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An Assessment of Noise Levels in Sylhet City Corporation, Bangladesh

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Authors' contributions

This work was carried out in collaboration between the two authors. The correspondent author MSM designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author RB managed the analyses of the study. Author MSM also managed the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

Noise pollution is a silent villain as it's quite easy for being ignored by us. Urban areas are more exposed to this deadly agenda as the density of population and their belongings are excessive in there. This study differentiated noise levels of Sylhet City Corporation, a growing city of Bangladesh into different types according to the land use purpose of the city like residential, silent etc. One hundred and sixty-eight noise level readings, taken at 14 different positions during the morning, afternoon, evening, and night of selective weekdays which are categorized as busy days, typical days and weekends were utilized for this research. Results put the average noise level readings in the city centers at between 45 dB(A) and 95 dB (A), dissented from the permissible limits of the World Health Organization (WHO) as well as national standardization organization: Department of Environment (DOE) in all the land use types, with the highest noise pollution levels recorded for transportation, commercial and silent typed areas. The result of the one-way ANOVA test completed where the dependent variable was noise and the independent variable was land use types uncovers a factually huge mean noise levels over the study area ($F(4,115) = 9.52, p = 1.1079$). Tukey's HSD

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method also carried away which showed the uneven difference of noise levels between the land types. The study represents noise pollution auditing, and the immediate needs to control urban noise pollution with convenient and effective policies some of which is recommended at the end of the study.

Keywords: Noise pollution; land types; comparative; WHO; DOE.

1. INTRODUCTION

Sound is started through vibration but it becomes noise when the frequency crosses its extent to create disturbance. Noise pollution is what makes distinctive physical and psychological well-being issue on everywhere throughout the environment by the generation of sound that goes past as far as possible. The study area is socio-economically living in a developing state directly. Diverse development ventures are occurring and for this noise born threatening issues are gradually expanding and stay ignored as it works more like a quiet executioner. In this way, the present noise condition of Sylhet should have been contemplated for further basic errands.

In 1971, a working group of WHO reasoned that noise is a noteworthy danger to human prosperity [1]. Objections to police and different authorities on noise are among the most incessant grumblings by occupants in urban conditions; in 1998, noise was the main grievance to the personal satisfaction hotline in New York City. In 1996, the Federal Environmental Agency in Germany announced two out of three of its residents had griped about over the excessive noise [2]. The number of individuals presented to undesirable dimensions of noise in the United States was irrefutably more noteworthy than it was in 1974; the level of oversight and control is obviously less. Presently in developed nations like the USA, thinks about noise pollution and results caused by it are being assessed. However, developing nations like our own are inclined to this sort of debacles as the results are ignored in there also.

There was an investigation held before by students of civil & environmental engineering of SUST, a university of this region which was published in a journal on 2014 represented two specific zones noise level, which were refueling station and power development industry [3].

In this study, the noise level broadly signified with adding more fields compared to that study and prescribed some approaches to diminish the

noise. Additionally, the noise levels were compared with the local (DOE) as well as international (WHO) noise level standards.

2. MATERIALS AND METHODS

2.1 Description of the Study Area

The study areas for this research were within Sylhet City Corporation having 27.36 sq km area, situated in the middle of 24°51' and 24°55' north latitudes and in the middle of 91°50' and 91°54' east longitudes. It is surrounded by Sylhet Sadar upazila on the north, Dakshin Surma upazila on the south, Sylhet Sadar upazila on the east, Dakshin Surma and Sylhet Sadar Upazila on the west. Sylhet is the third city in Bangladesh as per its population density and also in financial significance, with a normal population of around 4,85,138 and a normal population density of 17,732 people for every sq. km. Sylhet has a tropical monsoon atmosphere (koppen atmosphere grouping Am) verging on a humid subtropical atmosphere (koppen atmosphere order Cwa) at higher altitudes. The monsoon season from April to October is hot and moist with very substantial showers and rainstorms consistently, while the short dry season from November to February is very warm and genuinely clear. About 80% of the yearly normal precipitation of 4,200 millimeters (170 in) happens among May and September. The temperature was most extreme 36.8°C and least 7.7°C. Right now, the city is experiencing quick development, both spatially and socio-economically. Sylhet city has a few presumed universities, various shopping centers and so forth which demonstrate the quick financial development of the city.

