Effect of Spatial Planning on the Noise Level of Teacher's Chamber in University

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ABSTRACT

The impact of noise on productivity in institutional buildings can be significant. Excessive noise levels distract individuals, impairing their ability to focus, think clearly, and perform tasks efficiently. In educational settings, students and teachers may struggle to concentrate, leading to reduced learning outcomes. Addressing these issues often requires thoughtful architectural design, soundproofing materials, and strategic noise control measures to create a conducive environment for occupants. This study aims to asses the noise level in teachers chambers for two different spatial planning layout of university buildings. A combination of quantitative research methodology have applied in this study through experiment, computational, and analytic methods. For this study two universities are selected, one is Dhaka University of Engineering and Technology (DUET), Gazipur and the other one is Gazipur Agricultural University (GAU), Gazipur for data collection. Data has measured with a portable digital sound level meter (TES-1353S). A regular class day has been chosen and data was collected for 12 times for that day. The timing of data collection is chosen in accordance with the university's class schedule. In teacher's chamber, noise level measured in the both surveyed space was lower during class time ranging from 53.1 dBA to 41.1 dBA at DUET and from 43.6 dBA to 41.3 dBA at GAU. But during break time noise level was relatively higher, ranging from 68.7 dBA to 52.6 dBA at DUET and from 53.4 dBA to 47.6 dBA at GAU. During class time mean noise level was 46.5 dBA at DUET and 42.3 dBA at GAU whereas during break time mean noise level was 59.8 dBA at DUET and 50.0 dBA at GAU. Moreover, ANOVA test results show that different spatial planning of teachers' chambers had a statistically significant effect on mean noise level. So it could be concluded that the level of background noise in teachers' chamber is considerably affected by the spatial planning of the chambers.

Keywords: Noise level, Teacher's chamber, Spatial planning, University

1. INTRODUCTION

Universities offer a wide range of facilities to support academic, recreational, and social activities for students, faculty, and staff. Facilities range from academic facilities (such as classroom, lecture hall, library, teacher's room, laboratory, etc.) to recreational facilities (such as sports centers, outdoor fields, recreational clubs, etc.). These facilities are designed to enhance the overall university experience, providing support for academic success, and personal growth, especially for teachers and students [1]. By offering a supportive environment, these facilities contribute to various aspects of university life. Among those facilities, a teacher's chamber is a designated space where faculty members conduct their academic and administrative duties [2]. This private area is used for lecture preparation, study, research activities, meetings with students, and administrative and professional work.

Similar to any other study area, this teacher's chamber requires a quiet environment [3]. Noise in university buildings is a common phenomenon that varies based on the type of space, time of day, and the activities occurring within those spaces [4]. Noise can impact the academic environment, particularly in areas designed for studying, teaching, or research. The noise level in a learning space i.e. teacher's chamber, is a crucial factor that can significantly impact concentration, productivity, and overall study effectiveness [5]. Noise can stem from a variety of sources, and it often disrupts concentration and productivity for both students and faculty [6],[7]. Common sources of noise in university are foot traffic and conversations, construction and maintenance work, classroom overflows, noise from adjacent classrooms, lectures, or group discussions that can carry into nearby spaces, HVAC systems, and equipment, social areas near study spaces, events and gatherings etc. [8].

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Difficulties caused by noise in learning environments have been recognized and understood for over 100 years [9]. The learning process becomes slower in learning environments, which have high background noise levels [10]. Non-optimal acoustical conditions result in decreased learning effectiveness as well as fatigue, tension, health problems, and headaches [11]. High noise levels can significantly hinder the learning process by creating distractions that divert attention from tasks, making it challenging for learners to absorb information or complete assignments effectively [12]. Additionally, background noise contributes to an increased cognitive load, which can reduce both efficiency and retention of information. Over time, constant exposure to elevated noise levels may also lead to heightened stress and mental fatigue, further impacting learners' ability to concentrate and perform academically [13]. Creating a quieter study environment is therefore essential for optimizing focus, learning, and overall well-being [14].

