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Research Article

Study and Analysis of 'Traffic Noise Pollution' in Ahmadabad city

Shivendra kumar jha [1] Dr.Piyushkumar .j.patel[2]

[1]Research scholar, Ganpat university kherva, Mehshana, Gujarat India; email: shivendrajha.nit@gmail.com
[2]Vidush somany institute of technology and research kadi, Gandhinagar, Gujarat, India; email: drpjpatel72@gmail.com

ABSTRACT

Automobile industry has changed human life making it faster and comfortable. We cannot think modern life without vehicles. However, problems associated with these automobiles are many; one of them is 'Noise pollution'. Expanding urbanization has posed serious concern of noise pollution globally. In India, this is aggravated on account of demography, indiscipline and limited resources. It is apprehended that projected level of noise pollution may adversely affect human health. Accurate thorough analysis of this problem is therefore necessary to arrive at pragmatic solution. For this, major sources and conditions of noise generation are necessary to be identified and synthesized.

Ahmadabad is a fast growing city of Western India, facing acute traffic problems and as such, noise pollution is also associated. The prime purpose of this study is to measure traffic noise level at selected three prime intersections of Ahmadabad city, categorized on commercial, industrial and residential area. Study is made inclusive adding parameters like speed, honking, traffic volume, characterization of noise, and distance from intersection. Combination of various parameters has been considered affecting noise level. Regression analysis is resorted to correlate the significance of input parameters with respect to noise level using MINITAB software.

The primary measurements were carried out at selected intersections in commercial, residential and industrial areas installing noise meters, cameras with manual monitoring. Noise levels were measured during identified peak times and non-peak hours, in different seasons, using SLM 109 noise meter. Further, parameters were categorized for different types of vehicles, speed, traffic volume and honking. The noise were classified with regards to frequencies and analyzed. Parameters of noise level monitored were L_{eq}, L_{10}, L_{50}, L_{90}, L_{max} and $L_{min.}$ All the above measurements and observations were then rationally processed using MINITAB analysis.

Prima facie it is found that the traffic noise level is higher than permissible limits fixed by GPCB/CPCB. In all of the classified area of residential, commercial and industrial, the noise level is found to be higher than the permissible limits. Considering the projected population of Ahmadabad city and the growth in number of vehicles, the noise level will exponentially increase and could be detrimental to the health of citizens. It is therefore utmost necessary to check and control all the parameters responsible for noise pollution effectively.

It is found that honking has the paramount effect on noise level. In general, honking of heavy vehicles contributes the most. The insufficient road widths, absurd parking, building heights and

traffic volume are mainly responsible for this noise, in addition to the indiscipline and flurry of people.

Speed of vehicles is also a major factor for noise. Analysis on different types of two wheelers, four wheelers and types of fuels shows that noise level is almost directly affect the speed. Optimum speed derived for different types of vehicles would prove advantageous.

Third observation shows that noise level is proportional to the traffic volume. Heavy vehicles and auto rickshaw create more noise than other type of vehicles. However, it is observed that mass communication vehicles like buses can't be ignored as they are equivalent to about 10 to 15 small vehicles, and thereby may create less noise.

KEYWORDS: Noise level, (MINITAB). Etc

1. Introduction

India is a developing country and with the increase in infrastructural facilities, the urbanization is accelerated approaching to about 50 % of the total population is now residing in urban areas. This has posed serious concern over the traffic situation. India is facing drastic demographic growth and with the increase in per capita income, the number of vehicles is multiplying with time [I]. Due to this, traffic load in urban areas has been increased manifold, posing serious health hazards. In India, about 52% residents living near roadways are reported frequent irritation, 46% hypertention and loss of sleep to about 48.6% due to noise pollution [XIV]. Chennai is the nosiest among six metro cities. However, metros, Mumbai, Delhi, Kolkata, Chennai, Bangalore and Hyderabad exceeds noise pollution standard as per CPCB. In Europe, 120 million people are affected by traffic noise level above 55 dBA. In India, it is apprehended that this figure would have been much more. With the increase in the traffic, which expected to grow exponentially with temporal and spatial growth of urban areas, the issue will aggravated adversely affecting the citizen health [III]. It is therefore necessary that a scientific study is to be carried out relating noise level verses health, for Indian urban conglomerates and sensitize the law makers to come out with stringent statutory laws safe guarding people health. One of such application is GIS-Geospatial Information System, with which, the accurate analysis with effective glimpse can be presented **[II]**.Many tools and mathematical models are available like CRTN, FHWA-tnm, RLS90, and OAL Etc. In the present study of noise impact, popular FHWA-TNM model is used because it is efficient, accurate and its ease of handling. It is further to mention here that this study is based on the works of Abo-qudais and Alhiary, who evolved statistical models generating scenarios for maximum, Minimum and equivalent noise levels at controlled road intersections [IV]. In this study, the noise level has been assessed at specified locations of commercial, residential and industrial areas. Using GIS, the maps have been generated earmarking the spatial and temporal noise level higher than 50 dB [V]. **(Obaidat, 2008**) A model correlating noise level with different input parameters like types of vehicles, average speed, road widths, building height, traffic volume etc have been developed and validated for the study areas of Ahmadabad [VII]. **(Shukla, 2006)** This statistical regression model can be used for temporal and spatial predictions of noise level dynamics at different hotspots [XV]. This study has used the standards of GPCB, almost matching with the Indian National Standards. The noise level variability with respect to locations and time is estimated and presented using arcGIS 9.2[VII].

