Paper ID: CE 0125

Investigating the Correlation between Traffic and Noise Pollution at Varying Distances during Rush and Non-Rush Hours in Dhaka City

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Abstract

Noise pollution's negative impacts on healthy living in Dhaka City have been given less consideration than they deserve. This study assesses and evaluates the spatiotemporal variability of noise levels and pollution indices in Dhaka City, Bangladesh, during Rush and Non-Rush hours. 15 measurement sites have been selected. Data was collected at three different distances from the roadside (2m, 4m, and 6m). The study employs graphs to illustrate changes in noise descriptors and pollution indices. The study finds that even if the source of noise is not taken into account, city residents living near a road experience somewhat high noise levels, exceeding an average of 75 dB during Rush hours. During rush hour, the average noise levels at 2 meters, 4 meters, and 6 meters from the roadside are, respectively, 93.61 dB, 68.48 dB, and 52.42 dB, while during Non-Rush hours, they are 90.60 dB, 64.96 dB, and 49.90 dB. It is also clear that noise levels decrease with increasing distance from the roadside and that those living closer to the road experience significantly more noise than those living 4 to 6 meters away from the main road. Finally, a formula for measuring noise levels during Rush and Non-Rush hours is created, allowing for the determination of noise levels at a particular distance.

Keywords: *Decibel (dB); Distance; Traffic; Noise pollution; Rush and Non-Rush hours; Dhaka City*

1 Introduction

Noise pollution poses a significant environmental threat in rapidly developing urban areas. In the 21st century, we confront the human-induced catastrophe of environmental noise, which offers no respite. Loud music, phone conversations, traffic, and even incessant barking from pets have become ingrained in urban culture, frequently causing disturbances. Dhaka, Bangladesh, similar to numerous other developing cities, grapple with the pressing issue of noise pollution. Traffic noise is extremely effective within the center of cities especially in Dhaka city (Riyad et al.,2020). Noise emanates from various sources like traffic, loudspeakers, and public gatherings. However, when these sounds surpass reasonable thresholds and lead to headaches, they cease to be mere noise and transform into noise pollution. Regrettably, noise pollution has become a global reality that necessitates effective management. Alam (2006) studied risk assessment and proposed a logit model regarding willingness of the people to response to the law and order to control noise pollution. It is vital to acknowledge the extent of noise in our surroundings and implement appropriate preventive measures to curtail its further escalation. Noise denotes an unacceptable level of sound that not only annoys but also disrupts mental and physical tranquility, ultimately posing severe health risks. In addition to the rising levels of air and water pollution, noise pollution emerges as a newfound menace for the residents of Dhaka City. About 5% to 7% patients admitted to the Sylhet Osmani Medical College are suffering from permanent deafness due to noise pollution (Ahmed,1998). An in-depth multiple regression analysis was carried out to examine the variability in road traffic noise data. This was based on factors such as traffic volume, speed, and the distances between the observation point and the road. This analysis was performed by using an approximate predictive equation, as outlined by OECD (1995).

Exposure to high noise levels can exert severe stress on the auditory and nervous systems of urban dwellers, particularly children. In urban areas, including Dhaka City, motorized traffic constitutes a major contributor to noise pollution. Frequent exposure to elevated noise levels disrupts physical and mental peace, potentially causing health issues. Although noise can originate from various sources, such as industries, construction sites, and the indiscriminate use of loudspeakers, motorized traffic stands out as the primary noise source in urban settings. Noise pollution was not a major concern for Dhaka City residents in the 1970s and early 1980s. However, with the surge in the number of motorized vehicles within the city, the risk of noise pollution has surpassed the tolerable threshold.

According to Das (2001), the hearing ability of city residents has declined over the past decade. Notably, approximately five to seven percent of patients admitted to Sylhet Osmani Medical College have permanent deafness caused by noise pollution (Ahmed, 1998). Noise disturbances can contribute to various health conditions, including hypertension, headaches, indigestion, peptic ulcers, pharyngitis, atherosclerosis, bradycardia, and ectopic beats (Papacostas and Prevedouros, 1993; Kadiyali, 1997).

