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Noise Control in Hospital Building- Strategies and Solutions

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Abstract: ***Hospitals are expected to provide a quiet and comfortable environment that promotes patient recovery and efficient healthcare services. However, noise pollution has become a significant issue in hospital buildings due to medical equipment, staff activities, visitors, alarms, and external traffic. Excessive noise levels can negatively affect patient healing, disturb sleep, increase stress levels, and reduce staff efficiency. The present study investigates noise levels in selected hospital buildings and evaluates effective strategies for noise control.***

A questionnaire survey was conducted with hospital staff and patients to understand the perception of noise and its impact on hospital environments. Noise measurements were carried out using a digital sound level meter during three different time periods: morning, afternoon, and evening. For each time period, maximum and minimum noise levels were recorded and average values were calculated. The measured noise levels were compared with the recommended limits of the World Health Organization (WHO) and national standards. The results indicated that the observed noise levels exceeded the permissible limits in most areas of the hospital.

Based on the findings, several sound-absorbing materials and acoustic solutions such as acoustic ceiling panels, sound-absorbing wall panels, rubber flooring, and acoustic partitions were suggested to reduce noise levels. A cost estimation was also prepared for implementing these materials in a typical ICU room. The study concludes that proper acoustic design and the use of suitable sound-absorbing materials can significantly reduce noise levels in hospitals and create a healthier healing environment for patients and medical staff.

Keywords*: Noise pollution, hospital acoustics, sound absorbing materials, ICU noise control, acoustic design.*

I. INTRODUCTION

Noise pollution is one of the major environmental problems affecting modern urban environments. Hospitals are places where a calm and quiet atmosphere is essential for patient recovery and effective healthcare delivery. However, many hospitals experience high levels of noise generated from different sources such as medical equipment alarms, air conditioning systems, staff communication, visitors, and external traffic.

Excessive noise in hospitals can have several negative impacts. Patients may experience disturbed sleep, increased stress levels, and slower recovery rates. Healthcare staff may also face difficulty in communication, reduced concentration, and increased fatigue due to continuous exposure to high noise levels.

The World Health Organization (WHO) recommends that hospital noise levels should not exceed 35 dB during the day and 30 dB at night. However, studies have shown that noise levels in hospitals often exceed these limits.

This research study focuses on evaluating noise levels in selected hospital buildings and identifying effective strategies to control noise using acoustic materials and design solutions.

II. QUESTIONNAIRE SURVEY

Table 1: Questionnaire for hospital building

SR.NO	*QUESTIONS*	*YES*	*NO*
1	Do you consider noise control to be a priority in the hospital?	✓	
2	Are there currently any noise reduction measures in place in patient areas?		✓
3	Is there a dedicated team responsible for monitoring noise levels within the hospital?		✓
4	Do you conduct regular noise level assessments in different areas of the hospital?		✓

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5	Are the noise levels in the hospital within the recommended guidelines by health authorities?	✓	
6	Do you receive frequent complaints from patients or staff regarding noise disturbances?		✓
7	Have you implemented soundproofing materials in critical areas such as the ICU and operating rooms?	✓	
8	Are there specific quiet hours enforced within the hospital to minimize noise?		✓
9	Do you use white noise machines or other noise-masking technologies in patient rooms?		✓
10	Is there a policy in place to reduce noise from hospital equipment and alarms?		✓
11	Are staff trained on the importance of maintaining a quiet environment?	✓	
12	Do you have noise control guidelines for visiting hours and public areas?		✓
13	Are there designated quiet zones within the hospital?	✓	
14	Have you received feedback indicating that noise control measures have improved patient satisfaction?	✓	
15	Do you collaborate with acoustic consultants to improve noise control strategies in the hospital?		✓

A. Analysis of Hospital

The survey results of Hospital show a clear difference between the hospital's intention to control noise and the actual facilities available in the building.

1) Administrative Commitment vs. Infrastructure:

The hospital administration has identified noise control as a top priority. However, the survey shows that there are no acoustic materials used in corridors or patient rooms. Most surfaces such as concrete, tiles, and plaster are hard and reflective, which increases sound reflection and creates an echo effect. As a result, even small sounds like conversations or trolley movement can travel across the building and increase overall noise levels.

2) Behavioral Management Strategies:

Hospital mainly focuses on behavioral methods to control noise. Staff members receive regular training to maintain quieter operations, and the hospital has also introduced designated quiet hours to reduce disturbances for patients. However, these strategies have limitations because hospital environments naturally involve alarms, equipment sounds, and urgent communication that cannot be avoided.