The teacher's chamber is a type of educational setting. So, learning space requirements will be relevant for the teacher's chamber. Table 1 shows the allowable upper limit of indoor background noise for classrooms, libraries, small offices, and conference rooms is 38-48 decibels (dBA) according to BNBC 2020 [15]. ANSI standard for classroom acoustics addresses the issue of background noise. The maximum level of background noise allowed in the same learning space is 35 dBA [16]. In the UK, the allowable upper limit of indoor background noise for learning space is set by Building Bulletin 93 (BB93): Acoustic Design of Schools. For a typical learning space, the allowable upper limit of background noise is also 35 dBA [17].

Numerous studies have been done in the past to evaluate the noise level in educational settings like schools and universities. Most of them focused on subjects like the university or school's classroom. Augustyńska et al., 2010 carried out an assessment of teachers' exposure to noise in primary schools[18]. Noise was measured at the teachers' workplaces. Studies have shown that noise is the main factor of annoyance in the school environment. Almost 50% of teachers surveyed said that noise irritates them, and close to 40% said that noise is excruciating or intolerable. But based on published documents no research was found about the study of the noise level in teacher's chambers at the university. So, this study aims to achieve this research gap. This study aims to evaluate the prevailing noise level in teacher's chambers at the university.

2. METHODOLOGY

The survey was done in three steps. Firstly, a physical survey was conducted. In the second step, ambient noise was measured in the case space. Lastly, the data was analysed.

2.1 Selection of Case Space

In university building plans, different types of spatial planning layouts have been seen. Generally, three types of arrangement are very common. The first one is the classrooms and teachers' rooms in the same block, the second one is classrooms and teachers' rooms in a separate block, and the third is on different floors. Two universities are selected to study noise levels in teachers' chambers. One is Dhaka University of Engineering and Technology (DUET), Gazipur and the other one is GazipurAgricultural University (GAU), Gazipur. The Planning layouts of the universities are different. In DUET the classrooms and teachers' rooms are in the same block, separated by a common corridor (Fig.1). On the other hand the planning layout of GAU is different, these two blocks are separated (Fig. 2).

The teachers' block and the office exist just opposite the classrooms in the corridor of the floor in Architecture Department of New Academic Building, DUET. The noise comes during the interval time of the classes when students enter or exit from the classrooms and chat with each other in the corridor. The primary corridor is 10 feet wide, twelve feet high, and two hundred and twenty feet long. The wall of the corridor is a 5″brick plastered wall with wooden doors at several distances and a high window over 10′ height. The secondary corridor is 6′ wide with the same configuration as well as an additional operable window at 2′-6″ level. The chamber area is varying from144 to 165sft and each studio is 1867sft with 30No.s student capacity. Total floor area is 17851sft with 136 (120 students, 9 teachers and 7 staffs) users.

In GAU, faculty of fisheries building, the classroom and laboratory block is separated from teachers' block by staircase (Fig.2). These two blocks are connected with a 7′ wide corridor. The length of the corridor is 174′, and height is 13′. The wall of the corridor is a 5″-brick plastered wall with wooden doors at several distances and a high window over 10′ height. The chamber area varies from 487 to 681sft. The Lab areas are varying from 487 to 681sft with 30No.s student capacity and the classroom area is 838sft with 60 student capacity. Total floor area is 9078sft with 147 (130 students, 8 teachers and 9 staffs) users.

Table I: Allowable upper Limit of Indoor Background Noise [15], [21]

Type of space	dBA
Broadcast and recording studios (distant microphone used)	18
Large theatres and auditoriums, mosques, churches, temples and prayer space	<28
Small theatres, auditoriums, churches, music rehearsal rooms, large meeting and conference rooms	<38
Classrooms, libraries, small offices and conference rooms	33-48
Living rooms and drawing rooms in dwellings	38-48
Large offices, receptions, retail shops and stores, cafeterias, restaurants, etc.	43-53
Lobbies, laboratories, drafting rooms and general offices	48-58

Fig. 1: Case Study Floor Plan of New Academic Building, DUET

Fig. 2: Case Study Floor Plan of Faculty of Fisheries, GAU

2.2 Data Collection

A portable digital sound level meter (TES-1353S) was used to measure the noise level at the case spaces. The noise level is detected in decibels (dB).

