The Impact of Noise in Open Work-areas on Faculty Members' work in Tertiary Educational Buildings

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Abstract—Acoustic is an important part of any working environment. Particularly educational buildings where the level of concentration is required to be very high. Noise is probably the most common problem that arises in many places. Several studies have examined the effect of noise level either as an individual parameter or a combination of one or more environmental parameters. In this research, the aim is to analyze the acoustical satisfaction in faculty work-areas in five academic departments. A total of 63 respondents out of 84 users were included in the analysis. Occupants in private offices are significantly more satisfied with the acoustical quality than occupants in cubicles within the open work-area. The most prevalent problems are: “Faculty talking to students”, “Faculty overhearing private conversations” and “Students talking in surrounding areas”. Over 70% of cubicle occupants think acoustics level interferes with their ability to get their job done and show either very dissatisfaction or dissatisfaction with the noise level in their offices. These responses reveal the importance of the treatments needed to have a better acoustics level within the working zone which lead to more productivity and user satisfaction with the working environment.

Index Terms—Faculty Offices, Noise, Open Offices, Post Occupancy Evaluation (POE).

I. INTRODUCTION

Acoustics in record cases do not obtain the same level of design attention as thermal treatment, ventilation and other architectural and engineering considerations. It would therefore be valuable to determine, from users in the work place, how they perceive the acoustical environment, and what aspects of work-area design or environmental factors are influencing their performance. The research focuses on the faculty offices at Jubail University College, where the faculty members working areas are mostly common.

Acoustic quality is well-defined as the grade to which the totality of the individual requirements made on an auditory occasion is met. [1] Acoustic quality comprises three different kinds of influencing variables: Physical (sound field), psychoacoustic (auditory perception), and psychological (auditory evaluation). [1] Leadership in Energy and Environmental Design (LEED) which is one of the most popular green building guidelines has included acoustic credits as an option but lots more need to be done to make it a mandatory element of green building guidelines. [2]

The problems experienced in open-plan workplaces have been broadly documented in the literature. Results provide strong evidence that working in open workplaces reduces privacy and job satisfaction [3] and cell layouts were more successful in producing higher satisfaction scores on sound privacy and visual privacy [4]. In addition, open-plan offices are accompanying with various environmental complaints, particularly noise and lack of privacy [5].

According to a meta-analysis carried out by DeCroon there is strong evidence that working in open offices reduces worker’s psychological privacy and job satisfaction. Some evidence exists that cognitive workload increases in open offices. [6]

Several studies have examined the effect of noise level either as an individual parameter or a combination of one or more environmental parameters such as thermal load. [7] Other studies mentioned that irrelevant speak or intermittent noise like telephones ringing have an effect on office workers performance and it is the information content of the noise that causes distraction [8].

The present study aims to improve the general understanding of the importance of the post occupancy evaluation as well as the involvement of stakeholders in the design or renovation processes, especially in the educational tertiary buildings. Also, to address the question: how the acoustic in open work areas affect the faculty satisfaction?

II. MATERIAL AND METHODOLOGY

A. Data collection

The data can be divided up into subjective and objective variables. Subjective variables could be an occupant’s satisfaction with the noise level or satisfaction with the sound-privacy level or the noise source and the occupants’ preferences while work. In addition, the users point of view in achieving a better and a quitter working area. The occupants vote on a 5-point satisfaction scale ranging from 1 to 5. Objective variables are demographic related to the working department, office type, and room number. The type of the existing offices varies between private offices, shared offices by 4 to 8 members, or shared offices by 20 members.

B. Participants

In the JUC five academic departments’ offices in the female branch there are 84 users. The participants were recruited via university mailing lists for a whole semester with a weekly based reminder, to give a chance for all members to participate, an official approval for disseminating the survey questions and collecting the results is taken from the college through the hierarchy of responsible parties.