3) Technological and Monitoring Gaps:

The hospital currently does not use noise masking systems or white noise technologies, which are often used in modern healthcare facilities to reduce sudden noise disturbances. Additionally, there is no dedicated noise monitoring system or team to track sound levels. The hospital mainly depends on patient complaints to identify noise problems, which mean noise issues are addressed only after they affect patient comfort and recovery.

III. NOISE MEASUREMENT

Noise levels were measured using a digital sound level meter in different areas of the hospital. Measurements were taken at three different times:

- Morning
- Afternoon
- Evening

For each time period, maximum and minimum noise levels were recorded.

Table 2: Noise measurement

HOSPITAL NOISE MEASUREMENT				
SR	DEPARTMENT	MAXIMUM	MINIMUM	AVERAGE

NO		MORNING	AFTER NOON	EVENING	MORNING	AFTER NOON	EVENING	MAXIMUM	MINIMUM
1	HR DEPARTMENT (FF) OUTSIDE AREA	73.9	70.3	66.3	69.7	66.6	50.1	70.2	62.1
2	DIALYSIS UNIT WARD	80.2	77	60.2	67.1	62.3	50.3	72.5	59.9
3	ICU WARD	82.1	84.7	70.3	66.4	68.2	48.2	79.0	60.9
4	ICU GENERAL WARD	76.3	73	62.1	68.4	65.3	47.1	70.5	60.3
5	ICU HEART PATIENT (CARDIO)	75.3	77.6	60.3	51.8	52.7	45.9	71.1	50.1
6	CCU	71.2	70.3	60.1	52.3	52.7	44.8	67.2	49.9
7	SURGICAL	72.9	73.8	61.2	53.8	54.6	44.3	69.3	50.9
8	ICU MEDICAL DEPARTMENT	71.2	72.3	60.3	53.1	52.9	43.8	67.9	49.9
9	RENAL ICU	72.2	82	60.4	52.3	53.3	44.5	71.5	50.0
10	GENERAL WARD FOR ADMITTED PATIENT	70.9	69.2	65.4	54.2	53.2	50.1	68.5	52.5
11	RECEPTION & ADMINISTRATION	84.9	77.3	62.9	70.2	68.3	65.1	75.0	67.9
12	LADIES CHILD	82.3	77	65	54	66.8	48.2	74.8	56.3

IV. NOISE LEVEL ANALYSIS

Table 3: Noise measurement analysis

Department	Min Measured (dB)	Max Measured (dB)	Avg Noise (dB)	WHO Limit	National Limit	Remark
HR Dept Outside	62.1	70.2	66.2	35–45	45	Exceeds
Dialysis Unit Ward	59.9	72.5	66.2	35–45	45	Exceeds
ICU Ward	60.9	79.0	70.0	35–45	45	Exceeds
ICU General Ward	60.3	70.5	65.4	35–45	45	Exceeds
ICU Heart (Cardio)	50.1	71.1	60.6	35–45	45	Exceeds
CCU	49.9	67.2	58.6	35–45	45	Exceeds
Surgical Ward	50.9	69.3	60.1	35–45	45	Exceeds
ICU Medical Dept	49.9	67.9	58.9	35–45	45	Exceeds
Renal ICU	50.0	71.5	60.8	35–45	45	Exceeds
General Ward (Admitted)	52.5	68.5	60.5	35–45	45	Exceeds
Reception & Admin	67.9	75.0	71.5	35–45	45	Exceeds
Ladies Child Ward	56.3	74.8	65.6	35–45	45	Exceeds

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A. Noise Monitoring Analysis at Hospital

Noise monitoring conducted in Hospital across different areas such as administrative offices, wards, and critical care units shows that the recorded sound levels exceed the recommended limits of the World Health Organization (WHO) (35–45 dB) and the national permissible limit of 45 dB**.** The measured noise levels range from a minimum of 49.9 dB in CCU and ICU Medical Department to a maximum of 79.0 dB in the ICU Ward**.** High noise levels were mainly observed in ICU units, reception areas, and administrative zones due to continuous operation of medical equipment, staff activities, and heavy movement of visitors and patients. The results indicate that excessive noise is a hospital-wide issue affecting most departments**.**

B. Department-Wise Noise Levels and Major Sources

HR Department (Outside) – 62.1–70.2 dB

Noise levels are high mainly due to staff conversations, visitor movement, corridor traffic, door operations, and lack of acoustic separation between offices and circulation spaces.

