© 2016 IJSRSET | Volume 2 | Issue 3 | Print ISSN : 2395-1990 | Online ISSN : 2394-4099
Themed Section: Engineering and Technology

Developing Road Traffic Noise Prediction Model for Different Categories of Roads In Vadodara City

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ABSTRACT

Vehicular noise is one of the most prevalent forms of pollution. Traffic noise annoyance has become a major issue with the advent of fossil fuels and development in vehicle technology. Vehicular noise is dramatically increasing with the increased number of vehicle population, especially due to speeding vehicles. Amongst all the sources of noise pollution, vehicular noise has been identified as the most annoying and health impairing one. Therefore, it had become important to check the traffic noise and enhance the environmental condition along the transportation corridor. This study attempts the development of road traffic noise model for Indian condition. A statistical regression model for predicting road traffic noise is developed based on A-weighted equivalent noise levels.

Keywords: Noise, Noise Prediction Model, Noise Modeling

I. INTRODUCTION

Basically Noise Is an Unwanted Sound

- Especially One That Is Loud or Unpleasant Or That Causes Disturbance.
- Noise Is Unwanted Sound. Noise Can Be Produced By Many Sources - Man's Vocal Cord, a Running Engine, A Vibrating Loudspeaker Diaphragm, An Operating Machine Tool, And So On.
- Noise Interfere Communication.

Types of Noise

Types of noise sources.	examples
Transportation	Aircrafts ,trains ,road vehicles, vessels
Industrial buildings	Factories-machineries, air conditioning systems
	Office buildings, air conditioning systems, kitchen ventilation systems
Construction sites	Site formation(e.g. excavation), piling, road work, demolition, renovation
public places	Open markets, street parks

II. METHODS AND MATERIAL

A. Objectives

1) To study the existence status of noise levels in the study area.
2) Developing a multilinear regression model of noise at selected area.
3) Identification and consideration of suitable mitigation measure

B. Introduction to Noise Model

Noise Modelling Describe The Process Of Theoretically Estimating Noise Level Within A Region Of Interest Under A Specific Set Of Condition.

What Are Noise Model Used For?

1. Main Purpose Of The Noise Model Is Predicting The Future Noise.
2. By Knowing The Parameter Of Model At Particular Location And By Substituting This Value In Model It Is Possible To Get The Noise Data.

3. By Knowing The Future Noise We Can Provide Noise Mitigation Measure To The Particular Structure.

C. Site Selection

To develop mathematical model for predicting the traffic noise, the first task was site selection. So, according to surveys of different areas and nature of noise problem, a two lane straight stretch where continuous uninterrupted flow of vehicles occurs, without any obstructions like speed breaker, junctions, traffic signals etc. was selected on Vadodara City near SSG Hospital to Jetalpur Road. Also it is better to take noise measurement only in hot sunny days and it is better to avoid the rainy season. During rainy days, the level of noise due to tyre - road interaction will be more than that on normal days.

