

INVESTIGATING THE EFFECTS OF NOISE POLLUTION'S INFLUENCE ON THE BUILT ENVIRONMENT AT ZERO POINT, KHULNA

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ABSTRACT

A global problem that affects cities, noise pollution has grown to be a major worry that lowers people's quality of life and has an impact on the built environment. The term refers to a range of factors that can lead to increased noise levels and consequently affect one's physical and mental well-being, such as industrial operations, urbanization, and traffic. Noisy environments are dangerous and have a negative impact on people's health. Noise pollution is one type of environmental pollution. Located on the banks of the Rupsha and Bhairab rivers in southwest Bangladesh, Khulna is a major industrial city that faces many challenges, one of which is noise pollution. The consequences affect infrastructure, social cohesiveness, and general urban livability in addition to auditory disturbances. With regard to the built environment at Zero Point, the main entrance to the city, this study attempts to pinpoint the sources of noise pollution and evaluate their effects. The study utilized survey research methodology. According to our survey of buildings along Zero Point's main thoroughfares, the most significant sources of noise were vehicle traffic, pedestrian activity, and road construction. The public should be made aware of the detrimental effects of noise, and source-based noise reduction techniques should be employed in addition to appropriate setbacks, green buffers, insulation materials, and public awareness campaigns. In order to achieve both more ambitious urban development objectives and the urgent necessity of reducing pollution, careful planning that takes social and environmental factors into account is highlighted in this research paper.

Keywords: *Zero Point, noise, environmental pollution, built environment.*

1. INTRODUCTION

Following the Second World War and the European Industrial Revolution, technology has rapidly grown and advanced. In general, technological advancements have made life easier and more comfortable for people, but they have also had drawbacks. One major downside is the rise in environmental problems, particularly pollution from industrial advances. This comes in various forms: air pollution, water pollution, soil pollution, thermal pollution, and noise pollution. Noise pollution, the unwanted sound disrupting daily life, is a significant issue in built-up areas. The World Health Organization (WHO) ranks it as the third most impactful environmental problem after air and water pollution. Noise pollution in urban areas and large cities has adverse harms to human health and well-being, from insignificant annoyance, such as disturbance to sleeping, reading, speech communication, concentration of mental work, etc., to physiological and psychological damages. Among all of the sources responsible for noise pollution, such as traffic noise, industrial noise, and activity noise, traffic-related sources are from great environmental concern and increasing levels of discomfort in urban areas with high traffic concentration. Traffic noise pollution is 90% of total noise levels in developed urban cities, while it occurs at 10% in commercial, industrial, and residential activities.

Noise pollution has become a growing concern globally along with other environmental pollution. It's now recognized as a significant threat to global health, causing a range of illnesses in people exposed to excessive noise. Noise pollution falls under the umbrella of air pollution, referring to audible sounds that go beyond acceptable limits, being not just loud but also irritating and harmful to human health. The Latin word "nausea" is the root word of noise which means 'unwanted sound' or 'sound that is loud, unpleasant or unexpected. Sound is measured in the logarithm scale and expressed as a decibel (dB) unit. The government of Bangladesh recommended a threshold of the acceptable noise level in Schedule 1 of 'Noise Pollution (Control) Rules, 2006' for different areas at dB unit that were acted with the governance of the Bangladesh Environment Conservation Act, 1995. The accepted threshold limits are 50dB, 55dB, 60dB, 70dB and 75dB for sensitive areas, residential areas, mixed areas, commercial areas, and industrial areas respectively.

As a result of rapid urbanization and industrialization, Khulna City's deteriorating environment has become a major concern. Along with other environmental pollution, the occupants of Khulna city are suffering from a high amount of noise pollution. The noise comes from various sources like industries, vehicles, loudspeakers, and ongoing construction activities. The issue of noise pollution is a significant concern worldwide, with vehicles being a major culprit, accounting for approximately 55% of urban noise. The increasing number of vehicles not only worsens noise pollution but also poses potential health risks in the short and long term, negatively impacting both mental and physical well-being. The World Health Organization (WHO) reports that 10% of the world's population is exposed to noise levels that could potentially cause hearing problems. In Bangladesh, the problem is further exacerbated by the high levels of industrial noise in densely populated areas such as Khulna Zero Point, where various activities contribute to the overall noise pollution. Environmental noise causes various mental effects such as annoyance, hypertension, disturbance of sleep and genuine health effects such as cardiovascular disease. The effects of excessive noise could cause a permanent loss of memory or a psychiatric disorder. In Bangladesh, the most vulnerable to these health risks are pregnant women, the elderly, and children. Noise pollution is taking a toll on their well-being, emphasizing the urgent need to address this growing concern for the sake of public health.