The measurement points is selected in both the adjacent corridor and the teachers' chamber at each university. This selection is based on the objective of the study, which is to assess the noise levels within the teachers' chambers. As these chambers are situated adjacent to the corridors, and noise is primarily transmitted into the chambers through these corridors, it is essential to include the corridor as a measurement location. Within the teachers' chambers, noise measurements are taken at the reading position, approximately at ear level, to reflect the typical exposure experienced by occupants.

For measuring data 8 points are selected on the Architecture Department of NAB building in DUET (Fig. 3). On corridor for the points 1,2 and 3 data are collected at ear level at a standing height of 1.5m. In chambers for points 4,5,6,7 and 8, the data are collected at ear level at sitting position 1.2m [19], [20]. The data was collected 12 times on a regular class day. The time of data collection is selected according to the class routine of the university (Table I). Two different phases of time have been chosen that is class time and break time.

For the other case space GAU floor plan, 9 points have been selected for sound level measuring (Fig. 4). There are three points in the corridor and six points in the chambers. The routine of the university is more or less the same as DUET (Table II). Here also two different phases of time have been chosen that is class time and break time.

2.3 Data Analysis

This study aimed to analyze the collected data according to various zones and times. First, the data was analysed by two different zones, that were the teacher's chamber and the adjacent corridor. Secondly, it was analyzed by class time and break time. Thirdly the data was analysed by different spatial plans of two universities.

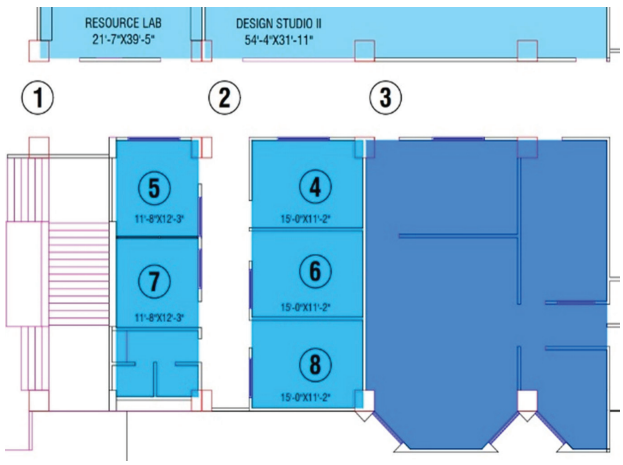

Fig. 3: Noise Level Measuring Points on Case Study Floor for DUET

Table II: Class Routine of DUET

Class Routine of DUET								
	Period 1	Period 2	Tea Break	Period 3	Period 4	Lunch break	Period 5	Period 6
Time	8:30-9:30	9:30-10:30	10:30-10:55	10:55-11:55	11:55-12:55	12:55-13:55	13:55-14:55	14:55-15:55

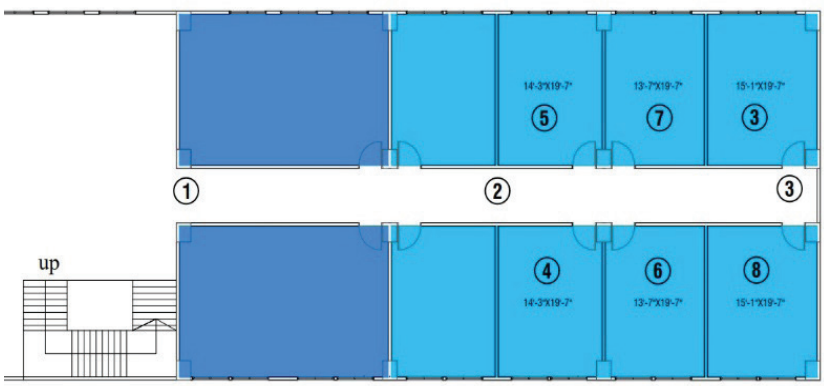

Fig. 4: Noise Level Measuring Points on Case Study Floor for GAU

Table III: Class Routine of GAU

Class Routine of GAU							
	Period 1	Period 2	Period 3	Period 4	Lunch break	Period 5	Period 6
Time	9:30-10:20	10:25-11:15	11:20-12:10	12:15-13:05	13:05-14:10	14:10-15:05	15:05-15:55

