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Unraveling the Urban Symphony: A Holistic Investigation of Traffic Noise in Vijayawada City

Presented by

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Outline

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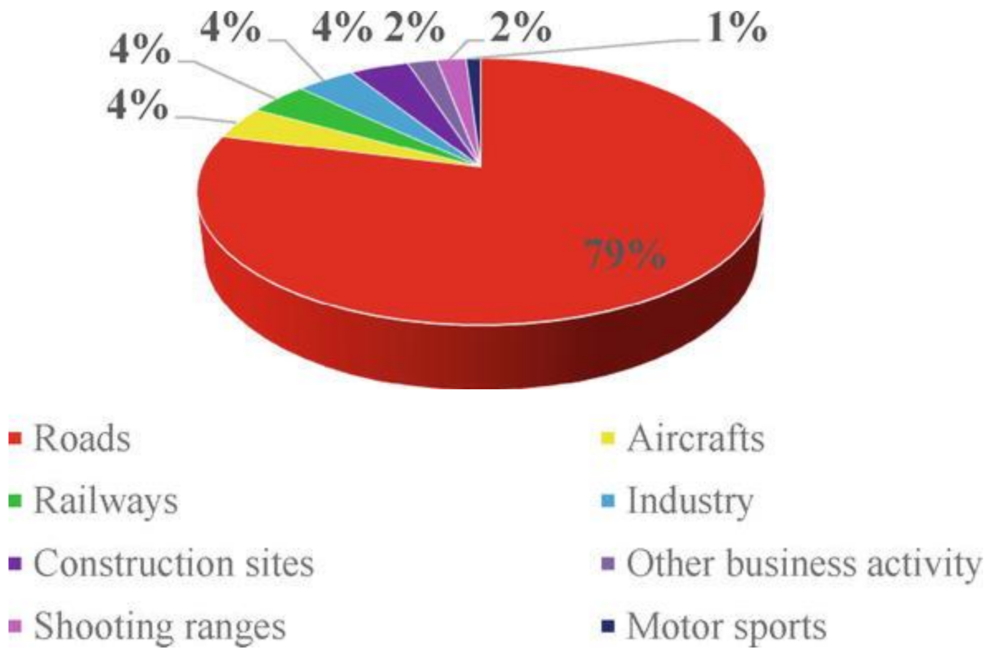
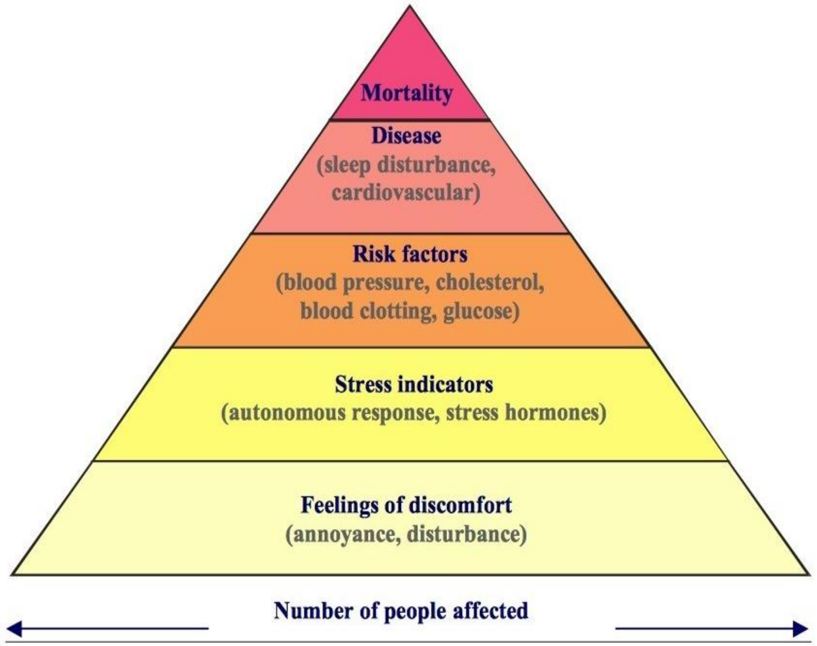
Introduction

- Rapid urbanization, migration and population growth induced demands exceed the carrying capacity of the cities and thus the existing urban infrastructure becomes insufficient.
- Since 1972, the World Health Organization (WHO) has declared noise third most hazardous environmental type of pollution.
- In urban areas, the concentration of both road networks and city dwellers makes of traffic flow the main culprit of noise annoyance (Jiang, 2020).