The focus of this study is to identify the sources of noise pollution in Khulna Zero Point, a commercial zone of the built environment to proffer a solution that will enhance the comfort of the estate. Relevant literatures were reviewed with a view to define the problem, identify the sources of noise pollution and the physiological and psychological effects of noise pollution on man. The results of a structured questionnaire administered on 40 users of Zero Point, Khulna are presented and discussed. Adequate setbacks, green buffer and creation of public awareness and enlightenment on the damaging effects of noise are recommended as practical ways of reducing the impact of noise on the built environment.

2. METHODOLOGY

2.1 The Study Area

Khulna is the third largest city in Bangladesh. It is an important industrial and commercial hub and serves as the gateway to the Sundarbans and the Port of Mongla. The present growth and development trend of Khulna City is phenomenal. Infrastructure projects such as the Padma Bridge and the new Mongla Railway hold immense potential to reshape the city's landscape and stimulate economic development. This analysis focuses on Zero Point, a central location within Khulna, exploring its potential to become a key driver for urban development and expansion. More than just a geographical coordinate, Zero Point symbolizes the convergence of aspirations and opportunities. Its strategic positioning in the city renders it capable of evolving into a dynamic commercial and civic hub, embodying progress and prosperity. For this analysis, we have focused on five key locations within a 500m radius of Khulna Zero Point - A. Cholachol Hotel, B. Shopnopuri Residential Area, C. Sheikh Hannan Road, D. Maizbhandari Khanka Sharif, E. Zero Point Centre. These locations have been selected for both instrumental and questionnaire surveys.