2.2 Sample Design and Procedure

There are 27 wards in Sylhet City Corporation alongside various types of areas in it, for example, residential, industrial, commercial, transport hub and silent zones (e.g. hospitals and schools). Tests executed after followed the stratified technique for sampling. The population is isolated into a few sub-populations that are exclusively more homogeneous than the

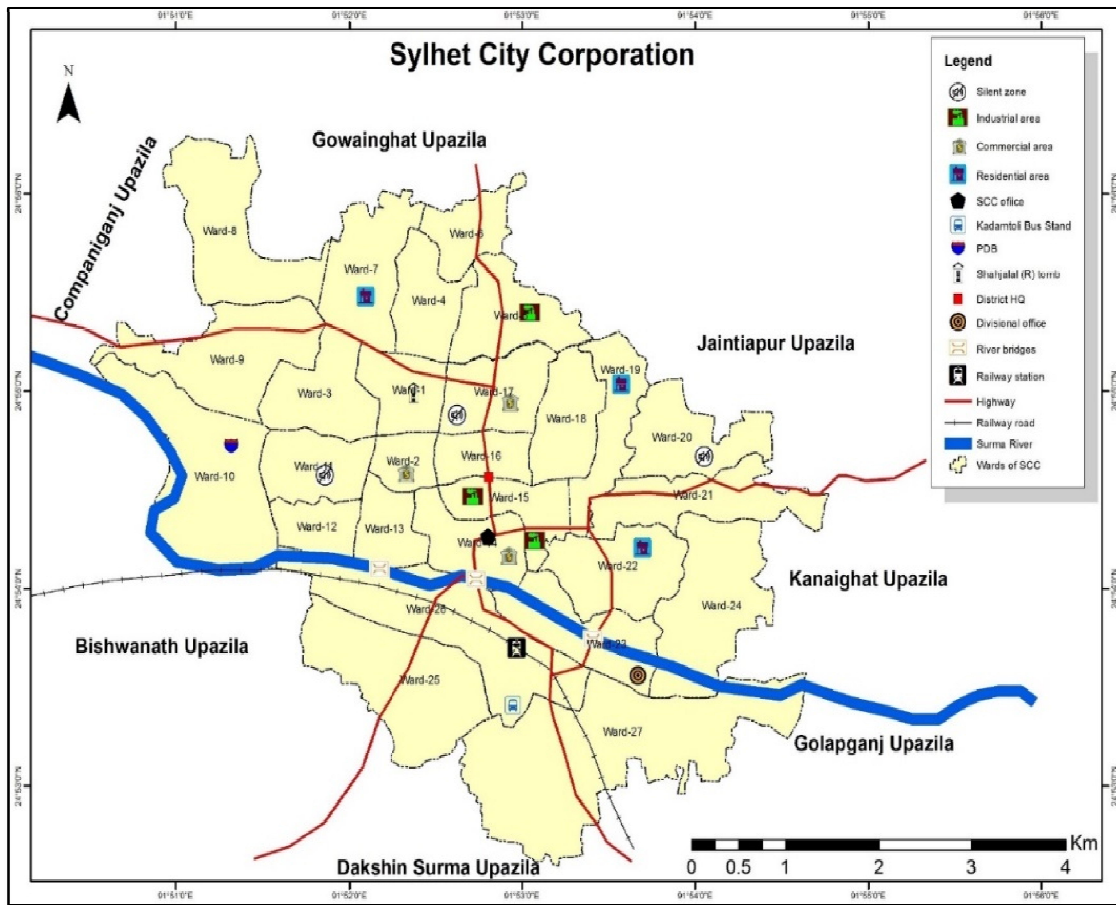


Fig. 1. Detailed map of the study area: Sylhet city corporation (produced through ArcGIS 10.3 during this study)

complete population (the diverse sub-populations are called 'strata') and after that items were selected from every stratum to comprise a sample [4]. Pilot study is conducted for deciding an increasingly proper and productive stratification plan. It was finished by taking little examples of equivalent size from every proposed strata and after that inspecting the differences inside and among the conceivable stratifications which built a proper stratification plan for the research. The standard technique for choice of items for the sample from every stratum, turned to is that of simple random sampling. The strategy for relative allotment under which the sizes of the samples from the distinctive strata are held corresponding to the sizes of the strata. That is, if P_i speaks to the extent of population incorporated into stratum I , and n speaks to the complete sample estimate, the quantity of components chose from stratum I is $n \cdot P_i$. For example, here in this study the sample size $n = 14$, to be drawn from a population of size $N = 27$

which is partitioned into five strata of size $I = 6$, $C = 6$, $R = 6$, $S = 6$ and $TH = 3$ where $I =$ Industrial, $C =$ Commercial, $R =$ Residential, $S =$ Silent zones like schools, mosques and so forth and $TH =$ Transport Hub. Receiving proportional allocation, we will get the sample sizes as under for the distinctive strata:

