I J C T A, 9(9), 2016, pp. 3951-3957

Modeling for Noise Levels Using Linear Regression Analysis

Dasarathy A. K.[1] **and S. Karthikeyan**[2]

ABSTRACT

Pollution from different sources affects peoples around environment. This paper deals with a simple case study presenting a regression analysis for noise levels generated from different sources in Chennai, Tamil Nadu, India. Two sets of Leq noise levels were recorded from selected places at an intersection near National Highway 4 were (97.9dBA and 98.9dBA) and other district road near Avadi was (56dBA and 57.8dBA). The data set consists of around 2500 measurements measured on two days. Apart from collecting noise data we have collected some of the noise producing parameters like speed of vehicle, mode of vehicles and distance of measurements. The first set data is used for prediction of noise levels show a variance of ±1.18% dBA for the developed Leq model. The second set of data is used for validating the above model which shows an adoptability of around 95% on predicting noise levels. The developed model can be used in traffic stream to predict noise levels.

Key words: noise pollution, regression model, noise level prediction, measurement, comparison

1. INTRODUCTION

Pollution is a disturbance to the human in environment and is escalating at such a high rate that it will become a major threat to the quality of human lives. Out of all pollution around environment noise is predominantly scene in all areas, especially in urban areas, has been increasing rapidly during the last few decades. There are numerous effects on the human environment due to increase in noise pollution, especially leading to physiological and psychological deterioration to human beings. The detection of road traffic noise as one of the main source of environmental pollution led to design models that can predict noise levels for designing for traffic needs. The traffic needs will aid for designing roads, change in traffic pattern and highways planning make people pay more and more attention to noise sevearity in terms of pollution [1].

Assessments of medium/long term prediction of urban traffic noise are of large importance for establishing environmental policy [2]. Noise pollution is one of the central issues of environmental pollutant in metropolitan areas and is almost one of the hurtful agents, and hence many countries have introduced noise emission limits for vehicles and suggested legislations to lessen the road traffic noise. In recent times some countries restricted rules for regulating and reducing urban road traffic noise.

The increase in land development the administrative agencies should find ways to control urban traffic noise and make long-term city planning on the basis of methodical noise level prediction. The recognition of road traffic noise as one of the main sources of environmental pollution led to design models that enabled [3] to predict traffic noise level. Study on prediction of urban traffic noise was carried out in some countries since 1970's [4]. A series of reports on traffic noise prediction of national scope have been published it is ideal time to predict the noise levels for Indian condition considering various parameters involved in noise generation.

[1] Professor, Department of Civil Engineering, Veltech Multitech Dr Rangarajan Dr Sakunthala engineering college, Avadi, Chennai 600062, India, *Email: pulikutty2000@yahoo.co.in*

[2] Assistant professor, Department of Civil Engineering, Veltech Multitech Dr. Rangarajan Dr. Sakunthala engineering college, Avadi, Chennai 600062, India, *Email: skarthikeyan.sel@gmail.com*

There were studies developed from fundamental variables such as the traffic flow, speed of vehicles and sound emission and other parameters [1 & 2] but the author predicted now consists of all parameters like speed of vehicles, mode of vehicles, no of pedestrians, total no of vehicles, accumulation of vehicles and delay timings.

2. NECESSITY OF PREDICTING NOISE LEVEL MODELS

The road traffic noise in India are based on the measurements taken from its source, the statutory authorities specifies Leq the equivalent noise levels as bench mark for identifying noise pollution levels. So if we develop a model that estimates Leq is applicable for predicting noise levels for other type of places. In existing situation in India here we have different road structure, mode of vehicle and clustered movement of traffic leads to develop a different model from other countries. The other models suggested by [1, 3, 4, 5, 6, 7, 8] were not suitable for prediction of road traffic noise in Indian condition. There is complete variation from the mode of transport starting from bicycle, two-wheeler, car, auto, LGV, HGV, bus and sometimes bullock carts [9, 10]. In this paper a statistical model for predicting-weighted equivalent level is proposed for the Indian condition. The objective of this study is to design a road traffic noise prediction model based on traffic variables.