Dialysis Unit Ward – 59.9–72.5 dB

Noise is generated from dialysis machines, alarm signals, staff communication, patient interaction, trolley movement, and HVAC systems.

ICU Ward – 60.9–79.0 dB

This department records the highest noise levels. Major sources include alarms from monitors, ventilators, infusion pumps, oxygen systems, staff coordination, emergency procedures, and movement of medical equipment.

ICU General Ward – 60.3–70.5 dB

Noise is mainly caused by monitoring alarms, nursing activities, patient handling, staff communication, and sound transmission from nearby ICU zones and corridors.

ICU Heart (Cardio) – 50.1–71.1 dB

Noise sources include cardiac monitoring equipment, ventilators, alarms, infusion pumps, staff communication, and medical equipment movement.

CCU – 49.9–67.2 dB

Noise is generated from cardiac monitoring systems, alarm sounds, nursing activities, staff communication, and HVAC systems.

Surgical Ward – 50.9–69.3 dB

Noise levels are influenced by post-operative care activities, nursing rounds, trolley movement, equipment use, visitor interaction, and nearby corridor noise.

ICU Medical Department – 49.9–67.9 dB

Continuous monitoring equipment, alarms, emergency procedures, and staff coordination contribute to elevated noise levels.

Renal ICU – 50.0–71.5 dB

Noise mainly comes from renal monitoring machines, alarms, medical procedures, staff activities, and HVAC systems.

General Ward – 52.5–68.5 dB

High noise levels occur due to patient and visitor conversations, nursing work, trolley movement, mobile phone usage, and shared ward layouts without acoustic separation.

Reception and Administration – 67.9–75.0 dB

This area generates significant noise due to heavy visitor movement, registration and billing activities, telephone ringing, staff communication, and announcements.

Ladies Child Ward – 56.3–74.8 dB

Noise sources include interaction between patients, children and attendants, nursing activities, equipment operation, visitor movement, and trolley circulation.

C. Summary

The department-wise noise analysis clearly shows that all monitored areas in Hospital exceed WHO and national permissible noise limits**.** Critical care units such as ICU and CCU record the highest noise levels due to continuous medical equipment alarms and staff activity, while reception and administrative areas act as major noise-generating zones**.** General wards are also affected by visitor interaction and operational noise. These findings highlight the need for effective acoustic planning and installation of sound-absorbing materials to reduce noise levels and improve patient comfort, recovery, and staff efficiency in the hospital environment.

V. SUGGESTED MATERIAL

Table 4: Suggested material

Area / Department	Measured Noise (dB) Min / Max / Avg	Specific Material	Recommended Modifications	Approx. Cost (₹)	Feasibility
HR Department (FF) Outside Area	Min 62.1 Max 70.2	Acoustic outdoor wall panels	Wall panels + anti-slip rubber mat flooring for footfall noise	1,200–2,500 / m² (walls) + 800–1,200 / m² (floor)	Medium cost, easy installation
Dialysis Unit Ward	Min 59.9 Max 72.5	Vinyl-coated acoustic wall panels	Wall treatment only; anti-fatigue rubber flooring for staff movement	1,800–3,000 / m² (walls) + 1,000–1,500 / m² (floor)	Medium–high benefit
ICU Ward	Min 60.9 Max 79.0	Acoustic wall panels	Wall panels + cushioned vinyl flooring for patient comfort	1,500–3,000 / m² (walls) + 1,200–2,000 / m² (floor)	High priority, essential
ICU General Ward	Min 60.3 Max 70.5	Acoustic wall panels	Wall panels + anti-slip flooring	900–1,500 / m² (walls) + 800–1,200 / m² (floor)	Medium cost, high benefit
ICU Heart Patient (Cardio)	Min 50.1 Max71.1	Hygienic acoustic wall panels	Wall panels + cushioned vinyl flooring	1,800–2,500 / m² (walls) + 1,200–2,000 / m² (floor)	High importance, essential
CCU	Min 49.9 Max67.2	Acoustic wall panels	Wall panels + anti-slip rubber flooring	1,200–2,500 / m² (walls) + 800–1,200 / m² (floor)	Medium cost, essential
Surgical	Min 50.9 Max69.3	Perforated acoustic wall panels	Wall panels only; flooring already smooth for hygiene	1,500–3,000 / m² (walls)	High cost, essential
ICU Medical Department	Min 49.9 Max67.9	Acoustic wall panels	Wall panels + cushioned vinyl flooring	1,500–2,500 / m² (walls) + 1,200–2,000 / m² (floor)	Medium cost, feasible
Renal ICU	Min 50.0 Max 71.5	Acoustic wall panels	Wall panels + anti-slip vinyl flooring	1,500–3,000 / m² (walls) + 1,000–1,500 / m² (floor)	High benefit, medium cost
General Ward for Admitted Patients	Min 52.5 Max68.5	Acoustic curtains + wall panels	Wall panels + bed curtains + anti-fatigue flooring	900–1,500 / m² (walls) + 2,000–4,000 per bed + 800–1,200 / m² (floor)	Medium cost, high benefit
Reception & Administration	Min 67.9 Max 75.0	Acoustic wall panels	Wall panels + carpet or rubber mat flooring to reduce footfall noise	1,200–2,000 / m² (walls) + 800–1,500 / m² (floor)	Medium cost, highly feasible
Ladies Child	Min 56.3 Max 74.8	Acoustic wall panels	Wall panels + cushioned flooring in corridors	1,200–2,500 / m² (walls) + 1,000–1,500 / m² (floor)	Medium cost, high benefit

