Outdoor Occupational Noise Assessment in Hospitals & Its Evaluation of Auditory and Non-Auditory Exposure

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Abstract — Today, in the present era of technological advancement due to rapid urbanization and industrialization, the sound generated from the source is now becoming the noise mainly in urban environments. For monitoring and controlling noise pollution, Central pollution control board (CPCB) has classified urban environment into four zones namely Residential Zone, Commercial zone, Industrial zone and Silence zone. Silence zone being the noise sensitive zone is now getting noisier, mainly Hospital premises in a manner that noise pollution level in hospital areas is crossing the permissible standard limit defined for industrial zone. Hospitals in the silence zone is among the areas which need attention regarding controlling and managing noise pollution sources to comply with the standards of CPCB (2009).

Keywords: Noise Pollution, Urban Environment, Silence Zone, Hospital Noise Levels, Central Pollution Control Board (CPCB), Environmental Noise Monitoring, Permissible Noise Standards, Industrial Noise Levels, Noise Management in Healthcare, Urban Noise Zoning

I. INTRODUCTION

Currently, in the era of rapid urbanization, the issue of environmental degradation has become one major concern for policy makers, and maintaining environmental quality has posed a big challenge. This concerns us in the most, especially in the workplace where the people are continuously defeating the external disturbance. However, hospitals are typically silent zones and these are places that are increasingly being exposed to heightened noise in their vicinity. Not only patients but this growing noise pollution effects the hospital employees who work in outdoor areas near the hospital premises as well.

Many previous studies have largely concentrated on the effect of noise pollution with regard to patient well-being, but the present study addresses its effect on the hospital employees outside the Out Patient Departments (OPDs). Noise pollution levels expressed in equivalent continuous sound level (Leq) have been evaluated at five of the major hospitals in Lucknow, King George Medical College; Veerangana Jhalkaribai Women & Child Hospital; Dr Shyama Prasad Mukherjee Civil Hospital; Balrampur Hospital; and Sahara Hospital. Daytime measurements were carried out in outdoor OPD areas.

II. NEED AND JUSTIFICATION OF PRESENT WORK

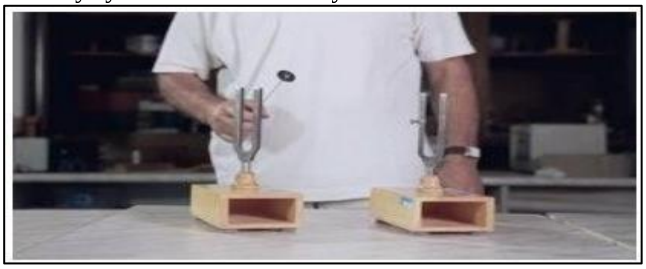
Although classed as Silence Zone — where daytime noise can only be as high as 50 dB — hospitals in metropolitan areas are always getting noisier. To gauge the effect, the level of noise was recorded outside the Outpatient Department (OPD) premises. High noise level exposure for long duration results in serious health problems, both physiological and psychological. Hearing loss and stress are caused by the continuous noise in the hospital which affects the well-being of the hospital employees. Auditory and non-auditory assessment are applied for the evaluation of these effects, assessing the complete quality of life in such workplaces. The amount of noise that is possible in hospitals is growing loud enough to call for the need for effective noise developed mitigating strategies. This is crucial to achieve tranquil, health friendly environment within hospital perimeter. This will allow for the preservation of silence zones and protect patient and healthcare staff health through implementing sustainable and site appropriate solutions.

III. OBJECTIVE OF PRESENT WORK

1) To determine the exposure of environmental noise in the hospitals and evaluate the current outdoor noise with the ambient noise standards for silence zones using NEI.
2) To evaluate the audiometry impact of outdoor noise on employees working outside OPD.
3) To evaluate the non-audiometry impact of outdoor noise on employees working outside OPD.
4) To suggest suitable mitigation measures to prevent noise pollution in hospital premises.

IV. DEFINITION OF SOUND

Sound is oscillation in pressure, displacement or velocity of atoms of the medium (mediums) propagated by the internal forces in the medium (mediums), e.g. elasticity and viscosity. Air in fact, and other elastic media, is the medium in which these oscillations propagate as waves. In this physical sense, sound is deemed to be a stimulus. Sound can also be understood to be the auditory sensation produced by the oscillations, when they reach and stimulate the human hearing system simultaneously. In this case, the sensory perception of sound is experienced. Sound can therefore be seen as a mechanical wave traveling through a medium or as the sensation of a wave motion which occurs when an auditory system is stimulated by it.