C. Average lettable area per person

The simplest standard to guide an organization on how
much space it requires is the average net lettable area (NLA) that is required per person. The range of average space per person found in different offices is wide, even within a particular type of organization, such as investment banks or solicitors’ offices. The lower end of the scale is represented by about 100 ft² (9 m²) lettable area per person, implying modest working areas for each of the few senior people in the office few amenities and perhaps a degree of desk sharing. At the high end is an average area of around 350 to 400 ft² (30 to 35 m²) per person, nearly four times as much, implying large amount of space for each individual and lavish shared spaces and amenities [9].

![Fig. 1. Workstation layout in Interior Design department.](image)

The area of the room is 60.00 m² which is not suitable for faculty members to have a level of privacy neither a level of concentration. In addition, this area does not match the lettable area per person neither the safety standards in such facility.

The load factor in offices is assumed to be 100 gross which equals 9.29-meter square. [10]

D. Finishes, Furniture, and building materials

Interior designers must pay special attention to details that might affect the integrity of sound insulation, such as walls, ceilings and flooring finishes, which should have a satisfactory level of acoustic quality.

Furniture selection is one of the crucial issues within the college facilities. Some pieces could allow eye-contact and collaboration. Others can prevent interaction and affect faculty’s level of security.

III. DATA ANALYSIS

Out of 84 faculty members 63 responded. As shown in the below fig. (1), out of 63 respondents, 35% was faculty members from the English department (ENGL), 18% was from the Interior Design (ID) department. The percentage of faculty members responded to the survey from the General Studies (GS) department is 22% and 14% from the department of Computer Sciences and Engineering (CS&E). While the percentage of faculty members responded from the Business Administration (BUS) department is 11%. This is related to the number of faculty members in each particular department.

The number of participants was all members from the Cs&E department which is nine. From the GS department 14 members replied. The English department has the most participants with 22 members. In addition, 11 members from the interior design department and 7 members from the business department. These numbers formulate the percentage of 75% of all faculty members working at the college, which reflects the opinion about the whole working environment in different departments.

A. Satisfaction level

The survey results revealed that only 29% out of 63 responses are satisfied with the noise level within their working area. The weighted average of the satisfaction ratio reached 2.75 out of five. The rest percentage of 71% occupants indicated that they are very dissatisfied, dissatisfied and neutral with the noise level in their offices. The below table shows a total of 43% of occupants are either very dissatisfied or dissatisfied. The result is forming an important alarm where specific actions need to be taken.

| TABLE I: PERCENTAGE OF RESPONDENTS OF LEVEL OF SATISFACTION WITH THE NOISE LEVEL IN THEIR OFFICES. |
|---------|--------|--------|--------|--------|--------|
| Very Dissatisfied | Dissatisfied | Neutral | Satisfied | Very Satisfied |
| 11% | 32% | 29% | 29% | 0% |
| 7 | 20 | 18 | 18 | 0 |

Previous studies did not have faculty offices as a particular case. Hence, the focus of this study is to evaluate the open work area as a working environment suitable for this kind of tasks.

Faculty members, especially if they are from different departments need a level of concentration where they can focus on assigned tasks and participate with their ideas.

B. Noise Sources

Sounds can be controlled in one of three stages. Stage one is related to the sound source where the study tries to identify all possible sources in the working area of the given case study. The results show that students talk (student to student conversation) was the most disturbing source of noise. It is weight is 3.63 out of five. This is actually one of the challenges within the college spaces. Students do not have enough spaces for their gathering, study, and other related activities where they need to meet and talk.

The second factor goes to students to faculty talk, where the weighted average is 3.25 out of five. This also goes with the research assumption, where it shows that there are no spaces for consultation or faculty members’ students’ conversation.