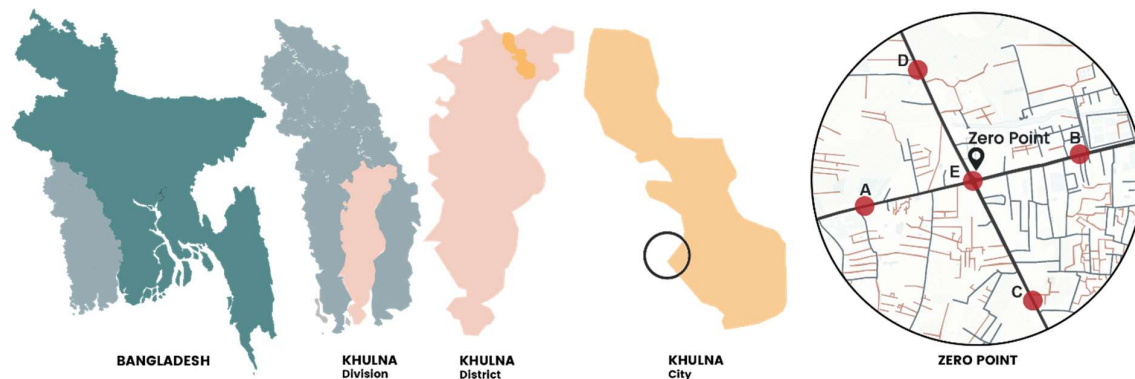


Figure 1: Location of the study area

2.2 Method of Data Collection

In this research, the data collection methods are divided into two separate sections: Survey-Based and Questionnaire-Based. In the survey-based data collection method, information about the types of buildings in Zero Point, the major sources of noise, and noise level analysis with standards is collected. In the questionnaire-based data collection method, information about the impacts of noise on people and the efficiency of various noise control measures is collected. Noise levels were measured by using Sound Level Meter (SM-815 Multi-functional Environment Meter). For that traffic congested commercial areas, the sound level meter was functioned at a height of about 1.2 m above the present road level and at a distance of 1.5 to 2.0 m from the edge of the roads. Data were collected during four shifts: morning (9:00 am-10:00 am), noon (1:00 pm-2:00 pm), evening (5:00 pm-6:00 pm), and night (9:00 pm-10:00 pm) in accordance with the Noise Pollution (Control) Rules, 2006, for different areas of Bangladesh, measured in decibels (dB). The research adopted a survey method of the study area using a structured questionnaire which was administered randomly on some of the buildings along the major streets in Zero Point. In this study, simple random sampling was used to administer the questionnaire on one building out of every five buildings along the major streets of the estate. In all, 40 questionnaires were administered and returned for analysis.

3. DATA PRESENTATION AND DISCUSSION OF RESULTS

3.1 Survey-Based Data Collection

In the study of noise pollution in Zero Point, Khulna, survey-based data collection entails methodically compiling details on the kinds of buildings, the main sources of noise, and the decibel levels of noise. The goal of the survey is to comprehend residents' perspectives and experiences through the use of a defined sampling strategy and an organised methodology. By putting quality control procedures in place, data reliability is ensured for later analysis, which offers insightful information about how noise pollution affects Zero Point's built environment.

3.1.1 Types of buildings in Zero Point

The survey analysis indicated that the distribution of land use in the Zero Point Area is as follows: 35% for residential purposes, 28% for commercial purposes, 14% for mixed-use purposes, 10% for industrial purposes, 5% for educational purposes, 4% for religious purposes, 2% for administrative purposes, and 2% for healthcare purposes. The area is predominantly characterized by business and residential activities. Located centrally within the city, this region is positioned to undergo a significant transformation into a vibrant centre for commerce and civic activities. Designed as a hub for economic activity and community involvement, it aims to attract business while promoting a sense of communal welfare, establishing a lively and comprehensive setting for both people and businesses.

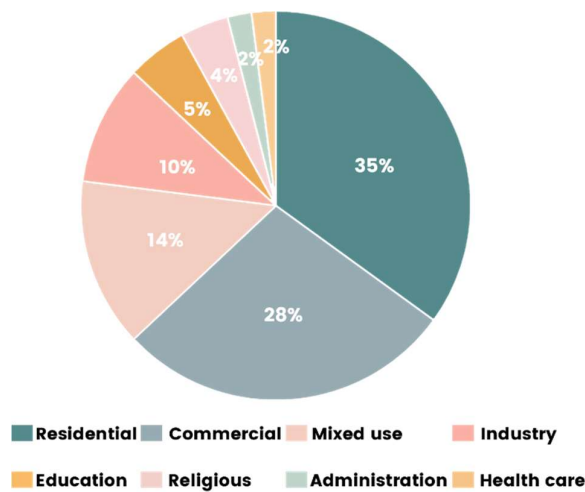


Figure 2: Types of buildings in Zero Point

3.1.2 Major sources of noise in Zero Point

Zero Point, acting as the primary nexus for economic transactions and social interaction, produces substantial levels of noise pollution originating from diverse sources. Vehicular traffic is the key contributor to the large volume of traffic passing through Zero Point, which serves as the primary connecting point between Khulna and other districts. This traffic constitutes 32% of the overall noise pollution. Another significant contributor is the road work linked to the establishment of an 8-lane highway, with the objective of enhancing communication with the Khulna region. This building activity significantly contributes to the second-highest amount of noise pollution, accounting for 28% of the total. Local commuters are encountering difficulties as a result of the ongoing road construction. The commercial zone, situated at Zero Point and acting as the entrance to Khulna city, is the third most significant contributor to noise pollution, accounting for 20% of the total. This region experiences diverse business activities, resulting in elevated levels of noise. 10% of the noise pollution is caused by pedestrian traffic, which involves many activities in the community. In addition, noise pollution originates from trains (4%), factories (4%), and religious structures (2%). To summarize, Zero Point

serves as a significant economic and community centre, yet it faces several types of noise pollution, with automotive traffic being the primary factor.