This study also tried to check whether there was any statistically significant effect of noise level due to different spatial planning. For this purpose, a one-way Analysis of Variance (ANOVA) is performed using the Analysis ToolPak extension of Microsoft Excel 2010 software. The significance level (α) for the ANOVA test was chosen at 0.05 in accordance with earlier research on this topic [20]. In the ANOVA test, the F_0 value is a ratio of two independent measures of variance for the provided data. The F_{crit} value is a specific value to which the resulting F_0 value is compared. If the F_0 value in the ANOVA test is greater than the F_{crit} value, the null hypothesis is rejected and the alternative hypothesis is accepted. If F_0 value is less than F_{crit} value, it indicates that there is insufficient evidence to reject the null hypothesis.

3. RESULTS AND DISCUSSIONS

3.1 Noise Levels in Teachers' Chamber

Background noise levels of the adjacent corridor and teacher's chamber at DUET are presented in Fig. 5. Data depicts noise levels from the beginning of the class to the end of the class for one day. In the adjacent corridor, the noise level varies from 81.7 dBA to 51.5 dBA. In teachers' chamber noise level varies from 78.8 dBA to 40.6 dBA. Data also shows that the noise level was highest at 15:55 which was the end of class. At 15:55 in the adjacent corridor, the noise level varies from 81.7 dBA to 75.4 dBA, and in the teachers' chamber from 78.8 dBA to 62.5 dBA. The noise level was also greater at 10:30 and 12:55. 10:30 was tea break and 12:55 was lunch break. During all class times such as 9:00, 10:00, 11:30, 12:30, 14:30, and 15:30 noise level was relatively lower.

Figure 6 illustrates the background noise levels of the adjacent corridor and teacher's chamber at GAU for one day. In the adjacent corridor, the noise level varies from 81.4 dBA to 47.2 dBA. In teachers' chamber noise level varies from 65.8 dBA to 40.2 dBA. Data also shows that the noise level was highest at 15:55 which was the end of class. At 15:55 in the adjacent corridor, the noise level varies from 81.4 dBA to 63.9 dBA, and in the teachers' chamber from 65.8 dBA to 58.6 dBA. The noise level was also greater at 13:05. That was lunch break. During all class time noise level was relatively lower.

During class time background noise levels of DUET are presented in Table IV. In the adjacent corridor, the noise level varies from 61.5 dBA to 51.5 dBA. The mean noise level was 56.4 dBA. In teachers' chambers mean noise level varies from 53.1 dBA to 41.1 dBA. The noise level was highest at locations 4 and 5 because these two were located just opposite of classroom and was lowest at location 8 which was located far away from the classroom. The mean value of noise levels of all the teachers' chambers is 46.5 dBA during class time.