The third factor goes to faculty talk. This point is related to speech privacy, rather than the noise level. Hence it needs some actions to be taken. The last two factors are printers and air condition (A/C) noise which show a weighted average of 2.55 and 2.35. The table below includes the weighted average for each noise source included in the survey.
TABLE II: THE WEIGHTED AVERAGES OF EACH POSSIBLE NOISE SOURCE INSIDE DIFFERENT OFFICES.

|                  | 1       | 2       | 3       | 4       | 5       | Weighted Average |
|------------------|---------|---------|---------|---------|---------|------------------|
| Students talk    | 16.07%  | 5.36%   | 16.07%  | 25.00%  | 37.50%  | 3.63             |
| Faculty talk     | 20.00%  | 16.00%  | 30.00%  | 12.00%  | 22.00%  | 3                |
| Students’ faculty conversation n. | 6.82%  | 27.27%  | 25.00%  | 15.91%  | 25.00%  | 3.25             |
| A/C.             | 41.18%  | 17.65%  | 20.59%  | 5.88%   | 14.71%  | 2.35             |
| Printer.         | 33.33%  | 12.12%  | 27.27%  | 21.21%  | 6.06%   | 2.55             |

C. Average wasted time per day

66.67% of the surveyed faculty members preferred to have quietness when they work. This cannot be achieved with noise sources mentioned earlier. In addition, they mentioned that they need from 5 to 10 minutes to get back to the task after interruption. With a simple calculation, if any faculty interrupted 3 to 5 times during the working hours, about 15 to 50 minutes will be wasted.

The remaining percentage of 32.00% chooses 10 to 20 minutes to get back to their work; this is at least 30 to 100 minutes.

TABLE III: PERCENTAGE OF AVERAGE TIME TAKEN TO GET BACK ON TASK AFTER INTERRUPTION

| Time in minutes | Responses | 5-10 min | 65.00% | 10-20 min | 32.00% | +20 min | 3.00 % |
|-----------------|-----------|----------|--------|-----------|--------|---------|--------|

Additionally, 40% of the faculty members surveyed are using earmuffs or earplugs. This percentage is quiet alarming. Using such tools during the working day for 8 hours might hurt ears and cause hearing loss on the long-term. Especially, about 20% are using them most of the time.

D. Participants’ perception for solution.

The survey focuses on having solutions related to the users, where they were asked about some spaces to be added to confine the noise and enhance the quality of their working areas.

The spaces are student’s lounge, private offices, consultation rooms, printing rooms, and quieter ventilation systems. The faculty response of having these areas was highly positive.

It seems that about 50% of the faculty members are in need to have private offices, where they can feel with privacy and can control the noise in a better way within the single space.

In addition, there is a need of having consultation rooms which is identically agreeing with the results in the previous section that students’ faculty talk is one of the most affecting factors in causing noise in the working areas.

The students’ lounge deemed to have a very high weighted average which is 3.67. This is one of the most important facilities that is required to be considered from the design stage in similar buildings.

IV. DISCUSSION

The importance of quiet working areas in faculty offices was explored in the survey questions. After the analysis of data, three main themes emerged.

A. Post occupancy evaluation.

The open ended questions added a considerable value to the findings. The research selected the most important problems which reveal that the post occupancy evaluation is a very important aspect to be considered, especially, if faculty members are affected.

One respondent stated that “I am one of those who can never work in a noisy environment and I am always suffering here in JUC. I hope you can solve this problem forever.”

This approach can help designers and architects better understand the effect that spaces can have on behavior, allowing them to recognize links between environmental and human variables. It can allow an understanding of how the physical environment can impact human behavior, and vice versa, helping inform future design practices and ensuring spaces can truly meet the needs of those using them.

B. Open verses closed offices.

The nature of work handled by faculty members is crucial. Most, if not all, members are working individually. Some faculty recommended private offices for everyone. This is aligned with the design or renovation stage that took place from the beginning. The designer should think about the nature of work which will be practiced within the facilities in the educational buildings. Some responded that “Private offices will solve the problem.” Or “Private office would help a lot.” And they have the right to tell so. Another responded that “We cannot have private conversation with the chairperson or any other faculty or student.” This is stating the problem of considering the building type and the users’ classification.