Figure 3: Photographs of some major sources of noise in Zero Point

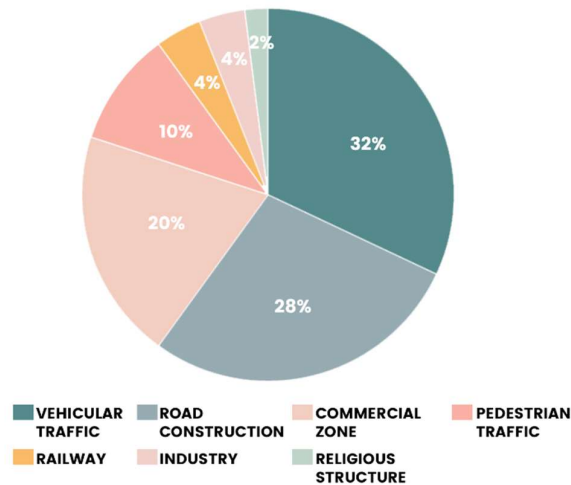


Figure 4: Major sources of noise in Zero Point

3.1.3 Noise level analysis with standards

The fluctuation of average noise pressure levels at five study areas in Zero Point, Khulna, has been shown in Figure 5. The results revealed that Zero Point Centre at Point E was the noisiest place among the study areas, with the highest average noise pressure level observed in every shift (morning 84 ± 5.06 dB(A), noon 79 ± 4.15 dB(A), evening 89 ± 5.93 dB(A), and night 87 ± 5.73 dB(A)) as detailed in Table 1. Similarly, the lowest average noise pressure level was observed in the morning (76 ± 5.06) and noon (73 ± 4.15) at Point C Sheikh Hannan Road, but in the evening (78 ± 5.93) and at night (81 ± 5.73) at Point D Maizbhandari Khanka Sharif. Therefore, it can be concluded that Point E Zero Point Centre is the

noisiest place among the study areas of Khulna metropolitan city (Figure 5 and Table 1). It was alarmingly observed that all the study areas in Zero Point exceeded the prescribed standard limit of noise level (70 dB(A) or 75 dB(A) for the commercial area) set by the DOE (Bangladesh Department of Environment), AASHTO (American Association of State Highway and Transportation Officials), and FHA (Federal Highway Agency) as shown in Table 1.

