International Journal of Technology Engineering Arts Mathematics Science
Special Issue 1, August 2023, pp. 310-319
ISSN: 2583-1224

'Performance Study of Acoustically Treated and Untreated Spaces to understand the Impact on Users'

Ar. Rutusha Laddha

S. B. Patil College of Architecture & Design, Nigdi, Pune, Maharashtra, India

Corresponding Author: Ar. Rutusha Laddha – r.laddha@sbpatilarchitecture.com

Article Information

Article history:

Received Jun 10, 2023
Accepted Dec 10, 2023

ABSTRACT

This study examined the contribution of acoustics in a workplace with respect to the overall noise exposure to the users at Westend mall in Aundh Pune. Based on the parameters of sound levels outside the areas, the acoustical materials used there and the impact of the noise on the users as a result, three different areas, one with complete acoustical treatment, the second with partial acoustical treatment, and the third without any acoustical treatment, were the cases studied.

Each location's noise level was assessed using an SPL meter. Customers of the adjoining mall were given a survey to gauge the impact of the noise. Observations and field studies led to the discovery of the following acoustical materials: Average sound pressure levels measured were 95 dB in regions with a lot of background noise and 75 dB in areas with less background noise. Noise levels in untreated areas were higher than in treated areas. The noise threshold for commercial environments is 65 dB. Average background noise levels exceeded the NC 65 dB limit, but only when occupancy was at its highest.

It is advised to reduce noise in places in mixed-use commercial locations. To accomplish the appropriate human comfort and preserve the desired noise standards as per regulatory rules, this can be done by restricting the sound pressure levels to an audible limit and effectively insulating the area using acoustic materials.

KEYWORDS: noise, acoustics, acoustic materials, impact of noise, noise criteria, noise control.

1. INTRODUCTION

Malls offer a variety of products from clothes to electronics, revolutionizing shopping for Indians. India's growing income and middle-class lifestyle changes make for a vast market, while its diverse culture spans generations. India's nightlife industry boosts economy with revenue growth, clubbing and nightlife are the pulse. Global parties invade pubs in India, noise control efforts fail. Adoptive measures are being taken to address the issue.

Noise is commonly defined as any unwanted or undesirable sound (Noise & Vibration Control, 1995). Our ears and brain can hear and understand sounds really well.

Problems with loud noises in bars and clubs can happen because of music, sound systems, people, and things being delivered. Noises vary in character and require different assessments. Users' acoustical comfort is crucial for their satisfaction with a space. Noise control enhances well-being by enabling activities without disturbing others. Noise exposure causes irritability, insomnia, and lack of focus in addition to hearing loss. India's clubs are too loud. Noise over 90 dB harms hearing; it's agonizing beyond 120 dB. Nightclub noise: 120 dB. Club speakers emit 95 dB, lower on floor. Indian dance clubs max floor sound = 105 dB. Loud music banned in India after 10.30pm. Amplifiers are allowed from 9am-10:30pm, for three hour increments. Acoustics missed in pub design. Consultants solve noise impact on surroundings. Pub noise needs improvement for customer comfort. Acoustic design impacts pub quality and user satisfaction. User comfort relies on factors such as lighting, indoor environment quality,

and acoustics. Acoustic comfort is critical for interaction and communication.

1.1. AIM

To evaluate the performance of acoustically treated and untreated spaces for their impact on users.

1.2. OBJECTIVES

- To list the materials used in all the three cases for acoustical treatment by observations.
- To study the performance of different acoustic materials used in pubs and multiplex by measuring the sound levels inside and outside the selected cases.
- To study the impact of noise on the users by carrying out a survey and filling up questionnaire.

1.3. METHODOLOGY

This empirical study surveyed 30 respondents using a close ended questionnaire in three selected cases at Westend mall in Pune. The sample is diverse in age, sex, visit time, purpose and noise-related issues, making it suitable for the study. Thus, it can be treated as a representative sample for such an exploratory study.

A study of different acoustical materials' performance was conducted by field measurements using a SPL or dB meter to measure sound levels inside and outside three selected cases. Acoustical materials in 3 cases were observed for their properties by the researcher.

1.4. SCOPE & LIMITATIONS

- This study only refers to the users in and around the zones that have been selected for the study, which is the First floor of the mall.
- It doesn't consider the impact of the outside noise on the users.
- It doesn't take into consideration the impact of structure borne noise.

2. REVIEW OF LITERATURE

2.1. NOISE & SOUND

The phenomenon of sound can be attributed to fluctuating pressure resulting from perturbations within an elastic medium. The molecules present within a given medium exhibit motion, which in turn results in periodic oscillations of the pressure around the equilibrium pressure levels both above and below said levels.

A sound wave is described as the oscillation of sound pressure variations. (Autenrieth, 2011) A noise wave moves through an ideal medium in a straight line, going back and forth. The sound's high or lowness is measured in Hertz (Hz), which depends on the number of sound waves. People can hear sounds that go from 20 to 20,000 vibrations every second. Amplitude describes sound wave energy. A dB scale is used for SPL measurements due to varied sound pressures.