V. TRANSVERSE WAVES AND LONGITUDINAL WAVES

In gases, plasma and liquids, sound waves are longitudinal waves—or pressure waves. One important aspect of this type of wave, as they are mechanical waves, is that they travel in a medium, because mechanical waves cannot travel through a vacuum. However, the sound in solids can propagate in both transverse and longitudinal waves. The variation of pressure with time would result into regions of compression and rarefaction where that pressure was greater or less than the equilibrium state, respectively. On the opposite hand, transverse waves entail alternating shear stresses that are perpendicular to the direction of the wave propagation.

Next the sound waves can be observed by the use of reflective surfaces or objects which make or reflect sound. In a vibrating sound wave, the energy at a given point on the wave is always being simultaneously converted between two forms. In longitudinal waves it alternates between kinetic energy of particle motion and potential energy of compressed regions. Energy is transferred in transverse waves between the strain from the particle lateral displacement and the kinetic energy of particle velocity. There is an exchange that allows sound to continuously move through different media

VI. CHARACTERISTICS OF SOUND WAVES PROPERTIES

As sounds, they can be thought of as a mixture of their component sinusoidal waves, of which each has a different frequency. Low and high frequency components of these waves are present. The transmission of sound is not easy, however, when sound is signaled at the point of perception, such as the human ear, the essence of that sound includes the property of pressure and time. These elements will be the foundation for every sound wave which can be used to describe any sound that we hear in absolute terms.

Sound waves are often decomposed into individual components so that complex sounds such as speech or music may be better understood. In this process, we analyze the wave considering it as superposition of many frequencies together with it being polluted by noise. A useful example is the separate of a complex wave, like the one shown against a blue background in many educational diagrams, into simple sine waves by a method called Fourier analysis. Studying this helps in understanding how different frequencies combine to create what we hear. Looking into sound in terms of the basic wave components that make it up gives us a better understanding of how different sounds are carried out, and how we can alter and analyze them in many cases.

VII. PERCEPTION OF SOUND

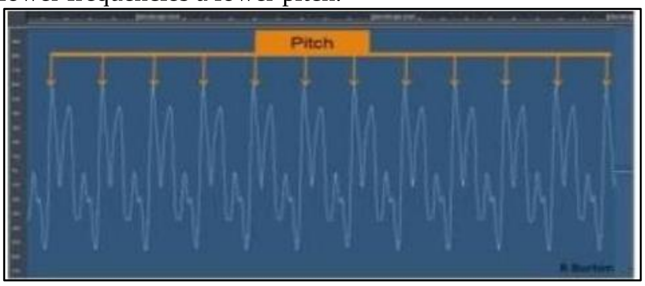
The term sound in the context of physiology and sometimes psychology is often used in the sense of perception of the brain on vibrations, as psychoacoustics examine. Historically, the term "sound" referred specifically to an effect within the mind. According to the 1947 Webster's Dictionary 'Sound' had been explained as 'something heard; an effect produced by the vibration of a body, that imparts sound to the ear.' This definition proposed that when a tree fell in the forest, with no one to hear, it made no sound. With contemporary usage, sound is more typically defined as the process as physical phenomenon, and since there is a listener not required there actually is sound when a tree falls.

The range of human perception of sound frequencies is typically between 20 Hz and 20 kHz, which shrinks with age. However, other species such as dogs can perceive sounds above 20 kHz. Sound is an important sensory input for many animals for purposes of communication, navigation, and survival. The sounds that characterize earth's natural environment; rain, wind, fire, earthquakes are all products of earth. There are different species such as frogs, birds and mammals that have specialized organs that produce sound that can be in songs or forms of communication.

Technology has also included human development such as the development of music, phones, and radio allowing for the transmission and recording, as well as the production of sound. In the realm of science and engineering, noise is typically viewed as a corruptive factor, and as a unwanted sound. Obscuring important signals about the timbre of a sound but also giving insight into how the sound sounds. A soundscape is the acoustic environment (listened to by humans), while the acoustic environment is comprised of all sounds within a given space, audible and inaudible. Six basic methods of sound analysis can be performed — pitch, length, noise, timbre, sonic texture and location; with additional consideration for temporal elements in modern acoustics research.