Source of Human Noise Annoyance in urban Areas
Source : Noise and Transport,2020.



Severity of Health Effects of noise and number of people effected.
Source : World Health Organization , 2017

Need of the study

- At present considering the seriousness, World Health Organization (WHO) emphasizes regulating traffic noise under certain limits to avoid adverse health effects caused by excessive noise (WHO, 2018).

Area Code	Category of Area/ Zone	Limit in dB(A) Leq*	
		Day Time	Night Time
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silence Zone	50	40

Fig : Noise limits in different land use zone. Source : Noise Pollution (Regulation and Control) Rules, 2000

- For Noise prediction, various types of conventional and mathematical models has been developed in various countries. But traffic conditions in developing countries like India differ greatly from those in developed countries (Kalaiselvi and Ramachandraiah, 2016).

- Indian cities embrace the heterogeneous and mixed traffic conditions with prevalence of Vikram (para-transit type),cycle and honking in the mixed traffic.

- Not only traffic volume but surrounding land-use and road geometry etc. other factors are the main contributors of Noise in urban areas particularly at intersections. Therefore, there is need to understand the direct and indirect impact of these parameters on Noise pollution by developing a noise prediction model based on the study area specific condition.

- There is a significant research gap in the field of noise pollution, particularly in tier-II cities like Vijayawada, situated in the state of Andhra Pradesh. Although some studies have monitored noise levels in Vijayawada, a comprehensive model for assessment is yet to be developed. In this research, a model utilizing structural equation modeling is developed to assess noise levels at signalized intersections.

- Thus, a comprehensive traffic noise model can assist authorities and planners in strategizing noise mitigation measures.

Aim & Objective

Aim –

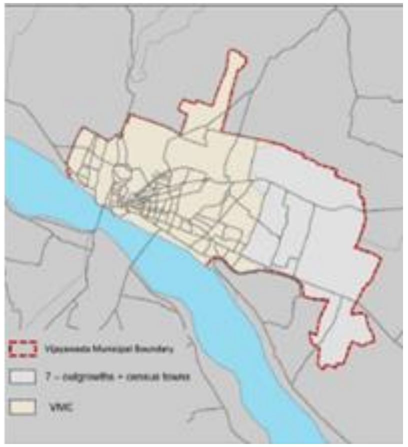
To develop a comprehensive noise model to determine the link between streamline flow parameters, Road geometry, Built Environment and noise Pollution.

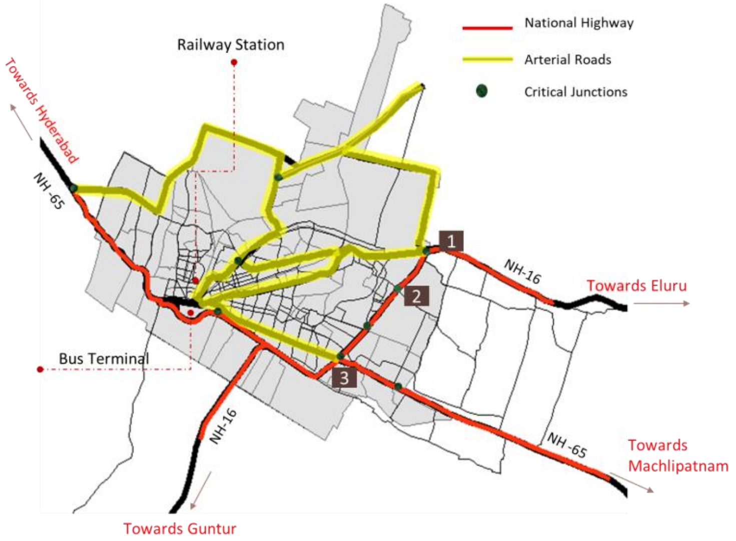
Objective -

To gain insights into the characteristics of traffic noise.