For strata with $I = 6$, we have $P_1 = 6/27$ and thus, $n_1 = n \cdot P_1 = 14 (6/27) = 3.1 \sim 3$
 Also, for strata with $C = 6$, $R = 6$, $S = 6$ we have
 $n_2 = n \cdot P_2 = 14 (6/27) = 3.1 \sim 3$,
 $n_3 = n \cdot P_3 = 14 (6/27) = 3.1 \sim 3$,
 $n_4 = n \cdot P_4 = 14 (6/27) = 3.1 \sim 3$ and
 For strata with $TH = 3$, we have
 $n_5 = n \cdot P_5 = 14 (3/27) = 1.6 \sim 2$

2.3 Datasets and Sources

Datasets were mainly primary but some secondary sources also used for comparing such

Table 1. A-weighted noise level standards in selected countries of the world [5]

Countries	Industrial area days/night	Commercial area days/night	Residential area days/night	Silent area days/night
Australia	65/55	55/45	45/35	45/35
India	75/70	65/55	55/45	50/40
Japan	60/50	60/50	50/40	45/35
U.S. (E.P.A.)	70/60	60/50	55/45	45/35
W.H.O. & E.C. (WHO 2009)	65	55	55/45	45/35

as the noise level standards in selected countries of the world (Table 1). Also US EPA provided noise sensitivity chart (Table 2) is utilized and compared on the results section.

Table 2. Noise sensitivity zones [6]

Sensitivity	Noise level db(A)
Below Risk (BR)	<55
Risky (R)	55-59
Moderately Risky (MR)	60-64
Highly Risky (HR)	65-69
Dangerous (D)	70-74
Highly Dangerous (HD)	75-79
Extremely Dangerous (ED)	>80

Other datasets for this study were gotten through primary sources and they incorporate noise level estimations, acquired with a digital noise meter, Lutron SL-3113B, with a measuring level range of 30–130 dB(A). GPS receiver Magellan Explorist- 510 was used to obtain positional details of the noise sample stations in Sylhet city. The noise measurements were haphazardly taken at road level around the distinctive sorts of zones in the study areas, including street intersections, advertise focuses, transport parks, and neighborhoods. In particular, these zones were delegated transportation, commercial, industrial, silent, or residential. The perceptions were made by taking an estimation of noise level at an area at any given moment, with the instrument pointing, as a rule, at any helpful bearing and not at a particular noise source. This was to ensure that the general surrounding noise levels were recorded and not the sound of a specific object or source of sound. A-weighted prompt sound level estimations were recorded at interims of 10 sec. for 10 min. The average value of this was then acquired, along these lines making 10 noise readings for every examined area. This methodology was completed for morning (9:00–11:30 a.m.), afternoon (1:00–3:00

p.m.), evening (4:00–6:00 p.m.) and night (8:00–11:00) periods on Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, and Sunday. All of these days of the week were intentionally picked for the accompanying reasons: Sunday was picked in light of the fact that it is the primary working day of the week, when those that may have gone for the end of the week are coming back to the urban areas; Monday, Tuesday and Wednesday was incorporated to embody working days not related with the standard surge all through the study areas; Thursday was incorporated on the grounds that it is the last working day of the week, when individuals might need to leave the urban areas, and when some get-togethers are composed; Friday, due to the religious exercises related with it and Saturday, was chosen since it is the standard day for shopping and numerous other social activities.

One noteworthy thing of noise level calculation is due to the logarithmic idea of the decibel unit, sound dimensions can't be arithmetically included or subtracted, and are fairly bulky to deal mathematically as well. However, fundamental principles apply when managing sound levels. To begin with, if a sound's power is multiplied, the sound dimension increments by 3 dB, paying little mind to the underlying sound dimension. i.e, 60 dB + 60 dB = 63 dB. Second, the absolute sound dimension delivered by two hints of various dimensions is generally just marginally more than the higher of the two. i.e, 60.0 dB + 70.0 dB = 70.4 dB [7]. Subsequently, for this examination, noise levels were recorded dependent on Finegold et al. presumptions [8].

2.4 Data Analysis

Distinct statistical investigations, including averages and simple charts, were utilized to outline the information, while inferential statistics in the form of a one-way analysis of variance (ANOVA) were completed to assess the impact of the types of areas on noise. The fixed factor

for the ANOVA was types of areas with five categories; residential, industrial, transportation, silent and commercial, while noise was the dependent variable. Tukey's HSD was also used for the pair-wise post hoc test.

