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Strategic Planning Approach for Noise Control in Urban Areas

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Abstract
Cities, accommodates more than half of the world population, contributes a major role in overall global development. However, the urban environment has its own challenges, and most prevalent issue is noise pollution, and it is described as a contemporary plague. This problem is linked to various health issues in public like depression, fatigue, insomnia, headaches, and decreased concentration etc. Compounding the issue is the cumulative impact of noise, where the detrimental effects may not manifest immediately. The study emphasizes the critical need for strategic planning approach and the measures to tackle various urban noise sources. The study also focuses into existing policies and guidelines on noise control in Indian urban context and explores different noise analysis approaches and regulations of other countries through case studies. The analysis delivers a set of recommendations on reducing noise pollution through noise zoning, based on the case studies. These recommendations range from the installation of noise barriers along transportation corridors to the implementation of zoning regulations that segregate noisy industrial or commercial activities from residential areas. Additionally, the study advocates for the establishment of strict noise limits tailored specifically for road traffic, underlining the pivotal role of well-designed public transport systems. This not only help in reducing noise impacts but also promotes sustainable urban development. Overall, the study attempts to create quieter, healthier sustainable urban spaces.

Keywords: Noise pollution, Noise control, Public health, Sustainable urban development, Noise zoning.

1 Introduction

Robert Koch's assertion that "Man will have to fight merciless noise as the worst enemy of health" underscores the significant impact of noise on human well-being (Krishan, 2017). Noise, characterized by disruptive sounds that impede clear thinking, focus, work, communication, and sleep, has become a pervasive issue in the modern world. The consequences of noise pollution are particularly pronounced in the context of rapid urbanization, notably in developing countries like India, where regional disparities in progress and population growth contribute to a deterioration in the quality of life in urban areas.

The exponential growth of population, coupled with traffic congestion and the convergence of commercial and industrial activities, has led major cities to grapple with escalating noise pollution problems. This challenge is exacerbated by the fact that noise pollution is becoming an increasingly prevalent yet often invisible form of environmental degradation even in developed countries.

In response to the rising concern over noise pollution, there has been a growing interest in researching and cataloguing noise levels from various sources in cities worldwide. This interdisciplinary approach is crucial for understanding the multifaceted nature of noise pollution and devising effective strategies for mitigation. Examining existing laws and regulations governing permissible decibel levels in different zones at various times of the day is essential at both domestic and international levels.

Many cities have initiated planning strategies to address noise pollution, with noise action plans being a notable example. These plans often involve a comprehensive examination of the sources of noise and the implementation of specific measures to control and reduce it. To enhance our understanding and address noise-related issues in our specific context, it is imperative to scrutinize the feasibility of implementing such measures and formulate tailored guidelines for noise control.

2 Literature Review

2.1 Noise

The word noise is derived from Latin word ‘‘Nausea’’ implying ‘‘unwanted sound’’ or sound that is loud, unpleasant or unexpected. It can be summed up as the incorrect sound occurring at the incorrect time and location. It is loud, disagreeable, unwelcome, and undesired to human ears (Verma, 2020). A tone that is bothersome and can cause minor to severe discomfort or annoyance is called noise. If a sound level is higher than 65 decibels dB, the World Health Organization considers it to be noise pollution. When noise levels rise above 75 dB and 120 dB, they become painful. It is advised that noise levels be kept below 65 dB during the day and that ambient noise levels at night exceeding 30 dB are detrimental to the ability to sleep soundly (WHO, 2010).

2.2 Types of Noise

Various types of noise can be distinguished based on their attributes, including their frequency, duration, and source (Storey, 2020) (Nyaaya, 2022).

2.2.1 Based on frequency

Table 1: Types of Noise Based on Frequency

Type of Noise	Description
Continuous noise	Noise that is produced continuously. E.g.:- Machinery that keeps running without interruption
Intermittent noise	Noise level that increases and decreases rapidly. E.g.:- Caused by a train passing by, factory equipment that operates in cycles, or aircraft flying above your house.
Impulsive noise	Most commonly associated with the construction and demolition industry. E.g.:- Created by explosions or construction equipment, such as pile drivers.
Low-frequency noise	Low-frequency noise makes up part of the fabric of our daily soundscape

2.2.2 Based on sources

Table 2: Types of Noise Based on Sources

Type of Noise	Description
Aircraft Noise	Often disruptive near major airports, aircraft cause noise pollution in the form of engine noise and air turbulence.

Railway Noise	Those living near a railway may find themselves disturbed by rail noise, caused by wheels, braking, turbulence, and engine thrust.
Road Traffic Noise	Sources of road traffic noise include engines, tyre, and turbulence.
Industrial Noise	Industrial and manufacturing processes generate large amounts of noise.
Domestic Noise	Day-to-day appliances such as vacuum cleaners and washing machines create noise.
Wind Power Noise	The sound of rotating wind turbine blades can cause noise pollution for those living nearby.