2. Literature Survey

In 2020, researchers focused on the studying the connection between traffic 97 density and an expansion or reduction in noise levels [XVI]. The noise levels were checked in a total 98 of 5 stretches and 12 areas of a busy commercial area of Surat city. It was discovered that noise 99 levels in the region are 77dB, which is excess that of admissible limits framed by the CPCB of 100 Government of India. It is reported that, if the quantity of vehicles is expanding, it isn't 101

fundamental that the proportional noise level should increment and the other way around, on 102 the grounds that noise levels are subject to different factors such as traffic flow, honking of 103 horns, lane indiscipline, unapproved parking, and heterogeneity of vehicles in traffic [VIII].

Researchers have explained that that a large portion of the regions of 114 city have exposed to unacceptable noise, and the noise level was high as 70–95 dB which is 115 excessively high than the permissible limits [IX]. High noise levels in developed and organized 116 zones such as residential areas, shopping zones are a significant concern. This is because of 117 more utilization of the roads close by it by a wide range of public, commercial, loader trucks 5 118 and private vehicles[IX],[X]. Some of the alleviation measures suggested are upkeep of automobiles, 119 regular servicing, and tuning of vehicles, fixing of silencers, installation of controlling barriers 120 between noise source and receiver. Other measures incorporate raising the awareness among 121 the local community and severe enforcement of laws.

It has been studied that the noise prompted by the traffic congestion and its 131 effect on the wellbeing of people in the Chittagong city corporation. The noise level in the 132 roadside was about 93dB, which is about surpassed as far as the acceptable limit. It is observed 133 that the level of noise pollution is firmly associated with traffic volume, especially with the 134 quantity of heavy vehicles such as trucks, buses as well as auto rickshaw [XI]. Due to this noise 135 pollution, majority were experiencing the headache, bad temper, restlessness, disturbance, 136 hearing issues, etc[XIII]. Ignorance of the population about noise pollution is likewise a factor for 137 expanding noise pollution. It is recommended to develop awareness about noise pollution [XVIII].

In 2008, it has been attempted to monitor and evaluate the road traffic noise in an 154 urban zone. It is revealed that current noise level in all the areas surpasses the limit 155 recommended by CPCB. In view of the discovering, it can be said that the population in this 156 industrial town are presented to essentially high noise level, which is caused generally because 157 of road traffic [XIX].

3. Study Area:

The data used in this study are collected during months of March, June and December, 2019 at three representative intersections of Ahmadabad City. SLM 109 sound level meter is used placing it at 1.2 m above the ground and 1.0 m away from the road side. The data were collected at these locations between 9:00 to 12:00 hrs [peak hrs] and thereafter in between 13:00 to 16:00 hrs [Non-peak hrs] and at 17:00 to 20:00 hrs.[peak hrs] **[XII]**.Data on traffic volume is simultaneously collected, categorizing the vehicles as two wheelers, three wheelers four wheelers and heavy vehicles. Speeds of different types of vehicles then randomly observed using a radar gum. Average speed of different types of vehicles is used in the analysis of noise level pollution [XIV]. Other parameters such as building heights, road widths etc have been collected for all the designated locations. These data is further processed by Statistical method of analysis of variance (ANOVA). Ahmadabad is a commercial and economic capital of Gujarat with a present population of 7.8million and it is likely increased to 10 m by 2030. With the flourishing economy of the state, the total registered vehicles in Ahmadabad city is 43 lacs, which is likely to be increased manifolds in coming years. Therefore, it is obvious that the noise level which has already crossed the standard 50dB level may increase exponentially to unbearable level [XIV]. This is shown in map at fig No.1 and table no-1. Observations were taken during peak and non-peak hours as stated in above para. Noise level is measured at the cross section, i.e. where vehicle stopped at the signal and thereafter at different locations at 250 m where it gained speed. This is done partly manual and partly using camera. Speeds of passing vehicles were observed. Using radar gun. The parameters like road width, Honking, avg speed, traffic volume and noise level is assessed by using statically analysis Minitab.