Sound can be affected by reflecting or passing through objects like wood or metal. Soft surfaces absorb sound well. Reflected waves raise SPL, becoming a secondary source of sound. In far-field, sound is predictable, and most equipment can only measure accurate SPLs there. Measuring sound in reverberant-fields is challenging due to increased SPL from reflections. To compare SPLs, compensate for ear canal resonance in the ear's reverberant-field and free-field.

Undesirable sound is defined as noise. The phenomenon of sound is the result of energy released from an object in motion, which, upon reaching the ear, triggers nerve impulses responsible for the sense of hearing. Noise issues have three elements: source, receiver, and transmission path. Sound travels through air and building materials to reach the receiver. Undesirable noise can have high or low frequency, causing hearing issues. For example, when a child cries, it can harm their ability to hear properly. We call unwanted sound noise. Perception of sound versus noise depends on people's habits and interests, ambient conditions, and sound impact at the time.

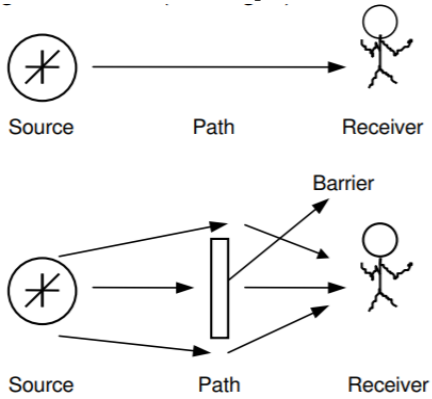


Fig 2.1: Noise element relationships.

Noise in this study refers to background noise and music output in pubs. The speakers' output in pubs is noise in this study due to the risk of hearing damage and the ease of identifying sound sources.

2.2. TYPES OF NOISE

Airborne noise is caused by vibrating mass particles and travels as sound waves at 344m/s, producing distinct tones based on frequency. For example, whistling has high frequency, while distant thunder growls with low frequency.

Structure-borne noise travels through solid materials like steel, wood, concrete, and stone. This includes noise from machinery installed in a building. The sound unit is dB.

2.3. BACKGROUND NOISE

Background noise comes in four stages:

- A noise that is very loud can make you unable to hear properly in the future.

- A loud sound that makes it hard to understand someone's speech.
- Sounds that are not too loud but disturb peaceful activities.
- Noise that bothers people in buildings because of what it sounds like, not how loud it is.

Background noise is measured in A-weighted decibel. This single number measure weighs noise per human sensitivity to frequency.

Type of Space (and Acoustical Requirements)	NC Curve	Equivalent[a] dBA
Concert halls, opera houses, and recital halls (for listening to faint musical sounds).	10–20	20–30
Broadcast and recording studios (distant microphone pickup used).	15–20	25–30
Large auditoriums, large drama theatres, and houses of worship (for excellent listening conditions).	20–25	30–35
Broadcast, television, and recording studios (close microphone pickup only).	20–25	30–35
Small auditoriums, small theatres, small churches, music rehearsal rooms, large meeting and conference rooms (for good listening), or executive offices and conference rooms for 50 people (no amplification).	25–30	35–40
Bedrooms, sleeping quarters, hospitals, residences, apartments, hotels, motels, and so forth (for sleeping, resting, relaxing).	25–35	35–45
Private or semiprivate offices, small conference rooms, classrooms, libraries, and so forth (for good listening conditions).	30–35	40–45
Living rooms and similar spaces in dwellings (for conversing or listening to radio and TV).	35–45	45–55
Large offices, reception areas, retail shops and stores, cafeterias, restaurants, and so forth (for moderately good listening conditions).	35–50	45–60
Lobbies, laboratory work spaces, drafting and engineering rooms, general secretarial areas (for fair listening conditions).	40–45	50–55
Light maintenance shops, office and computer equipment rooms, kitchens, and laundries (for moderately fair listening conditions).	45–60	55–70
Shops, garages, power-plant control rooms, and so forth (for just acceptable speech and telephone communication). Levels above PNC-60 are not recommended for any office or communication situation.	—	—
For work spaces where speech or telephone communication is not required, but where there must be no risk of hearing damage.	—	—

Fig 2.2: Suggested noise criteria level for background noise (Magrab, 1975)

2.4. SOUND PRESSURE LEVEL (SPL)

SPL is sound in an enclosure from its source, affected by space and listener position.

2.5. SOUND TRANSMISSION CLASS (STC)

A method of measuring the noise isolation effectiveness for speech can be stated as Sound Transmission Class. STC offers a single number rating. It doesn't consider measuring low frequency sounds.

2.6. NOISE CRITERIA (NC)

Noise criteria metric suits indoor noise. Noise levels in room are measured and graphed with NC curves. Higher NC levels mean louder spaces, with an NC-25 room considered quiet and an NC-60 room considered noisy.