2.3 Noise Pollution

The World Health Organization classified noise pollution in 1972. Noise pollution is described as "unwanted or disturbing sound that has an adverse effect on human health and well-being" by the WHO (Karina Mary de Paiva Vianna, 2015). Noise pollution is defined as "the harmful or unpleasant impact of excessive noise, particularly when it interferes with human or animal life" by the US Environmental Protection Agency (United States Environmental Protection Agency, n.d.). The definition of noise pollution given by the European Environment Agency is "the persistent and diffuse presence of noise that has negative effects on human health and the environment" (Agency, 2020). Often referred to as "environmental noise," noise pollution Air pollution is the primary environmental cause of health issues, with noise pollution coming in second. Environmental noise is limited to sounds that are audible to humans and includes only outdoor noise produced by transportation, industry, and leisure activities.

2.4 Noise Pollution in Urban Area

Over the past ten years (2001–2011), India's urban population has grown by 31.8% on a decadal basis. Environmental pollution is one of the many public health issues brought on by rapid urbanization. The majority of polluting activities are necessary to meet the demands of the expanding population and development. Rising noise pollution is correlated with both the increased traffic of automobiles and the faster urbanization of developing nations. The structure and physical location of buildings, the density of construction, open spaces, the kind of passageways, and the distribution of population all influence how noise pollution is distributed spatially in urban areas (Limalemla Jamir, 2014).

2.5 Classification of Noise Pollution

The noise pollution is mainly classifies as two categories:-

1. Community Noise/ Environmental residential or domestic noise / non-industrial noise pollution
2. Occupational Noise / Industrial noise pollution

2.5.1 Community noise

Community noise, a major public health concern, comes from various sources such as neighborhoods, industries, construction, roads, trains, and aircraft. Indoor noise comes from neighbors, office equipment, and ventilation systems, while outdoor noise comes from food-related businesses, music, and outdoor activities (Birgitta Berglund, 1999). Despite regulations, few have noise ordinances due to its difficulty in quantifying and regulating noise. Roadway noise, primarily from moving cars, is the most damaging source of environmental noise exposure in the United States.

2.5.2 Occupational noise

Noise pollution, primarily from industrial sources, can cause harm to people and animals. Occupational exposure limits are the maximum sound pressure levels and exposure durations that workers can tolerate

without experiencing negative effects. After 40 years, most people should be protected against permanent hearing impairment by an occupational exposure limit of 85 dB for eight hours. The National Institute for Occupational Safety and Health recommends limiting industrial noise levels to 85 dBA or lower to reduce hearing loss risk.

2.6 Noise Pollution and Effects

The effect of noise pollution is multifaceted and inter related. It harms the activity or balance of human beings, animal life, and the environment.

2.6.1 Effects of noise pollution on human health

Effects on health have been neglected, despite the ability to precisely measure or calculate exposure from peak levels or energy averaged over time. If exposure to noise is chronic and exceeds certain levels, then negative health outcomes can be seen. Depending on its duration and volume, the effects of noise on human health and comfort are divided into four categories;

1. Physical effects - hearing defects.
2. Physiological effects - increased blood pressure, irregularity of heart rhythms and ulcers.
3. Psychological effects - disorders, sleeplessness and going to sleep late, Irritability and stress.
4. Work performance - reduction of productivity and misunderstanding what is heard.

Noise has numerous health effects, including auditory and non-auditory effects. High decibel levels can cause tinnitus and hearing loss, which can result from prolonged exposure to noise levels over 75 dB. Children with NIHL have lower educational attainment, socio-emotional development, basic skills, behavioral issues, and self-esteem. Non-auditory effects can occur at low levels, as our bodies respond to noise exposure through hormonal responses. Noise pollution increases a person's susceptibility to tension and stress, causing agitation, frustration, and fury. Sleep disturbances can impact sleep duration, with immediate effects including inspiration responses, sleep phase shifts, awakenings, body movements, total wake time, and autonomic responses (Mathias Basner, 2020).

Ambient noise significantly impacts mental health and sleep, leading to issues like trouble falling, staying asleep, waking up early, decreased sleep quality, and changes in rapid eye movement sleep. Noise pollution may worsen other medical conditions, increasing blood viscosity and blood pressure, and increasing the risk of cardiovascular disease. Prolonged exposure to noise pollution may be due to stress hormone levels and the nervous system, leading to illness. Noise-induced hearing loss in children can lead to permanent impairments, hindering learning, cognitive capacities, speech and communication development, conduct, self-assurance, and bond-forming abilities. Exposure to sound can lead to high blood pressure, hearing loss, and tinnitus in adults and teenagers. The WHO estimates that ambient noise causes over a million healthy life year’s loss annually in European a member states.