A. Acoustic Wall Panels

Acoustic wall panels are one of the most effective materials used to reduce noise in hospital environments. These panels are usually made from sound-absorbing cores such as fibreglass, Rockwool, or mineral wool, which are covered with fabric or perforated surfaces. The main purpose of these panels is to absorb sound waves and reduce echo or reverberation within a room.

In hospitals, acoustic wall panels help control noise generated from medical equipment, staff communication, alarms, and patient activity. When installed on walls, they prevent sound from reflecting back into the room, which significantly improves the acoustic comfort of spaces like ICU wards, dialysis units, and patient rooms. Many hospital-grade acoustic panels are also antibacterial, fire-resistant, and easy to clean, making them suitable for healthcare settings.

Typically, acoustic wall panels can achieve a Noise Reduction Coefficient (NRC) of 0.70 to 0.95, meaning they can absorb a large portion of sound energy. These panels are also available in different colours and finishes, allowing them to blend with hospital interior design while improving acoustic performance.

B. Premium Acoustic Suspended Ceiling System

Acoustic suspended ceilings are widely used in hospitals to control noise coming from both inside the room and mechanical systems above the ceiling. These ceilings consist of acoustic tiles made from mineral fibre, fibreglass, or perforated gypsum, installed within a metal grid system.

The primary function of acoustic ceiling systems is to absorb sound and reduce reverberation, which helps maintain a quieter environment in hospital spaces. In areas like ICU, CCU, and patient wards, ceiling tiles with a high NRC value (around 0.80–0.90) can significantly reduce background noise caused by conversations, equipment, and ventilation systems.

Another advantage of suspended ceilings is that they allow easy access to electrical wiring, air conditioning ducts, and medical gas pipelines, which are commonly located above the ceiling in hospital buildings. Many hospital-grade ceiling tiles are also moisture resistant, antimicrobial, and fire rated, ensuring hygiene and safety.

C. Cushioned Vinyl Flooring

Cushioned vinyl flooring is commonly used in hospitals because it provides both acoustic and hygienic benefits. This flooring system consists of a vinyl surface layer with a soft acoustic backing, which helps reduce impact noise caused by footsteps, trolley movement, and medical equipment.

In busy hospital environments, corridors and patient rooms experience continuous movement of staff, patients, and equipment. Cushioned vinyl flooring helps absorb the vibrations generated by these movements, thereby lowering the overall noise levels. It also provides a comfortable and slip-resistant walking surface, which improves safety for patients and healthcare staff.

Another important advantage of vinyl flooring is that it is seamless, waterproof, and easy to clean, making it highly suitable for areas where hygiene is critical. It also has good durability and requires relatively low maintenance, which makes it a cost-effective solution for hospitals.

D. Anti-Slip Rubber Flooring

Rubber flooring is another effective material used for impact noise reduction in hospitals. It is made from natural or synthetic rubber and has excellent shock-absorbing properties, which help minimize the sound generated by footsteps, wheelchairs, stretchers, and equipment carts.

This flooring material is particularly useful in corridors, reception areas, and high-traffic hospital zones where continuous movement creates noise. Rubber flooring not only reduces sound but also provides high slip resistance, which improves safety in healthcare environments.

