysis of Indoor Environmental Quality in an Office: The Case of an University Campus in Istanbul

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INTRODUCTION

The main purpose of this study was to assess the environmental quality of the office and the occupant’s satisfaction in a university campus and to compare the results of the measurements and occupants' comments with standards set for thermal, visual and acoustic environments. Furthermore, occupants' evaluations regarding their own working spaces in terms of these three parameters in their office settings enabled researchers to gain solid feedbacks for the renovation to enhance the conditions of the work environment.
MATERIALS AND METHODS

Physical Setting

The office space studied is the faculty of architecture and design of a university in Istanbul. The office is situated in one of the three renewed warehouses positioned side by side on the shore. These three buildings are in the shape of long, narrow rectangular prisms sited very close to each other and are interconnected. These buildings face the garden on the shore and sea with one of their narrow sides, and a high traffic artery of the city with the other.
MATERIALS AND METHODS

Physical Setting

The office occupies 1/2 of the 1st floor of Block B and faces sea on the East, and other two neighboring buildings (buildings A and C) on the north and south. There are two different types of office spaces in the faculty. Open-offices with semi-enclosed partitions in the central area and are used by the teaching/research assistants; the closed offices surrounding the central area from three sides, shared by two or three academic staff. Closed offices, with regard to their orientation as A and B, create 2 sub groups within closed office type.

A: Limited access to natural light and ventilation
B: Access to natural light and ventilation
C: No access to natural light and ventilation
**MATERIALS AND METHODS**

*Occupants and Work Duration*

The users of the office differ according to age, gender and the academic title. The ages vary from 23 to 67; gender from female to male; academic titles from teaching assistants to professors and administrative titles, from chairperson to dean of the faculty.

The measurements was performed in June and July. According to the academic calendar except August, office is highly occupied and active whole year. Office work hours are between 08.30 - 17.30. Since all users are teaching staff and attend to the classes in different times of the day, time spent in open or enclosed offices by each changes according to the syllabuses.

The study was conducted in three phases; review of the literature regarding the three key factors of indoor comfort conditions in office spaces, analysis of technical data of the office analyzed and finally, evaluations and comments of the occupants collected via questionnaires and short interviews.
METHODS

Technical Data Complication Method

Thermal Comfort
Thermal measurements (temperature and humidity) were taken from the point where seat is located for each work unit, at the desk height. The measurements were repeated for each work unit in all three offices (A, B and C) in 3 different times of the day (morning 10.00-, noon 13.00, afternoon 16.26)

Visual Comfort/Lighting
Illumination in the office has been also been evaluated in 3 different times of the day (morning; 10.00, noon; 13.00, afternoon; 16.26). Significant changes in the values have been observed especially in the rooms having outside connections. The amount of illumination on each user’s desktop, which is approximately 75 cm high from the ground, has been measured with Sekonic L-358 light meter.
METHODS

Technical Data Complication Method

Acoustic Comfort/Noise Control
Measurements regarding the environmental noise in the space were taken in the morning (10.00-10.11), noon (13.00-13.12) and afternoon (16.26-16.36) times of a workday, with closed window conditions. These periods were decided in reference to the standard occupation times of the users. Sound level meter and sound pressure equipments were set in the middle of the each office and central area 150 cm above the ground level and then used for comparison with the standards IEC 60651 and IEC 60804.
METHODS

Statistical Analysis Method/Questionnaire

The questionnaire was prepared in reference to the recent literature on the subject and the IEQ Survey made by the Center for the Built Environment (CBE) at the University of California, Berkeley. Questions were arranged in four parts such as, personal information, physical characteristics of the workspace, assessment of the existing conditions in the workspace and the user satisfaction levels regarding key components of indoor environmental comfort conditions. Fifty-five occupants of the faculty from different age groups, gender and academic titles have been given the questionnaire of 34 questions in total. Questions in the first part were prepared with the intention of gathering information about users’ age, gender and the academic title; and time spent in the office per week and the total months/years spent in the office. Ones in the second part focused on the physical conditions of the office such as type, location, and orientation of the office space. Third part comprised of questions that define the existing conditions regarding thermal comfort, lighting and noise control conditions. Finally, last part targeted at recognizing whether or not the occupants are satisfied with their office environment. The results were recorded and analyzed with the statistical analysis program SPSS, and were studied with t-tests and f-tests. Data was analyzed with respect to the office type and the time spent in the office.
## RESULTS AND DISCUSSION

### Questionnaire

![Bar charts and table showing dissatisfaction levels for various factors in different offices. The table includes the following columns: Temperature, Humidity, Air Movement, Lighting, Noise, and Sound Privacy. The bars represent the percentage of dissatisfaction in each category. The table includes data for different ranges of dissatisfaction levels, with the following distribution: 10 or less: 47% for Temperature, 36% for Humidity, 80% for Air Movement, 60% for Lighting, 85% for Noise. 11-30: 50% for Temperature, 41% for Humidity, 82% for Air Movement, 47% for Lighting, 76% for Noise. More than 30: 40% for Temperature, 30% for Humidity, 55% for Air Movement, 40% for Lighting, 40% for Noise.]