Table 3: Health Issues Related to Noise Pollution

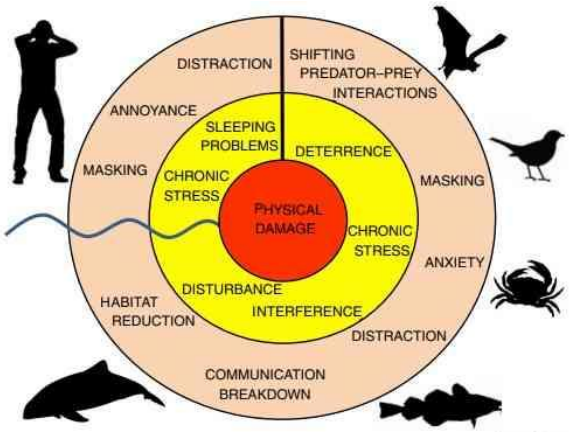
Stage 1	Stage 2	Stage 3	Stage 4
Noise hazard		Noise nuisance	
Threat to survival	Causing injury	Curbing efficient performance	Diluting comfort and enjoyment

Communication interference	Neural humeral stress response	Mental stress	Invasion of privacy
Permanent hearing loss	Temporary hearing loss	Task interference	Disruption of social interactions

2.6.2 Effects of Noise Pollution on Animals

Noise pollution is a significant threat to wild animals, disrupting their balance, communication, reproduction, and navigation, increasing the risk of death. Acoustic overexposure can cause hearing loss, behavioral issues, and disorientation, making them more susceptible to predators and predators. Birds struggle to find mates, and marine mammals become more vulnerable to collisions with ships if they cannot detect approaching sounds. Noise pollution also hinders animals' ability to recognize and understand important sounds in their environment, such as aircraft or traffic noise, which can mask predators' or prey calls, increasing their susceptibility to predators and confusion for marine animals relying on underwater sounds for navigation.

Figure 1: Noise pollution and health



Physiological stress in animal's increases heart rate, breathing, blood pressure, weakens immune systems, increases illness proneness, and affects reproductive and care abilities, potentially leading to lethal outcomes. Noise pollution disrupts the balance between predators and prey by disrupting their ability to detect and respond to each other. Prey animals may be less able to recognize predators, making them more vulnerable, while predators may struggle to locate and capture prey.

Noise pollution can cause permanent hearing loss in animals, making communication and hunting difficult and increasing vulnerability to predators. It can also disrupt reproductive processes, reduce hatching rates, and increase the risk of miscarriage or birth defects. Noise pollution can also hinder nest building, making animals more vulnerable to predators and exposing their eggs or young to unfavorable conditions. Unusual behavioral changes, such as increased aggression, avoidance behavior, and changes in feeding patterns, may be a coping mechanism for stress and significantly impact the survival and reproductive success of animal populations. Balancing issues can also hinder hunting, and moving to calmer areas can disrupt marine ecosystems (Waddington, 2022).

2.7 Noise Pollution – Cities

Cities offer opportunities, excitement, and a sense of community due to their diverse experiences, cuisines, and cultures. However, they also contribute to environmental and social problems, such as noise pollution, which negatively affects marginalized communities. Some of the world's greatest cities, such as Bangkok, Barcelona, Bogotá, Cairo, Delhi, Damascus, Kolkata, Karachi, and New York, are at risk from environmental issues. Noise pollution in marginalized communities, particularly near busy roads and industrial areas, disproportionately affects the elderly and young. Factories, factories, and construction projects generate loud machinery, contributing to increased levels. Marginalized communities face residential segregation, lack of political influence, and language barriers, which hinder their ability to support legislation and access information about noise pollution and its health effects (UNEP, 2022).

Moradabad, Uttar Pradesh, India, has the second-highest levels of global noise pollution, disproportionately affecting underprivileged populations due to rapid industrial growth and inadequate controls. The city government has not implemented stringent measures to mitigate noise pollution, and locals are unaware of potential health risks. The World Health Organization recommends a safe noise level of 55 dB, but the UNEP 2022 list shows an average daytime noise level of 67.8 dB, significantly higher than Delhi's 61. Chennai is India's most noisy metropolis, with an average daytime noise level of 67.8 dB (Bhagirath, 2022).

2.8 Noise and Urban Planning

Urban land use significantly impacts noise pollution rates, with higher density of urban land uses correlated with lower levels. Urban design features like density, morphology, street distribution, street environment, and land use all impact noise pollution levels. Car-free zones have lower noise levels, while high density areas like commercial and street intersections generate more. Mixed land use areas have higher noise levels than single land use areas. There is a negative correlation between Leq and the density of green land, with higher densities of green land resulting in lower noise pollution.

