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GIS Based Mapping and Assessment of Noise Pollution in Gazipur City, Bangladesh

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ABSTRACT

Noise pollution is an extensive concern for urban areas around the world. Gazipur is one of the significant hubs of the garment industry in Bangladesh. The purpose of the study was to address the highest sources of noise pollution in this City and identify the public perceptions of noise pollution. Noise levels have been measured from 38 locations of the City from 8.00 am to 6.00 pm including industrial, mixed, commercial, residential and sensitive zones on both working and non-working days. ArcGIS based assessment using IDW spatial interpolation technique was used for the mapping of the measured noise levels across the study area. The highest average noise level (100.9 dB) was observed at Joydebpur Junction in the period of evening (4.00 pm to 6.00 pm) and the lowest average noise level (47.5 dB) was observed in front of the Banghabandhu Satellite Ground Station in the period of afternoon (12.00 pm to 2.00 pm). Heavy industrialization, vehicles horn, construction sites, traffic noise, loudspeakers, expired engines, loud talking; outdoor parties are the extensive reasons for the increase in noise pollution in Gazipur City. Study showed that the noise level in every location was higher than the standard levels. Survey data indicated that the city dwellers endure from noise pollution are headaches, irritable moods, sleeplessness, bad temper, stress. This study strongly suggests that proper implementation of the existing laws helps to mitigate and reduce the noise pollution situation in the study area.

Keywords: Noise pollution, ArcGIS, Noise level, Industrial area, Public health, and Bangladesh.

INTRODUCTION:

Noise is defined as an imperceptible environmental threat that cannot be seen, tasted, felt, removed, or filtered as garbage or water. Noise pollution is defined as any undesired, unpleasant, or displeasing sound that causes distress to all living beings and stresses the environment (Mesene *et al.*, 2022). Gazipur is the most densely populated city in Bangladesh. Noise pollution is regarded as one of the most serious issues confronting urban areas, with several negative effects on the urban environment and the potential for significant societal costs (Chuhan and Pande, 2010; Martin *et al.*, 2006). Here noise is

generated from different sources like public gatherings, vehicles horn, traffic and loudspeakers. Noise pollution is becoming an additional hazard to the citizens of Gazipur City Corporation, in addition to the increasing levels of air and water pollution. Noise pollution can occur as a result of poor urban planning, since adjacent industrial and residential buildings can produce noise pollution in the residential neighborhood.

Noise is a pleasantly and momentarily undesired sound that causes aggravation, interferes with dialogue, and disrupts sleep and the teaching learning

process (Gour, 2013). The Department of Environment (DoE) of Bangladesh recommended a verge of the admissible noise level for different decibel (dB) units, which is thoroughly known as Noise pollution (Control) Rules, 2006. The admissible verge limits for Sensitive areas, residential areas, mixed areas, commercial areas and industrial areas are 45 dB, 50 dB, 60 dB, 70 dB, and 75 dB (DoE, 2006).

In urban environments, private cars, car horns, car alarms, and public transit systems may be the offenders. The primary source of noise is the growing number of transportation systems and automobile exhaust systems. Hydraulic horns of buses, trucks, minibuses, construction work, factories etc. are the major source of noise pollution in Gazipur city. Adverse health effects of noise pollution are hearing impairment, sleep disturbances, interference with spoken communication, cardiovascular disturbances, disturbances in mental health, impaired task performance, negative social behavior and annoyance reactions (Haglar and Goines, 2007). The purpose of the study was to identify the highest noise polluted area and to know the awareness of public perceptions about noise pollution.

MATERIALS AND METHODS:

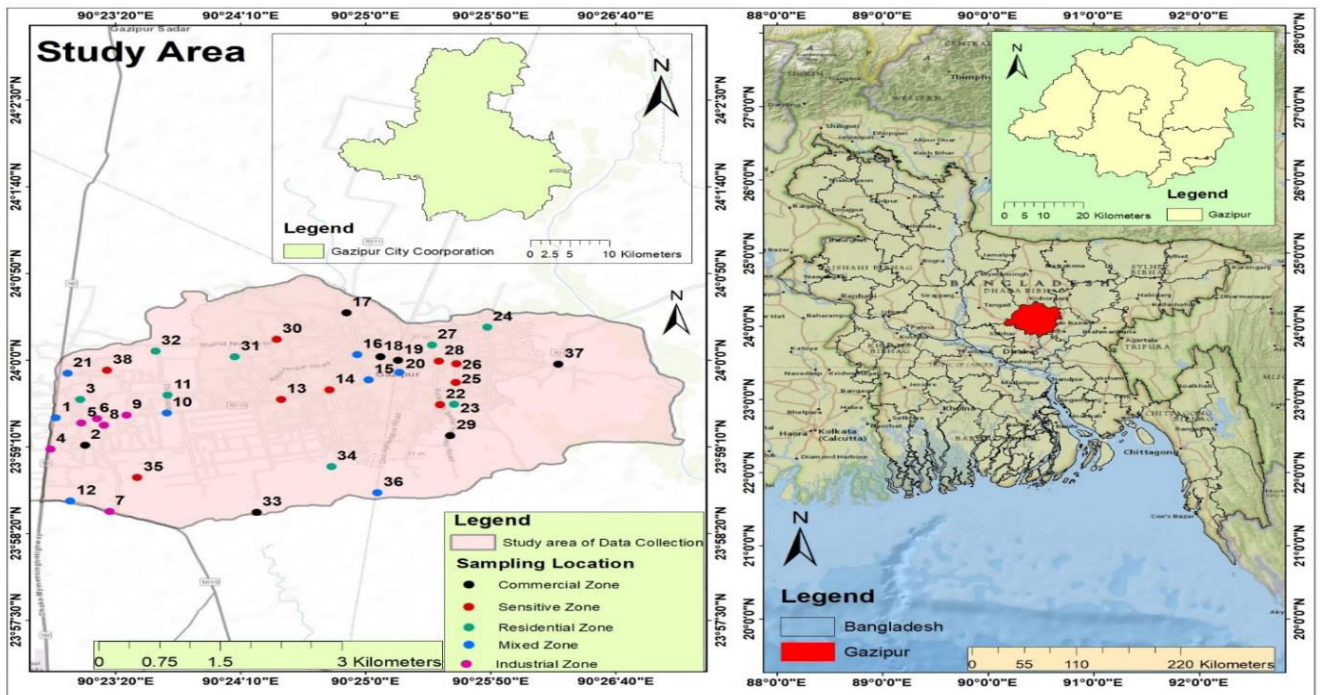
Location of study area and sampling locations