Identify the factors that contribute to noise pollution.

Case Area – Vijayawada (Andhra Pradesh), India

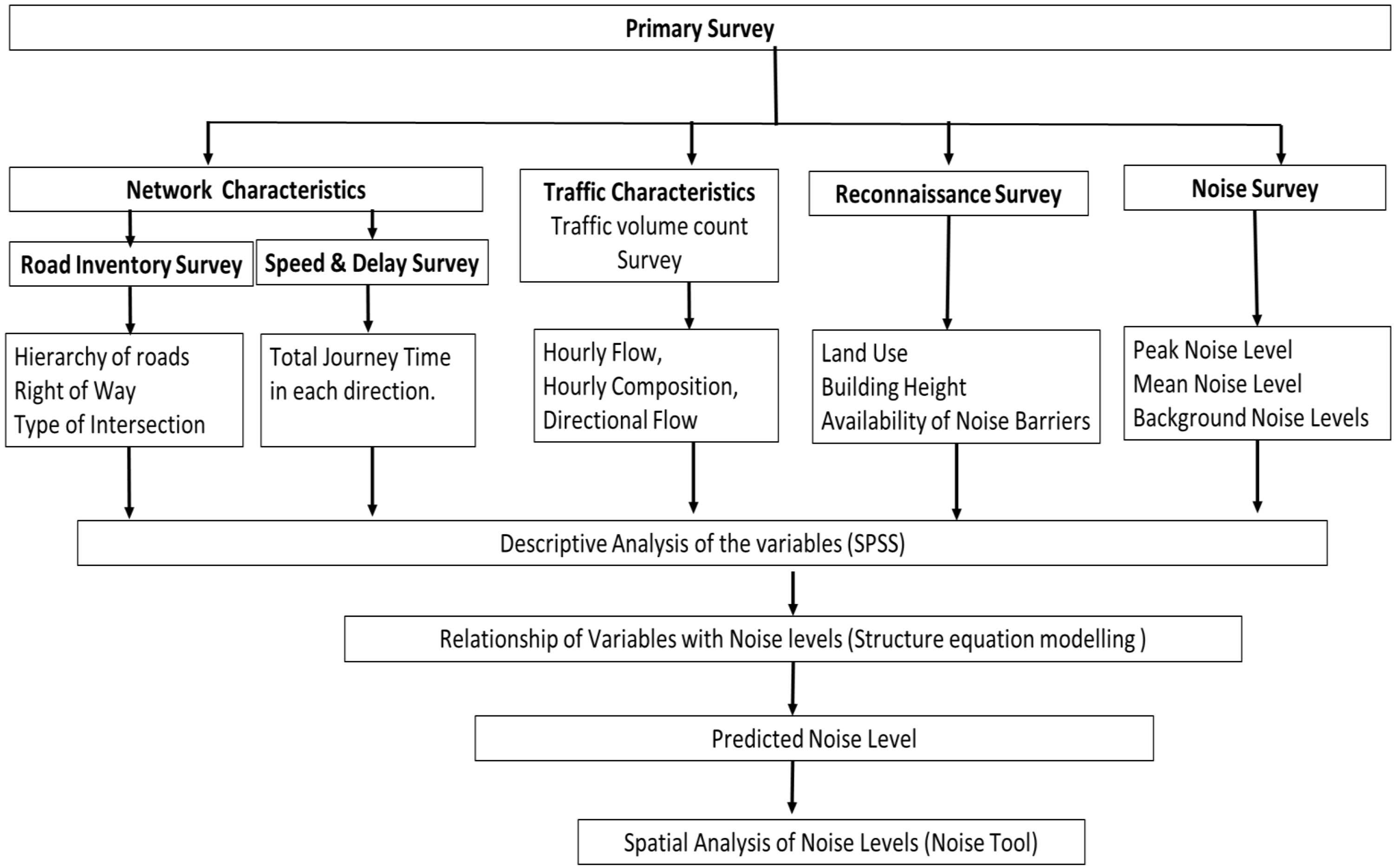




A comprehensive evaluation, integrating literature review and pilot study results, showed that noise levels significantly rise along National Highway NH-16 as it traverses the city, primarily due to the intermix of local and bypass traffic and development along the National Highway. These intersections, strategically chosen based on considerations of land use, traffic density, and prior noise monitoring studies.