3. RESULTS AND DISCUSSION

3.1 Characterization of noise levels in Sylhet City

The recorded noise level of inspected areas in Sylhet in the morning, afternoon, evening and night. The mean, normal least, and normal most extreme noise levels for the morning surge hour were 62.7 dB(A), 56 dB(A), and 69.4 dB(A); the afternoon measurements were 71.5 dB(A), 64.7 dB(A) and 78.4 dB(A); the evening observations were 70.5 dB(A), 63 dB(A), and 77.8 dB(A); and the night measurements were 65.9 dB(A), 58.8 dB(A) and 72.9 dB(A) respectively. The noise level readings for Sylhet demonstrate that the most astounding noise levels were recorded on Sundays, trailed by Thursdays, while the least noise levels were recorded on Fridays and Saturdays (Fig. 2).

3.2 Spatial Variation of Noise Sensitivity

Using the US EPA standards on noise sensitivity [6], the spatial variety of average noise levels in Sylhet, for the morning, afternoon, evening, and night, was mapped to demonstrate the dimension of noise sensitivity related to the different zones. The zones around Terminal

street, a noteworthy transportation hub point in the city, fall inside the extremely dangerous zone of noise sensitivity (70– 85 dB(A)) in the mornings, afternoons, night times and evenings. Places around Chalibondor likewise fall inside the extremely dangerous zone in the mornings and afternoons, however, lessen to highly risky dimension (65– 70 dB(A)) in the evenings, which could be credited to individuals moving far from the zone and into the downtown area. One striking characteristic of the noise in the Sylhet city is that not the vast majority of the zones examined fall underneath the suggested noise sensitivity level. Spots like Kharpara, just as Uposohor and Subidbazar Kolapara residential domain fall inside the moderately risky zone of between 60 dB(A) and 65 dB(A). Observable is the pattern in the focal piece of Sylhet, where noise levels are in the highly dangerous and extremely dangerous, paying little respect to the time of day. Fig. 3 uncovers that 10%, 10%, 17% and 5% of spots in Sylhet City Corporation are inside the extremely dangerous zone (ED) in the mornings, afternoons, night times and evenings, individually, while a bigger level of the city is found inside dangerous zone (D) of between 70 dB(A) and 75 dB(A) in the afternoons (26%), evenings (31%) and nights (19%). Nonetheless, a portion of the spots in Sylhet City are inside the moderately risky (MR) run in the mornings, afternoons, night times, and evenings, with the rest of the spots shifting back and forth between highly dangerous zone (HD) and highly risky zone (HR) at various times of the day.