Table no 1: Study area of given location

Sr no	Location	Latitude	longitude	Categorized area
1	Vijay cross road	23.0525	72.5337	Commercial
2	Nava vadaj	23.0732	72.5604	Residential
6	Narol	22.9642	72.5903	Industrial

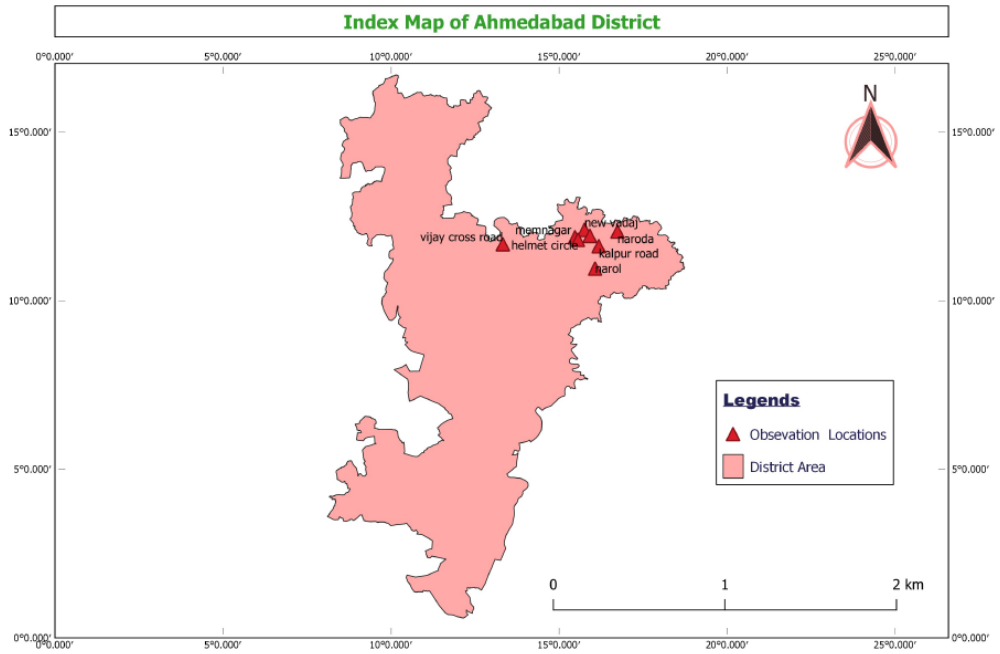


FIG 1: LOCATION MAP OF STUDY AREA

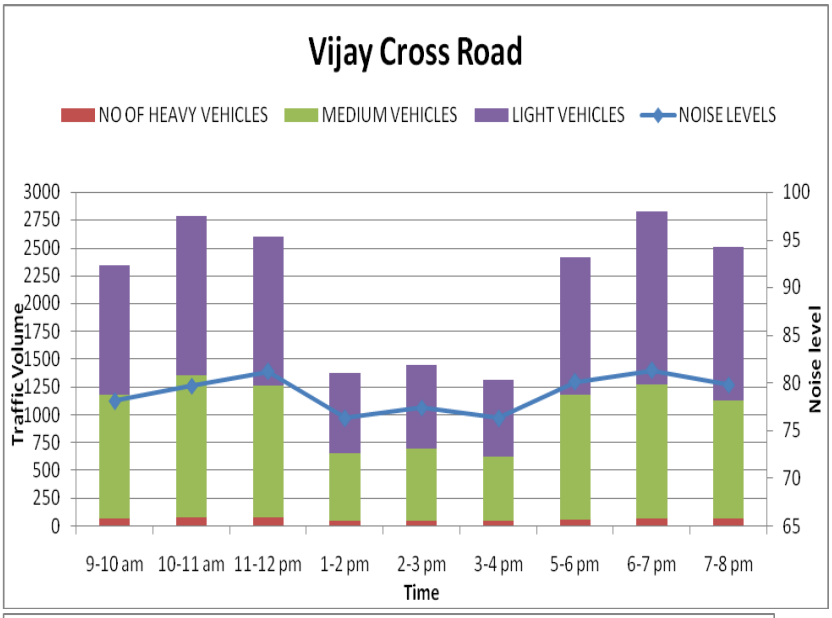
4.0 DATA COLLECTIONS:

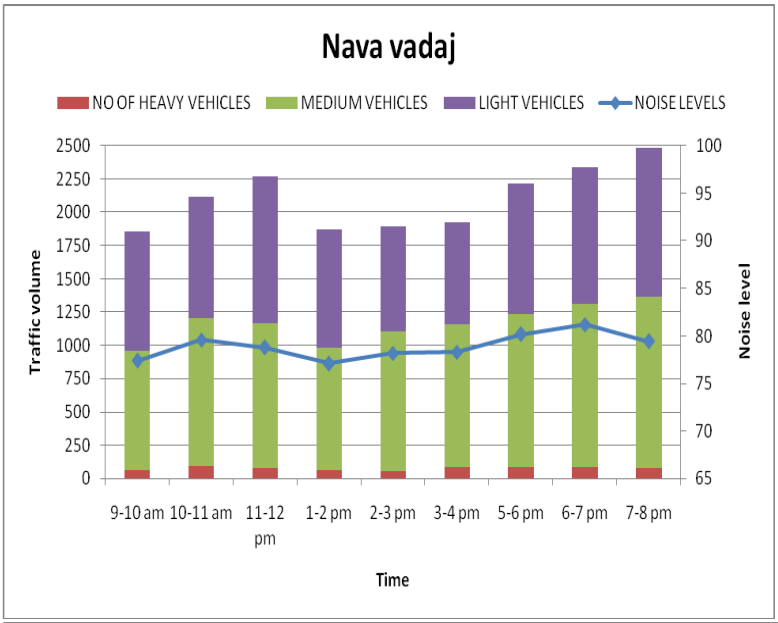
Traffic volume studies were conducted to determine number, movements, and classification of vehicles at a given location and sampling period. Traffic volume was recorded using video camera and vehicles were counted by viewing recorded footages from cameras on computer system. Vehicles were classified as heavy (truck, bus, bulldozer, trailer, dumper), medium (car, jeep, auto-rickshaw, loading auto rickshaw) and light (motorcycle, scooter) based on their size and noise emission level. Auto-rickshaw is a three wheeler used as a common means of transportation in India. Noise emitted by traffic vehicles was measured as per standard methods using sound level meter. Sound level meter was mounted on a tripod stand1.5 m above ground level with slow response mode, frequency weighting “A” and data logging of 1 second time interval. Traffic noise was measured using sound level meter at a distance of 10 m from the center all intersection road respectively. Similarly, speedometer was mounted on tripod stand for monitoring speed of vehicles Noise emitted from a particular vehicle with corresponding speed was also measured and analyzed for noise-speed response.

4.1 DATA ANALYSIS:

An attempt has been made to analyze traffic volume, vehicle speed and honking with their corresponding noise levels. Initially traffic volume was monitored for 9 am to 12pm, 1pm to 4 pm and 5pm to 8pm with 15 min time intervals to identify peak traffic time in morning and evening. Later, two sets of traffic volume and noise data were monitored during morning and evening peak traffic hours. In the first set of data, traffic and noise levels while in the second set, honking along with traffic and noise level were measured for 15 minutes with time interval of 1 minute duration. A statistical analysis was performed to assess the impact of diverse conditions on traffic noise based on the relationship between traffic volume, road geometry and noise data

For this, analysis of variance (ANOVA) and correlation analysis were carried out to quantify the dependence of traffic volume - equivalent noise, honking – equivalent noise and vehicular speed - corresponding noise level.