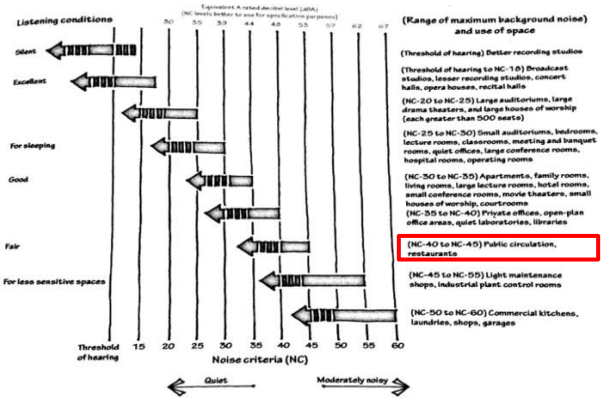


Fig 2.3: Range of Noise Criteria (M.D.Egan, 2007)

2.7. NOISE REDUCTION COEFFICIENT (NRC)

Noise Reduction Coefficient, abbreviated as NRC, is a measures material's sound absorption within speech frequency. NRC 0 reflects all sound hitting it. NRC 1.0 absorbs all sound. High NRC rating means poor absorption of sound.

2.8. PERFORMANCE OF ACOUSTIC MATERIALS

This states the difference in the transmission of noise outside a space with and without any acoustical treatment been done. This takes into account the noise travelled through the path and its impact on the surroundings and the users.

2.9. IMPACTS OF NOISE

Noise harms humans and other organisms. Adverse effects are as listed below:

- Annoyance: Sound level fluctuations create annoyance to receptors. Periodic and irregular sounds cause displeasure and annoyance to hearing.
- Physiological effects: Breathing, BP, heart rate, pulse, and cholesterol.
- Loss of hearing: Prolonged exposure to loud sounds can lead to hearing loss. Noise can have a negative effect on hearing and worker performance.
- Nervous system: Loud noise causes pain, ringing in ears, and fatigue, thus affecting human functioning.
- Sleeplessness: It affects sleep, inducing restlessness and loss of concentration during activities.
- Material damage: may result from exposure to infrasonic/ultrasonic waves.

2.10. NEGATIVE IMPACTS OF NOISE

- Mental or emotional
- Loud noises that bother people and disrupt their activities.
- Problems that affect the body, like difficulty hearing.

2.11. CONTROLLING NOISE

Noise control means finding ways to make things less noisy, either to stop noise from bothering people outside or to make noise inside a building less bothersome.

This is specifically for pubs that play loud music, which can be annoying if not managed well.

This can be categorized as below –

- Physical division and
- Making sure the music is heard in the right places.

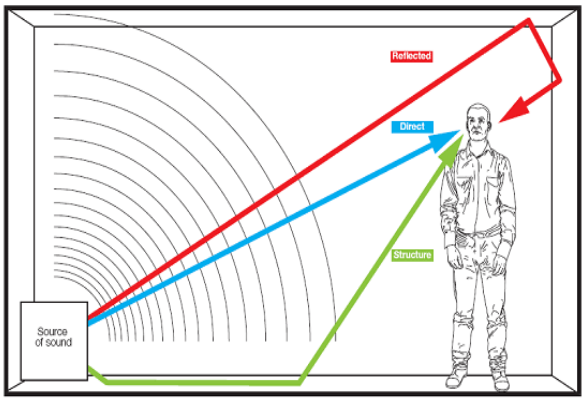


Fig 2.4: The three components of noise

The three components of noise:

The three components of noise in a venue are: direct path, structural path & reverberant path. Positioning speakers carefully and using isolation mountings can reduce noise exposure. Noise control mainly aims to reduce the reflected sound, whereas absorption controls reverberation.

a) Physical separation:

- Move the pubs from the dance floor and performance areas.
- Provide quiet off-duty areas for staff.
- Find pubs in peaceful places or 'chill-out' rooms with noise levels below 80 dB.
- Provide acoustic screening against noise.

b) Focusing the music:

- Use distortion-free equipment with lower volume levels for desired effect. Directional speakers help focus sound away from sensitive areas.
- Add more loudspeakers to prevent hot-spots.
- Install vibration mounts on loudspeakers to reduce building structure noise.
- Avoid loud peripheral speakers or lower their volume if necessary.
- Avoid loudspeakers facing the bar or work areas.
- Representative exposure levels in pubs :

OCCUPATION	dB LEVEL
Bar staff	89-99
Glass collectors	90-100
Waiters	102
DJs	93-99
Lighting technician	104
Security	97
Door	84
Dance floor	94-104

Table 2.1: Exposure levels in pubs

- Indian standard for ambient noise levels:

Table 2.2: Standard for ambient noise level from NBC

Area	Noise Limits, Leq, dB (A)	
	Day Time [2]	Night Time [3]
Silence zone [4]	50	45
Residential area	55	45
Commercial area	65	55
Industrial area	75	65

2.12.1. NOISE FROM PUBS AND CLUBS - FINAL REPORT

(Davies, P. Hepworth, A. Moorhouse, & R. Oldfield, March 2005)- March 2005 at University of Salford, UK.

This paper explores noise assessment in pubs and clubs. This issue analyses published information on pubs and clubs and creates assessment lists. Noise's impact on communities studied extensively. Noise annoyance is evident with differing assessments nationwide. UK assessment standard needed. Various assessment methods exist. Noise methods for pubs and clubs; include low-frequency noise and criteria (absolute and relative). Noise issues at pubs and clubs: entertainment, equipment, patrons, and deliveries. Sounds vary and need separate assessment. Project studies pub/club noise on entertainment.