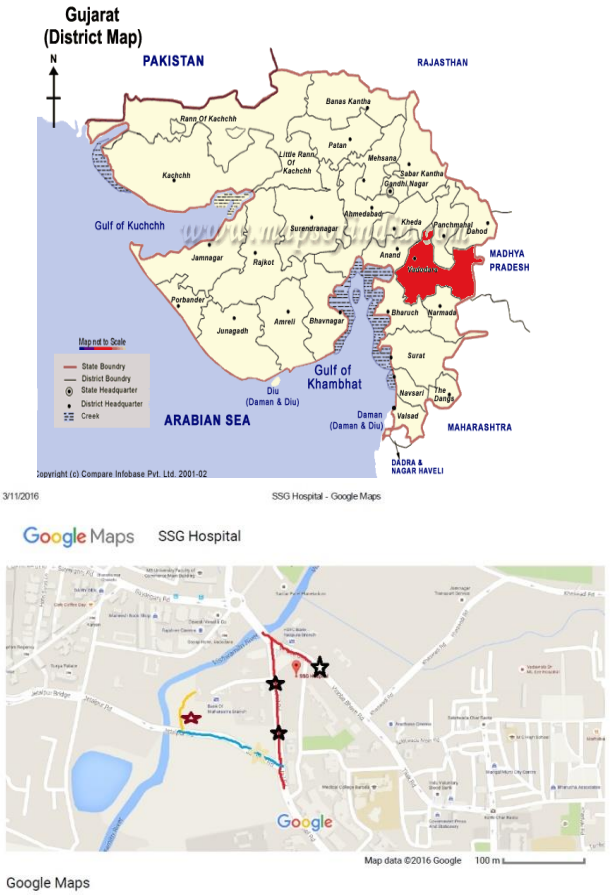


Figure 1. Areal View of Site (Courtesy Google Map)

D. Data Collection

Parameters for regression analysis

a) Traffic volume
b) Spot speed of each category of vehicles
c) Noise level
d) Atmospheric temperature
e) Pavement surface temperature
f) Relative humidity

Figure 2. Actual Photo of Instruments Used For Data Collection

- **Vehicle Count**

The vehicle count was done for various classification of vehicles based on the Indian Roads Congress guidelines given in IRC:9-1972 for the full time period of 12 hours at each measurement time on both sides of the road

- **Spot Speed of Vehicle**

The uninterrupted free flowing speed of each category of vehicles was recorded in a separate form by using a hand held speed radar gun (Bushnell make) in kmph. This speed radar gun was also placed on the berm portion of the road.

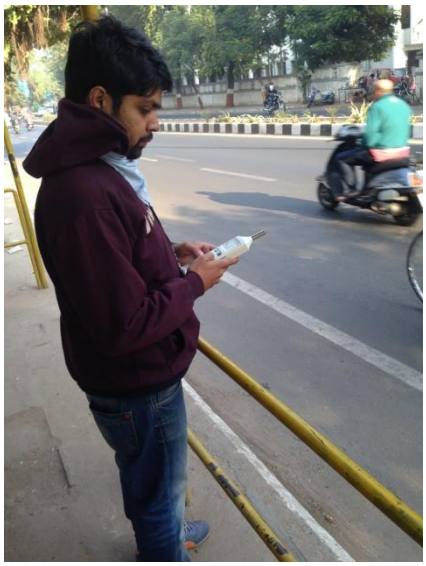
- **Road Surface Temperature**

Pavement surface of the Arterial Road is flexible Pavement. Pavement Surface temperature is dependent

on type of weather. Here in this study pavement surface temperature is a one parameter of creating model and pavement surface temperature is measured by temperature infrared gun (Frontier DT5200).

- **Noise Measurement**

The Sound Level Meter (SLM) with a wind screen was placed on a tripod at a distance of 1.50m from the existing road edge at a height of 1.20m from the existing road level. The noise levels created by each category of vehicles were recorded manually in a separate form using the sound level meter (SL 4005,METRAVI) in decibels.



- **Atmospheric Temperature**

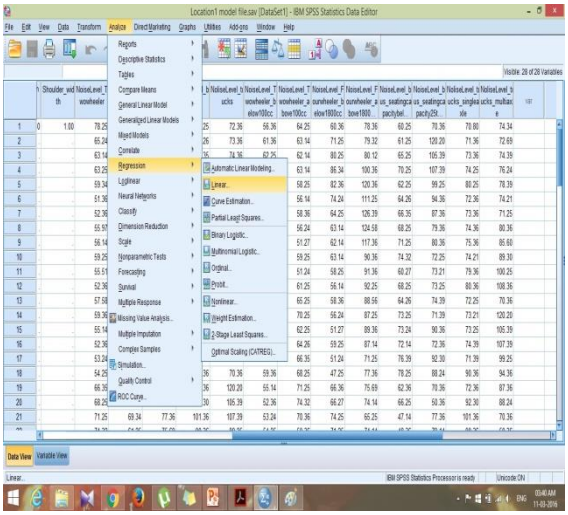
Atmospheric Temperature Is A Measure Of Temperature At Different Levels Of The Earth's Atmosphere. It Is Governed By Many Factors, Including Incoming Solar Radiation, Humidity And Altitude. Here In This Study Atmospheric Temperature Is One Of The Parameter For Making A Model In This Study Atmospheric Temperature Is Measured By Application Which Is Sync With Indian Meteorological Department.
(http://www.imdaws.com/viewawsdata.aspx)