Vijay Cross Road
NO OF HEAVY VEHICLES
MEDIUM VEHICLES
LIGHT VEHICLES
NOISE LEVELS
Traffic Volume
Noise level
3000
2750
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
100
95
90
85
80
75
70
65
9-10 am
10-11 am
11-12 pm
1-2 pm
2-3 pm
3-4 pm
5-6 pm
6-7 pm
7-8 pm
Time


Nava vadaj
NO OF HEAVY VEHICLES
MEDIUM VEHICLES
LIGHT VEHICLES
NOISE LEVELS
Traffic volume
Noise level
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
100
95
90
85
80
75
70
65
9-10 am
10-11 am
11-12 pm
1-2 pm
2-3 pm
3-4 pm
5-6 pm
6-7 pm
7-8 pm
Time

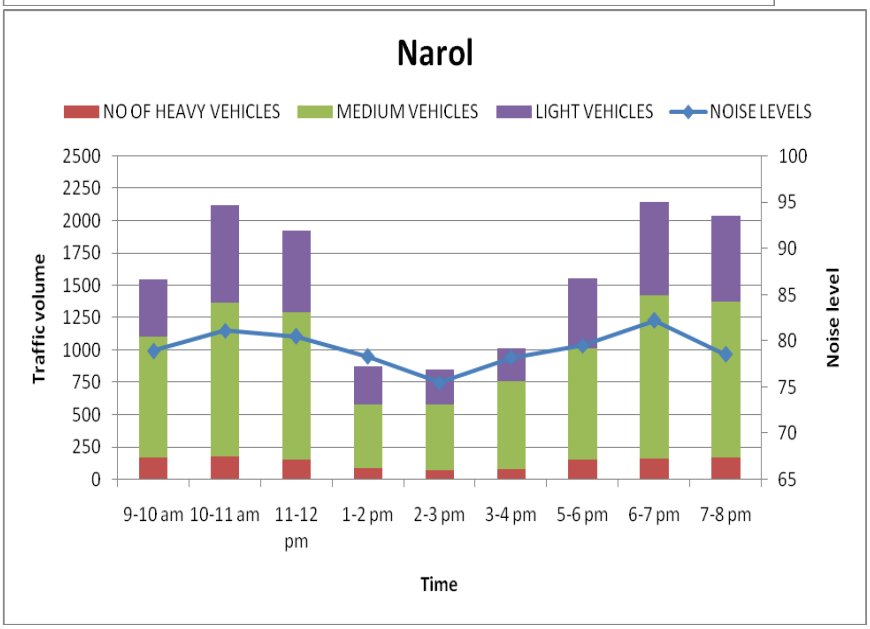
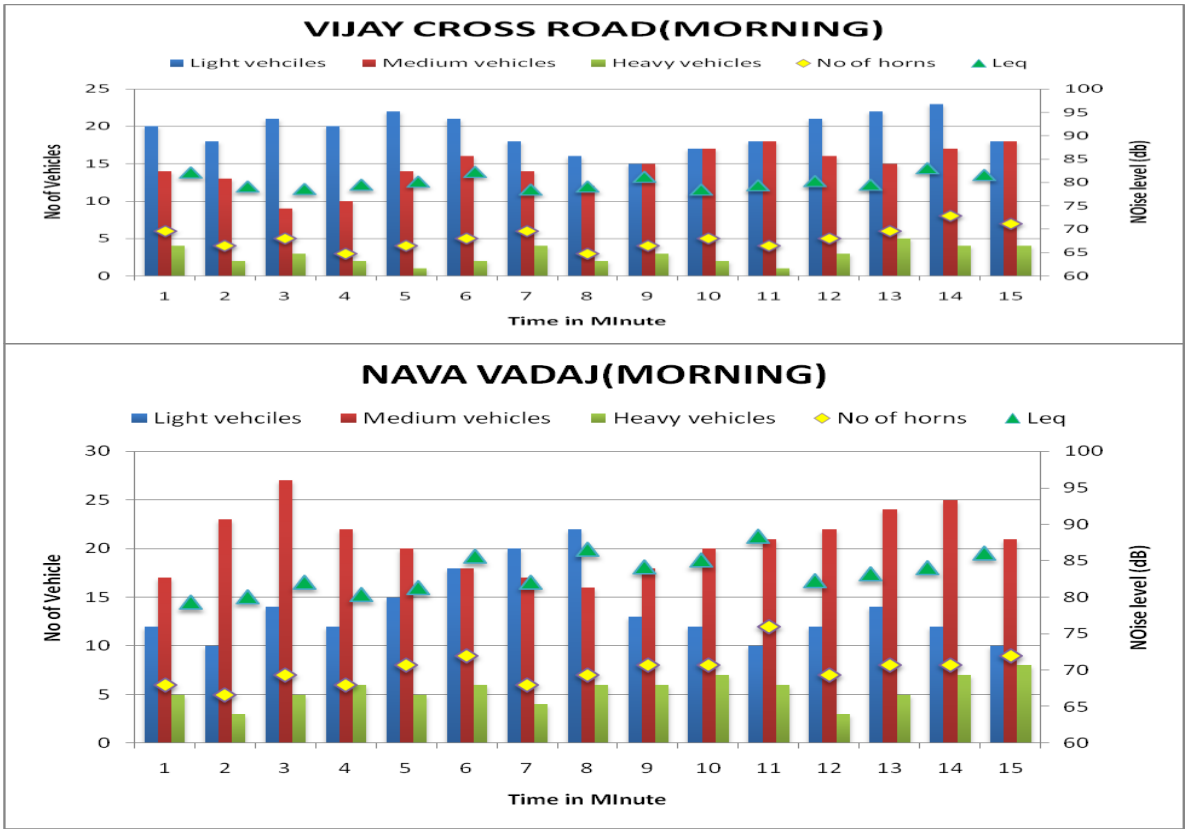