Gazipur City Corporation (GCC) is a local government body located in Gazipur district in central Bangladesh. Among the city corporations of Bangla-

desh, GCC is the youngest in terms of establishment and the largest in terms of size. It is located at 23° 59' 20" N and 90° 22' 30" E. About 75% of the country's garment industry is located in this region (GCC). The field survey started from 27-11-2021 and continued up to 02-12-2021. Noise levels have been measured from 38 locations in the main town of Gazipur. Some of these were sensitive, commercial, residential, industrial and mixed zones. On both working and non-working days, data have been collected in three shifts, Morning (8.00 am-10.00 am). Afternoon (12.00 pm-2.00 pm) and Evening (4.00 pm-6.00 pm).

Measuring Instruments

Noise measurements were determined by using digital sound level meter, model: SL-4010. This meter is a complex and sophisticated instrument. Geographical Positioning System (GPS) device (Model: Garmen eTrex 10) was used to draw the latitude and longitude of the position of the sound generating points while taking sound level readings. In this study, we take advantage of the Inverse Distance Weighting (IDW) interpolation method of spatial analysis tool. ArcGIS version 10.8 is a geographic information system (GIS) software package maintained by Environmental Systems Research Institute (ESRI). By analyzing the noise level of the point location, IDW can evaluate noise levels in the surrounding area. The IDW determines cell values using linear-weighted combination set of sample points.



Map 1: Location map of the study area (Gazipur City).

RESULTS AND DISCUSSION:

In Gazipur City, noise levels have been measured at 38 diverse locations including 6 industrial zones, 8 mixed zones, 7 commercial zones, 8 residential zones and 9 sensitive zones. Data has been collected in three shifts from morning to evening. In which there was one non-working day and six working days.

Table 1 provides the information about noise level (dB) at different locations in Gazipur City. The lowest average noise level (48.1 dB) was observed at infront of Banghabandhu Satellite Ground Station in the period of morning. The highest average noise level (100.9 dB) was found at Joydebpur Junction in the period of evening.

Table 1: Average noise levels (dB) at different locations in Gazipur City.