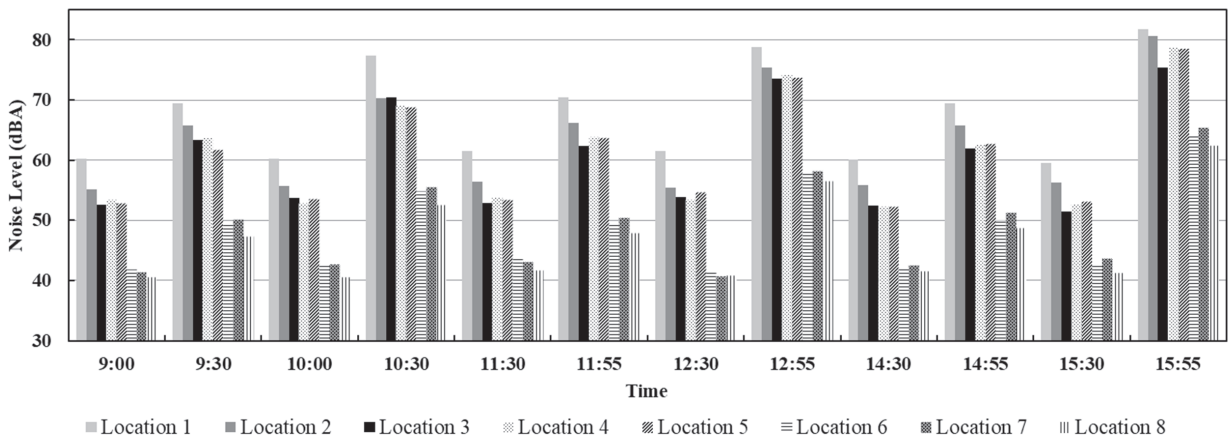

Fig. 5: Background Noise Levels of Adjacent Corridor and Teacher's Chamber at DUET

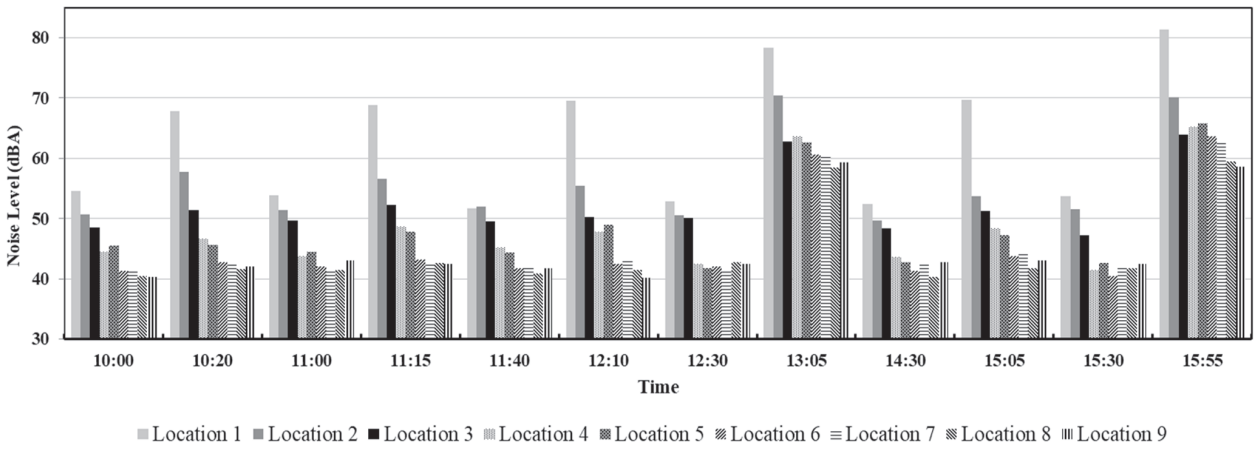

Fig. 6: Background Noise Levels of Adjacent Corridor and Teacher's Chamber at GAU

Table V illustrates data of background noise levels of DUET during break time. In the adjacent corridor, the noise level varies from 81.7 dBA to 61.9 dBA. The mean noise level was 71.0 dBA. In teachers' chambers mean noise level varies from 68.7 dBA to 52.6 dBA. The mean value of noise levels of all the teachers' chambers is 59.8 dBA during break time.

During class time background noise levels of GAU are presented in Table VI. In the adjacent corridor, the noise level varies from 54.5 dBA to 47.2 dBA. The mean noise level was 51.0 dBA. In teachers' chambers mean noise level varies from 43.6 dBA to 41.3 dBA. The noise level was relatively lower in all the teachers' rooms because all of these were located far away from the classroom zone. The mean value of noise levels of all the teachers' chambers is 42.3 dBA during class time.

Table VII illustrates data of background noise levels of GAU during break time. In the adjacent corridor, the noise level varies from 81.4 dBA to 50.3 dBA. The mean noise level was 62.9 dBA. In teachers' chambers mean noise level varies from 53.4 dBA to 47.6 dBA. The mean value of noise levels of all the teachers' chambers is 50.0 dBA during break time.