- **Humidity**

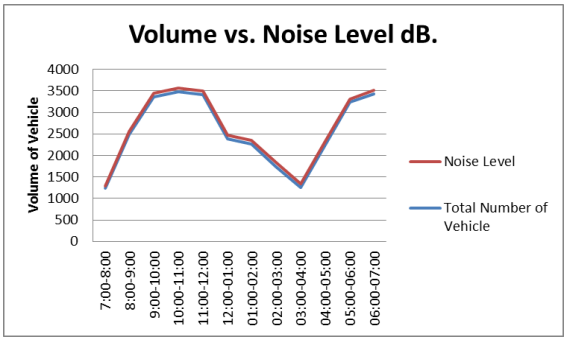
Humidity Is The Amount Of Water Vapour In The Air. Study Shows The Amount Of Humidity Affects The Equivalent Noise Level In The Particular Area. Here In This Study Humidity Is Also One Of The Parameter Of Making A Regression Model. And Humidity Is Measured By Application Hygrometer And Calibrate With Indian Meteorological Department Data With Particular Time.

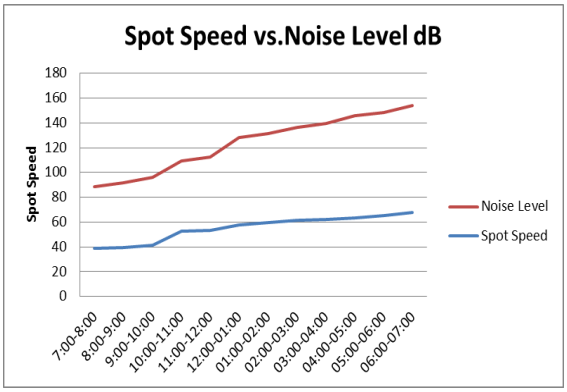
- **Data Analysis**

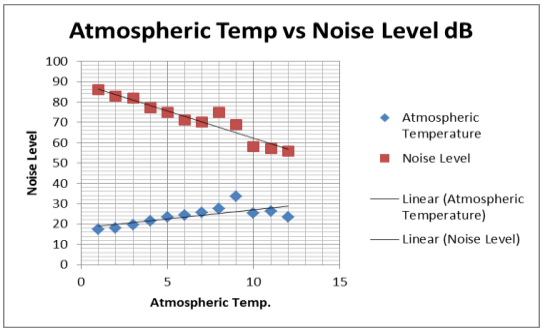
Collected data is fit in to the software name SPSS software (Statistical Package for the Social Sciences.)