Rubber floors are also resilient, durable, and easy to maintain. They can withstand heavy loads and constant use without significant wear. Many rubber flooring products are also designed with antibacterial properties, making them suitable for healthcare settings.

E. Acoustic Curtains (Hospital Bed Curtains)

Acoustic curtains are soft sound-absorbing fabrics used in hospital wards to reduce noise and provide privacy between patient beds. These curtains are usually made from thick, multilayered fabrics with sound-absorbing properties.

In shared hospital wards, patient conversations, medical equipment noise, and visitor interactions can easily spread across the room. Acoustic curtains help absorb some of these sounds and reduce noise transmission between beds. They also provide visual privacy and a sense of comfort for patients.

Modern hospital curtains are designed with antimicrobial coatings and fire-retardant properties to meet healthcare safety standards. They are also removable and washable, which helps maintain hygiene.

Overall Importance of Acoustic Materials in Hospitals

The use of sound-absorbing materials such as acoustic wall panels, suspended ceiling systems, cushioned vinyl flooring, rubber flooring, and acoustic curtains plays an important role in controlling noise levels in healthcare facilities. These materials help reduce sound reflection, impact noise, and reverberation, creating a quieter and more comfortable environment.

By implementing these materials in critical areas like ICU, CCU, dialysis wards, and patient rooms, hospitals can improve patient recovery, reduce stress, and enhance communication among healthcare staff. Therefore, integrating acoustic materials into hospital design is an essential step toward creating a healing and patient-friendly environment.

Recommended Modifications and Cost Analysis

This chapter presents the architectural and acoustic modifications proposed for critical care units at Hospital. The main objective is to reduce excessive noise levels by introducing high-performance sound-absorbing materials suitable for hospital environments and to evaluate the economic feasibility of these improvements.

VI. CASE STUDY: SELECTED ICU ZONE

A Surgical ICU was selected for the study based on its bed capacity and higher noise exposure. The space maintains a floor-to-ceiling height of 8’3” and is designed for five patient beds.

Room Dimensions: 36’ × 32’

Floor to Ceiling Height: 8’3”

Proposed Material Specifications

To improve the acoustic performance of the ICU, specialized medical-grade acoustic materials are recommended for walls, ceilings, floors, and partitions.

Table 5: Recommended material

Element	Recommended Material	Rate (₹/sq ft)	Purpose
Wall Treatment	Fabric/Acoustic Panels (Medical Grade)	210	High sound absorption in critical care areas
Ceiling	Premium Acoustic Suspended Ceiling System	350	Reduces echo and improves overall acoustic performance
Flooring	5–8 mm Thick Rubber or Cushioned Vinyl	230	Reduces impact noise from footsteps and equipment
Partitions	STC Rated Fabric Acoustic Panels	450	Controls sound transmission between spaces

Cost Calculation for Surgical ICU

1) Wall Treatment

Wall Area = 1125 sq ft

Material = Rockwool / Mineral Wool Acoustic Panels

Cost = 1125 × 210

Total = ₹2,36,250

2) Ceiling Treatment

Ceiling Area = 1152 sq ft

Premium Acoustic Ceiling Tiles (NRC ≈ 0.85)

Cost = 1152 × 350

Total = ₹4,03,200

3) Flooring Treatment

Floor Area = 1152 sq ft

Cushioned Vinyl with Acoustic Backing

Cost = 1152 × 230

Total = ₹2,64,960

4) Acoustic Partitions

Partition Area = 350 sq ft

STC Rated Acoustic Wall System

Cost = 350 × 450
Total = ₹1,57,500
Total Estimated Cost
Total Investment = ₹10,61,910
Economic Feasibility
The proposed acoustic modifications are economically feasible for hospital environments. Durable materials such as cushioned vinyl flooring and STC-rated partitions reduce long-term maintenance costs while improving the acoustic quality of the space. The use of high-performance acoustic ceiling systems (NRC ≈ 0.85) helps reduce noise levels, creating a quieter and more comfortable healing environment for patients.
Overall, implementing these acoustic solutions in Hospital can improve patient recovery conditions, enhance staff efficiency, and justify the investment in long-term healthcare infrastructure improvements.