Figure 7 demonstrates the mean background noise level during class time and break time at DUET and GAU in the teachers' chamber. During class time mean noise level was 46.5 dBA at DUET and 42.3 dBA at GAU whereas during break time mean noise level was 59.8 dBA at DUET and 50.0 dBA at GAU.

Table IV: Background Noise Levels (dBA) of DUET During Class Time

Class time at DUET								
Adjacent Corridor				Teacher's Chamber				
Location				Location				
Time	1	2	3	4	5	6	7	8
9:00	60.2	55.1	52.6	53.5	52.8	41.8	41.4	40.6
10:00	60.3	55.7	53.7	52.9	53.6	42.7	42.6	40.6
11:30	61.5	56.4	52.9	53.8	53.4	43.8	43.1	41.7
12:30	61.5	55.4	53.9	53.5	54.7	41.4	40.7	40.8
14:30	60.1	55.8	52.5	52.3	52.3	42.3	42.5	41.5
15:30	59.6	56.3	51.5	52.7	53.1	42.6	43.7	41.2
Mean	60.5	55.8	52.9	53.1	53.3	42.4	42.3	41.1
Mean		56.4				46.5		

Table V: Background Noise Levels (dBA) of DUET During Break Time

Break Time at DUET								
Adjacent Corridor				Teacher's Chamber				
Location				Location				
Time	1	2	3	4	5	6	7	8
9:30	69.4	65.7	63.4	63.7	61.8	49.6	50.2	47.3
10:30	77.4	70.3	70.4	69.2	68.8	54.8	55.6	52.6
11:55	70.5	66.2	62.4	63.9	63.7	49.4	50.5	47.9
12:55	78.8	75.4	73.6	74.2	73.8	57.9	58.3	56.6
14:55	69.5	65.7	61.9	62.6	62.8	50.1	51.3	48.8
15:55	81.7	80.6	75.4	78.8	78.6	64.0	65.4	62.5
Mean	74.6	70.7	67.9	68.7	68.3	54.3	55.2	52.6
Mean		71.0				59.8		

Table VI: Background Noise Levels (dBA) of GAU During Class Time

Class Time at GAU									
Adjacent Corridor				Teacher's Chamber					
Location				Location					
Time	1	2	3	4	5	6	7	8	9
10:00	54.5	50.6	48.5	44.5	45.5	41.3	41.5	40.5	40.3
11:00	53.9	51.4	49.6	43.7	44.5	42.1	41.6	41.4	43.1
11:40	51.7	51.9	49.5	45.2	44.3	41.8	42.1	40.9	41.7
12:30	52.8	50.5	50.1	42.4	41.8	42.1	41.4	42.7	42.5
14:30	52.4	49.7	48.3	43.6	42.7	41.3	42.7	40.3	42.7
15:30	53.7	51.6	47.2	41.5	42.6	40.5	41.8	41.8	42.5
Mean	53.2	51.0	48.9	43.5	43.6	41.5	41.9	41.3	42.1
Mean		51.0				42.3			

Table VII: Background Noise Levels (dBA) of GAU During Break Time

Break Time at GAU									
Adjacent Corridor				Teacher's Chamber					
Location				Location					
Time	1	2	3	4	5	6	7	8	9
10:20	67.8	57.7	51.4	46.7	45.7	42.7	42.3	41.6	42.1
11:15	68.9	56.6	52.3	48.7	47.8	43.2	42.6	42.6	42.5
12:10	69.5	55.4	50.3	47.8	48.9	42.5	43.2	41.5	40.2
13:05	78.4	70.4	62.8	63.6	62.7	60.6	60.4	58.5	59.4
15:05	69.7	53.7	51.3	48.4	47.2	43.7	44.1	41.7	43.1
15:55	81.4	70.2	63.9	65.3	65.8	63.6	62.6	59.5	58.6
Mean	72.6	60.7	55.3	53.4	53.0	49.4	49.2	47.6	47.7
Mean		62.9				50.0			