Noise planning controls can be implemented at two scales: general land use allocation noise controls and noise buffers. General land use allocation noise controls involve distributing development into designated noise-environment zones, while noise controls in land use management involve enhancing or constructing noise buffers between acoustically incompatible land uses. The Australian Environmental Protection Authority recommends noise levels in urban residential areas be between 45 and 55 dB, depending on time and location. Mixed-use neighborhoods with central development are preferred due to rising healthcare and municipal service costs, but noise levels in mixed-use areas are higher than residential neighborhoods.

2.9 Existing Statutory Provisions Related To Noise Pollution in India

Since the 1970s, India has prioritized environmental planning, management, and policy to ensure a clean environment. The Fourth Five Year Plan (1969–74) addressed environmental despoliation. However, India lacks comprehensive legislation to regulate noise pollution, leading to the global decibel war. The government uses legislation and the Constitution to combat decibel levels, but proper implementation is crucial. While there are many laws, some specifically address noise pollution (Laura, n.d.) (Pleaders, 2019).

Table 4: Existing Statutory Provisions Related To Noise Pollution in India

Laws	Description
Constitution of India	India's Article 21 guarantees citizens the right to life, which extends beyond survival and dignity. It guarantees a better life. Noise pollution, which disrupts a person's peace and comfort, is considered a violation of their right to life, as it disrupts their ability to live with dignity.
The Code of Criminal Procedure	Section 133 of The Code of Criminal Procedure allows executive, district, or sub-divisional magistrates to conditionally remove noise-related nuisances within a set timeframe. This is applicable when a police officer reports loud noises causing unlawful obstruction or nuisance in lawful public places. If the magistrate fails to take action, the section can be contested in a Civil Court.
Indian Penal Code	Certain offences are addressed in Chapter 14 of the Indian Penal Code. Such offences include any action that jeopardises public health or safety. Sections 268, 287, 288, 290, 291 and 294 are concerned with noise pollution.
Law of Torts	Noise pollution can be classified as a nuisance under tort law, allowing affected individuals to file a civil suit for compensation, provided they can prove damages caused by the interference with land use.
Control of noise pollution under other central legislations	Aircraft Act, 1934, The Motor Vehicles Act of 1939, Factories Act 1948, Noise Control under Railway Act, 1890, Police Act, 1861, Air (Prevention and Control of Pollution) Act, 1981, The Environment (Protection) Act, 1986 and the Environment (Protection) Rules, 1986.

2.9.1 Noise pollution (regulation and control) rules, 2000

The Noise Pollution (Regulation and Control) Rules, 2000 were enacted by the Central Government to regulate urban noise pollution from various sources. However, these rules are insufficient as they do not address many contributing factors. The rules are implemented in accordance with the Environment (Protection) Act, 1986. Noise pollution from vehicles, loudspeakers, and other mechanical devices is believed to hinder physical and physiological development. Regulations were implemented to reduce pollution and promote health. However, these rules, which prohibit night-time loudspeaker use and impose penalties for non-authorized use, have proven inadequate and lack implementation, despite Supreme Court reminders. The Supreme Court has repeatedly reminded the Supreme Court of the inadequate and lack of implementation of noise pollution rules prohibiting nightly loudspeaker use.

2.9.1.1 Ambient noise standards for different areas/ zones

The Indian government has established four zones: industrial, commercial, residential, and silence zone. The zone's ambient standards include daytime - 6 a.m. to 10 p.m. and nighttime - 10 p.m. to 6 a.m. The noise level is measured in decibels, with dB (A) Leq representing frequency weighting. The silence zone is a 100-meter radius around hospitals, educational institutions, and courts (Pleaders, 2019).

Table 5: Ambient noise standards

Area code	Categories of area/zone	Limits in dB(A) Leq	
		Day time	Night time
A	Industrial zone	75	70
B	Commercial zone	65	55

C	Residential zone	55	45
D	Silence zone	50	40

Source: Central Pollution Control Board

3 Literature Case Studies

3.1 Hong Kong, China

The high-density living environment in Hong Kong, with many residential developments near busy roads, has resulted in significant noise pollution.

Figure 2: Buffer zone between industrial and residential areas

Issue - Tai Po Industrial Estate situated nearby a housing estates with residential buildings. Incompatible land use, where industrial activities and residential spaces coexist, can cause significant noise pollution problems for residents.

Solution - Create a physical distance between noise sources and sensitive receptors by designating separate zones for industrial enterprises and residential buildings, such as the Tai Po Industrial Estate and nearby housing estates. Encouraging rail-based development. Utilizing underground/sunken road design. Locating trunk roads and primary distributor on the outskirts.