CONCLUSION:

This paper outlines measurement methods for assessing pub and club noise, identifies noise issues, and locates noise sources in pubs. Field measurement technique uses questionnaires to analyse individual cases, attitudes, values and behaviours.

2.12.2. AN APPROACH TO IMPROVE ACOUSTIC PERFORMANCE IN MULTIPURPOSE HALL

Firas M. (Sharaf, March 2014), the University of Jordan, March 2014

Study aims to improve acoustic design for pleasant interior. This paper measures hall volume, sound reflection surfaces, reverberation time, and background noise. This study measured acoustic implementation before and after. Assess hall's acoustics post-intervention. Sound in hall addressed, not in pub. This paper analyses acoustical measurements before and after treatment on site. Measuring reverberation time and noise levels pre and post implementation of acoustic solution, then comparing to standards.

CONCLUSION:

This study evaluates acoustic performance before and after treatment, with a methodology for comparing treated and untreated spaces on factors like sound pressure levels in pubs.

2.12.3. OCCUPATIONAL EXPOSURES TO NOISE RESULTING FROM THE WORKPLACE USE OF PERSONAL MEDIA PLAYERS

(Autenrieth, 2011) D., Colorado State University Fort Collins, Colorado, Spring 2011.

This study assessed PMP's effect on noise exposure at a Colorado plant. 24 workers were identified with workplace PMP exposures, 12 HBNE and 12 LBNE. 55k PMP users were surveyed on occupational behavior. Levels of listening and noise were measured for estimating daily exposure.

CONCLUSION:

Three aims for this study were addressed:

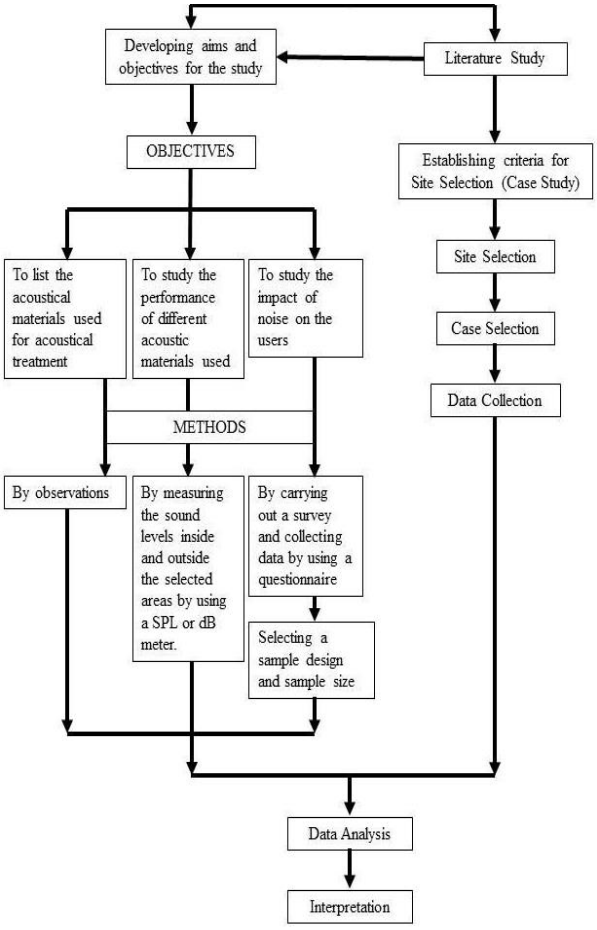
- Assess PMPs' sound-output levels in the workplace for potential worker overexposure to noise.
- Examine PMP sound levels in relation to workplace noise.
- This study explains how to conduct a field survey, take measurements, and define parameters effectively.

2.12.4. GAP CONSIDERATIONS

Above review establishes site selection criteria for study. To achieve study objectives, site selection parameters include:

- Area that is exposed to noise (where there is a problem of noise coming outside the area ad affecting the users).
- Areas where there is a scope of performing a comparative study with respect to the performance of acoustical materials.
- Areas where different acoustical materials that have been used for acoustical treatment can be observed and studied.

3. METHODLOGY



This empirical study is based on a sample survey of three cases at Westend mall in Pune. 30 people were surveyed using a closed-ended questionnaire in this study. The sample includes various age groups, genders, visit times, reasons for visiting, and noise-related problems from pubs. It's a representative sample for an exploratory study. Additionally, acoustic material performance was studied via field measurements. Levels were measured inside and outside three cases using an SPL or dB meter. Finally, the researcher observed and recorded the acoustical properties of materials used in selected cases.

Westend mall is chosen for the study due to its three cases: Pub I, Pub II, and Multiplex. These cases have varying levels of acoustic treatment and can aid in achieving the study's objectives by examining gaps in the literature. This study is done to understand noise impact on surroundings and users.

Objective:

- To list the materials used in all the three cases for acoustical treatment by observations.
- To study the performance of different acoustic materials used in pubs and multiplex by measuring the sound levels inside and outside the selected cases.
- To study the impact of noise on the users by carrying out a survey and questionnaire.