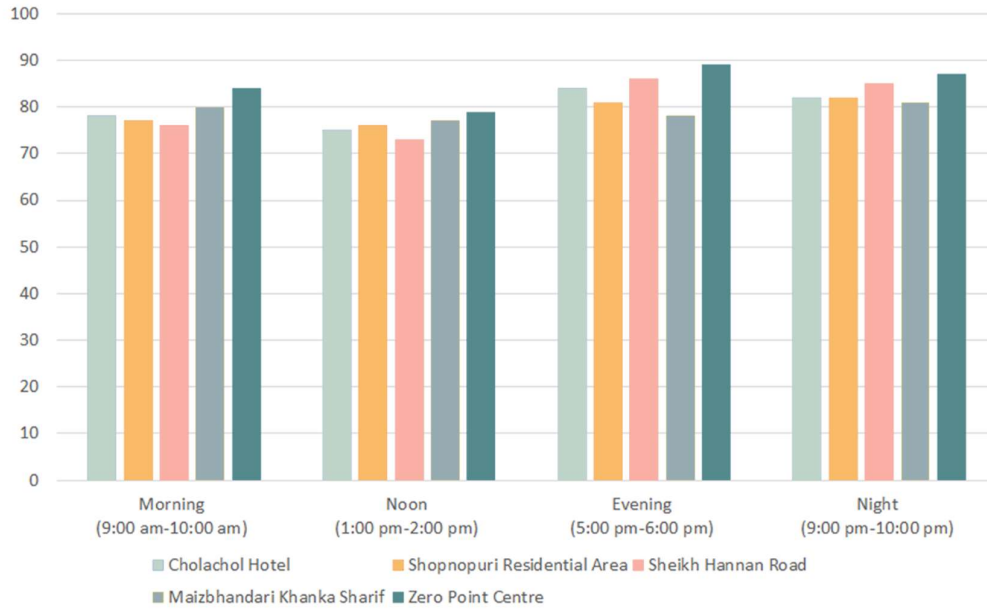


Figure 5: Noise level analysis of 5 study areas in Zero Point

Table 1: Noise level analysis with standards

Point	Location	Morning (9:00 am- 10:00 am) average	Noon (1:00 pm- 2:00 pm) average	Evening (5:00 pm- 6:00 pm) average	Night (9:00 pm- 10:00 pm) average	The acceptable limit of Noise level (dB) for commercial area		
						DOE	AASHTO	FHA
A	Cholachol Hotel	78 dB ± 5.06	75 dB ± 4.15	84 dB ± 5.93	82 dB ± 5.73	70	75	75
B	Shopnopuri Residential Area	77 dB ± 5.06	76 dB ± 4.15	81 dB ± 5.93	82 dB ± 5.73	70	75	75
C	Sheikh Hannan Road	76 dB ± 5.06	73 dB ± 4.15	86 dB ± 5.93	85 dB ± 5.73	70	75	75
D	Maizbhandari Khanka Sharif	80 dB ± 5.06	77 dB ± 4.15	78 dB ± 5.93	81 dB ± 5.73	70	75	75
E	Zero Point Centre	84 dB ± 5.06	79 dB ± 4.15	89 dB ± 5.93	87 dB ± 5.73	70	75	75

3.2 Questionnaire-Based Data Collection

The research employed a survey method in the study area, utilizing a structured questionnaire randomly administered to some buildings along the major streets in Zero Point. Simple random sampling was used for administering the questionnaire, focusing on the impacts of noise pollution and the efficiency of various noise control measures. In total, 40 questionnaires were administered and returned for analysis. The research aims to answer the following questions:

1. When do they perceive the sound intensity to be the highest?
2. Do they face difficulties while talking?
3. What types of health effects do they experience due to noise pollution?
4. Which measures are considered most effective in controlling noise pollution?

3.2.1 Impacts of noise on people of Zero Point

A social survey was conducted to assess the impacts of noise on the local people of Zero Point Area. The research employed a survey method in the study area, utilizing a structured questionnaire randomly administered to 40 people in Zero Point. The resulting data were compiled and consolidated into pie charts, illustrating the percentage of the effects on health and other problems. These charts provide insights into the local people's perceptions of noise.

Sound Intensity

Figure 6 shows that 42% of people feel that sound intensity is high at night, while 35% think it is high during the evening. Additionally, 14% believe it is high in the morning, and 9% think so during noon. This perception is attributed to the significant vehicular traffic during the evening and the substantial movement of heavy-load vehicles at night, contributing to increased noise pollution.

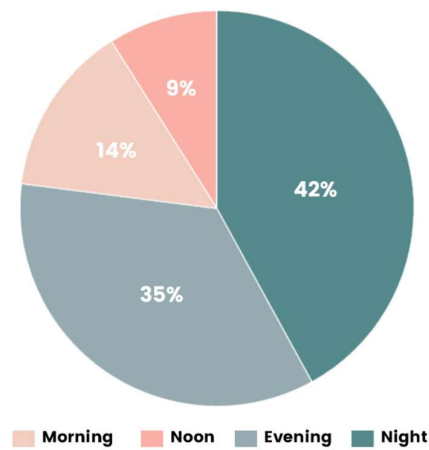


Figure 6: Respondent's opinion regarding sound intensity at different period of day

Talking Problem

Figure 7 shows that the 52% people faced high problem and 38% people faced moderate problem when talking each other due to noise pollution. And 10% people faced no problem.

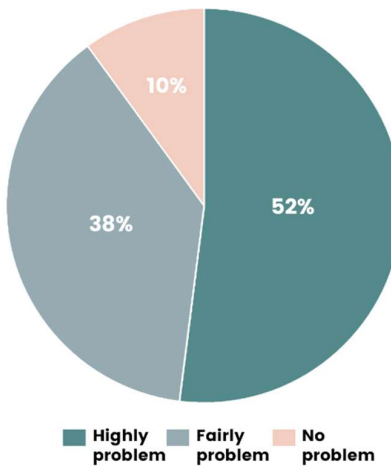


Figure 7: Respondent's opinion regarding problem talking to each other

Health Effect

Figure 8 shows that 32% people feel disturbance of sleep, 21% faced headache, 18% feel hearing problem, 16% feel irregular heartbeat and 13% feel lack of concentration.