Narol
NO OF HEAVY VEHICLES
MEDIUM VEHICLES
LIGHT VEHICLES
NOISE LEVELS
Traffic volume
Noise level
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
100
95
90
85
80
75
70
65
9-10 am
10-11 am
11-12 pm
1-2 pm
2-3 pm
3-4 pm
5-6 pm
6-7 pm
7-8 pm
Time

Figure 2 first set of data for traffic and noise during morning and evening hours



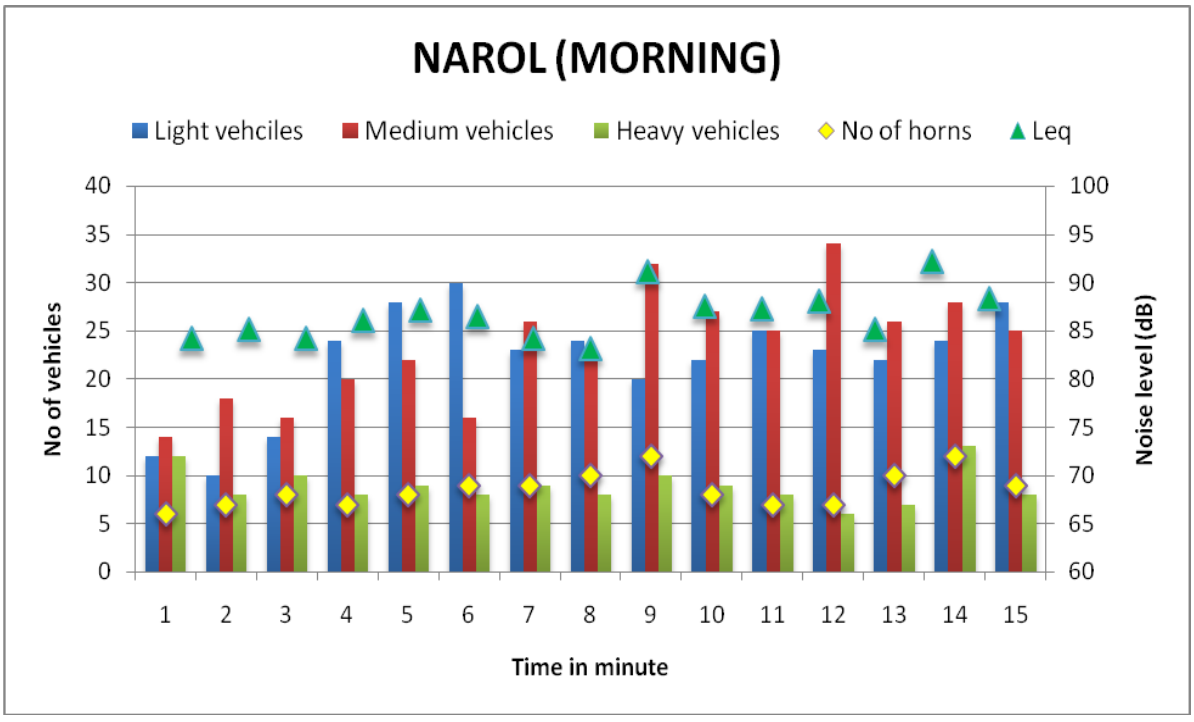


Figure 3 Second set of data for traffic, noise and horn honking for 15 minutes during morning and evening peak hours.