Issue - specific location in unsuitable for the development due to adverse environmental noise impact on existing sensitive development.

Solution - Choosing an appropriate alternative alignment, the noise impact of road traffic can be reduced.

Issue - Traffic noise from the Fung Mo Street.

Solution - Constructing Hong Keung Court, Lok Fu to protect its residents from traffic noise from the Fung Mo Street. By putting a noise-tolerant building between the road and the residential building, the noise in the "shadow zone" is reduced (Environmental Protection Department, n.d.).

3.2 Dublin Agglomeration

South Dublin County stretches from the River Liffey to the Dublin Mountains and is bounded by Dublin City, Fingal, Dun Laoghaire Rathdown, Wicklow, and Kildare. The character of land use varies greatly, from busy local towns to rural landscapes to developing suburban residential developments.

Issues - exposure to environmental noise.

Solution - Proposes the following thresholds sound levels:

- Desirable–<50dB(A)Lnight,<55dB(A)Lday
- Undesirable–>55dB(A)Lnight,>70dB(A)Lday
- Quiet Area–<45 dB(A) Lnight, <55 dB(A)Lday,<55dB(A)Lden.

Noise reduction and prevention measures for traffic sustainable travel infrastructure projects, traffic management plans. Implementing local transport plans, promoting electric charging stations. Transport planning, reduces excessive driving speeds, encourages low-noise road surfaces, and uses road side noise

barriers. Rail noise reduction and prevention measures. Comprehensive impact assessment and mitigation measures for new rail infrastructure and ancillary developments. Protecting 'Quiet Areas'. Existing ones should be preserved and new ones should be created (Dublin Agglomeration Environmental Noise Action Plan , 2018).

3.3 Antwerp

Figure 3: General map of the site and numbered areas

Antwerp, Belgium, is proposing a test site for a road infrastructure node with heavy traffic, considering various urban configurations. The site's complexity emphasizes the need for a holistic approach considering acoustical, architectural, and urban views. The strategy aims to provide analysis, tips, and perspectives, demonstrating the complexity of potential acoustic problems in a city. The figure shows the numbered areas 1-Tuinwijk, 2 - Hof ter Lo , 3 - Rivierenhof Park, 4- 126 Spoor Oost, 5-connection with Rivierenhof ParkIssue - The city's proposed test site consists of various areas affected by a road infrastructure node in the North West with heavy traffic that combines two major road infrastructures and a ring road with local roads. The busy E313 highway, which surrounds the park on the south side, causes high noise levels in Rivierenhof Park

Solution - The crossing road's problems could have been avoided in the planning stage by stage. Reducing the number of lanes. Redistribute traffic flow to other possible routes bordering the park. Reducing traffic speed with calming measures. Adding a porous road surface material. Locating vegetated low barriers next to the source. Including absorbent vegetated areas between source and receiver to give visual continuity to the park, avoiding the impression of park border (Wolfgang Kropp, 2016).

3.4 Japan

Noise control in Japan is a robust and comprehensive endeavor, driven by stringent regulations, advanced technologies, and community engagement. The country has implemented strict noise regulations at both national and local levels, targeting various sources such as transportation, construction, and industrial activities.

In Japan, the road traffic noise limits vary in respect of zone categories and time periods. Road traffic noise limits in respect of type of zone categories and time periods.

Figure 4: Standard Noise limits

Zone category	Road traffic noise limit	
	Day-time (dB(A))	Night-time (dB(A))
AA	50	40
A and B	55	45
C	60	50

Notes: (1) AA zone requires particular quietness.
(2) A zone is almost exclusively for residential purpose.
(3) B zone is primarily for residential purpose.
(4) C zone has a substantial number of residences mixed with commercial and industrial establishments.

Area category	Road traffic noise limit	
	Day-time (dB(A))	Night-time (dB(A))
Areas adjacent to roads of two or more lanes in zone A	60	55
Areas adjacent to roads of two or more lanes in zone B and areas adjacent to roads with one or more lanes in zone C	65	60
Areas adjacent to roads that sustain major arteries of traffic	70	65

Solution - Zoning land and planning urban projects with the considerations of noise factor. Building by passes and ring roads. Establishing buffer zones on both sides of a road. Resurfacing roads with low-noise material. Installing double-glazed windows and air-conditioning for the affected residents. Managing traffic flows. Improving public transportation networks. Installing advanced traffic management systems that respond instantaneously to traffic conditions. Implementing bus-only lane scheme. Adopting advanced construction method. Employing elevated roads and bridges. Installing sound-absorbing panels on the underside of elevated roads. Reducing road traffic noise at source-crack down on illegal vehicle modifications such as muffler alterations (WU, 2006).