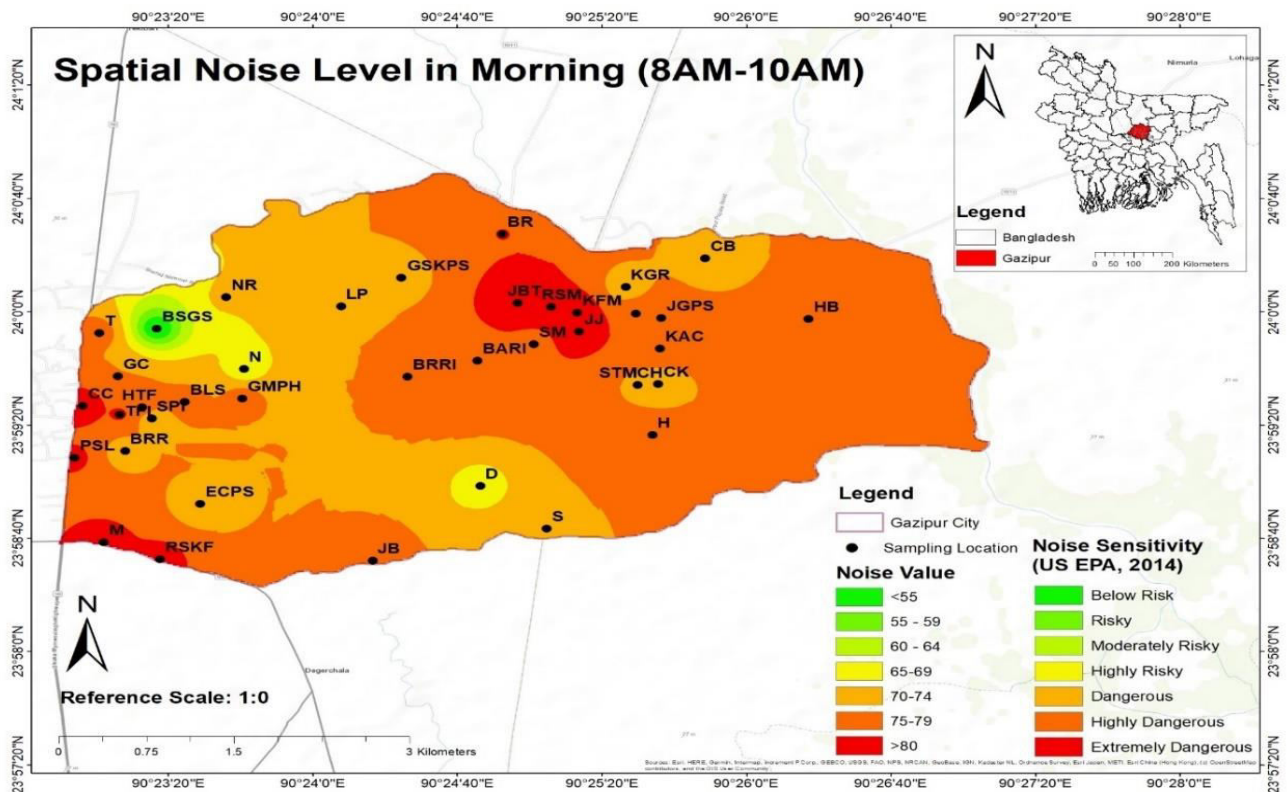
Sampling Number	Location Name	Category of the Area	Sound Level (dB)			Noise Level Standard (dB)		
			Morning	Afternoon	Evening	DoE, 2006	WHO and EC (WHO, 2009)	U.S. (E.P.A)
1	Chandona Chowrasta (CC)	Mixed	86.8	93.7	96.7	60	-	-
2	Banarupa Road (BRR)	Commercial	71.4	79.3	86.3	70	55	60
3	Greatwall City (GC)	Residential	75.7	77.2	82.4	50	55	55
4	Posmi Sweaters Ltd. (PSL)	Industrial	82.6	85.9	92.6	75	65	70
5	Target Finewear Industries Ltd. (TFI)	Industrial	82.2	89.6	90.5	75	65	70
6	Hasan Tanvir Fashionwear Ltd. (HTF)	Industrial	81.9	88	92.3	75	65	70
7	R. S. Knit Fashion Ltd. (RSKF)	Industrial	82.9	89.9	91.2	75	65	70
8	Sofy Processing Industries (SPI)	Industrial	70.1	77.1	84.3	75	65	70
9	Body Link Sweater Ltd. (BLS)	Industrial	77.9	86.6	92	75	65	70
10	Gazipur Metropolitan Police Headquarters (GMPH)	Mixed	78.8	87.9	92.1	60	-	-
11	Noljani (N)	Residential	66.6	68.8	79.1	50	55	55
12	Mugurkhal (M)	Mixed	83.3	84.5	90.3	60	-	-
13	Bangladesh Rice Research Institute (BRRI)	Sensitive	80.3	89.2	87.7	45	45	45
14	Bangladesh Agriculture Research Institute (BARI)	Sensitive	78.1	82.4	87.9	45	45	45
15	Shib bari Mor (SM)	Mixed	79.2	88	92.8	60	-	-
16	Joydebpur Bus Terminal (JBT)	Mixed	86.3	92.9	100.7	60	-	-
17	Bilaspur Road (BR)	Commercial	81.3	87.6	94.8	70	55	60
18	Rufiya Super Market (RSM)	Commercial	81.2	86	94.1	70	55	60
19	Kolapotti Food Market (KFM)	Commercial	85.8	91.7	94.6	70	55	60
20	Joydebpur Junction (JJ)	Mixed	85.3	89.1	100.9	60	-	-
21	Telipara (T)	Mixed	78.5	82.6	85.8	60	-	-
22	Shaheed Tajuddin Medical College and Hospital (STMCH)	Sensitive	75	81.6	86.8	45	45	45
23	Chayakunja (CK)	Residential	70.2	68.2	80.7	50	55	55
24	Chayabithy (CB)	Residential	70.6	69.8	80.8	50	55	55
25	Kazi Azimuddin College (KAC)	Sensitive	81.4	81.1	86.4	45	45	45
26	Joydebpur Govt. Primary School (JGPS)	Sensitive	78.9	83.1	85.4	45	45	45

27	Kobi Govindo Das Road (KGR)	Residential	69.8	76.5	77.9	50	55	55
28	Ranibilasmoni Govt. Boys High School (RGBHS)	Sensitive	81.4	83.9	89.1	45	45	45
29	Hazibag (H)	Commercial	80.1	87.2	88.9	70	55	60
30	Gazipur Shishu Kollan Primary School (GSKPS)	Sensitive	72.7	74.1	78.7	45	45	45
31	Luxmipara (LP)	Residential	72.1	72.3	78.4	50	55	55
32	Neyamot ali Road (NR)	Residential	70.9	74.7	77.5	50	55	55
33	Jogitola Bazar (JB)	Commercial	78.2	82.2	93.1	70	55	60
34	Deora (D)	Residential	67.6	71.6	77.8	50	55	55
35	East Chandona Primary School (ECPS)	Sensitive	71.6	75.1	77.7	45	45	45
36	Samantapur (S)	Mixed	74.9	88.5	92.1	60	-	-
37	Harinal Bazar (HB)	Commercial	78.9	87.9	96.3	70	55	60
38	Bangabandhu Satellite Ground Station (BSGS)	Sensitive	48.1	47.5	57.6	45	45	45