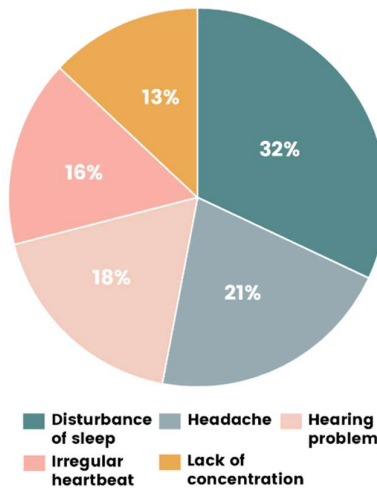


Figure 8: Respondent's opinion regarding health effect due to noise

3.2.2 Efficiency of various noise control measures in Zero Point

The research aims to understand the opinions of the people regarding measures to control noise and the impact of these control measures, as presented in Table 2. The majority of respondents expressed the view that increasing the distance between the noise source, such as setting back buildings from the road, would help control noise. It has been confirmed that noise intensity decreases with an increase in distance. Additionally, people suggested that reducing noise at the source would contribute to noise control. Insulating the noise source and providing effective insulating screens, tiles, and materials were also identified as measures to significantly reduce external noise, particularly that from vehicular and

pedestrian traffic. The provision of adequate setbacks and the creation of a sufficient green buffer zone between vehicular roads and buildings were recognized as factors that could enhance the acoustic comfort level of residents. There is a need to create public awareness about the effects of noise pollution to minimize noise from various sources.

Table 2: Respondent’s opinion regarding the efficiency of various noise control measures on 40 people

Item	Strongly Agree	Agree	Disagree	Strongly Disagree
Adequate setback	62.5%	20%	10%	7.5%
Green buffer layer	45%	30%	15%	10%
Reduce the noise at source	57.5%	30%	12.5%	0
Insulation material	30%	40%	20%	10%
Public awareness and enlightenment	45%	37.5%	17.5%	0

3.3 Proposed Solutions

Based on the above findings, the following recommendations are proposed:

1. Buildings should be sited with an adequate setback from the road to minimize the effects of vehicular and pedestrian traffic noise because noise intensity decreases with an increase in distance. Development authority could take an authoritative role in making comprehensive layering between living and vehicular movement.
2. Where possible, buffer zones made of fences, trees, hedges, and/or shrubs should be provided to reduce the impact of noise on buildings because greenery absorbs sound.
3. Buildings should be equipped with effective insulating screens, tiles, and materials that will significantly reduce external noise, particularly from vehicular and pedestrian traffic. A greener layer outside of building can design for insulation purposes.
4. There is a need to create public awareness to educate the masses on the ethics of noise pollution, which may induce general negative physiological and psychological impacts on the built environment.

4. CONCLUSIONS

In order to limit the detrimental consequences of noise pollution, this study set out to identify the main causes of the problem in Zero Point, Khulna, as well as evaluate how it affected the built environment. The study's conclusions apply to each of Zero Point's five location points. It is no longer possible to dispute the unquestionable growth of sources of noise pollution in our built environment and their increasing influence on people' quality of life. In order to effectively mitigate these effects, this research identifies the primary sources of external noise pollution in Zero Point as being vehicular traffic, road construction, noise from commercial zones, and pedestrian traffic. These sources' noise levels were measured and compared with accepted benchmarks. All of the chosen locations have noise levels that substantially exceed the DOE, AASHTO, and FHA guidelines, according to the overall report. To mitigate the adverse effects of noise pollution in the built environment, this research concludes that appropriate setbacks (The minimum standard of front setback for all categories of plots is 4.92 ft according to Dhaka Metropolitan Building Construction Rule, 2008), buffer zones (varies on the width

of the road by KDA (Khulna Development Area) standard), insulating materials (screens, tiles, paints etc) and public awareness programs should be put into place. An investigation based on a questionnaire formed the basis for the recommendations.

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