Methodology

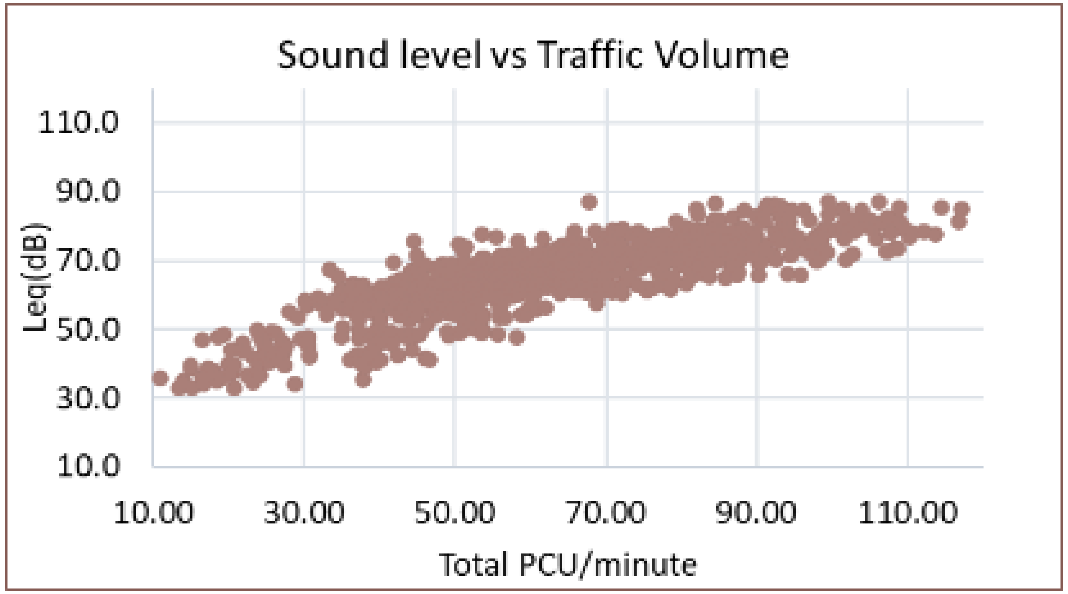
Survey was conducted during morning peak hours (8:00am to 10:00am), afternoon non-peak hours (12:30pm to 2:30pm), and evening peak hours (5:00pm to 7:00pm) at a 1-minute interval for one week (42 hours) as described in the methodology.