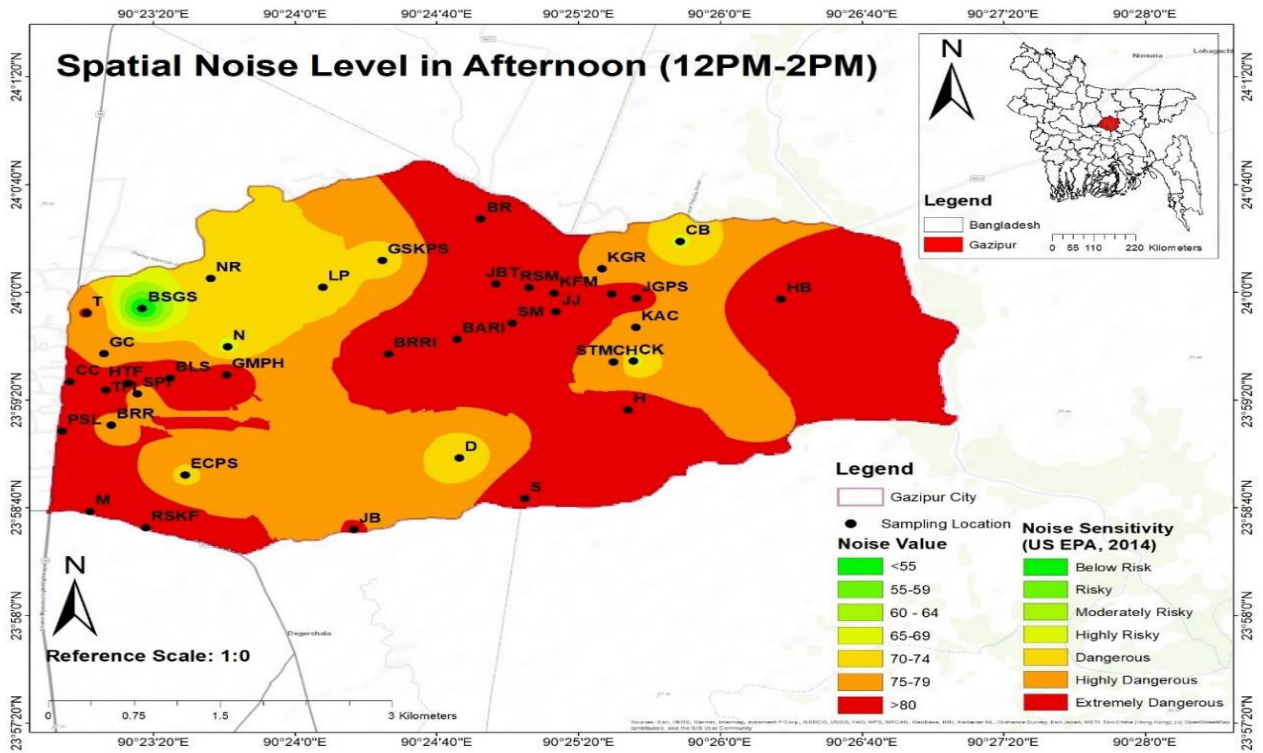
[Note: DoE = Department of Environment (Bangladesh) (DoE, 2006), W.H.O = World Health Organization, E.C= European Commission (Chauhan and Pande, 2010), U. S. (E. P. A) = United States (Environmental Protection Agency) (Chauhan and Pande, 2010)].

Map 2 illustrates that the highest average noise level (86.8 dB) was found at Chandona chowrasta. The second highest average noise level (86.3 dB) was found at Joydebpur Bus Terminal. Noise value has been measured around 80 dB in almost all mixed, commercial and industrial zones. The lowest average noise value (48.1 dB) was observed at Banghabandhu Satellite Ground Station. Map 3 provides the spatial

noise mapping on afternoon. The highest average noise value (93.7 dB) was observed at Chandona Chowrasta in the period of afternoon. The lowest average noise level (47.5 dB) was found at Banghabandhu Satellite Ground Station and the second lowest noise level (68.2 dB) was found at Chayakunja in the period of afternoon.