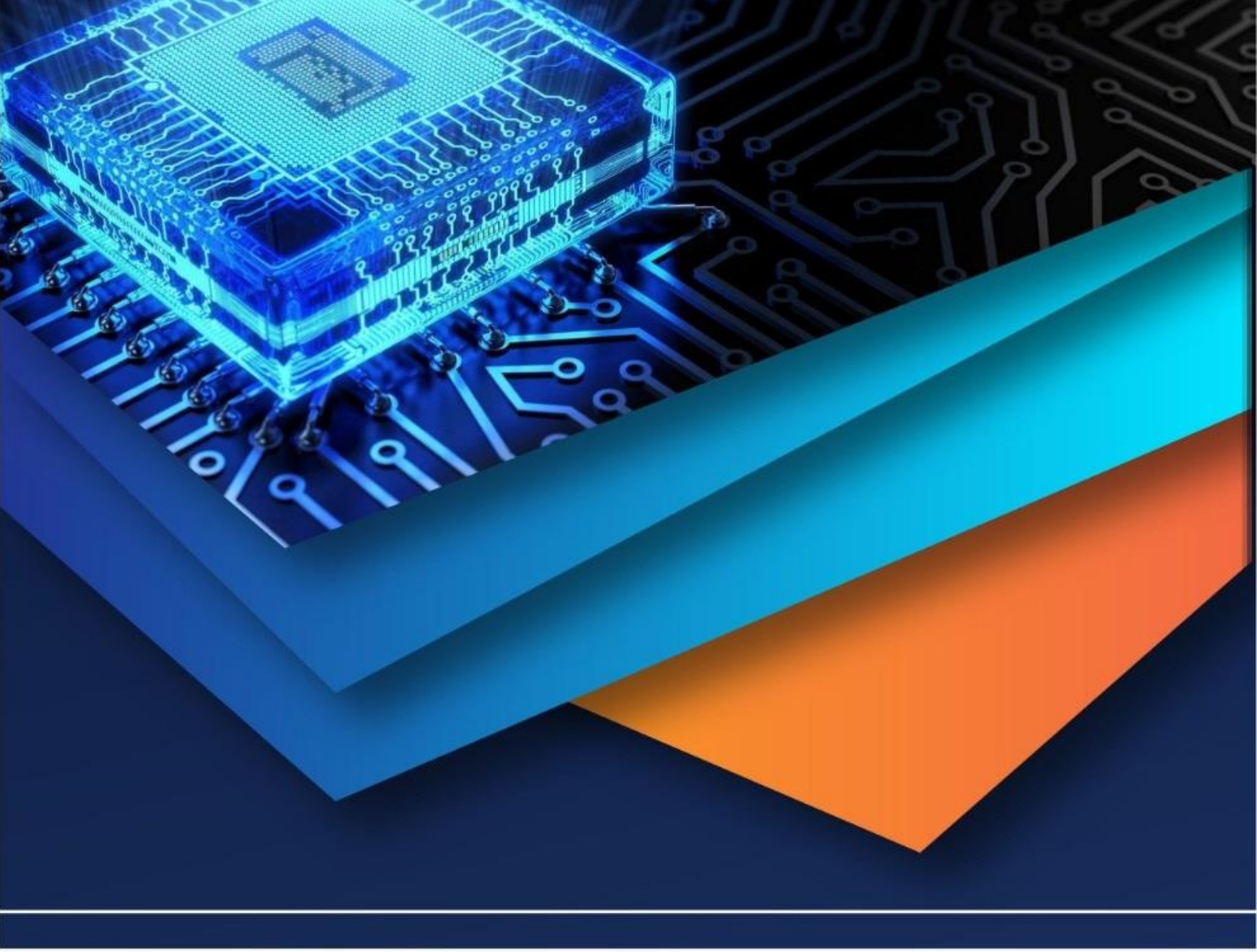
VII. CONCLUSION

The study highlights the growing problem of noise pollution in hospital environments. The noise measurements conducted using a sound level meter revealed that noise levels in the selected hospital exceeded the recommended limits set by the World Health Organization and national standards. Excessive noise can negatively affect patient recovery, disturb sleep patterns, and reduce staff productivity.
The research suggests that implementing acoustic design strategies and installing sound-absorbing materials such as acoustic ceiling panels, wall panels, rubber flooring, and acoustic partitions can significantly reduce noise levels in hospital buildings. Additionally, proper planning and zoning of hospital spaces can further help in controlling noise.
The cost estimation for an ICU room demonstrates that acoustic treatment can be implemented with a reasonable investment while providing long-term benefits for patient comfort and healthcare efficiency. Therefore, integrating acoustic solutions into hospital building design is essential for creating a healthy and healing environment.

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