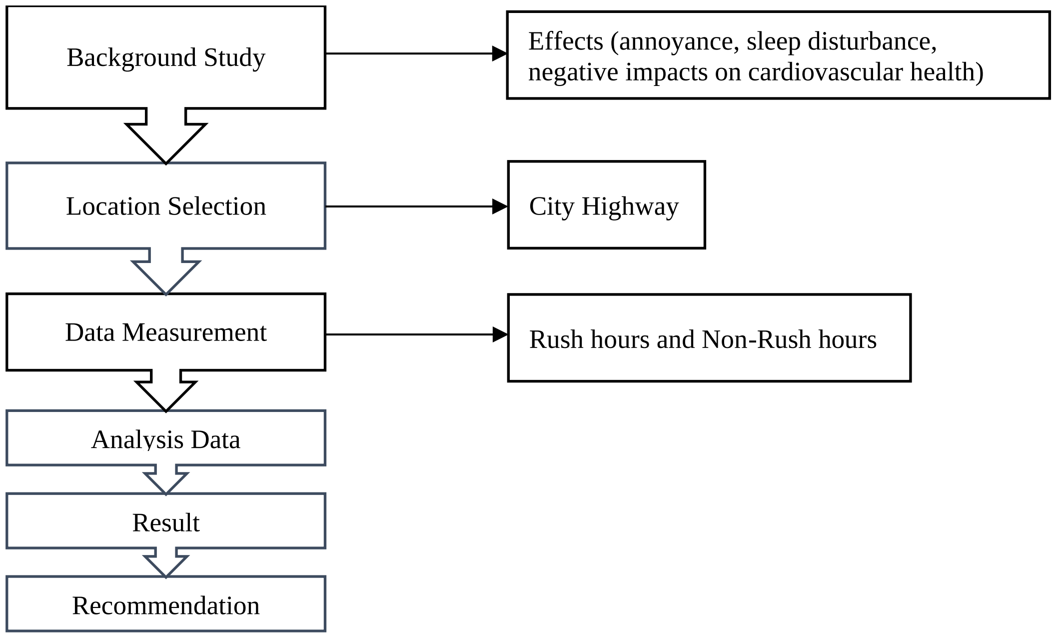
This study aims to examine the severity of noise pollution in Dhaka City by analyzing the diurnal variation of roadside noise and its correlation with traffic volume. Furthermore, the study proposes two general linear equations to predict the noise level (in dB) in the future: one for Rush hours and another for Non-Rush hours.

2 Materials and Methods

For the purpose of this study, a Sound Level Meter (SLM) was utilized to determine the sound pressure levels, as shown in Figure 1. The device was controlled by hand, and the sound levels were measured in a consistent and standardized manner.

Figure 1: Sound Level Meter (SLM)

The methodology of this study can be explained through the use of a flowchart presented below:



2.1 Study Area and Time

Noise levels were assessed at 15 different locations within Dhaka City during regular workdays from 7 a.m. to 11 p.m. The study included significant areas of the city, namely Zero-Point Dhaka (GPO), Kaptan Bazar, Sayedabad Bus Terminal, Jatrabari Police Station, Jatrabari Fish Market, Kajla Bus Station, Sonir Akhra, Rayerbag, Matuail, Sainbord, Sanarpar, Mouchak, Chittagong Raod Bus Station, Kanchpur, and Madanpur. Time-weighted average noise levels were measured both at the roadside and at various distances from the roadside. This approach aimed to investigate the impact of distance and roadside barriers on noise reduction. Daily traffic volume data was collected using a two-direction count methodology, following the guidelines provided by Road Materials and

Standard Study Bangladesh (LGED, 1998). The survey sites were selected based on: (i) Good visibility of traffic, (ii) Adequate shelter and safety for staff, (iii) Seasonal variations in traffic, (iv) Diversity of land use, (v) Presence of sensitive receptors, (vi) Road characteristics, (vii) Availability of electricity and internet connection, (viii) Proximity to public transportation, (ix) Accessibility to the site. These factors were considered to ensure accurate and representative data collection that covered various types of land use and noise sources, including sensitive locations such as hospitals, schools, and residential areas. Some of the schools and hospitals located near highways, such as Donia College, Adarsha High School & Barnamala Adarsha High School, Institute of Child and Mother Health at Matuail, and Anabil Hospital at Kajla, were incorporated in the study. Figure 2 illustrates the precise locations of the study area on the official geographic map of the Dhaka North City Corporation. This visual representation provides a comprehensive overview of the study area's placement within the larger city context. Furthermore, Figure 3 offers a zoomed-in view, specifically highlighting the names of the study areas on the map. This closer examination allows for a more detailed understanding of the specific geographic boundaries and landmarks within the study area. The study area encompasses a section of the Dhaka-Chittagong highway, which serves as a crucial transportation route connecting the capital city of Dhaka with the city of Chittagong. This highway provides an important entry point for vehicles entering Dhaka, facilitating efficient transportation and connectivity between these two major cities.