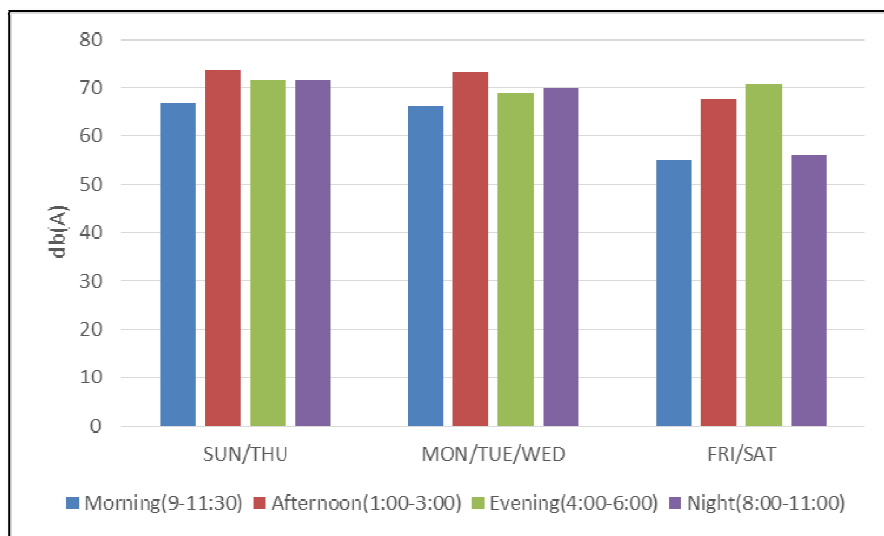


Fig. 2. Daily average noise levels in Sylhet city

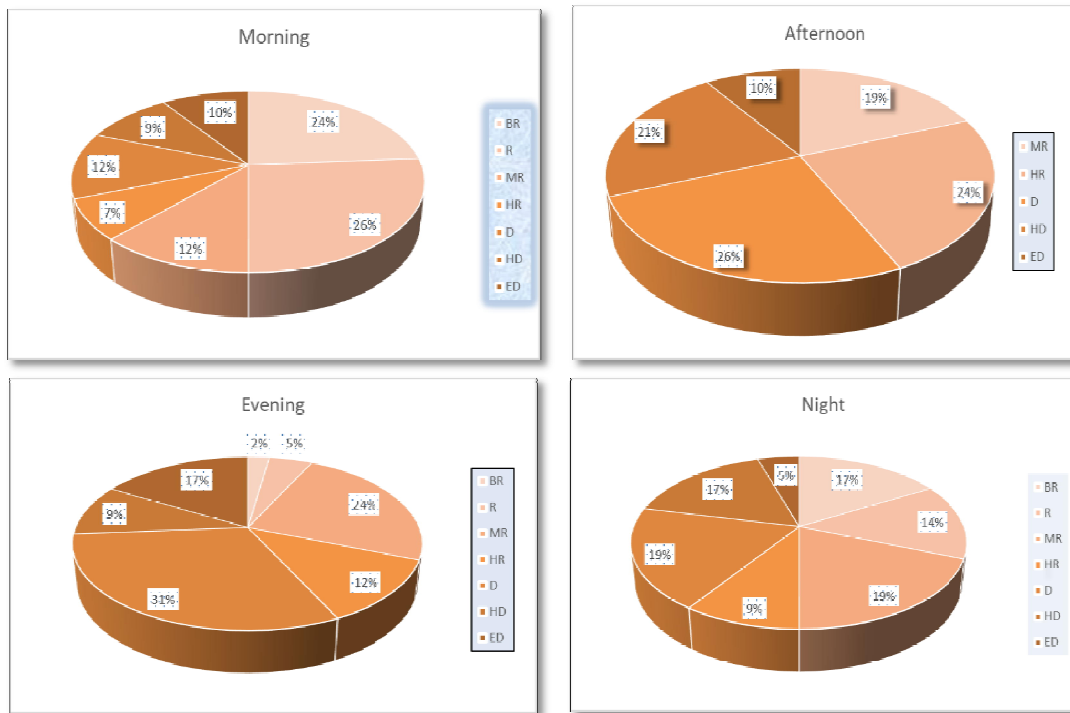


Fig. 3. Percentage of noise distribution in Sylhet city

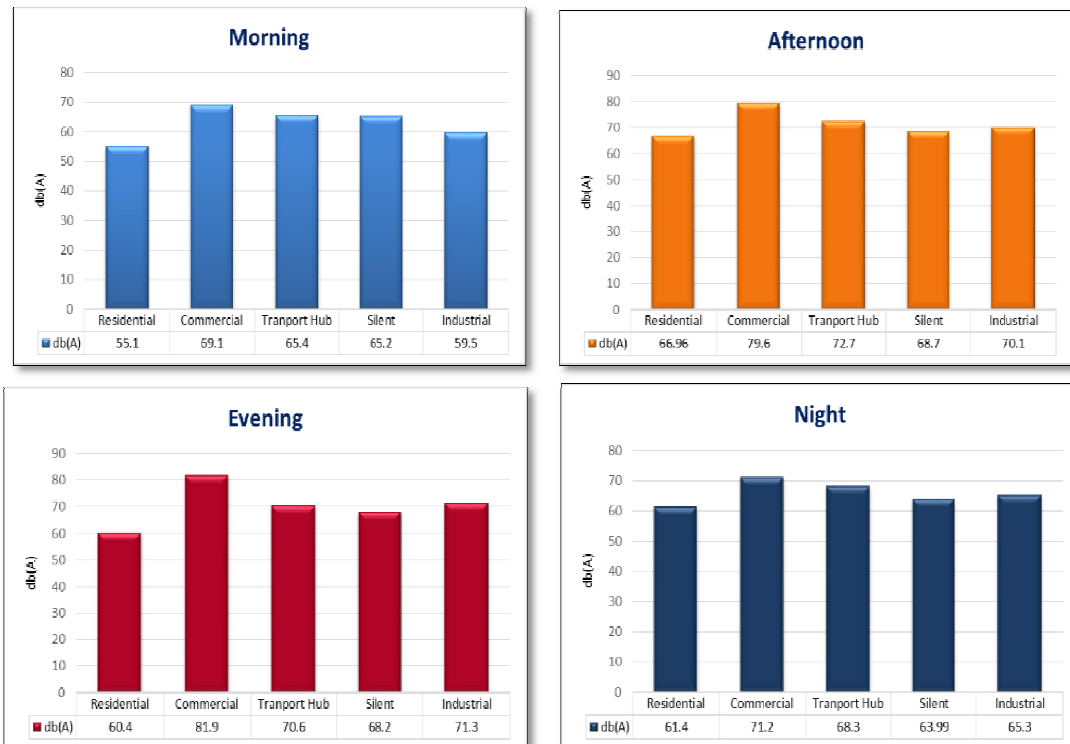


Fig. 4. Average noise levels and in different zones of Sylhet city