3.5 Gothenburg: Frihamnen Area

Gothenburg, Sweden's second-largest city, has around 550,000 inhabitants and is primarily composed of the mainland and Hisingen Island. The SONORUS project is testing Frihamnen, a 1920s inner harbor built in Hisingen. The area is being transformed into a dense, mixed-use neighborhood, becoming one of the most significant urban planning projects in Gothenburg City Centre. The area is a frame for the river.

Issue – Frihamnen area is subjected to a variety of noise sources. This area is being transformed into a dense and mixed-use neighbourhood. Road traffic dominates owing to two major road infrastructures located to the north and east. A busy railway track in the north east also connect strains to the outer harbour.

Solution - A dynamic tool assessment to study the transport system and its effects on the Frihamnen acoustic environment is being developed. The work focuses primarily on the transportation system and ways to improve its acoustic quality. The study in this tool focuses on developing four scenarios and nine alternatives to the traffic office's preliminary traffic planning. The goal is the evaluation of the future acoustic environment in relation to traffic demands (Wolfgang Kropp, 2016).

3.6 Analysis and Inference

Table 6: Analysis

Criteria	Location	Context	Assessment	Solution
Based on different zones	Hong Kong	High-density living high rise residential buildings are frequently built next to heavily trafficked highways.	Land use planning	Create physical distance between noise sources and sensitive receptors by designating separate zones. Other techniques used; Alternative, Siting/Alignment, Screening by Noise, Tolerant Buildings, Building Disposition, Decking Over, Podium, Noise Barrier / Enclosure, Road Surfacing
Based on different zones	Antwerp	High noise levels in silent zones.	Integration of urban sound planning	Combination of different noise abatement measures proposed
Based on different zones	Frihamnen area	Dense and mixed-use neighbourhood, subjected to a variety of noise sources	Integration of urban sound planning	Proposals to improve an area's acoustic situation

Based on noise source	Japan	Increase in traffic noise	Environmental Impact assessment	Use of noise barriers Land use planning. Resurfacing roads Improving public transportation. Implementing bus-only lane scheme. Elevated roads and bridges.
Based on noise source	Dublin	Increase in environmental noise	Passive measures Active measures	Noise reduction at source, Land use planning & management,

In the modern era, the noise has become an inseparable in urban life, plaguing the world's major metropolises, cities, and conglomerations, with India being no exception. The advancement of culture, driven by the constant intensification of automobile has reshaped urban landscapes, encroaching upon precious green spaces. This transformation, many serious issues one among them being noise pollution.

An in-depth analysis emphasizes the increasing dangers linked to this auditory attack and primarily links the problem to the disjointed nature of urban planning processes. Unchecked noise pollution has become a problem in cities due to weak regulations and a disorganized planning effort fragmentation. Meanwhile, as role models, pro-active nations all over the world have launched successful campaigns to evaluate and reduce noise pollution.

However, India is in a state of emergency regarding the development of noise control guidelines, as the negative effects of noise pollution are severely affecting citizens. In the face of this escalating crisis, concerted efforts must be undertaken to formulate and implement effective noise abatement measures, safeguarding the health and well-being of citizens.

3.7 Recommendations

The recommended implementation phases for noise control in urban areas through spatial planning address the complex challenge of mitigating noise pollution systematically. In first phase, understanding and defining existing sound levels and sources provide a foundational understanding of the scope of the issue. Second phase emphasizes the integration of noise considerations into land use planning, strategically zoning areas to minimize the impact of noise on residents and sensitive spaces. Third phase involves the crucial implementation of targeted mitigation measures, such as noise barriers and green spaces, to actively reduce noise levels in identified hotspots. Finally, fourth phase underscores the importance of enforcement, ensuring that established rules and regulations are followed to maintain the effectiveness of the noise control strategy. This phased approach acknowledges the multifaceted nature of noise pollution in urban settings and seeks to create a harmonious and livable environment by addressing sources, spatial arrangements, and regulatory compliance.

Phase 1 - Define sound levels and sources

- Identify major noise sources and noise sensitive locations.
- Operational and activity data on major sources.
- Obtain estimates and future noise activity levels and growth of major sources
- Develop current and future noise exposure contours for major sources
- Define similar intensity noise exposure zones by land use category

Phase 1 of the noise control plan establishes a foundation by defining urban sound levels and sources, identifying major noise sources, and sensitive locations. Operational data gathering is crucial for understanding the current noise landscape. Proactively addressing challenges, planners estimate future

noise levels, develop exposure contours, and define noise zones based on land use. This systematic approach enables tailored noise control strategies, prioritizing noise-sensitive areas. In summary, Phase 1 sets the stage for subsequent implementation by analyzing, projecting, and categorizing noise elements for effective, customized urban noise control measures.