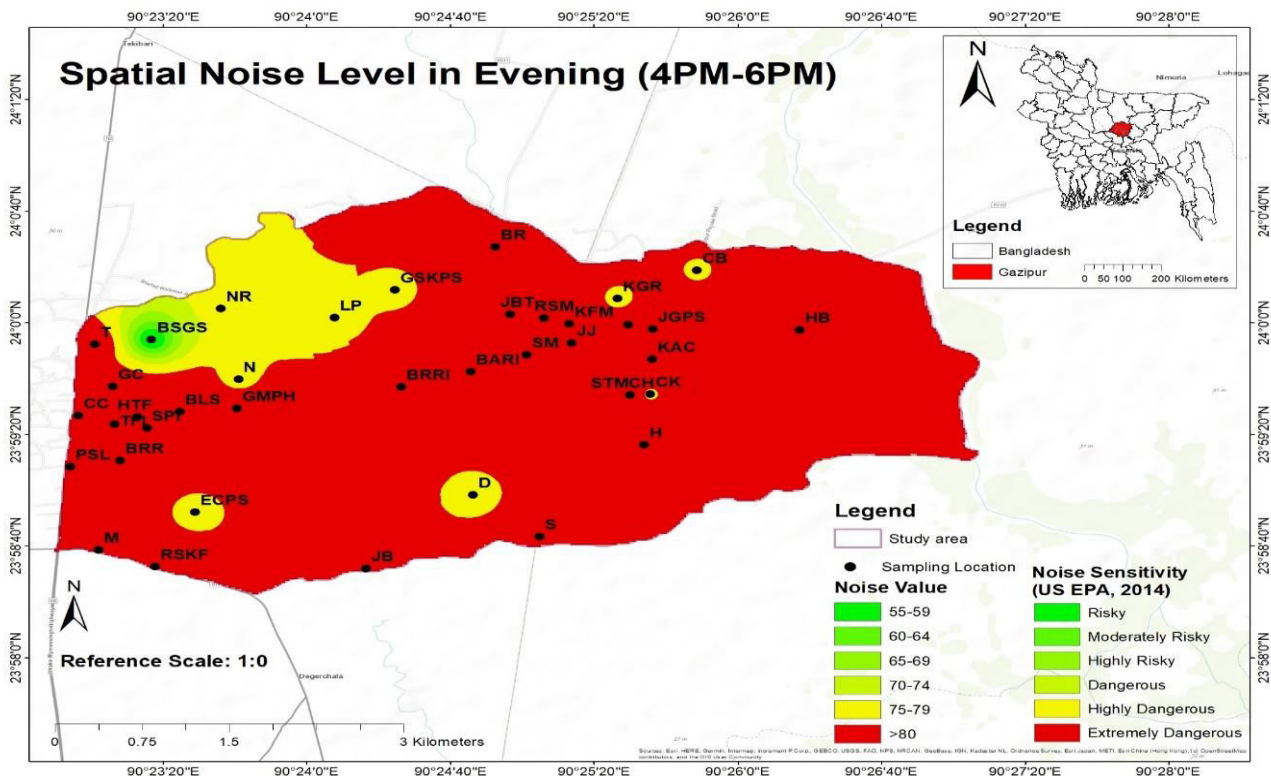
Map 2: Spatial Noise Mapping on Morning in Gazipur City.



Map 3: Spatial Noise Mapping on Afternoon in Gazipur City.

Map 4 shows the highest noise level (100.9 dB) was found at Joydebpur Junction which is a mixed zone. In the evening, there is more gathering of people and vehicles than the other time, as a result noise pollution is high. The lowest noise level (57.6 dB) was found at in front of Banghabandhu Satellite

Ground Station. The map compares the measured noise value with the US EPA, 2014 provided noise sensitivity chart. From which it can be seen that maximum measured value falls in the last category which is extremely dangerous.



Map 4: Spatial Noise Mapping on Evening in Gazipur City.

Variation of noise level with time

Fig. 1(a) shows the average noise levels variation with time in industrial zones. The highest noise level (92.6 dB) was found at Posmi Sweaters Ltd. in the period of evening. All of the industries are located on the side of the road. In the morning everyone goes out together for work which creates a gathering in front of the industry which creates a lot of traffic jams. As there are more people in front of the industry in the morning, a group of people were seen raising money by playing loud mike. The huge number

of cargo vans in industrial zone is noticeable in the period of evening which carries industrial goods. These are one of the major causes of noise pollution at Gazipur city. According to DoE, the standard of industrial zone is 75 dB, but all the measured noise level crossed the standard. The lowest noise level (70.1 dB) was found at Sofy processing industries in the period of morning. The second lowest noise levels (77.1 dB) was also observed at Sofy Processing Industries in the period of afternoon.