3.1. DOCUMENTATION OF THE ACOUSTICAL MATERIALS USED

This study was evaluated through observation method. Observation collects data by observing natural behavior, events or characteristics. Study observations were overt. This technique identified the acoustical materials in the pubs and multiplex. The acoustic properties of the materials were noted to ensure adequate treatment.

3.2. TO MEASURE THE SOUND LEVELS INSIDE AND OUTSIDE THE SELECTED CASES

This was carried out in the following manner-

Collect the map of the mall and mark the selected zones on it.

1. Find out the noise sources in each zone - The noise levels (dB level) are measured inside as well as outside the spaces for all the three cases during three time zones namely; 12noon to 2p.m, 4p.m to 8p.m and 9p.m to 12p.m. A Decibel meter measures sound pressure to assess noise levels & captures sound with a microphone. Acoustic measurement values are displayed after sound evaluation within the device.

   Check if the mall's noise levels meet regulatory standards for its zone.

3.3. QUESTIONNAIRE DEVELOPMENT

Conduct a survey in three areas by having users fill out questionnaires about their experiences in and around the space.

The survey questionnaire was specifically designed to reflect the users experience in that space. A group of 30 people from the nearby area, including those visiting the multiplex, pubs, and nearby stores, was sampled. The questionnaire contains 11 questions that may be grouped as follows:

- Identification of respondent by sex and age;
- Purpose of their visit;
- Users' interpretation about the noise;
- Noise sources annoyance and its effect on the people nearby that space.

The questionnaire is designed to take 5-10 minutes and consists of standard close and multiple-choice questions, as well as a general open ended question.

3.4. DATA COLLECTION

The proposed first floor plan of the Westend Mall, in Aundh, Pune, is shown in Figure 3.3.

Both the night pubs and multiplex are on the eastern side of the first floor of mall, along with the other shops. The main road is adjacent to the eastern side of the mall.

An issue of noise littering out from the pubs in the nearby interiors and exteriors was witnessed and noticed by the surrounding people and local authority there. Further investigation revealed that inadequate acoustical treatment in both pubs resulted in noise pollution.

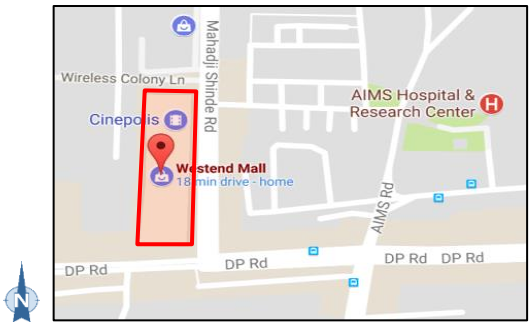
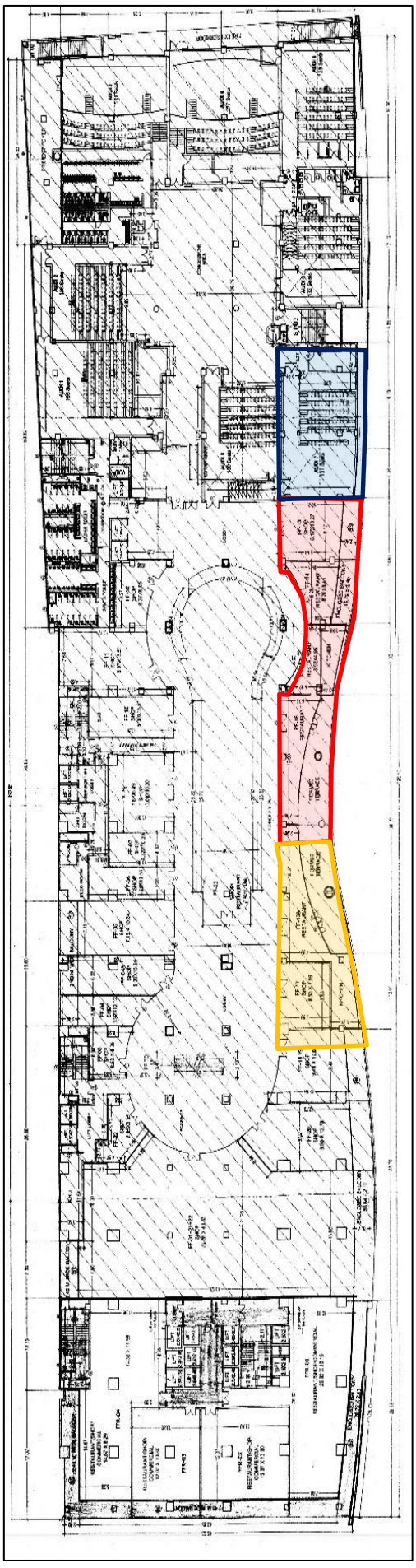


