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Differentiating Sources of Noise at Busy Road Intersections in Dhaka City

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Abstract. Along with air and water pollution, noise pollution, particularly along busy roads, is also an emerging threat to the inhabitants of Dhaka. This study attempts to identify the major sources of noise at road intersections and their relative contributions to overall noise level, and suggests possible mitigation measures. Noise levels were recorded at five busy intersections in Dhaka city on both working days and on holidays. Noise level was measured using a noise meter over a period of one hour, while at the same time real-time traffic flow was monitored and synchronically video recorded to analyze the traffic characteristics. Noise data were analysed in MATLAB, while the video data were analysed in VegasPro and Trazer. During analysis, maximum, average and minimum noise levels, and number of different types of vehicles and their average speed were determined for each data set. In addition, variations of noise levels with traffic conditions were carefully analyzed for determining the causes of high noise levels. Results reveal that the level of noise at road intersections exceeds the allowable limit regardless of the traffic condition. When vehicles are in motion along road, noise is generated mainly by the engine and the exhaust system of the vehicles, aerodynamic friction and use of horns. When vehicles are not in motion, noise is created mainly by the excessive use of horns and shouting of the bus conductors. In both situations, unnecessary use of horns was identified as a prime cause of sharp and high noise levels. Behavioural patterns of the road users (drivers, passengers and pedestrians) appear to be primarily responsible for the traffic noise pollution on the roads. Failure to implement the traffic and environmental laws and ignorance of general people about these laws contribute to noise pollution. Several measures have been proposed for mitigation of noise pollution, which include bus-lay-by, restricting barrier along footpath, active lane separation, etc. Along with these, enhancing mass consciousness and implementation of proper monitoring system may significantly reduce noise pollution along roads.

Keywords: behavioural pattern, mitigation measures, noise pollution.

1. Introduction

Dhaka, the capital city of Bangladesh is one of the most populous mega cities in the world. As the growth of urban population is taking place at a very rapid pace, the city is being unable to cope with changing situations due to the internal resource constraints and management limitations. During the 70s and 80s, noise pollution was not a major concern for the dwellers of Dhaka city, but with the increase in the number of motorized vehicles in the city, the hazard of noise pollution has increased and exceeded the level of tolerance [1]. Exposure to high level of noise causes severe stress on the auditory and nervous system. The hearing ability of the inhabitants of Dhaka city has reduced during the last ten years and about five to ten percent of the patients admitted to the Bangabandhu Sheikh Mujibur Rahman Medical University, Dhaka are suffering from permanent deafness due to noise pollution [2]. Disturbances created by noise may cause hypertension, headache, indigestion, peptic ulcer, etc. [3]. Being subjected to adverse level of noise during pregnancy may result in high-frequency hearing loss in new-borns, prematurity, intrauterine growth retardation and disruption to the normal growth and development of premature infants [4].

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Road side noise has become one of the biggest challenges for urban planners and environmental engineers [5]. To overcome this, at first the sources of noise are needed to be differentiated. Once differentiated, relative contribution of different sources and the reasons for increased noise levels are to be assessed. Thus, the major sources along with the reasons for their higher contribution to overall noise level need to be carefully evaluated. Then efforts shall be made to reduce the undesired noise levels from the major noise generating sources. This will lead to overall reduction of noise levels.

2. Methodology

2.1. Site selection

The study locations include the major intersections in the central part of Dhaka, the capital city of Bangladesh. For convenience of detecting and separating the major causes of noise, one directional traffic flows with minimum turning and under stop-and-go condition were needed. So, strategically the temporal noise level measurements were made at the five busy intersections in Dhaka city namely,

- Bangla Motor
- Banani
- Science Laboratory
- Dhanmondi 27
- Moghbazar

2.2. Data collection

At the five study locations, data were recorded on both working days and holidays during the period of November 2013 to December 2013. The weather was dry and the wind speed was negligible on those days. The noise monitoring data were collected using a calibrated Extech HD600 Sound Level Meter at a definite distance from the intersection along the roadway at deceleration sides. The probe was held at the height of the receptors' ear level. Noise level measurements were made for around one hour during peak periods at one second recording intervals. Before the noise level measurement, the Sound Level Meter was calibrated by a Sound Level Calibrator at 94dB with 1 kHz. During noise level measurements, 'A-weighting' scale was selected and the Sound Level Meter was switched to fast response mode. The real time data were saved as data logger memory data and transferred from the Sound Level Meter to a Desktop computer. The data output was in the form of Microsoft Excel Worksheets. The time was recorded simultaneously both manually and by the Sound Level Meter. The characteristics of the traffic and the prevailing conditions of the surroundings were also observed along with the recording of the sound level. Video camera recording was carried out simultaneously with the noise level recording at each study location to make the observation more accurate and to find out the traffic volume and speed during the recording period. The video camera was set on the foot over bridge facing the observed traffic flow in such a manner that the direction of the flow was perpendicular with the face of the camera lens.