Some members highlighted the connection between the offices layout and the person doing specific work. “Open cubicles are not a good idea for such environment. It can
work for HR and Administration, but not for faculty staff members where we MUST interact with students, trainees, and staff members. In addition, we do not have a meeting room in our department. The ENGL department has two major programs: The Bachelor and the Prep. Thus, we have meetings constantly, which leads to a lot of discussions and arguments and those who are not involved in these meetings have to suffer listening and getting annoyed. It's VERY annoying and this is one of the reasons I cannot work in my office, unfortunately."

Open offices may be suitable for specific jobs that are mainly comprised of teamwork. The main problem seems to be that the selection of occupant's workstation is not based on the analysis of job demands. [6]

Additionally, the suggestion of having consultation rooms was highly recommended. One respondent stated that "As there is no separate room or area for student-faculty discussion or faculty-faculty discussion, the noise source disturbs the other faculty. We cannot force a faculty to be quiet for the whole working hours. Faculty needs to communicate with others to perform the tasks. But, if there is a separate nearby room for somebody, who wants to works in quiet environment, it will be better. At present, there is a quiet room in building B only. But, if it is nearby, that will be very convenient for the faculty to use the facility. Even for the Faculty-Student discussion, we either use the staff room or empty class rooms. We need a separate room for discussions."

C. Interior finishes and furniture selection.

Some responses were related to the furniture selection and the building materials that should be treated acoustically to reduce the office noise.

The cubicles design used within the college spaces, which is similar to the one shown in the figure below, is preventing the communication between members. In addition, it is not providing a satisfactory level of privacy.

Although introducing open-plan offices may appear cheaper in the short-term, it is important to acknowledge the indirect costs to the wellbeing, performance and retention of staff.

![Fig. 3. Cubicles layout at JUC.](image)

V. CONCLUSION

The overall findings of this study are consistent with most previously reviewed studies (see table 5). The results of this study support the findings of Annu Haapakangas [6] regarding the workers’ perception and its relation to the work performance. Additionally, this study contributes to the body of the exiting literature regarding design strategies to enhance the quality of working areas especially in educational buildings.

| TABLE V: COMPARING FINDINGS BETWEEN THE STUDY AND PREVIOUS STUDIES. |
|---------------------------|-----------------|-----------------|--------------|--------------|
| Support in the current study | Faculty perceptions | work performance | Noise as environmental problem | open office | Post occupancy evaluation |
| Annu Haapakangas as, 2008 | ✔ | ✔ | ✔ | ✔ |
| Annu Haapakangas as, 2018 | ✔ | ✔ | ✔ | ✔ |
| Danielsson, 2009 | ✔ | ✔ |
| M. Pierrette, 2014 | ✔ | ✔ |

Note. "•" indicates which topics are addressed in each source.

The study benefits from qualitative data which was based on real experience and perception of participants. The case selected was conservative in disclosing the existing acoustic related data within the scope of the study. However, more other perspectives can be applied to triangulate the results. The current study was conducted in a college which was renovated from a high school building. Results are generalized to similar functions such as educational buildings or colleges. Future studies might include a wider variety of tertiary education buildings. The participants in the study were from different departments with different backgrounds. Future study could use randomly selected participants.

The study supports the idea that all noise sources could be controlled to avoid wasting time, elevate users’ satisfaction, and take the benefits of the valuable time of faculty members in different departments.

Applying this research result in design decision can improve the acceptance of design solutions by stockholders. It will be helpful for faculty members, architects, interior designers, college administrators, and students who are affected by the noise and facilities distribution all over the building.

The results can be used by college administrators and designers to improve the students’ as well as staff faculty members’ satisfaction and performance through interior design, by reducing the noise level and giving suitable spaces for faculty members to do their tasks effectively.

Also, the data offers a baseline theory for future researchers to develop other conceptual plans with more details for colleges’ layouts and students’ needs in such kind of buildings.

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