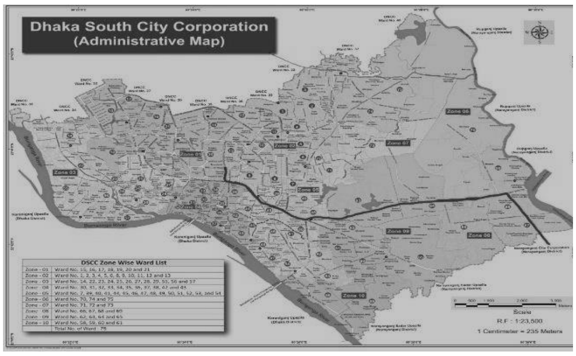


Figure 2: Official map of Dhaka South City Corporation (DSCC,2023)

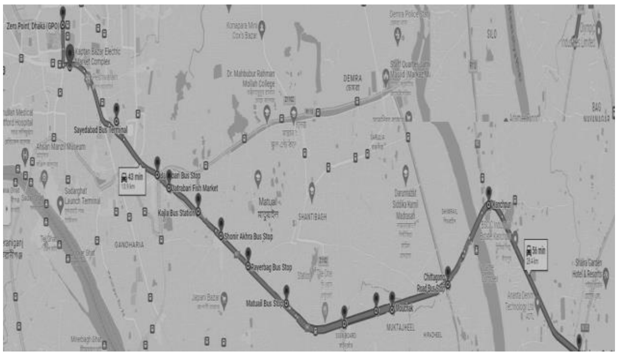


Figure 3: Locations of study area

3 Results and Discussion

The study aimed to assess the noise pollution level in Dhaka City and determine its severity. The study analyzed the noise levels at different distances to further evaluate the safety of schools and hospitals located near roads. These locations were particularly interesting as they are particularly vulnerable to the effects of noise pollution, and the study aimed to determine the safe distance to mitigate the impact of noise pollution on these sensitive areas.

Distance from road side (m)	Location Name							
	Zero-point Dhaka (GPO)	Kaptan Bazar	Sayedabad Bus Terminal	Jatrabari Police Station	Jatrabari Fish Market	Kajla Bus Station	Sonir Akhra	Rayerbag
2	105.23	91.05	108.26	94.84	88.30	86.63	86.97	88.20
4	81.26	62.68	79.66	68.48	63.50	60.30	61.90	62.10
6	66.37	50.12	55.65	51.58	48.82	46.50	45.88	45.28

Table 1: Noise level (dB) at different locations at Rush hours in Dhaka City

Distance from road side (m)	Location Name						
	Matuail	Sainbord	Sanarpar	Mouchak	Chittagong Raod Bus Station	Kanchpur	Madanpur
2	90.46	104.64	88.60	89.25	102.65	86.78	92.29
4	66.29	79.36	64.11	65.46	74.06	59.98	76.02
6	53.22	68.14	51.77	52.49	54.53	47.47	48.38

Table 1 shows the collected noise level data from 15 different locations in Dhaka city during Rush hours. The Sayedabad Bus Terminal area was the noisiest, with a noise level of 108.26 dB at a 2m distance from the main road, while the Kajla Bus Station area had the lowest noise level of 86.63 dB. At a distance of 4m from the main road, all locations had a value less than the average noise level of 75 dB, except for Sainbord, Madanpur, Sayedabad Bus Terminal, and Zero-Point Dhaka (GPO). During Rush hours, 6m from the main road, the Sainbord area had the highest noise level of 59.60 dB, while the minimum value was measured at Rayerbag at 45.28 dB. Both matters were below the average noise level.

Figure 4 shows us the relationship between noise level (dB) and actual distance (m) from the roadside during Rush hours. Investigating the impact of distance from the roadside on noise levels during Rush hours, a notable trend emerged. As the distance from the roadside increased, a consistent decrease in noise levels was observed. Additionally, a general linear equation was derived, enabling the prediction of noise levels at any distance in future.