2.3. Data analysis

The collected noise and traffic data were analyzed with the software MATLAB to find the L_{eq} , maximum and minimum sound level from the temporal noise data for all the sites and also for each minute for a particular site as noise measurements were made at one second interval. It was also used for presenting the variation of noise level with time graphically. It gave graphical representation both in the form of images and videos. Vegas Pro, a video editing software, was used to create the combined videos of real time traffic condition and corresponding noise level at different times for all the sites. Thus, it was possible to observe the variation of noise level with traffic conditions offsite. Trazer, an image processing software, was used to determine the traffic parameters from the real time videos of the traffic conditions. It gave the total number of vehicle of each type and their average speed per minute. From the videos, noise levels at different traffic conditions were observed carefully for all the sites. The conditions when noise levels exceeded the standard limit and the major causes of excessively high noise levels were determined. Through the output of Trazer, relationship between vehicular speed and noise level was assessed.

3. Results and Discussion

3.1. General characteristics of noise at the intersections

Table 1 shows the sound level characteristics at the study intersections. At all the sites, noise level was found to remain continuously well above the standard limit set by Department of Environment (DoE), Bangladesh. Though the minimum value for noise level, L_{min} has been found to be below the standard, the value of the energy mean noise level, L_{eq} has been found to be above it for all the sites. The maximum noise level, L_{max} has been found to be above 100 dBA at all the intersections, which is a clear indication of health hazard.

Table 1: Summary table of noise levels at the intersections

			Noise levels at the intersection			Standard for sound at dBA unit during daytime[6]
		Intersection	Maximum noise level L_{max} (dBA)	Minimum noise level L_{min} (dBA)	Energy mean noise level L_{eq} (dBA)	
Category of area	Commercial	Banglamotor	104.6	66.2	80.471	70
		Banani	106.8	65.2	83.82	70
		Science Lab	105.4	58.5	82.334	70
	Mixed	Dhanmondi 27	102.9	56.6	79.588	60
		Moghbazar	100.9	53.2	77.047	60
			all above standard	all below standard	all above standard	

The maximum, minimum and mean noise levels were found to be less for the intersections at mixed areas than those for the intersections at commercial areas. So, category of area has a distinct contribution on the noise level at the intersection. It is due to the reason that land use pattern has a direct effect on the traffic characteristics of a particular area and thus affects the noise level indirectly.

3.2. Major causes of high noise levels at intersections

Noise level above 90 dBA slowly damages the auditory cells. Therefore, efforts were made to determine the reasons for sound level peaks above 90 dBA, so that possible mitigation measures could be found. Table 2 shows the major "causes" of high noise levels at the study intersections.

Table 2: Relative percentage of the causes of high noise level at the intersections

	Intersection				
Causes of high noise level	Banglamotor	Banani	Science Lab	Dhanmondi 27	Moghbazar
Pedestrians	7%	…..	19.3 %	3%	30%
NMV	4%	…..	…..	3%	35%
Motorcycle drivers	10.3 %	15.80%	6.8 %	12%	35%
Occupied left lane	30%	…..	44.4 %	58%	…..
Vehicles on opposite side	4%	…..	12.5%	12%	…..
Local bus drivers and helpers	18.0 %	67.10%	17%	…..	…..
Manual signaling	2%	3.9 %	…..	…..	…..
Congestion	8%	13.2 %	…..	…..	…..
Sudden change of the direction and speed	2%		…..	…..	…..
Use of horn while turning left as a signal	11.2 %	…..	…..	…..	…..
Siren emitted from the ambulance and VIP cars	1.5 %	…..	…..	…..	…..
Vehicles turning right	2%	…..	…..	…..	…..
On-street Parking	…..	…..	…..	12%	…..

Different "causes" were found to have different level of contribution to high noise at different intersections. While some "causes" were major contributors to high noise level at some intersections, they

had minor contribution at other intersections, or altogether absent at some intersections (see Table 2). This is due to the difference in the characteristics of the intersections. Land use pattern has been found to be a significant reason behind the difference among the major causes of high noise level at the intersections.

To determine whether there is any relationship between the velocities of the vehicles to the noise levels at the intersections, average velocity of all types of vehicles per minute was estimated. It was compared with the L_{eq} of the corresponding time period which was the energy mean noise level of the 60 noise data recorded per second during that particular one minute duration. The average velocities were plotted against the corresponding L_{eq}.