3. PARAMETERS FOR PREDICTING NOISE LEVELS

Prediction process involves factors governing noise generated from its source. Usually it involves more factors like volume of vehicles, type of vehicles, speed of the vehicles, number of pedestrians, pavement width, surface of pavement, height of building from road way etc [3]. The list is enormous that contributes to the generation of noise among the humans. Measuring all the variables for predicting road traffic noise is difficult and it takes a long time. Therefore in this paper a compact model consisting of seven variables were taken to obtain a prediction of noise level. The purpose of this study is to introduce a compact road traffic noise model from traffic variables for the traffic conditions of the city like Chennai. The writers have suggested the basic parameters such as volume of vehicles, type of vehicles, distance of the source of sound from the observation point and speed of vehicles as exploratory factors to predict equivalent sound level.

4. STUDY AREA

The study area was chosen in such a way as to replicate a real life situation. The human interfaced area was selected as follows and the same is shown in Figure. 1:

Traffic noise is recorded at National Highway 4 near ORR (outer ring road).

- Traffic noise again recorded at ODR(other district road) near Avadi

5. DATA COLLECTION

In order to predict noise and get sufficient noise information from the above selected places the observations which were as follows.

- The noise levels were recorded from morning 10.00 AM to 18.00 PM at an interval of 10 sec on two days at both locations.
- Total volume of vehicles for the entire period was recorded.
- Number of vehicles/Hr according to the type of vehicle such as bus, car, two-wheeler, auto, LGV, and HGV)
- Speed of the vehicle by using radar Speedo gun method.
- Noise measurements were taken at distances of 1.10 from the nearest road border

Figure 1: Field measurement of noise level at NH4

- The height of noise measurement was 1.40 m above the road surface.
- No of pedestrians crossing the point at the time of survey were counted
- The total no of vehicles that are accumulated on the traffic were counted
- The delay time due to accumulation of vehicles were noted.

It was understood that only these contribute to the generation of road traffic noise.

6. EQUIPMENT

An important part of the noise assessment was the actual measurement of the noise levels. The "A" weighted network was used as it corresponds very closely to a person's hearing sensitivity. The noise level at two locations were measured with the help of HTC make Sound Level Meter (3241 – c type II data logger) on a digital display type.

7. PREDICTING AND DEVELOPING THE MODEL BASED ON THE VARIABLES

With the contributing parameters, the urban traffic noise pollution for the whole city could be predicted as described below.

The option of prediction models could be divided into two steps: first to find out the prediction function which is a dependent variable y secondly select independent variable x_1, x_2, x_3, etc., which are helpful to solve dependent variable. Here we have considered Leq as dependent variable which a noise level indicator and parameters such as traffic volume, vehicle's type, and driving speed were independent variable that means to set up a relationship between traffic noise levels. Once the values of y were determined, the prediction could be arrived. As the traffic noise pollution was not the same as other types of pollution, the multiple linear regression method was the best suitable method, since traffic varied statically. The situations of traffic noise pollution in the future could be predicted using the obtained regression equation [9]. All of the collected data were entered in the statistical sheet of Excel and SPSS software. Multiple linear regression models were applied to develop a new model for Chennai city. The correlation between independent variable and dependent variable and the cases considered is presented in Table 1.

8. RESULTS

The developed model has most promising doorway variable for estimation of traffic noise (Leq). Eight groups of independent variables were considered to assist the dependent variable Leq in the model. This designed model could predict Leq at distances of about 1.10 m from the roadside edge. There were other models described the modeling of noise pollution and prediction of noise Leq. The models suggested by the several authors are shown in Table 2 and a comparison was drawn. Considering the prevailing situation the model suggested by the writer was fit for all condition of road traffic existed in country like India. Here

Table 1
Variables used and their respective representation

Sl. No	*Location*	*Case considered*	*Dependent variable*	*Independent variable*
1		X1 to X5		Mode of Vehicles – Car/LCV/Two-wheeler /Bus/HCV
2				
3	National Highway 4 and ODR	X6 to X10	Leq	Average Speed of all type of vehicles (Car/LCV/Two-wheeler/Bus/HCV
		X11		Total Volume / hour
4		X12		Distance of measuring noise from its source
5		X13		No of pedestrians /hour
6		X14		No vehicles accumulated
7		X15		Delay time due to accumulation of vehicles
8		X16		All the above parameters