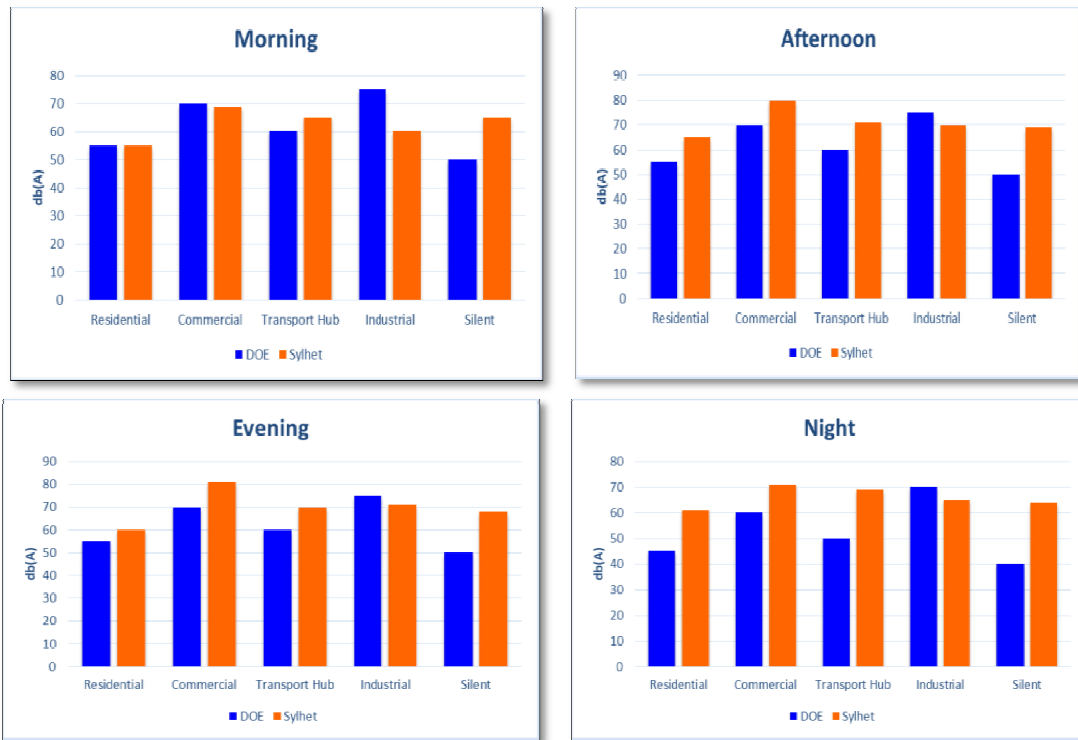


Fig. 5. Comparison of mean of daily noise levels across different types of areas in Sylhet city with doe

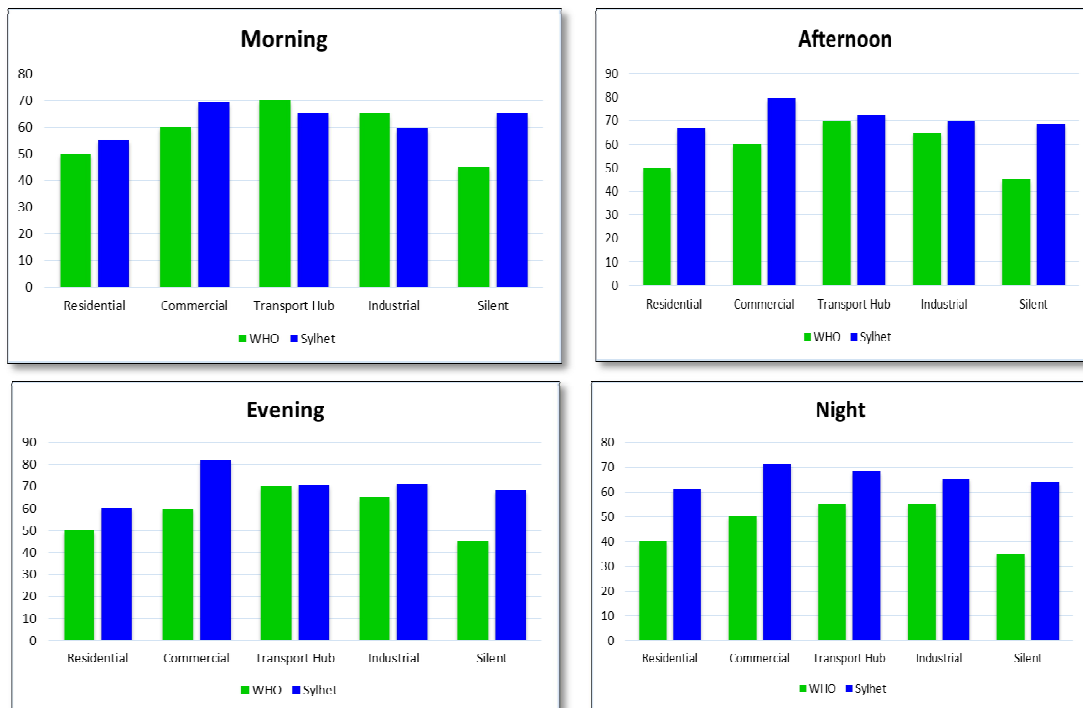


Fig. 6. Mean of daily noise levels comparison across different types of areas in Sylhet city with who