Fig 3.1: Location map of Westend Mall, Pune
Source: Google maps

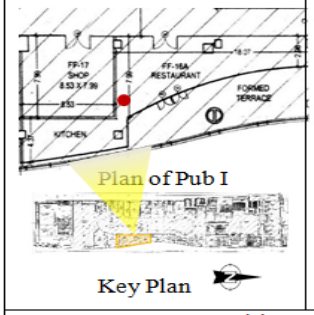
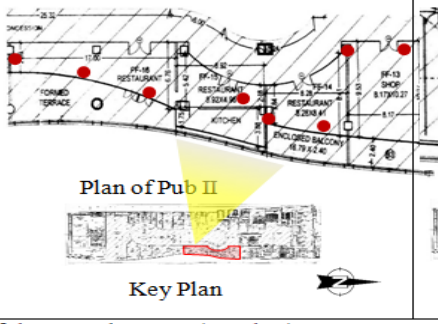
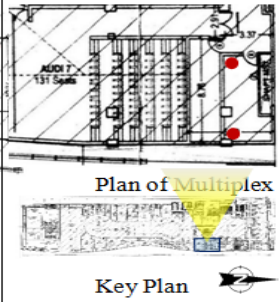
Fig 3.2: Satellite map of Westend Mall, Pune
Source: Google satellite maps



LEGEND	
Pub 1	
Pub 2	
Multiplex	

Fig 3.3: First Floor plan of Westend mall, Aundh,Pune
Source: Pune Municipal Corporation, Pune

Table 3.1: Comparative study of the selected 3 cases

PARAMETER	CASE 1	CASE 2	CASE 3
1. Plan			
	● - Position of the sound source (speaker)		
2. Area	250 sq.m	350 sq.m	240 sq.m
3. Volume	1000 cu.m	1400 cu.m	1450 cu.m
4. Surfaces	No acoustical treatment done.	Partially acoustically treated.	Total acoustical treatment is done.
5. Acoustical Materials used	No treatment done.	i) Wall - Salon board with an inner layer of foam cladding is done. ii) Floor – Wooden flooring.	i) Wall – a G.I framing, in-filled with acoustic panels and covered with acoustic stretch fabric. ii) Floor – Woolen carpet. iii) Ceiling – Suspended Acoustic ceiling tiles
6.Interior Images	 	  	

4. ANALYSIS & FINDINGS

4.1. LIST OF ACOUSTICAL MATERIALS USED & THEIR PROPERTIES

List of all the materials used for acoustical treatment in all the three selected cases wherever given.

ACOUSTIC MATERIAL USED FOR-	CASE 1- PUB 1	CASE 2- PUB 2	CASE 3- MULTIPLEX
Wall	No treatment done	Salon board with an inner layer of foam cladding.	G.I framing, in-filled with acoustic panels and covered with acoustic stretch fabric.
Floor	No treatment done	Wooden flooring.	Woolen carpet
Ceiling	No treatment done	No treatment done	Suspended Acoustic ceiling tiles

Table 4.1: List of acoustical materials used in all three cases

Also, the properties of these materials were studied and enlisted as follows.

- **Salon board-** Made of treated wood fibre and inorganic cement binder, sizes vary from 610 X 3050 and thickness ranges from 25 mm to 75 mm, with smooth or shredded finish. NRC ranges from 0.40 to 0.70. STC ranges 9-13 based on weight (lbs). Used in Pub II for noise reduction in disco area.
- **Acoustic Fabric wrapped wall panels-** Backed by wood or metal, with mineral or fiberglass sub-strata and fabric covering. NRC ranges from 0.5 to 0.85 based on sub-strata thickness. Fabric is fire-rated. STC 29. Used for wall treatment in multiplexes.
- **Woollen carpets-** Carpets cover acoustically reflecting surfaces. NRC 0.30. A-rated. They absorb medium and high sound frequencies strongly. STC rating of 49 effectively controls room noise through absorption. Multiplex flooring.
- **Acoustic ceiling tiles**- High-quality, aesthetic, NRC ceiling tiles. Absorbs 0.9 NRC sound and enhances diffused lighting. STC rating up to 45.Used in Multiplex for ceiling.

4.2. SOUND LEVEL MEASUREMENTS

Following are the measured sound levels inside and outside at all the three areas namely; Pub I, Pub II and Multiplex taken by using a dB meter:
Noise should be 65 dB during the day and 55 dB at night in a commercial space per NBC norms.

dB LEVEL at	PUB I (untreated)		PUB II (partially treated)		MULTIPLEX (completely treated)	
	INSIDE	OUTSIDE	INSIDE	OUTSIDE	INSIDE	OUTSIDE
12 noon – 2 p.m.	75 dB	77 dB	75 dB	70 dB	100-105 dB	68 dB
4 p.m. – 8 p.m.	85 dB	90 dB	85 dB	80 dB	100-105 dB	70 dB
9 p.m. – 12 p.m.	95 dB	97 dB	94 dB	89 dB	100-105 dB	65 dB