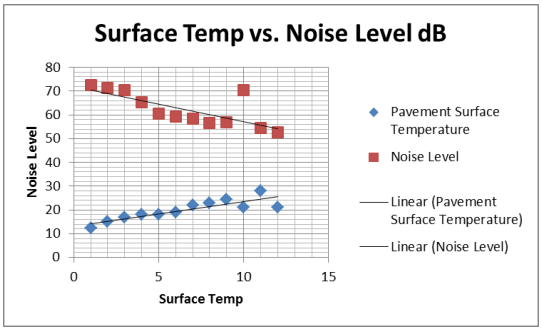


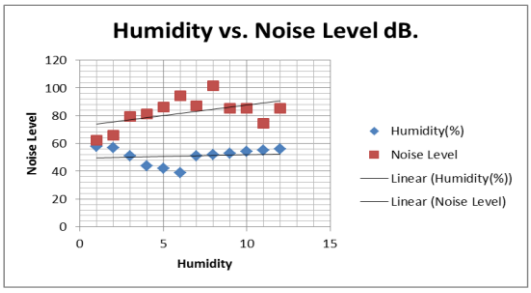
Software view of Data in SPSS Software











- **Model Formation**

Model for Arterial Road

S/N	Category of Vehicle	Individual Noise predicting Model
01	**Two Wheeler** displacement upto 80cc	**Leq(two wheeler) =135.628+ (-0.02)A+(0.09)B+(0.963)C+(0.589)D+ (-0.2911)E**
02	**Two wheeler** displacement more than 80cc	**Leq(two wheeler) =177.037+(0.015)A+(0.378)B+ (-3.131)C+(4.116)D+ (-5.355)E**
03	**Three wheeler**	**Leq(three wheeler) =106.455+(0.007)A+(-0.051)B+ (-0.704)C+(1.961)D+(-2.374)E**
04	**Four wheeler** less than 1600cc	**Leq(four wheeler) =233.955+(0.018)A+(0.254)B+ (-3.032)C+(4.886)D+(-7.324)E**
05	**Four wheeler** more than 1600cc	**Leq(four wheeler) =233.229+(0.006)A+(0.505)B+ (-3.319)C+(80259)D+(-7.536)E**
06	**Bus** Seating capacity in between 25	**$L_{eq(bus)}$ =143.525+(0.001)A+ (-0.355)B+(1.128)C+(1.579)D+ (-3.556)E**
07	**Bus** Seating capacity between 25-55	**Leq(bus) =503.588+(0.028)A+(1.913)B+ (-2.607)C+(9.811)D+ (-19.438)E**
08	**Trucks** Single axle	**Leq(truck) =85.742+(0.04)A+(0.631)B+(-0.208)C+(0.969)D+ (-1.600)E**
09	**Trucks** multi axle	**Leq(truck) =-22.257+(0.004)A+(-0.010)B+(0.481)C+(-1.453)D+ (3.101)E**

Model for Sub Arterial Road

S/N	Category of Vehicle	Individual Noise predicting Model
10	**Two Wheeler** displacement upto 80cc	**$L_{eq(two\ wheel)}$ =-22.257 +(0.004)A+(-0.010)B+(0.481)C+(-1.453)D+ (3.101)E**
11	**Two wheeler** displacement more than 80cc	**$L_{eq(two\ whheel)}$ =62.828+(0.003)A+(-0.054)B+(-2.951)C+(0.923)D+ (1.080)E**
12	**Three wheeler**	**$L_{eq(3\ wheel)}$ =45.098+(0.004)A+(0.217)B+ (-2.575)C+(0.587)D+ (1.074)E**
13	**Four wheeler** less than 1600cc	**$L_{eq(4\ wheel)}$ =45.098+(0.004)A+(0.217)B+(-2.575)C+(0.587)D+ (1.074)E**
14	**Four wheeler** more than 1600cc	**$L_{eq(4\ wheel)}$ =98.298+(0.007)A+(0.447)B+ (-1.349)C+(0.841)D+ (-1.710)E**
15	**Bus** Seating capacity in between 25	**$L_{eq(bus)}$ =88.235+(-0.005)A+(0..252)B+ (-5.169)C+(4.722)D+ (0.496)E**
16	**Bus** Seating capacity between 25-55	**$L_{eq(bus)}$ =108.289+(0.00)A+(0.236)B+ (-1.459)C+(1.268)D+ (-3.251)E**
17	**Trucks** Single axle	**$L_{eq(truck)}$ = 226.532+(0.003)A+ (-0.124)+(1.327)C+(-0.273)D+ (-4.525)E**
18	**Trucks** multi axle	**$L_{eq(truck)}$=30.072+(0.003)A+(-0.067)B+(-0.231)C+ (-0.482)D+ (1.396)E**