Phase 2 - Land use planning based on noise zoning

- Noise impact assessment should be done
- Land use compatibility study is to be done before any new developments
- Studies related to urban Typology, patio-Acoustic Typology, predominant uses of the area should be done.

Phase 2 of the noise control plan focuses on comprehensive noise zoning in land use planning. It includes a noise impact assessment for proposed developments, ensuring compatibility with the existing noise environment. A vital step involves a land use compatibility study before new projects, aligning intended developments with the noise conditions. Studies on urban and patio acoustic typology provide insights, enabling informed decisions for a strategic development framework that prioritizes compatibility, fostering a harmonious coexistence between the urban landscape and its acoustic environment.

Phase 3 - Mitigation measures for noise control

- Strategic noise mapping should be done.
- Noise action plans should be prepared for each five years.
- Phase 3 of the noise control plan emphasizes the implementation of mitigation measures to address urban noise challenges. This includes conducting strategic noise mapping to identify and analyze high-noise areas, allowing for targeted interventions. Additionally, the development of Noise Action Plans at five-year intervals ensures a systematic and adaptive approach to noise control. These plans serve as proactive frameworks, incorporating strategic measures to effectively mitigate noise pollution and enhance the acoustic environment over the specified periods.

Phase 4 – Enforcement

- Strict enforcement of rules and regulations

In Phase 4, the focus of the noise control plan shifts towards enforcement, emphasizing the strict implementation of established rules and regulations. This crucial phase ensures that the outlined noise control measures are adhered to consistently. Enforcement mechanisms involve monitoring and penalizing violations, fostering a culture of compliance. By implementing rules and regulations, this phase plays a pivotal role in sustaining the effectiveness of the noise control strategy, fostering a quieter and more harmonious urban environment in line with established guidelines.

3.7.1 Recommending noise limits for different zones in urban areas:

Table 7 : Ambient Noise Standards

Area code	Categories of area / zone	Acceptable		Unacceptable	
		Day time dB(A) Leq	Night time dB(A) Leq	Day time dB(A) Leq	Night time dB(A) Leq
A	Industrial zone	75	70	> 75	> 70
B	Commercial zone	65	55	> 65	> 55
C	Residential zone	55	45	> 55	> 45
D	Silence zone	50	40	> 50	> 40

Source: Central Pollution Control Board

3.7.2 A - Industrial zone

Developments with noise produced 75 dB during day time and 70 dB during night time are concentrated into industrial zones.

Controlling the transmission of noise there are two approaches:-

- land-use controls
- use of barriers

- When new industrial development is implemented in a city noise impact assessment and land use compatibility study should be done.
- Industrial developments should be concentrated away from the densely populated noise sensitive zones of the city.
- Less noise sensitive land uses (active recreation areas or access ways) can be located as a spatial separation between noisy activities and noise-sensitive areas.
- Increasing distance and designing protective green zones between industrial areas and settlements,
- Taking advantage of any natural topographical features that can be used to screen noise impacts when planning land use in an area.
- Designing the industrial zone at the lower elevation according to the residential area and barrier design.
- Constructing intervening structures such as multilevel buildings to act as barriers.

3.7.3 B – Commercial zone

Zone with noise produced 65dB during day time and 55 dB during night time are commercial land uses.

- Land use zoning to keep noise sensitive areas from high noise producing commercial zones.
- Providing tiny green spaces or water features scattered within the zone.

3.7.4 C – Residential zone

Zone with noise produced 55 dB during day time and 45 dB during night time are residential land uses.

- Green buffers: To act as sound barriers, place trees and green spaces between residential areas and noisy areas.
- Minimum setbacks should be established between residential zones and noisy sources such as roads or industrial areas.

3.7.5 Recommending noise limits for three major sources of noise generation in urban areas:

Table 8: Recommendations for Noise from different sources

Road traffic noise	• When new roads are planned, an assessment of the noise impact should be executed to evaluate the impact. • For existing road if the noise level exceeds the permissible limit the residents can request for necessary actions. • Zoning land and planning urban projects with the considerations of noise factor. • Building bypasses and ring roads. • Establishing buffer zones on both sides of a road. • Installing noise barriers of suitable material. • Resurfacing roads with low-noise materials. • Reduce traffic flow and restrict truck traffic. • Improving public transportation networks. • Implementing bus-only lane scheme.

	• Construction method for elevated roads and bridges and installing sound absorbing panels on the underside of elevated roads. • Clamp down on illicit car modifications like muffler alterations. • Encourage the purchase and use of low-noise automobiles like electric cars. • Design/make available a "quiet side" in the dwelling; create nearby green space.
Railway noise	• Installation of noise barriers of suitable material. • Strict land-use zoning to separate noise-sensitive areas from railways. • Providing buffer zones or green spaces between noise sensitive spaces. • Elevated railway lines above the populated area.
Aircraft noise	• Restrict noise sensitive zones in close proximity to airports. • Locating airports in sparely populated areas. • Multiple runways positioning to minimize noise impact on specific communi-ties. • Noise-absorbing surfaces -Special paved surfaces around runways absorb sound generated during take-off and landing.