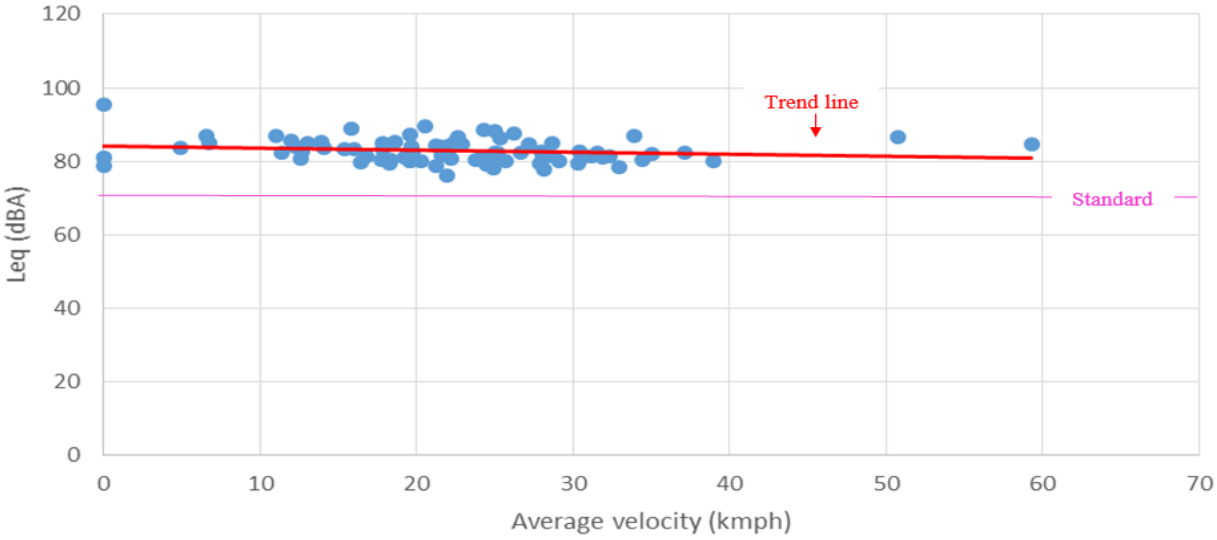

Fig 1: Average velocity of vehicles vs corresponding L_{eq} per minute graph for Bangla Motor intersection

Figure 1 shows the relationship between average velocity of vehicles and L_{eq}. The trend line was found to be almost a horizontal line, which indicated that the velocity of vehicles does not have any effect on the noise level at the intersection. It has been found to lie above 70 dBA, which indicates that noise level remains above the standard limit irrespective of vehicular speed. The trend line has also been found to almost overlap the line for 80 dBA, which is almost equal to the L_{eq} determined for the total duration of observation for the site i.e. 80.5 dBA. The absence of a particular relationship between the average velocity of vehicles and L_{eq} shows that the "flowing" or "stop" condition of vehicles does not have any effect to the noise level at the intersection.

3.3. Recommendations to reduce noise level at intersection

Though different "causes" have different level of contribution to high noise at different intersections, some general noise reduction measures could be applied to all of them as some causes are common and some specific noise reduction measures could be applied to the sites where they are certainly required.

If a bus-lay-by is there along every decelerating lane of the intersection, then local buses won't stop to take or drop passengers at the intersections and the flow of vehicular stream would not be hampered. Moreover passengers would not wait on the road for the buses obstructing the left lane. Then drivers of other vehicles would not be compelled to use horn to maintain speed or clear their way while turning left. Restricting barrier along the footpath and the road divider, especially at intersections, is needed to control random movement of pedestrians.

If restricting barriers are constructed along footpath, pedestrian will be compelled to use sidewalk for movement rather than walking along the left lane and obstructing vehicular flow. Moreover, sudden crossing of road by them could also be restricted through barriers both along footpath and road divider. Thus the pedestrians could be forced automatically to use the foot over bridges, which would not only reduce the use of horns but also increase their safety against road accidents.

Effective separation of lane through lane divider would help in keeping the left lane clear for vehicles during the red signal. Then drivers, intending to turn left, would not be compelled to use horns to get right-of-way.

Digital signalling system along with installation of counters will eliminate the disadvantages of manual signalling. Confusion among drivers about the signals will not occur. Impatience during long red signals will be reduced, thereby reducing the use of unnecessary horns during that period.

Proper enforcement of both traffic and environmental laws is a must to keep the sound level below the acceptable limit. Without it, no engineering measure will be effective or sustainable in reducing noise level or improving the prevailing situation.

Awareness among general people about the environment can play a significant role in reducing the noise level. If their knowledge about the hazardous effects of sound pollution can be increased through mass media, general training in public institutions and other effective ways, they themselves will follow the rules related to traffic and environmental management and take voluntary steps against generation of high level of noise.

4. Conclusion

Irrespective of the traffic condition, the noise level at busy road intersections in Dhaka city remains continuously above the acceptable limit almost all the time. The major causes of high noise level at the intersection include pedestrian behaviour (e.g., random movement), presence of NMV, unruly behavior of motorcycle drivers, occupied left lane, vehicles on opposite side, shouting by bus drivers and helpers, manual signalling system that creates confusion, congestion, sudden change of direction and speed, use of horn while turning left at a signal, siren emitted from the ambulance and VIP cars, vehicles turning right and on-street parking. The relative contributions of these major causes vary depending on the characteristics of the intersection. At both "flowing" and "stop" condition, unnecessary use of horns creates very sharp peaks in the noise level. This has serious implication on the general health and well-being of the inhabitants of the city. Road users including drivers, passengers and pedestrians are primarily responsible for the traffic noise pollution on the roads due to their behavioural patterns. Absence of implementation of the traffic and environmental laws and ignorance of general people about these laws contribute to the high level of noise pollution in the city. To reduce noise pollution, several measures should be taken which include bus-lay-by, restricting barriers along footpath and the road divider, active lane separation, digital signalling system, etc. It is very important to raise public awareness about noise pollution, and traffic and environmental laws.

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