3.3 Relationship between Area Types and Noise Levels

The variety in noise level under various dominant region types for the three times of the days of a week were studied for Sylhet city. Area type-based distributions of noise in Sylhet reveals that residential areas had the least average noise levels of 55.1 dB(A), 66.96 dB(A), 60.4 dB(A), and 61.4 dB(A), for mornings, afternoons, evening, and night respectively (Figure 6). The recorded maximum noise level in the commercial areas are 69.1 dB(A), 79.6 dB(A), 81.9 dB(A), and 71.2 dB(A), for mornings, afternoons, evening, and night respectively (Fig. 4).

3.4 Comparison of Noise Levels in Sylhet City with Standard Recommended Values

3.4.1 Comparison of noise levels across area types with DOE

The mean values of different types of areas in Sylhet on different times compared to ideal values given by Department of Environment Bangladesh (DOE). In residential areas, the actual values were equal to the recommended value of DOE but only during morning hours. But other times of the day such as afternoon, evening and night, the acquired values were above than the DOE recommended values. In commercial areas, the mean noise levels were equal to the DOE values on morning and night times but goes above than the ideal values on afternoon and evening. In transport areas and silent areas like schools and mosques, the found values were always much higher than the recommended values of those areas given by DOE. But in industrial areas, values were below to the ideal DOE values of that areas in different times (Fig. 5).

3.4.2 Comparison of noise levels across area types with WHO

The acquired values here compared with the standard values given by WHO for those particular area-types. In morning rush hour, almost all acquired values were above than the recommended values by WHO except in Transport Hub and Industrial areas where the values remain below from the recommended values. In afternoon times, all areas crossed the ideal values of WHO. In evening hours, all the values around different types of areas were

recorded above the WHO recommended values. Only transport hub areas remained equal to the recommended values. In night hours all the values are far more above than the recommended values of WHO for that time in those zones. (Fig. 6).

3.5 Running ANOVA and Tukey's HSD to Determine Significance of Variance among Types of Areas

To assess the impact of zone types on noise, a one-way analysis of variance (ANOVA) was conducted with the fixed factor being area-type, with five classifications; residential, educational, transportation, silent, and commercial, while noise was the dependent variable. The results of the ANOVA test, revealed a statistically significant relationship $F(4,115) = 9.52$, $p = 1.1079$ shown in Table 3.

Additionally, the Tukey's HSD (Table 4) pair-wise follow-up test uncovered that noise levels among residential and transportation, residential and commercial and residential and industrial area types are statistically significant, similarly as with noise levels among commercial and silent and commercial and industrial area types. However, the differences in noise levels between other groups are not statistically significantly different.

Excessive noise is a noteworthy ecological risk happened in urban territories emanating from various types of areas. Noise disturbance influence essentially, impacts numerous areas with a high population density and influences the occupants in their day to day life, rest, work, and study. The results in the preceding sections narrated the compilation and statistical calculations of noise levels in Sylhet, as well as the comparative analysis of noise with WHO and DOE. Sunday and Thursday as the noisiest days of the week in Sylhet (Fig. 2), could be credited to the economic practices of the occupant of the city. The expanding noise created by the different urban area-types, particularly those identifying with transportation and commercial exercises in Sylhet city, and by augmentation in developing nations, is a reason of concern. The normal noise level in the residential, commercial, silent, industrial and transportation regions of Sylhet are 60.4 dB(A), 75.5 dB(A), 66.5 dB(A), 66.6 dB(A) and 69.3 dB(A) (Fig. 4), separately, which surpass the admissible noise level breaking points given by WHO just as DOE.