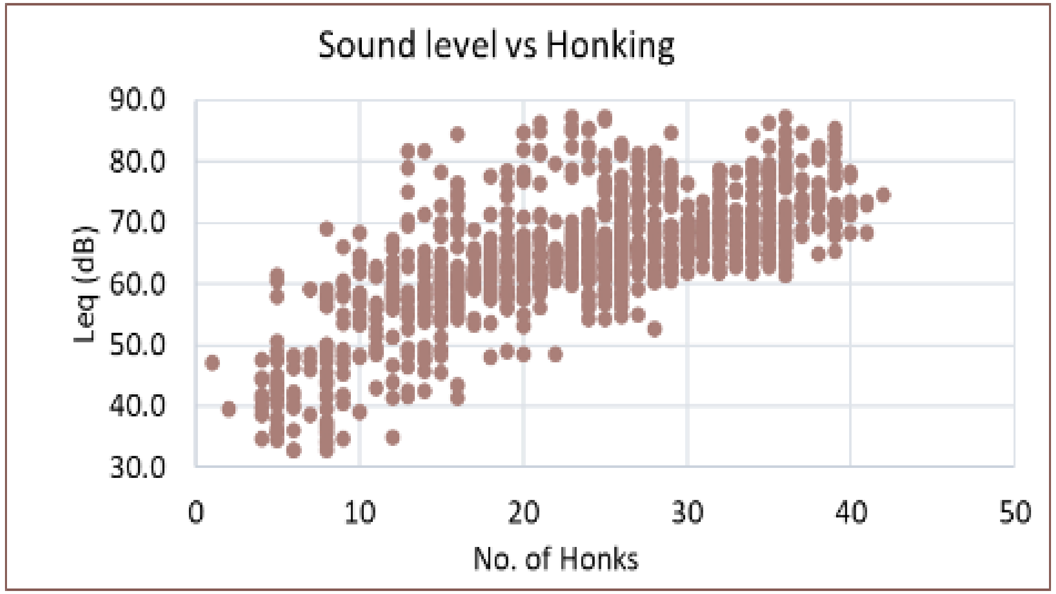


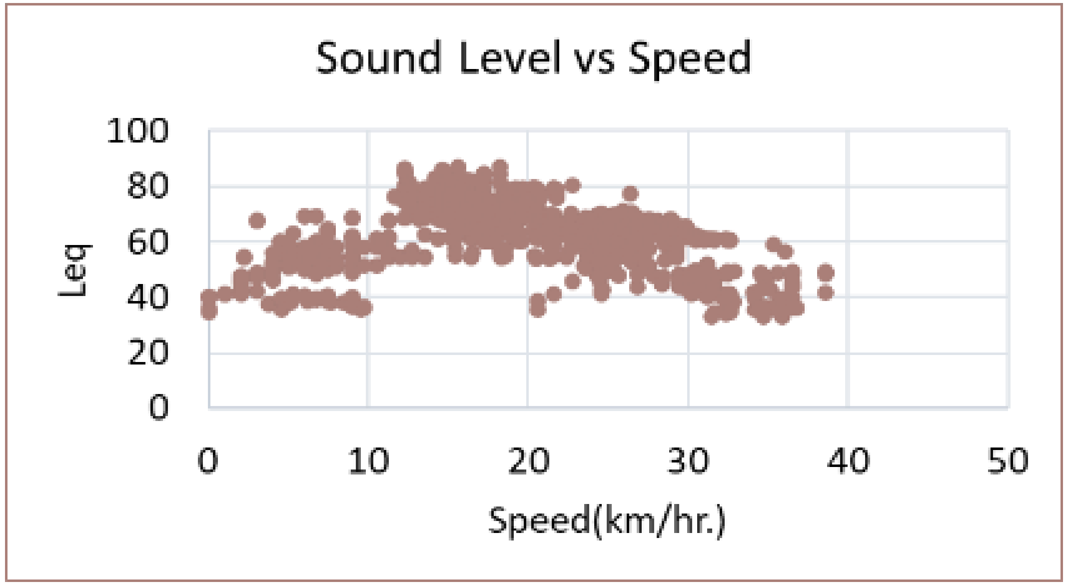
Survey	Method
Vehicular Turning Movement Count	Videographic Survey – For 1 min count according to signal Timings and CCTV Footage (Source – Command control center Vijayawada).
No. of Honks	Videographic Survey – (1 sec of Honking is considered as 1 count).
Free Movement	Traffic characteristics with respect to Signal cycle length.
Pedestrian Crossing Behavior	Non-Compliance Behavior of Pedestrians was found while Crossing during Green Time for each phase.
Queue Length (If any)	Length of queue is identified based on Signal Phase in each arm.
Reconnaissance Survey	Building height, land use, road inventory.