Table 2: Noise level (dB) at different locations Non-Rush hours Data in Dhaka City

Distance from road side (m)	Location Name							
	Zero-point Dhaka (GPO)	Kaptan Bazar	Sayedabad Bus Terminal	Jatrabari Police Station	Jatrabari Fish Market	Kajla Bus Station	Sonir Akhra	Rayerbag
2	103.36	80.26	104.68	93.44	84.72	85.70	84.94	87.32
4	78.63	50.42	78.87	65.41	60.41	58.47	59.77	59.80
6	64.02	46.12	52.92	49.35	47.52	47.53	46.64	47.37

Distance from road side (m)	Location Name						
	Matuail	Sainbord	Sanarpar	Mouchak	Chittagong Raod Bus Station	Kanchpur	Madanpur
2	88.77	99.40	83.60	86.36	100.52	84.31	91.68
4	63.41	73.54	59.25	63.74	72.43	56.01	74.24
6	50.79	53.37	49.87	49.63	51.86	45.98	46.38

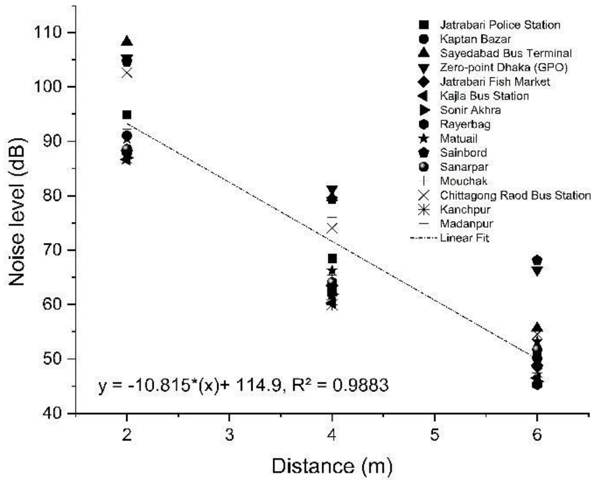


Figure 4: Variation in Noise Level (dB) with Distance (m) during Rush hours

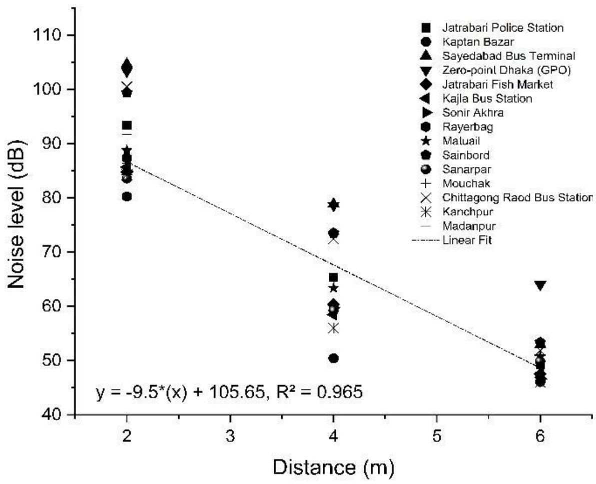


Figure 5: Variation in Noise Level (dB) with Distance (m) during Non-Rush hours

Table 2 showcases the comprehensive data collected on noise levels from 15 diverse locations within Dhaka city during Non-Rush hours. The analysis reveals intriguing insights into the noise pollution landscape of the city. Among the recorded measurements, the Sayedabad Bus Terminal area emerged as the site with the highest noise level, reaching an alarming 104.68 dB at a distance of 2 meters from the main road. In contrast, the Kaptan Bazar area demonstrated the lowest noise level of 80.26 dB, measured at a 2-meter distance from the roadside. When extending the observation to a distance of 4 meters from the road, the Sayedabad Bus Terminal area continued to exhibit the maximum noise level, albeit slightly reduced to 78.87 dB. Conversely, Kaptan Bazar showcased the minimum noise level at this distance, recording a relatively lower value of 50.42 dB. Exploring further, at a distance of 6 meters from the main road, zero-point Dhaka (GPO) marked the highest recorded noise level, reaching 64.02 dB. On the other hand, Kanchpur stood out with the lowest noise level at this distance, measuring at a more tranquil 45.98 dB.

Figure 5 presents similar information to that depicted in Figure 4 but focuses on Non-Rush hours. The overall trend of observing noise levels remains consistent; however, there are specific locations, including Jatrabari Police Station, Kajla Bus Station, Rayerbag, and Madanpur, where the expected decrease in noise level did not occur significantly. Despite the anticipation of a decline, these areas exhibited sustained high noise levels. Further analysis revealed that the constant traffic flow along the Dhaka-Chittagong highway played a significant role in maintaining the noise levels during Non-Rush hours. Being one of the busiest roads granting access to the main city of Dhaka, irrespective of office or schooling hours, the constant vehicular activity contributed to the sustained noise levels. Consequently, a linear equation was developed to aid in predicting noise levels in these circumstances.