The recommendations for noise limits in urban areas address road traffic, railway, and aircraft noise. For road traffic, a proactive approach involves noise impact assessments for new roads and resident-requested actions for existing noisy roads. Zoning and urban planning considerations factor in noise mitigation, including building bypasses, establishing buffer zones, and installing noise barriers. Measures like resurfacing roads with low-noise materials, traffic flow reduction, and promoting public transportation contribute to a quieter urban environment. Railway noise is tackled through noise barriers, strict land-use zoning, buffer zones, and elevated railway lines. Aircraft noise control includes zoning restrictions, strategic airport locations, multiple runway positioning, and the use of noise-absorbing surfaces. These comprehensive measures aim to create a harmonious urban soundscape, considering infrastructure development, technological solutions, and community engagement for noise control.

4 Conclusion

The study on "Strategic Planning Approach for Noise Control in Urban Areas" emphasizes the urgent need to address the widespread challenge of noise pollution within urban settings. It highlights the profound impacts of noise pollution on human health and ecological systems, including increased stress disrupted sleep patterns, cognitive impairments, and potential cardiovascular issues. The study also highlights the ecological implications, including disturbances in wildlife habitats and imbalances in ecosystems. Moreover, the study explores the existing rules and recommendations governing noise management in urban regions of India, scrutinizing various methods of noise analysis and global planning regulations through detailed case studies. These practical instances offer valuable insights into the intricate landscape of urban noise issues, enhancing understanding of the complexities and proposing effective strategies for intervention. This encompasses the implementation of tailored noise limits across distinct urban zones, the strategic installation of noise barriers, the enforcement of zoning regulations, and the integration of green spaces as natural buffers against noise propagation. In summary, the study serves as a call to action, emphasizing the imperative for strategic interventions and the implementation of mitigation measures to counteract the detrimental impacts of noise pollution. Its significance extends beyond raising awareness,

providing a compelling basis for advocating proactive strategies towards creating harmonious, healthier, and more livable urban spaces for the well-being of present and future generations.

5 References

1. Agency, E. E. (2020). *Environmental noise in Europe*.
2. Bhagirath. (2022). *Down to Earth* . Retrieved from Moradabad 2nd most noise polluted city globally, says UNEP.
3. Birgitta Berglund, T. L. (1999). *Guidelines for Community Noise*. World Health Organization, Geneva.
4. (2018). *Dublin Agglomeration Environmental Noise Action Plan* .
5. *Environmental Protection Department*. (n.d.). Retrieved from Mitigation Measures.
6. Karina Mary de Paiva Vianna, M. R. (2015). Noise pollution and annoyance: An urban soundscapes study. *Noise & Health*.
7. Krishan, P. (2017). The Adverse Psychosocial Impact Of Noise Pollution And Its Health Hazards.
8. Laura, J. (n.d.). *Environmental Pollution - Air & Noise*. Retrieved from Legal provisions and Act for Noise Pollution.
9. Limalemla Jamir, B. N. (2014). Community Noise Pollution in Urban India: Need for Public Health Action. *Centre for Community Medicine, All India Institute of Medical Sciences, New Delhi, India*.
10. Mathias Basner, W. B. (2020). Auditory and non-auditory effects of noise on health. *Pubmed*.
11. *Nyaaya*. (2022). Retrieved from Sources of Noise Pollution.
12. *Pleaders*. (2019). Retrieved from Prevention and control of Noise Pollution.
13. Rafael A Lara, R. O. (2021). Impact of noise on development, physiological stress and behavioural patterns in larval zebrafish. *PubMed*.
14. Storey, C. (2020). *NoiseNews*. Retrieved from What are the 4 Different Types of Noise?
15. *UNEP*. (2022). Retrieved from The world's cities must take on the cacophony of noise pollution.
16. *United States Environmental Protection Agency*. (n.d.). Retrieved from Clean Air Act Title IV - Noise Pollution.
17. Verma, M. B. (2020). Investigation & Examination of Noise Pollution - Definition, Sources, Effects, Monitoring and Control. *International Journal of Research in Social Sciences*.
18. Waddington, E. (2022). *earth.fm*. Retrieved from Noise pollution and its impact on wildlife and ecosystem health.
19. *WHO*. (2010). Retrieved from Noise.
20. Wolfgang Kropp, J. F. (2016). *Urban Sound Planning - the SONORUS project*.
21. WU, J. (2006). *Mitigation Measures against Road Traffic Noise* .