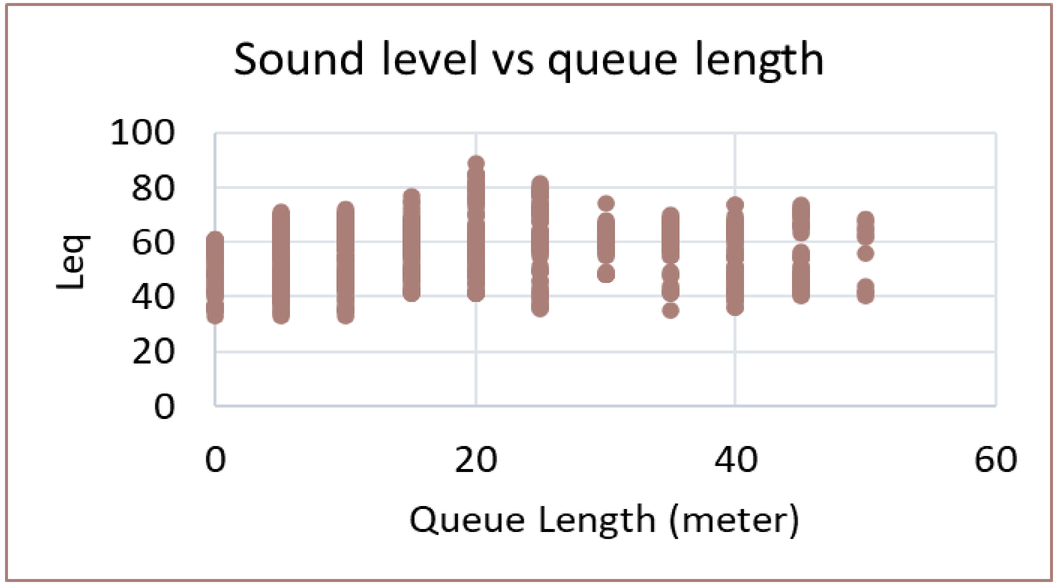
Noise levels from traffic were observed at the entry and exit points of the arm of junction using a noise level meter (Norsonic 140) positioned at a height of 1.5 meters above the ground

Survey Findings



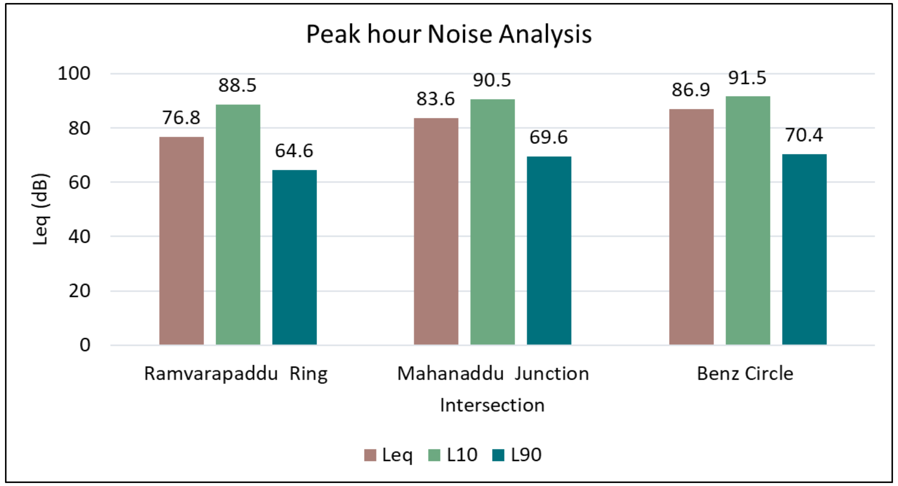


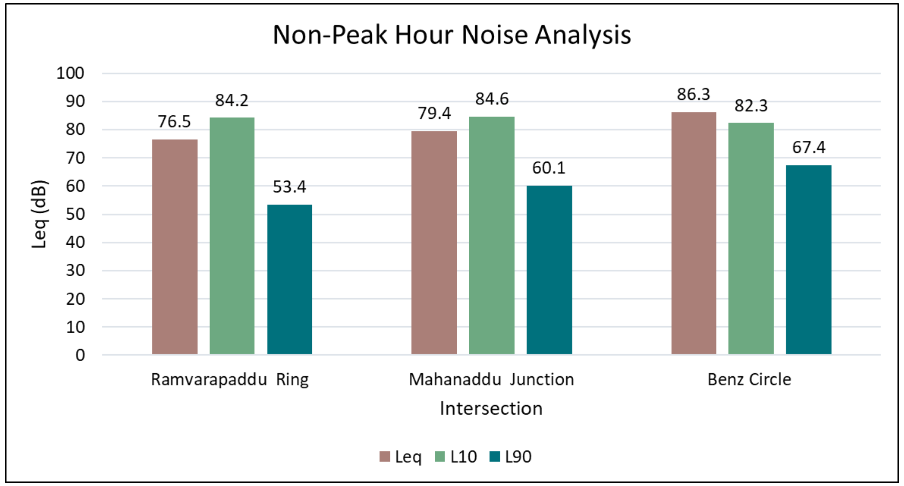




Analysis

Speed Analysis - Through microsimulation (using Vissim model), it was found that vehicles tend to have higher speeds at the exit arm compared to the entrance arm of the intersection. After leaving the intersection, vehicles experience an initial increase in speed, which then gradually decreases over time.