Table 3. Analysis of variance of noise levels across type of areas

ANOVA						
Source of variation	Sum of squares	Df	Mean square	F	P-value	F critical
Between groups	3147.206125	4	786.8015313	9.516152	1.1079	2.4505705
Within groups	9508.273542	115	82.68063949			
Total	12655.47967	119				

Table 4. Tukey's multiple comparison between noise levels across different types of areas

Comparison	Tukey-kramer procedure		
	Absolute mean difference	Critical range	Results
Residential to silent	5.885416667	6.867	Not Significantly Different
Residential to industrial	7.69375	6.867	Significantly Different
Residential to commercial	15.86666667	6.867	Significantly Different
Residential to transport hub	9.0625	6.867	Significantly Different
Silent to industrial	1.808333333	6.867	Not Significantly Different
Silent to commercial	9.98125	6.867	Significantly Different
Silent to transport hub	3.177083333	6.867	Not Significantly Different
Industrial to commercial	8.172916667	6.867	Significantly Different
Industrial to transport hub	1.36875	6.867	Not Significantly Different
Commercial to transport hub	6.804166667	6.867	Not Significantly Different

Noise levels can be affected by time of day and day of the week. For example, Sunday denotes the start of numerous monetary exercises, and a high inflow of individuals who left the city for the end of the week, while Thursday is primarily portrayed by the expansion of vehicular traffic and mass development out of the urban areas by travelers. Henceforth, results uncovered that Mondays and Fridays recorded the most astounding noise in Sylhet. The development of Friday as the calmest day of the week in Sylhet can be clarified by the socio-cultural exercises of the general population in the city. Customarily, Fridays are generally without numerous financial activities, aside from religious and social exercises, which much of the time are solemn and take around three to four hours in some spots of worship and social focuses in Sylhet. In the light of this, vehicular traffic and movements are always limited, as individuals regularly remain inside to rest from all financial commitment of the earlier week and to plan for the coming week. The general outcomes on noise levels in various zones of Sylhet city shows that the noise weight levels were highly variable and were the indication of differing man-made exercises in these zones. However, almost all readings in this regard are higher than the prescribed qualities which propose that a significant number of the overwhelming exercises on these zones are completed without a least

regard for the environment. The test of the connection among noise and area-types demonstrates that noise in normal urban areas in Bangladesh is significantly affected by prevailing types of areas, and that there is a checked distinction in noise levels crosswise over various types of areas. The implication for the present noise regime in Bangladeshi urban areas, as typified by those obtained in this study, transcends the health consequences of this environmentally-degrading phenomenon.

4. CONCLUSIONS

This study uncovers that every one of those area-types crossed the prescribed range. Indeed, even some unexpected values also occurred such as quiet areas like schools emerged with most extreme noise level over 90 db(A). The palatable outcome indicated only by industrial areas as it kept up recommended values and also some values found underneath the suggested values. The reason beneath this special case contains a clarification. However, there are no clear industrial zones in the metropolitan radius of Sylhet rather those areas can be called as blended zone. The primary industries situated in the sub-urban locale thus these small scale personal level industries are included as an industrial region in this study, hence the sound levels were not extraordinary.

Sylhet is as yet not completely developed city. It is passing its emerging state and this is the reason it is critical to pull the reins now because if this issue isn't considered important, it can go to a wild state. This metropolitan requires to present some appropriate arranging and enactments by the concerned expert for the advancement of all. A few suggestions made accordingly to control the current circumstance:

- ❖ The strategies for mitigating roadway noise such as horn restriction implementation for vehicles, alteration or banning heavy vehicles from the main roads of metropolitan area to outside the town area.
- ❖ Vehicles failed in the fitness test which makes bothering sounds should be banned.
- ❖ Vehicle parking stations within the city should be taken to the outer part of the city where population is low.
- ❖ Complete banning of the vehicular hydraulic horns in any places of the country.
- ❖ Law enforcement against unnecessary or needless use of sound.
- ❖ Plantation of trees and construction of sound barriers.
- ❖ Modern technology should be applied in every sector to minimize noise of machineries as well as vehicles.
- ❖ Complete restriction of the use of miking for elections campaigns, processions and advertising.
- ❖ Schools, hospitals etc. sensitive areas should be moved from center to suburbs and make transportation easier so that distance could not be felt and services would be accessible always with maintaining the recommended noise level.
- ❖ To reduce traffic noise planned and limited public transport like town bus should be introduced banning other unplanned, discrete so called public transports which not only polluting but also robbing the mass people.
- ❖ Low noise producing machines should be used in the industry. Workers should use noise protector inside the industries. The owners of the industries should make arrangement to reduce noise pollution.
- ❖ People should avoid unnecessary horns at roads. Drivers and passengers should obey traffic law and punishment giving should be maintained strictly for violating rules.

- ❖ In hospitals the patients, accompanying persons, staffs should avoid unnecessary conversation.
- ❖ The govt. should take proper steps to reduce noise pollution. NGOs, media have to keep contributions to reduce noise pollution.

This is seen that this very problem has always been neglected all over the civilizations in the world before the bell rang to an irritating condition. Noise pollution is very hazardous for our physical and mental health. What is the profit of being rich and solvent industrially or commercially with the increasing of medically unfit population? So it is imperative to take action and be concerned at this high time.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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