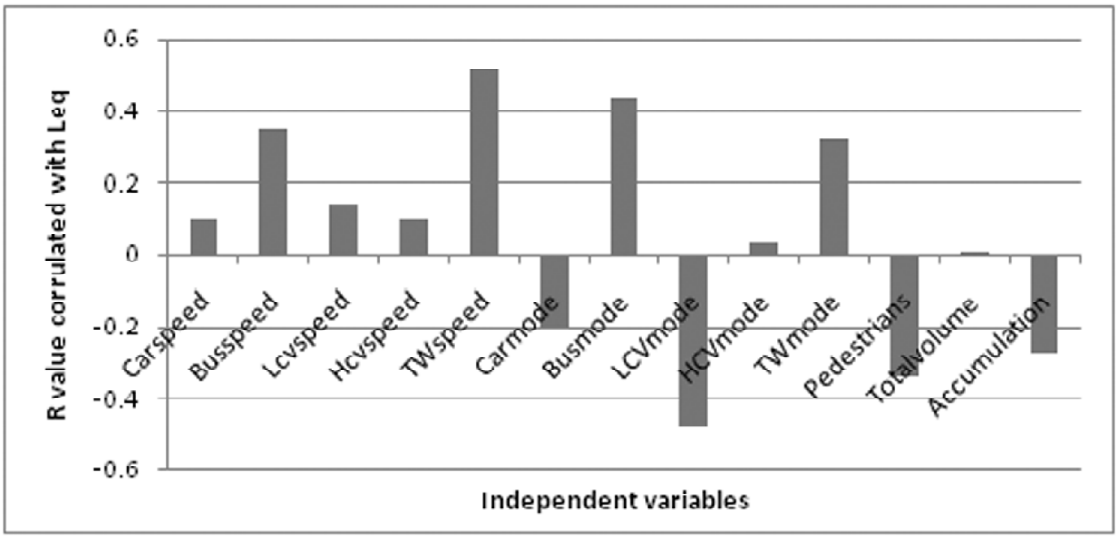

Figure 2: R value corresponds to Leq value

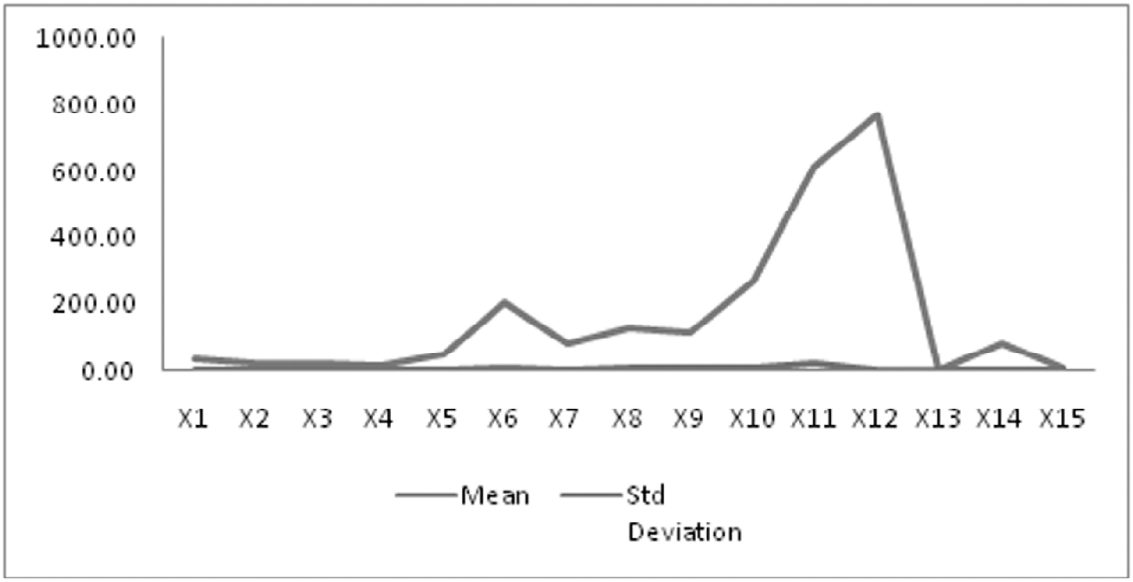

Figure 3: Descriptive statistics of all the variables

pattern of traffic was not uniform and the mode of transportation varied from public transportation vehicles to private transportation. The share of private transportation was about 70% of total volume [10]. The results are shown in figures and tables. Figure 2 shows the R value corresponding to Leq value and Figure 3 shows the descriptive statistics of all the variables.