5.0 Data Analysis Results

Based on the analysis of morning 9am to 12 pm and evening 5pm to 8 pm traffic flow and peak traffic flow is observed between 10.45am to 11am and 7.15pm to 7.30 pm in vijay cross road which is under commercial area and between 11.15 am to 11.30 am and 7.45pm to 8pm in Nava vadaj area which is under residential area .and between 10.15 am to 10.30 am and 6.15 pm to 6.30 pm in Narol area which is under industrial area. The no of light, medium and heavy vehicles passing through vijay cross road stretches are 223,259 and 18 respectively during morning peak hour and 267,261 and 16 respectively during evening hour. . The no of light, medium and heavy vehicles passing through Nava vadaj stretches are 278,278 and 23 respectively during morning peak hour and 281,345 and 19 respectively during evening hour. The no of light, medium and heavy vehicles passing through Narol stretches are 201,313 and 46 respectively during morning peak hour and 167,376 and 43 respectively during evening hour. To assess the impact of traffic on noise levels, peak hour traffic and noise were measured for 15 min interval .As per reviewed paper noise is directly proportional to traffic volume. However some conflict results are observed in my research work in all selected locations. As per my research work I found that there is no specific relation of traffic volume vs. noise .this suggests that other factors are also responsible for contributing noise. To identify other factors responsible for traffic noise assessment, a separate set of reading of equivalent noise, traffic volume and honking was collected. These data were collected for 15 min durations of peak time with 1 min interval. Highest Leq 85.1dB in vijay cross road circle was observed in 5^{th} min for 35 number of vehicle per min .this was due to maximum no of honking is recorded. The maximum traffic volume recorded in helmet in 13 th minutes even through Leq was 83.4 dB .In each locations there is same case more no of honking more noise is produced even traffic volume is less . In some locations same no of honking and also same traffic volume noise level is different is due to vehicle type, speed, width of road, road surface condition. In third set of reading of equivalent noise and speed of different types of vehicles is measured .speed of light vehicles, medium vehicles, heavy vehicles varied in the range of 20 Kmph to 100 kmph for all categories of vehicle noise level linearly with speed. Impact of heavy vehicles and auto rickshaw on traffic noise is comparatively more than 2 wheelers and cars .while in case of 2w while increase in speed 30 kmph to 50kmph increases the noise level by 4 decibel and in case of 3w while increased the speed 30 kmph to 50 kmph increases the noise level by 7-8 decibel .in case of heavy while increased the speed 30 kmph to 50kmph vehicles noise level increases by 10 decibel.

5.1 Regression analysis:

1) vijay cross road

Similar to the intersections, multi regression analysis has been carried out as discussed above and shown at fig 17. Coefficient of determination, R^2 value is worked out to be 0.7010. Hence, it confirms that the predicted independent variable were the major noise contributors. Combination of noise contribution by TR (Traffic volume), Speed, Horn (L+M) and Horn(H) accounted for 70.10 % stated above. For adjusted R^2 value of 0.6624, p value works out to be less than 0.05 for three factors namely, TR, speed and honking (H). However, there is no significant impact of honking (L+M).

(Table 7: Regression analysis for VIJAY CROSS ROAD)

VIJAY CROSS ROAD

Regression Analysis: Leq versus TR, Speed, Horn(L+M), Horn(H)

Regression Equation

Leq = 62.94 + 0.01172 TR + 0.467 Speed + 0.00627 Horn(L+M) + 0.516 Horn(H)

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	62.94	2.16	29.13	0.000	
TR	0.01172	0.00320	3.67	0.001	3.89
Speed	0.467	0.125	3.74	0.001	1.12
Horn(L+M)	0.00627	0.00980	0.64	0.527	4.02
Horn(H)	0.516	0.235	2.20	0.035	1.04

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
1.45952	70.10%	66.24%	59.51%

2) Nava vadaj:

Similar to the above intersection multi regression analysis has been carried out as discussed above and shown at fig 18. Coefficient of determination, R^2 value is worked out to be 0.7031. Hence, it confirms that the predicted independent variable were the major noise contributors. Combination of noise contribution by TR (Traffic volume), Speed, Horn (L+M) and Horn (H) accounted for 70.31 % stated above. For adjusted R^2 value of 0.6648, p value works out to be less than 0.05 for four factors namely, TR and honking (L+M), speed and honking (H).