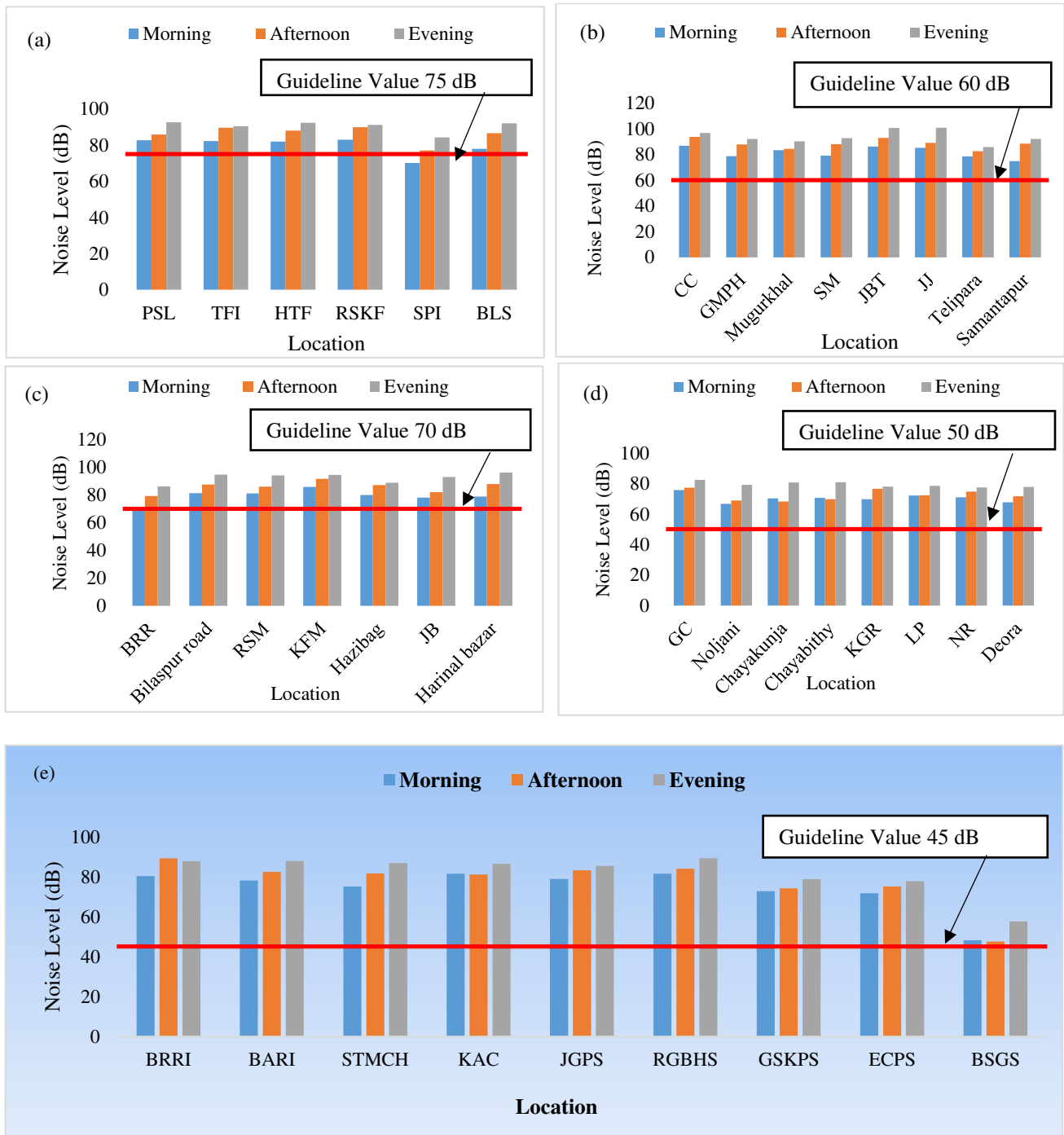


Fig. 1: Variation of noise levels with time in different zones (Average of working & non-working days); (a) Industrial zone, (b) Mixed zone, (c) Commercial zone, (d) Residential zone, and (e) Sensitive zone.

Fig. 1(b) illustrates the variation of average noise levels with time in mixed zones. The highest noise level (100.9 dB) was found at Joydebpur Junction in the period of evening. All mixed zones are crowded in the afternoon and evening. Using Gazipur city as a transit, long distance buses pass over the city. As a result, the level of noise pollution in Gazipur has increased. The lowest noise level (74.9 dB) was found at Samantapur in the period of morning. **Fig. 1(c)** provides the variation of noise levels in commercial zones. The highest noise level (96.3 dB) was found at Harinal bazar in the period of evening. Government employees and garment workers flock to the commercial zone to buy essential goods on holidays. Some shops are closed in the morning but large crowds can be seen in the afternoon and evening. In the morning most shops are closed in commercial zones (Such as clothing stores, shoe stores, food hotels etc). In the commercial zones, notable vehicles are rickshaws, autos, motorbikes etc. Lots

of hawkers sit on either side of the street, hawkers screaming is another cause of noise pollution. **Fig. 1(d)** shows the variation of noise levels of working and non-working days with time in residential zones. The highest noise level (82.4 dB) at Greatwall city in the period of evening. In the residential zones, noticeable vehicles are motorbikes, rickshaws etc. The lowest noise level (66.6 dB) was found at Noljani in the period of morning. **Fig. 1(e)** provides the variation of noise levels with time in sensitive zones. The highest noise level (89.1 dB) was found at Ranibilasmoni govt. boys' high school in the period of evening. Schools, colleges, hospitals are basically silent zones. There is a CNG bus stand in front of the Joydebpur govt. primary school. There are public transport roads in front of schools and hospitals, which is one of the main causes of noise pollution in Gazipur city. The lowest noise level (47.5 dB) was found at BSGS in the period of afternoon.