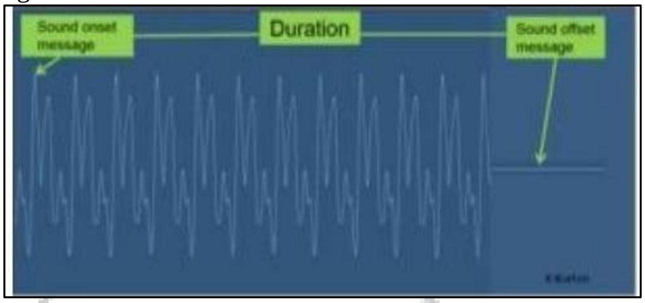
VIII. PITCH

Pitch is perceived as the sound is heard as being either higher or lower. It has to do with the frequency of the vibrations producing the sound. Pitch of simple sounds is the frequency of the slowest vibration in the sound wave (or fundamental harmonic). However, pitch perception can be different in complex sounds that possess multiple frequencies, or harmonics. The brain understands these frequencies to be equal to pitch, and higher frequencies mean a higher pitch, lower frequencies a lower pitch.



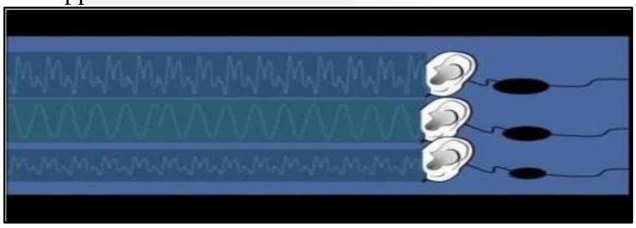
IX. TIME DURATION

Duration is how "long or "short" a sound is, and is also dealing with the onset and offset of signals taking at the level of small nerve responses to noises. Length of a sound is usually from the time of the first reception of a sound to the time in which it becomes recognized as having changed or ceased. This, though, is not necessarily the length of the sound in actual physical terms. Similarly, suppose hearing begins and stops over and over, and the brain misses those signals for beginning and ending due to a surrounding noise. This concept can be used in cases of distorted messages, e.g. in interference of radio signals, to which the message feels like being continuous all the time. As this new sound is detected (figure 1.5 green arrows), a signal is sent to the auditory cortex and any missed repeating patterns result in a signal to sound balance.



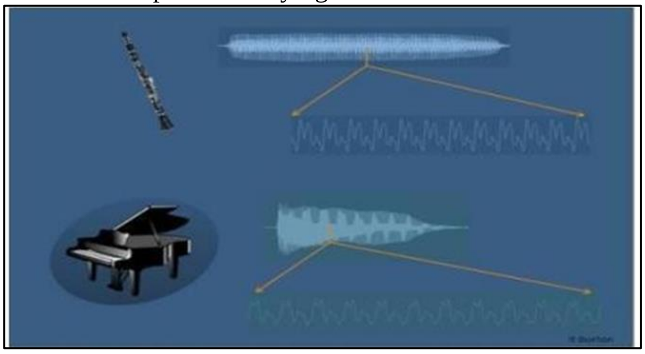
X. LOUDNESS

Loudness is perceived as how 'loud' or 'soft' a sound is, does it excite the auditory nerve more, and correspondingly happens over cycles shorter than the theta wave cycles. This implies that a short sound, presented at the same power as a longer sound, sounds less loud than a longer sound over very short periods of time. But longer than approximately 200 milliseconds, the duration of the sound makes little difference to its apparent loudness.



XI. TIMBRE

What is perceived to be the quality of different sounds such as the crash of a fallen rock, hum of a drill, tones of musical instruments, or the quality of voices is Timbre. The subconscious identification of a sonic character's sound, "It's an oboe' — is rather well represented. Timbre is the result of factors like frequency distribution, noise, instability, perceived pitch, spread and intensity of harmonics in the sound over a long period of time. The information necessary for identifying timbre is the way a sound changes over time, such as shown in Figure 1.7. Although a small segment may look the same, the orange segment in Fig. 1.7 highlights how the sound evolves over time, which is different amongst each instrument. The timbre differences have both a loudness and a difference in the harmonic content. For example, the clarinet and piano exhibit clear differences in their sound characteristics over time. Less noticeable elements, such as the airiness of the clarinet or even the hammer strike of a piano are what contribute to each instrument's unique timbre, which also helps in identifying it.



XII. CONCLUSION

The study on noise in hospitals and its auditory and non-auditory impact assessment presented in the thesis draws upon the concept outlined in Chapter 1 and work done on noise pollution from India and abroad as study done in another research as discussed in Chapter 2. The research, analysis and methodology were discussed in Chapter 3 with the outcome being demarcated in Chapter 4. This study is a cohesive and comprehensive effort to evaluate both objective and subjective measures to make conclusive and suggest recommendations based upon those developments made in the study.

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