Table 4.2: Measured sound levels inside and outside the selected cases of study

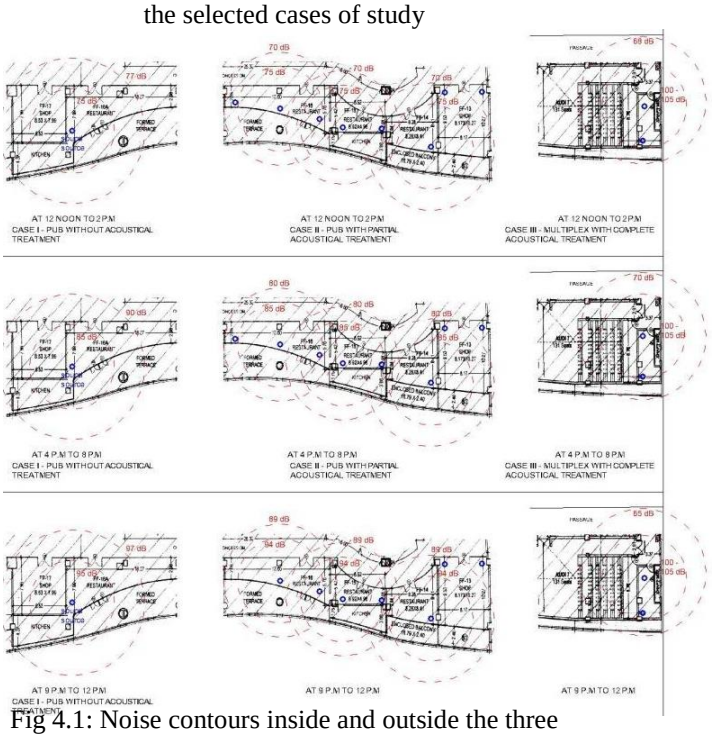


Fig 4.1: Noise contours inside and outside the three selected cases

4.3. DESCRIPTIVE STATISTICS

Descriptive statistics is a way of summarizing data. The data may be from a group of people or just a smaller group within that population.

4.3.1. SOCIAL CHARACTERISTICS OF SAMPLE

Table 4.1 displays the age and gender of venue-goers by pub/multiplex category. Most visitors fall into the 25-34 age range. Those aged 18-24 visited pubs most frequently.

AGE	MALE	FEMALE	TOTAL	
	NO.	NO.	NO.	%
18-24 YEARS	5	6	11	37
25-34 YEARS	6	7	13	43
35-44 YEARS	3	2	5	17
45-54 YEARS	0	1	1	3
55-64 YEARS	0	0	0	0
65 AND ABOVE	0	0	0	0
TOTAL	14	16	30	100

Table 4.3: Responses to Question no.1 & Question no. 2

- Purpose of visit: It can be seen from Fig. 4.1 that majority of the people (33%) visited the mall either to go to the multiplex for watching movies or to go to the night pubs.

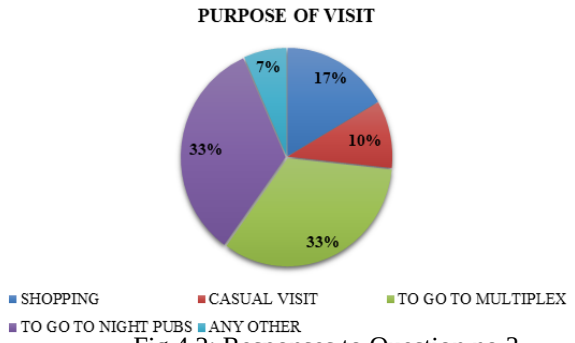
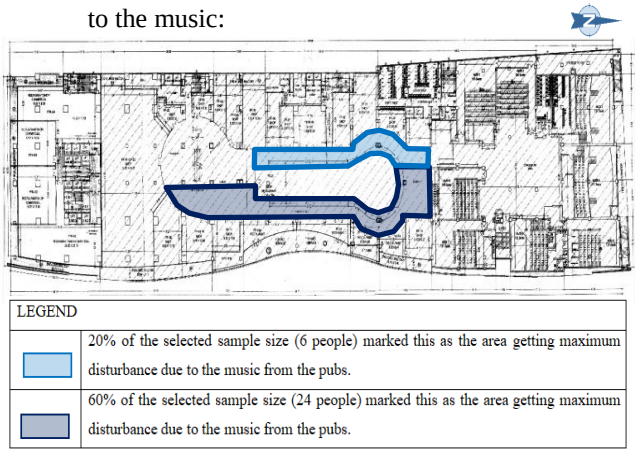


Fig 4.2: Responses to Question no.3

- Area where maximum disturbance is caused due to the music:



LEGEND	
	20% of the selected sample size (6 people) marked this as the area getting maximum disturbance due to the music from the pubs.
	60% of the selected sample size (24 people) marked this as the area getting maximum disturbance due to the music from the pubs.

Fig. 4.3: Map of the mall showing the areas marked by the surveyed people where maximum disturbance was caused due to the music from the pubs

- Frequency of people visiting this place:

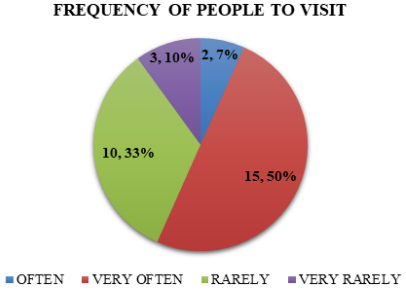


Fig 4.4: Responses to Question no.9

- Time of visit: It can be seen in fig. 4.5 that majority of the people visited the mall during 8 p.m to 12 p.m. (60%)

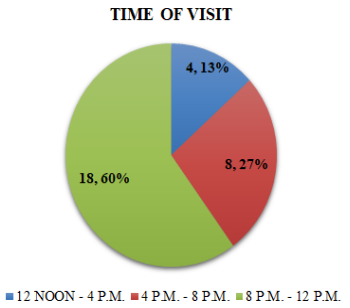


Fig 4.5: Responses to Question no.10

4.3.2. ACOUSTIC ENVIRONMENTS OF THE SAMPLE

This includes the questions pertaining to the users' response and perception about the noise.