The regression analysis predicted the mean Leq was 98.11 ± 0.65% dBA of the average value 98.4dBA. The results showed that R value for Leq was in the range of-0.48 to 0.52 for all independent variables. The regression model developed had 15 independent variables and one dependent variable of about two sets each. The Figure 2 showing the dependency of Leq on independent variable. The R value for HGV was found to be 0.1 on speed criteria and 0.32 on no of vehicles. Similarly in bus criteria and t/w show a value of 0.35 and 0.44, 0.51 and 0.38 respectively. The significance of the values were so close to zero level show a good amount of Leq contribution. So the noise is exhibited on the road show volume of trucks, buses and two wheelers were a major contributor of noise polluter. The equation for noise prediction is presented below and shows as a sample for one and two variables.

Case 1 (Independent variable as Speed of Bus)

$$y = a + bx_1$$

where y = dependent variable (Leq)

a and b are the coefficients and

x_1 = Independent variable (number of cars)

$y = 42.35 - 0.0222x_1$ where R value is 0.443

Similarly, if two sets of Independent variable (number of bus and speed of bus) were considered,

$$y = a + b_1x_1 + b_2x_2$$

where y = dependent variable (Leq)

a and b are the coefficients

x_1, x_2 = Independent variable (number of cars and speed of car)

$y = -2.1250 + 0.053x_1 + 2.034x_2$ where R value is 0.3542

The predicted and observed value is shown in Figure 4.

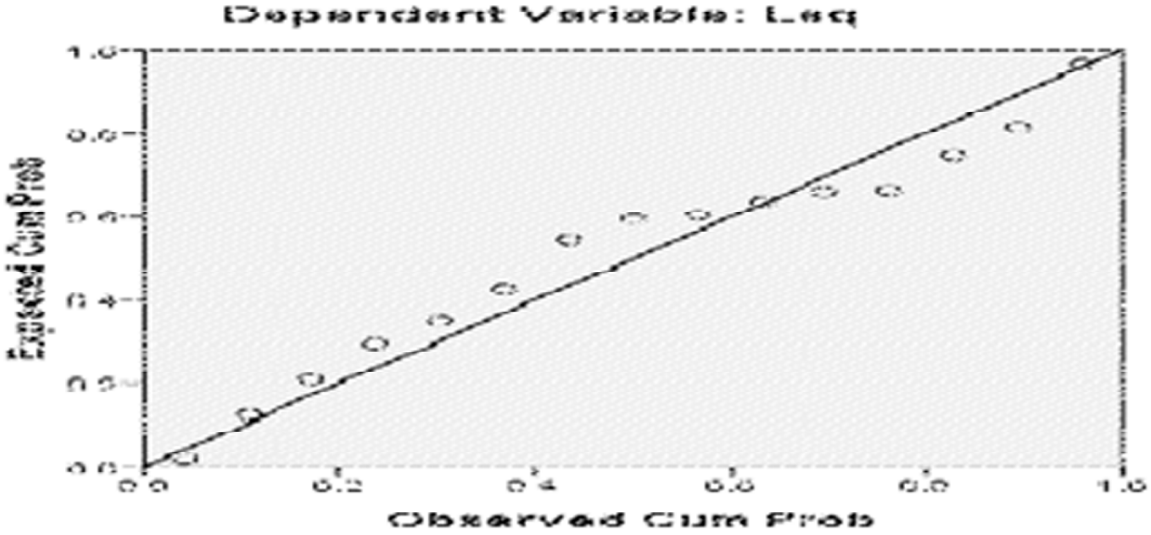

Figure 4: Distribution of predicted Leq and measured value

It shows a residual statistics of about 96.10 dBA minimum and 99.10 dBA maximum with a difference of about -.89 dBA to 0.71 dBA was obtained.

The figure 4 showing the distribution of predicted Leq value to observed value. The predicted model has the best distribution of ± 0.65% dBA. So the model developed by the authors show a residual R2 value as 0.143. which is close to zero show a good response to the variables used for prediction. It is ideal to validate the model with the other studies that were conducted worldwide and the presentation is presented in Table 2.

The models developed by different authors show prediction based on certain independent variables and use software or analytical method for predicting the noise models. The traffic pattern is not uniform in all the cases and they were not considering all aspects in generation of noise pollution. It is complex nowadays that the traffic is heterogeneous and the growth of vehicles is excessive. So to predict certain element in traffic multiple linear regression analysis is most common method adopted in developing models for traffic study. The present study used a simple method of regression model for predicting traffic noise level Leq. The correlation also has a good range of R value for predicting noise level. The authors focused on developing a suitable model for noise prediction in certain places in Chennai. The model developed can be used for prediction of noise levels in congested city like Chennai. There are certain limitations on adopting this model like the noise meter has to be placed at a distance of about 1010m from the source.