- **Temperature**:
  - 10 or less: 47%
  - 11-30: 50%
  - More than 30: 40%

- **Humidity**:
  - 10 or less: 36%
  - 11-30: 41%
  - More than 30: 30%

- **Air Movement**:
  - 10 or less: 80%
  - 11-30: 82%
  - More than 30: 55%

- **Lighting**:
  - 10 or less: 60%
  - 11-30: 47%
  - More than 30: 40%

- **Noise**:
  - 10 or less: 85%
  - 11-30: 76%
  - More than 30: 40%
When average temperatures and humidity levels are evaluated due to the Turkish Regulation (TS 825) and ASHRAE 55 standard, it was observed that measured average indoor temperatures are over the acceptable limits but the humidity levels are in the limits of comfort zone. Comparing the data of satisfaction and measurements, the most dissatisfied occupants about temperature and humidity are the users of office C, on the contrary to the measured values.
Considering the measurements about the illumination levels in offices, it is observed that the highest illumination levels are obtained in office B. Office A and C average lux values (265, 45; 211, 99) are below the standard levels. It is stated in TS EN 12464 regulation that the illumination level in offices should be 500 lux. Correlation between the statistical data for satisfaction and measured illumination levels are compatible with each other according to the office types. The most dissatisfied occupants are the users of office C (above 50%) and measured average lux value 211, 99 is far below the standards.
## RESULTS AND DISCUSSION

*Technical Data Compilation - Acoustic Comfort*

Office A _closed with neighboring building_

<table>
<thead>
<tr>
<th>Time</th>
<th>Office A</th>
<th>Office B</th>
<th>Office C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning</td>
<td>53.45</td>
<td>61</td>
<td>55.4</td>
</tr>
<tr>
<td>Noon</td>
<td>55.35</td>
<td>61.3</td>
<td>54.4</td>
</tr>
<tr>
<td>Afternoon</td>
<td>51.85</td>
<td>58</td>
<td>54.3</td>
</tr>
<tr>
<td>Average</td>
<td>53.55</td>
<td>60.1</td>
<td>54.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Leq[dB] (TS EN ISO 3745)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning</td>
</tr>
<tr>
<td>46</td>
</tr>
<tr>
<td>50</td>
</tr>
<tr>
<td>54</td>
</tr>
<tr>
<td>60</td>
</tr>
</tbody>
</table>

*Graphs showing acoustic comfort levels for different times of the day.*
RESULTS AND DISCUSSION

Technical Data Compilation-Acoustic Comfort
Office A_Campus side

<table>
<thead>
<tr>
<th></th>
<th>Office A</th>
<th>Office B</th>
<th>Office C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning</td>
<td>53.45</td>
<td>61.00</td>
<td>55.40</td>
</tr>
<tr>
<td>Noon</td>
<td>55.35</td>
<td>61.30</td>
<td>54.40</td>
</tr>
<tr>
<td>Afternoon</td>
<td>51.85</td>
<td>58.00</td>
<td>54.30</td>
</tr>
</tbody>
</table>

Average Leq dB:
- Office A: 53.55
- Office B: 60.10
- Office C: 54.70

Graphs showing acoustic levels over the day for Office A, B, and C.
RESULTS AND DISCUSSION

Technical Data Compilation-Acoustic Comfort

Office B

Morning

Noon

Afternoon

Average

Office A

53.45

55.35

51.85

53.55

Office B

61

61.3

58

60.1

Office C

55.4

54.4

54.3

54.7

Leq dB

TS EN ISO 3745

46 48 50 52 54 56 58 60 62 64

Morning Noon Afternoon
RESULTS AND DISCUSSION

Technical Data Compilation - Acoustic Comfort

Office C

<table>
<thead>
<tr>
<th></th>
<th>Morning</th>
<th>Noon</th>
<th>Afternoon</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office A</td>
<td>53.45</td>
<td>55.35</td>
<td>51.85</td>
<td>53.55</td>
</tr>
<tr>
<td>Office B</td>
<td>61</td>
<td>61.3</td>
<td>58</td>
<td>60.1</td>
</tr>
<tr>
<td>Office C</td>
<td>55.4</td>
<td>54.4</td>
<td>54.3</td>
<td>54.7</td>
</tr>
</tbody>
</table>
Among the features mentioned above, thermal comfort and environmental noise appeared to influence the perception of environmental quality the most.

-Although the measured values of temperature was slightly higher than the acceptability range indicated by TSE and ASHRAE, and humidity stayed with the acceptability range, still the occupants stated their discomfort especially in Office C.

-Air movement was the content criticized by the occupants, strictly. Therefore the further study will include the air movement measurements and ‘met’ and ‘clo’ values as for the renovation and enhancement practices of the office.

-Lighting, although criticized less than the other features, seemed to lack the most in the work environment when the measurements taken to reveal the existing conditions are compared with the codes and standards of TS EN 12464. As in the other features, occupants of Office C were more dissatisfied with the lighting conditions than the occupants of Offices A and B.
CONCLUSION

- Environmental noise, which usually is the major problem in open-plan offices, appeared to be as significant as the thermal comfort conditions. In the office where the study takes place, sound privacy and noise were the features that the occupants are most dissatisfied with. Although the occupants of Office C seemed to be more dissatisfied than the other users, enclosed-shared offices appeared to have the highest dB values, due to the outdoor environmental noise, coming from highly active urban setting.

The results put forth that the thermal conditions and noise are more influential in the satisfaction of the users of than lighting conditions in a workspace. In addition, the study as a whole exemplify a methodology for the investigation, analysis and assessment of an active office space, which reveals the relationship between the users' comments, measurements taken, and the codes and standards. The results revealed and discussed above will be used in the renovation to enhance the work environment.
ACKNOWLEDGMENTS

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Thanks are due to all occupants who responded to the questionnaire.
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Thank you for Listening...