Model for Collector Road

S/N	Category of Vehicle	Individual Noise predicting Model
19	**Two Wheeler** displacement upto 80cc	**$L_{eq(two\ wheel)}$ =58.684+(0.003)A+(0.008)B+(0.481)C+(-2.819)D+ (1.184)E**
20	**Two wheeler** displacement more than 80cc	**$L_{eq(two\ whheel)}$ =120.865+(0.00)A+(-0.107)B+(1.341)C+(-0.242)D+ (-2.505)E**
21	**Three wheeler**	**$L_{eq(3\ wheel)}$ =74.963+(-0.004)A+(-0.203)B+(-2.493)C+(2.328)D+ (0.76)E**
22	**Four wheeler** less than 1600cc	**$L_{eq(4\ wheel)}$ =123.139+(-0.07)A+(-0.132)B+(-1.824)C+(1.355)D+ (+1.421)E**
23	**Four wheeler** more than 1600cc	**$L_{eq(4\ wheel)}$ =306.073+(0.003)A+(0.589)B+(-4.126)C+(8.006)D+ (-8.708)E**
24	**Bus** Seating capacity in between 25	**$L_{eq(bus)}$ =143.525+(0.001)A+(-0.355)B+(1.128)C+(1.579)D+ (-3.556)E**
25	**Bus** Seating capacity between 25-55	**$L_{eq(bus)}$ =187.647+(0.006)A+(-0.007)B+(-1.870)C+(0.970)D+ (-2.477)E**
26	**Trucks** Single axle	**$L_{eq(truck)}$ = -79.778+(0.004)A+(0.289)B+(1.845)C+(-3.303)D+ (4.957)E**
27	**Trucks** multi axle	**$L_{eq(truck)}$ =-39.699+(0.002)A+(0.783)B+(-0.0887)C+(-2.018)D+ (4.294)E**

E. Model Validation

The new estimated was then compared with the measured values to investigate the accuracy of eq (3). ($R2$) value of 0.9165, which is acceptable. ($R2$) value of 1.0 is considered to be the best fit, where as any value above 0.7 is considered to be good. Also coefficient of determination ($R2$) for the regression line of new estimated $LdB(A)$ is comparatively higher than the previous one. Highly significant at 95%of confidence level.

III. RESULTS AND DISCUSSION

The Following Results Were Obtained From The Graphs

a) The noise level **increases** with increased total number of vehicles.
b) The noise level **increases** with increase in speed of vehicles.
c) The noise level **decreases** with increased atmospheric temperature.
d) The noise level **decreases** with increased surface temperature.
e) The noise level **increases** with increased humidity.

Existence Status Of Noise Levels In The Study Area.

Types of Road	Location	Maximum Noise Level
Arterial Road	Location 1(Jail Road To Station Road)	82.56dB
Arterial Road	Location 2(Dandiya Bajar To Jail Road)	110.85dB
Arterial Road	Location 3(Kothi To Station Road)	76.24dB
Sub Arterial Road	Jetalpur bridge to alkapuri	72.25dB
Collector Road	Hotel surya palace to vadodara stock exchange	70.29dB

Mitigation Measures

1) Grow Trees By Pattern Like At The Distance Of Every 15 Meters On Edges Of The Road Both Sides.
2) Using Of Sound Absorbing Material While Construction Of Building Like Educational And Hospital Buildings.
3) If There Is More Noise Than A Maximum Limit We Can Change The Routes From Affected Area. (diverting a traffic)

IV. CONCLUSION

Noise pollution is emerging as an environmental problem in Vadodara City and also other parts of India. This can cause negative impact on public health and welfare. Considering the above aspects, we can conclude that noise dominates the spectrum of environmental noise. The people staying in noisy area especially above 70 dB(A) should take precautionary measures in order to avoid noise induced hearing loss. This study has led to the following conclusions:

- The sources of noise pollution varied from places to place.
- The sound pressure level was maximum i.e., 110.85 dB at Location 2 Arterial Road.
- In all the places, above 110 db sound was recorded. Hence sound becomes physically painful.
- Traffic density was also high in peak hours at all the twenty locations.
- Noise pollution has quantifiable negative effects on people. However acoustic sound masking and other acoustic treatments can eliminate or ameliorate these problems in a sustainable and cost effective manner. It is very essential to control noise at source, along the transmission path and at receivers end by using the remedial measures.

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