(Table 8: Regression analysis for NAVA WADAJ)

NAVA WADAJ

Regression Analysis: Leq versus TR, Speed, Horn(L+M), Horn(H)

Regression Equation

Leq = 74.44 - 0.0456 TR + 2.117 Speed + 0.0913 Horn(L+M) + 1.029 Horn(H)

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	74.44	9.69	7.69	0.000	
TR	-0.0456	0.0177	-2.58	0.015	3.98
Speed	2.117	0.875	2.42	0.022	1.23
Horn(L+M)	0.0913	0.0243	3.75	0.001	3.88
Horn(H)	1.029	0.299	3.44	0.002	3.81

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
3.09358	70.31%	66.48%	57.89%

3) Narol:

Similar to the above intersections, multi regression analysis has been carried out as discussed above and shown at fig 15. Coefficient of determination, R^2 value is worked out to be 0.7034. Hence, it confirms that the predicted independent variable were the major noise contributors. Combination of noise contribution by TR (Traffic volume), Speed, Horn (L+M) and Horn (H) accounted for 70.34 % stated above. For adjusted R^2 value of 0.6651, p value works out to be less than 0.05 for three factors namely, TR, speed and honking (H). However, there is no significant impact of speed and honking (L+M).

(Table 11: Regression analysis for NAROL)

NAROL

Regression Analysis: Leq versus TR, Speed, Horn(L+M), Horn(H)

Regression Equation

Leq = 35.9 + 0.0280 TR + 3.84 Speed - 0.0164 Horn(L+M) + 0.818 Horn(H)

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	35.9	13.3	2.70	0.011	
TR	0.0280	0.0156	1.79	0.083	15.66
Speed	3.84	1.35	2.85	0.008	2.82
Horn(L+M)	-0.0164	0.0293	-0.56	0.579	12.85
Horn(H)	0.818	0.228	3.59	0.001	3.67

Model Summary

S	R-sq	R-sq(adj)	R-sq(pred)
3.06889	70.34%	66.51%	61.57%

A statistical analysis using two –way ANOVA was performed to assessed $P< 0.01$ for vehicular type and $P<0.05$ for speed and honking .the analysis suggests that types of vehicles is more dominant than speed and honking.

6.0 Conclusion:

Extensive and elaborate exercise has been carried out at the selected and representative intersections of Ahmadabad city to measure noise level and allied factors. Thereafter in-depth analysis of noise level corresponding to all contributing factors to the noise is done. Finally, synthesis of noise, frequencies of noise sources and correlating them with their quantitative contribution has been done. Based on these studies important outcome those have been drawn are as under.

1) At present, the noise level during entire peak time at all the intersections is found around 80 dB which is exceeding the prescribed permissible limits of 45 dB for residential, 55 dB for commercial and 75 dB by GPCB and CPCB. At present, population of Ahmadabad city is 80, 00,000. Projected population in 2031 would be 1,00,00,000. Therefore, in near future, these issues will assume alarming situation with the growth of the city, adversely affecting the health of the citizens.
2) It is observed that honking is the prime factor, which contributes to about 40 % to the noise. However, this has varying stack at different locations.
3) Traffic volume also significantly contributes to the noise level. Intersections have different volumes of two wheelers, three wheelers, light and heavy vehicles and hence, this variation has an impact on the noise level. In the industrial area of Narol, due to comparatively larger volume of heavy vehicles, noise level is found to be above 90 dB. Whereas, in the residential and commercial areas, having comparatively low percentages of heavy vehicles, the noise level is found to be around 80 dB.

In view of the above detailed analysis, following steps are suggested to control against the pernicious noise pollution.

1) Noise is an inevitable part of vehicular traffic. Traffic volume will also increase with the passage of time. Therefore, technological advancement can help reducing the noise. Electric vehicles have promising future in this regards and hence to be promoted.
2) Civic sense is essential for abating honking noise. For this, road infrastructure should be better, facilitating traffic with less congestion. Sensitization of citizen right for primary education will lead to less honking. Efficient horn designs shall be evolved, which may be less health hazardous. Penalty is also one of the tactics.
3) Heavy vehicles shall be restricted during peak times. Electric vehicles shall be promoted. Mass communication shall be encouraged.
4) Citizens shall be educated for the speed and fuel economy, so that they may drive their vehicles at optimum speed.

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