- How do you find this area: It can be seen in fig. 4.6, 60% people found the area near the pubs and overall to be a noisy area where as 30% found it to be very noisy too

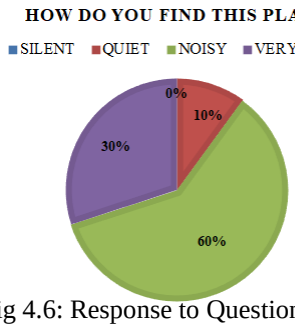


Fig 4.6: Response to Question no.5

- Do you face any problems from the music coming from the pubs: It can be seen in fig. 4.7 that 40% each people voted that they got disturbed as well as annoyed in and around the pubs because of the loud music being played.

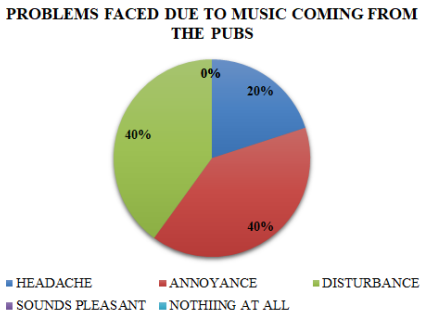


Fig 4.7: Response to Question no.6

- How much does the music or entertainment noise from the pubs bother, disturb or annoy you: 47% voted that the music from the pubs was very disturbing or bothered them and 33% voted for extreme disturbance as seen in fig. 4.8.

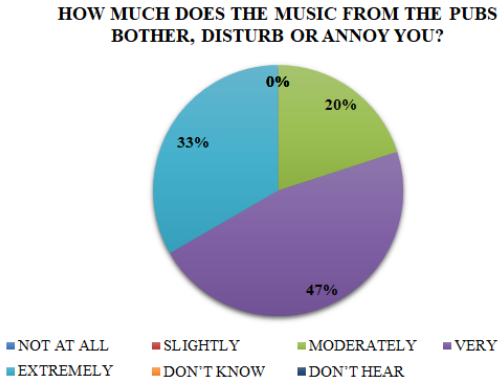


Fig 4.8: Response to Question no.7

- During what period of time, do you find the noise from the clubs more disturbing: The noise coming from the pubs was found to be more disturbing during the night time that was 8 p.m. to 12 p.m. (77%) as seen in fig. 4.9.

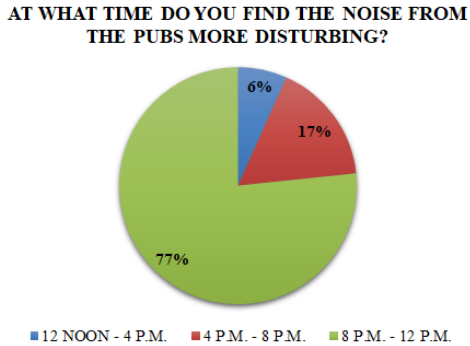


Fig 4.9: Response to Question no.8

5. INTERPRETATIONS

The study found that untreated pubs produce high noise which affects nearby users and vendors. Comparing three cases (untreated pub, partially treated pub, and fully treated multiplex), only the last showed no negative impact from music. The mall's loud music annoyed users and disturbed nearby vendors with noise levels from 75dB to 100dB, exceeding standard levels. No proper acoustical treatment in pubs caused high noise levels outside. Standards were exceeded with 65-70dB all day. The multiplex had better acoustics and sound insulation than pubs, making it more comfortable for people. Acoustics are crucial in designing the interior of music venues, such as pubs, theatres, multiplexes, and auditoriums.

REFERENCES:

[1] Autenrieth, D. (2011). *OCCUPATIONAL EXPOSURES TO NOISE RESULTING FROM THE WORKPLACE USE OF PERSONAL MEDIA PLAYERS.* Colorado: Publisher Name.

[2] Christie, L. H. (October 2004). *Psycho – to – Building Acoustics: Are Bars, Café's and Restaurants Acceptable Acoustic Environments?* Wellington.

[3] Davies, W. J., P. Hepworth, A. Moorhouse, & R. Oldfield. (March 2005). *Noise from Pubs and Clubs.* Manchester.

[4] Harris, C. M. (1991). Handbook of acoustical measurements and noise control. 3rd.Journal of Sound & Vibration, Vol.58. (n.d.).

[5] M.D.Egan. (2007). *Architectural Acoustics.*

[6] Magrab, E. B. (1975). *Environmental noise control.* John Wiley and Sons, 1975. *Noise & Vibration Control.* (1995). Washington, DC.

[7] Patel, K. (2013). Impact of Noise on Humans and its control measures. *International Journal of Engineering Science & Advanced Technology, Volume 3*, 148.

[8] Sharaf, F. M. (March 2014). An Approach to Improve Acoustic Performance in Multipurpose Halls. *Journal of American Science*.