Comparison between standard and measured noise level

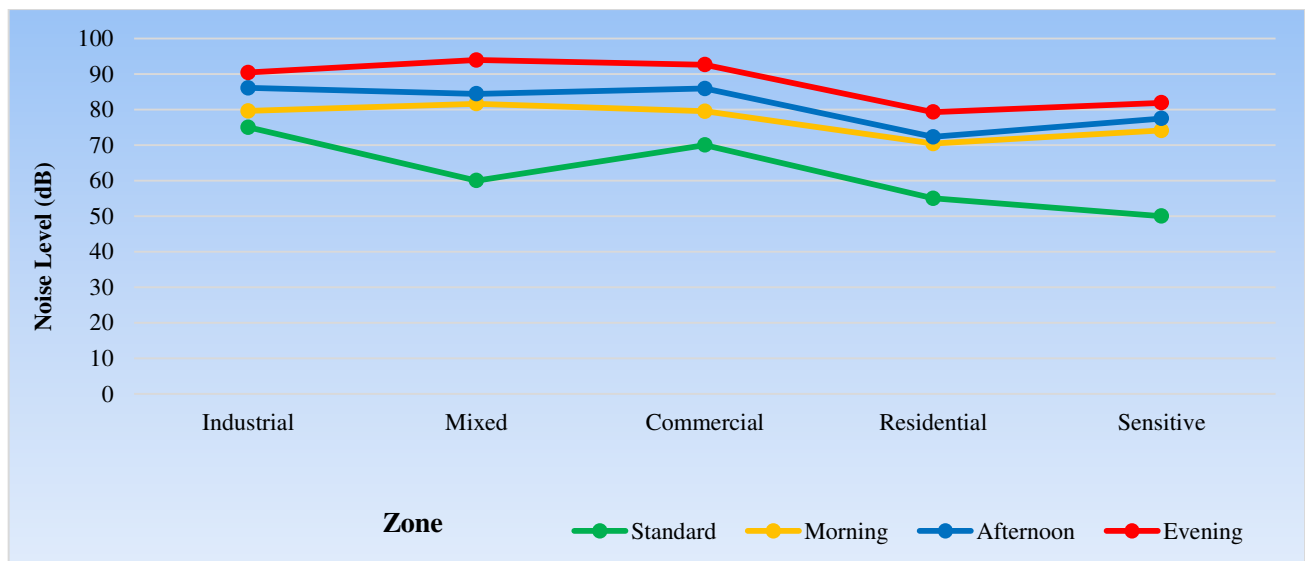


Fig. 2: Comparison between Noise Pollution (Control) Rules, 2006 and measured noise level in morning, afternoon and evening.

The line chart (**Fig. 2**) compares noise pollution (Control) Rules, 2006 to observed noise levels. This figure illustrates the noise level of different zones in the period of morning, afternoon and evening which is much higher than the standard value.

Questionnaire survey results

The survey method is a practical study, where noise level measurement, public opinion, observation and calculation methods are mainly used. They have also

been asked about laws and regulations to control noise pollution. In this context, more than half of the respondents said that they do not know about the Noise pollution (Control) Rules, 2006. Attempts were made to get a balanced opinion in the survey but it did not happen due to the reality. Among the survey participants, 66.3% were male and only 33.7% were female. Where 13.8% were under the age of 18, 60% were between the ages of 18-40 and 16.2% were the ages of 40-62.

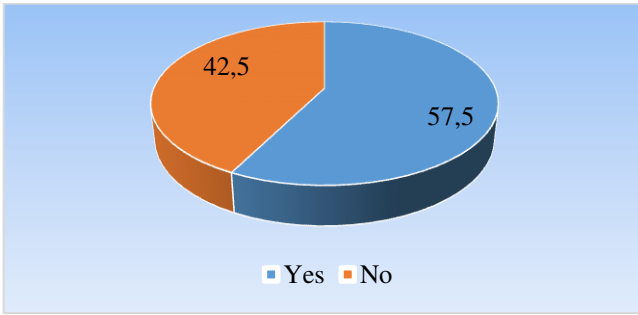


Fig. 3: Opinion about harmfulness of noise pollution.

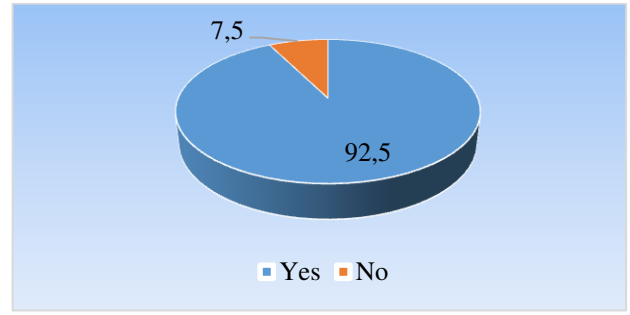


Fig. 4: Problem rate with excess noise.

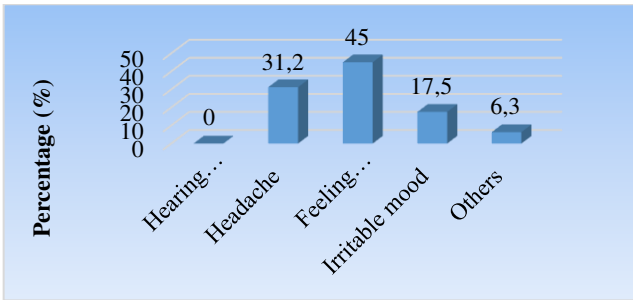


Fig. 5: Problem caused by noise pollution.