Table 2
Comparison predicted model with other developed models

Authors list based on the references given	*Variables used*	*Analtical or software*	*Value of Mean*	*Value of Standard deviation*	*Approximate estimation of differences*
1	Mean speed, number of vehicles in different types, distance	Analitical	69.69	3.45	0.365
3	Mean speed, number of vehicles, number of trucks, distance	Analitical	68.27	3.81	-0.77
4	Traffic flow, population near, distance,	Analitical	72.3		±0.10 to -1.30
5	Spot speed, type of vehicles, distance	Analitical			±10.91 dbA
6	Total vehicles, mean speed of vehicles, barriers provided, etc,	Software	75.2	4.8	±2.3
7	Light vehicle, heavy vehicle, mean speed of vehicle, number of lanes etc.	Software			±1.0 to 2.0 dbA
8	Growth of vehicles	Analitical		R^2 = 1 to 0.7	
Present study	Total volume of vehicles, Mode of vehicles/Hr, Spot Speed distance, no of pedestrians, accumulation and delay timings.	Software		R = ±0.48dBA to 0.52dBA	

9. CONCLUSIONS

Predicting noise pollution is need of the hour and its utilisation on the traffic pattern is very important. We have developed mathematical model for predicting noise level Leq based on certain criteria which are the sources of noise pollution. Here we have considered about 16 independent variables which influences noise pollution. The R value show a variance of about ±0.48dBA to 0.52dBA on a macroscopic scale and the applicability of its predicted value are showing difference of about -0.89 dBA to 0.71 dBA. The noise data collected is for present year but it is not uniform to the coming years. It is only a disadvantage of using the model developed by the authors. The mathematical expressions conceived by the authors considering

open traffic flow in prevailing condition. Hence negelcting the disadvantage and considering other aspects of sound absorbing aspects, age of vehicles and seasonal representations can be applid to develop a scientic model.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the contribution of Govt. of India for Financial Assistance, DST-FIST F.NO:SR/FST/College-189/2013

REFERENCES

[1] Golmohammadi, R., Abbaspour M., Nassiri, P., and Mahjub, H**.,** (2007), "Road Traffic Noise Model, "Journal of Environmental Health Science and Engineering, Vol. 7, No. 1, pp. 13-17.

[2] Dasarathy, A.K. & Thandavamoorthy, T.S. 2014 "Noise Reduction Using Concrete Barriers: A Case Study", International Journal Earth Sciences and Engineering, vol. 7, no. 4, pp. 1449-1452

[3] Golmohammadi, R., Abbaspour M., Nassiri, P., and Mahjub, H., **(**2009), "A Compact Model For Predicting Road Traffic Noise," Journal of Environmental Health Science and Engineering, Vol. 6, No. 3, pp. 181-186.

[4] Fan Dan-Qun, Liu Ke and Chen Qian, (1989), " Prediction and Evaluation of Pollution of Urban Traffic Noise in China," Science in China Series A, Vol. 32, No. 1, pp. 93-100.

[5] Sooriyaarachchi, R.T. and D.U.J. Sonnadara, (2008), "Modelling Free Flowing Vehicular Traffic Noise," Journal of Institution of Engineers, Vol. 40, No. 2, pp. 43-47.

[6] Anon., (2010), " Proceedings of 20th International Congress on Acoustics, ICA 2010 23-27 August 2010, Sydney, Australia Peter Karantonis et al, " Further Comparison of Traffic Noise Predictions Using the CadnaA and SoundPLAN Noise Prediction.

[7] Al-Mutairi.N, Al-Rukaibi.F and Koushki.P (2009), "Measurements and Model Calibration of Urban Traffic Noise Pollution "American Journal of Environmental Sciences, Vol. 5, No;. 5, 613-617, ISSN 1553-345.

[8] Dinesh Kumar, R., Mathivanan, V., Ponmaran, P., and Pradeepraj, V., (2012), "A Case Study of Traffic Noise in and around Melmaruvathur, A Project Report, Anna university

[9] Saxena, S. C., (1989), "A Course in Traffic Planning and Design," V. Nemichand and Bros., Roorkee, first edn.

[10] Staff Reporter, (2013), "City's Transport Network," The Times of India, Vol. 6, Issue 299, December 18, pp. 1-2.