According to Berglund et al., in their 1999 study, the Guidelines for Community Noise provide recommendations for managing noise pollution. For instance, the recommended limit for outdoor noise levels in residential areas near highways is 55 decibels (dB) during the day (defined as 6:00 a.m. to 10:00 p.m.) and 50 dB during the night (defined as 10:00 p.m. to 6:00 a.m.) to protect sleep and reduce disturbance. It is clearly noticeable that during rush hour, the average noise levels at 2 meters, 4 meters, and 6 meters from the roadside are, respectively, 93.61 dB, 68.48 dB, and 52.42 dB, while during Non-Rush hours, they are 90.60 dB, 64.96 dB, and 49.90 dB. These findings indicate that people who live within 6m are facing a noise level higher than the WHO guideline, except for those who live 6m from the edge of the highway at night. The recommended value is 50 dB, and the average nighttime noise level value was found to be 49.90 dB.

Table 3: Information about Passenger Car Units (PCU) in Dhaka City from 2017 to September, 2022 provided by Bangladesh Road Transport Corporation (BRTC)

Year	2017	2018	2019	2020	2021	2022 (Sept.)
PCU (Million)	1.29659	1.46182	1.6039	1.70664	1.83716	1.95279

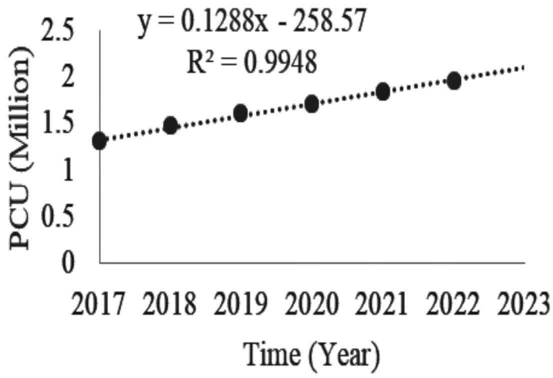


Figure 6: Variation of PCU (million) with time (year)

Table 3 displays the relationship between PCU in millions and time in years. The data has been updated until September 2022, revealing a consistent upward trend in PCU over the years. Based on the available data, a general equation has been derived to predict PCU values for future years, allowing for projections and forecasts of PCU growth beyond the current data range, as shown in Figure 6. This equation serves as a useful tool for estimating PCU values and understanding the expected trends in passenger car usage in the coming years.

4 Equations

Noise level (dB) during Rush hours:

Y (Noise level) = -10.815* x (Distance) +114.9 -----------------(1)

Noise level (dB) during Non-Rush hours:

Y (Noise level) = -9.5* x (Distance) +105.65 --------------------(2)

Putting the safe Noise level recommended by WHO guidelines 55 dB, 50 dB for daytime and nighttime, respectively, into both equations, the safe distance was found to be 5.86 m, 6.0 m for night, and 5.33 m, 5.54 m for daytime.

PCU prediction for Dhaka City:

Y (PCU) = 0.1288* x(Time)-258.57------------------------------(3)

5 Conclusion

The findings of the study indicate a potential health risk for individuals living within 6 meters of a highway due to excessive noise exposure. Prolonged exposure to high noise levels can lead to several health issues, including annoyance, sleep disturbance, and negative impacts on cardiovascular health and cognitive performance. The findings also highlight the crucial role of distance from the main road in mitigating noise exposure, emphasizing the need for targeted noise reduction strategies that take into account individuals' proximity to busy roads. Furthermore, data provided by the Bangladesh Road Transport Corporation indicate a consistent upward trend in PCU over the years, which could result in severe noise pollution in Dhaka city and negatively impact the health of its citizens.

6 Recommendation

The Rajdhani Unnayan Kartripakkha (RAJUK), as the planning and development agency of the government, has implemented setback rules that require a certain portion of land to be kept free for the well-being of users, society, and the city. In the context of this study, it has been discovered that the minimum safe distance from the edge of the highway concerning noise pollution is 6 meters. However, it is worth noting that RAJUK has not established any mandatory distance in their setback rules for noise reduction purposes. Instead, they encourage users to maintain a greater distance of free space, as doing so allows for an additional Floor Area Ratio (FAR), which facilitates the creation of wider roads.

In light of the findings of this study, it is recommended that the RAJUK authority revise their rules, particularly concerning residential houses situated in proximity to highways. By incorporating mandatory minimum setback distances specifically aimed at noise level reduction, the RAJUK authority can ensure that residents are shielded from excessive noise pollution. This revision would contribute to creating a more peaceful and livable environment for individuals residing near busy roadways while also promoting the development of wider road infrastructure to accommodate the needs of the city.

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