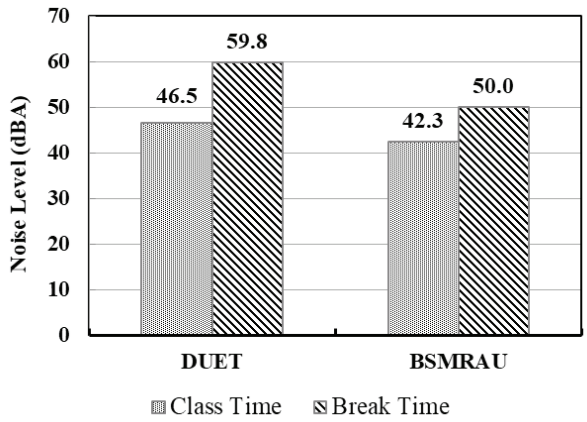

Fig. 7: Mean Noise Level During Class Time and Break Time at DUET and GAU in Teachers' Chamber

3.2 Statistical Analysis

DUET and GAU had two different spatial planning of the teacher's chamber. It was initiated to check whether there was any statistically significant effect of noise level due to different spatial planning of teachers' chambers. The results of ANOVA for the mean noise level in teachers' chambers due to different spatial planning are summarized in Table VIII. Here F_0 value is greater than F_{crit} value, so it can be stated that there are statistically significant effects of mean noise level due to different spatial planning of teachers' chambers in DUET and GAU. Results of ANOVA testing conclude that the level of background noise in teachers' chambers is considerably affected by the spatial planning of the chambers.

Table VIII: ANOVA for Mean Noise Level in Teachers' Chamber Due to Different Spatial Planning

Source of Variation	SS	df	MS	F_0	P-value	F_{crit}
Between Groups	1588.78	1	1588.78	20.76676	1.18×10^{-5}	3.913989
Within Groups	9945.771	130	76.50593	--	--	--
Total	11534.55	131	--	--	--	--

3.3 Summary

A summary result is shown in Table IX.

Table IX: Summary Chart

Case Study	Planning Layout	Noise Level	Conclusion
DUET	Classrooms and teachers' rooms in the same block	The mean noise level is 46.5 dBA during class time and 59.8 dBA during break time	The level of background noise in teachers' chambers is significantly influenced by the way the spaces are planned though it is still higher than the allowable upper limit (48 dBA) [15].
GAU	Classrooms and teachers' rooms in a separate block	The mean noise level is 42.3 dBA during class time and 50.0 dBA during break time	

4. CONCLUSION

This research was initiated to investigate the effect of noise levels on the spatial planning of teacher's chambers in the university. Selected case space DUET and GAU had two different spatial planning of the teacher's chamber. In the teacher's chamber, the noise level measured in both surveyed spaces was lower during class time ranging from 53.1 dBA to 41.1 dBA at DUET and from 43.6 dBA to 41.3 dBA at GAU. But during break time noise level was relatively higher, ranging from 68.7 dBA to 52.6 dBA at DUET and from 53.4 dBA to 47.6 dBA at GAU. During class time mean noise level was 46.5 dBA at DUET and 42.3 dBA at GAU whereas during break time mean noise level was 59.8 dBA at DUET and 50.0 dBA at GAU.

Moreover, ANOVA test results show that different spatial planning of teachers' chambers had a statistically significant effect on mean noise level. So, it could be concluded that the level of background noise in teachers' chambers is considerably affected by the spatial planning of the chambers.

In this study, although the two case spaces exhibit minimal variation in the number of users, there is a significant disparity in floor area. Consequently, the findings may not be entirely conclusive. Further investigation, incorporating additional case spaces with similar floor area, may yield more accurate and reliable results.

Further research would be carried out in other universities with the same spatial plan like DUET and GAU. Again, another case where teachers' block and classroom block located on different floors would be investigated. The findings of this research are expected to provide valuable insights for architects and designers in creating more comfortable and productive workspaces when planning educational facilities.

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