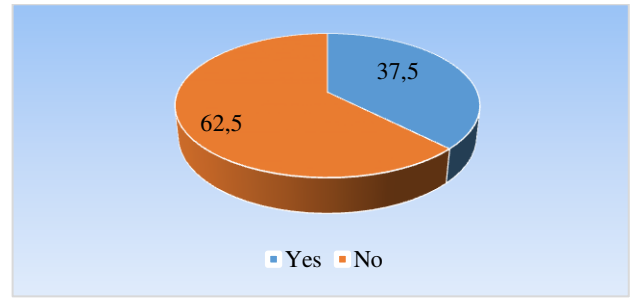


Fig. 6: Knowledge rate about Noise pollution (Control) Rules, 2006.

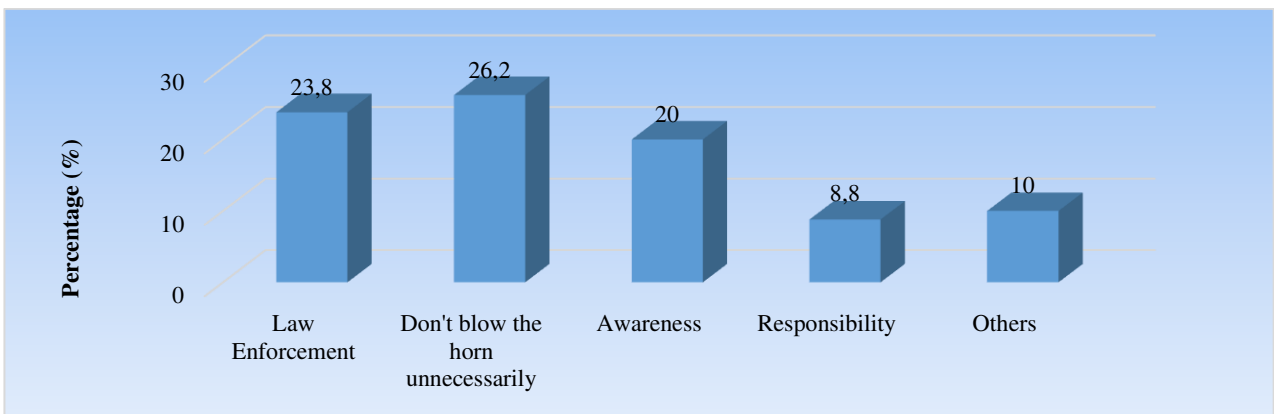


Fig. 7: Advice on noise pollution control.

Among the survey participants, 23.8% were students, 22.5% were Housewife's, 10% were Businessman, 12.5% were Labor, 15% were Employee and others were 16.2%. For the survey, data were collected from both those who are pedestrian and those who settled permanently in Gazipur City. According to the opinion of survey participants, 80% live in Gazipur City and 20% of the respondents were pedestrians. The pie chart (Fig. 3) represents the opinion about harmfulness of noise pollution. It has been reported that many people are not aware of the harmful effects of noise pollution. Noise pollution is so much harmful. Among the survey participants, 92.5% reported experiencing various problems due to noise pollution (Fig. 4). When asked about the problems encountered due to noise pollution, the survey participants mentioned various problems, some of which are similar (Fig. 5). Feeling annoyed is the most problematic but there are also other problems such as irritable mood and headache. Few people also have sleeping disorder, reluctance to work, absence of mind etc. More than half of the respondents (62.5%) are not aware of the Noise Pollution (Control) Rules, 2006. They also said that no steps have been taken yet to control noise pollution. Noise pollution can cause anxiety, irritability, high blood pressure, hearing loss, sleep disturbances and 100% of the respondents in the survey voted in favor of controlling noise pollution. Benefits can only be achieved by raising awareness about laws that are helpful in controlling noise pollution.

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CONCLUSION AND RECOMMENDATIONS:

The noise is one of the most common dangerous emissions. With the rise of industrialization and urbanization, noise pollution in urban areas is increasing. This paper highlights the current state of noise pollution at Gazipur city. Residential and silent zones are exposed to loud noise. Ordinary people, patients and especially students are at risk of high levels of noise. Silent zones such as hospitals, schools should be relocated away from the city. Public unawareness about noise pollution is also a factor for increasing noise pollution. But many people are affected by noise pollution impact like headache, feeling annoyed etc. Compared to the previous results, the noise level in Gazipur city is increasing which is alarming for the environment. It has been surprisingly noticed that most noise producing and noise affected people are not aware of the harmful effects of noise pollution. This paper will definitely help the government to understand the noise level and take the next step. The following steps should be taken to prevent noise pollution in order to create a livable environment for human beings.

- 1) Planting of trees creates natural barriers to noise pollution. Trees can be planted on school premises, sidewalks and road dividers. However, care must be taken that the trees do not obstruct the movement of vehicles.
- 2) Horn limitation policy must be implemented. Playing the horn unnecessarily has now become a habit.
- 3) Low noise generating devices should be used in industrial work purposes.
- 4) Traffic jams are another major cause of noise pollution. Traffic control needs to be further improved. This will not only reduce noise pollution but also reduce road accidents.
- 5) Hydraulic horns should be prohibited.

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CONFLICTS OF INTEREST:

The authors declare that there is no conflict of interest.

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