Additionally, Noise levels were indirectly affected by Traffic Flow through pathways involving Honking and average speed. Study found that reducing the speed limit from 30 mph to 20 mph resulted in a 3 dB decrease in noise levels, which is equivalent to cutting the perceived loudness of traffic noise in half.

Noise levels are 3-5dB lower during non-peak time shows the direct impact of decrease in traffic volume.

Structure equation modelling

S1	Define Individual constructs

Define the measured variables

S2	Devlop and specify Measurement model

Create measured variables with constructs and draw a path Diagram for measurement model using hypothethesis.

S3	Design the study to produce emperical results

Assess the adequacy of sample size and select the estimation method for missing data approach.

S4	Assessing measurement model validity

Using Goodness of Fit (GOF) indices to check the validity of model.

S5	Measuremnt model valid or not

If Yes > continue to step 6

If No > Refine measures and draw a new study

S6	Specify Structure Model

Convert measurement model to Structure model

S7	Assess structure Model validity

Assess the GOF indices, direction and size of the structural parameters estimated.

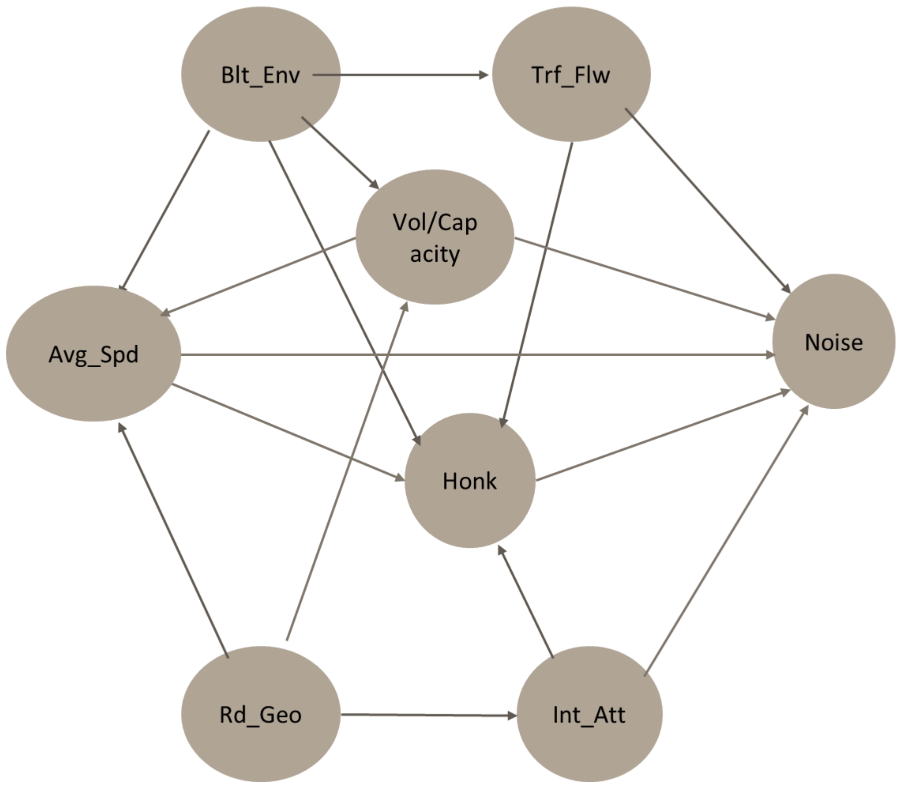
S8	Is structtural model Valid?

If Yes > Finish Draw the conclusion

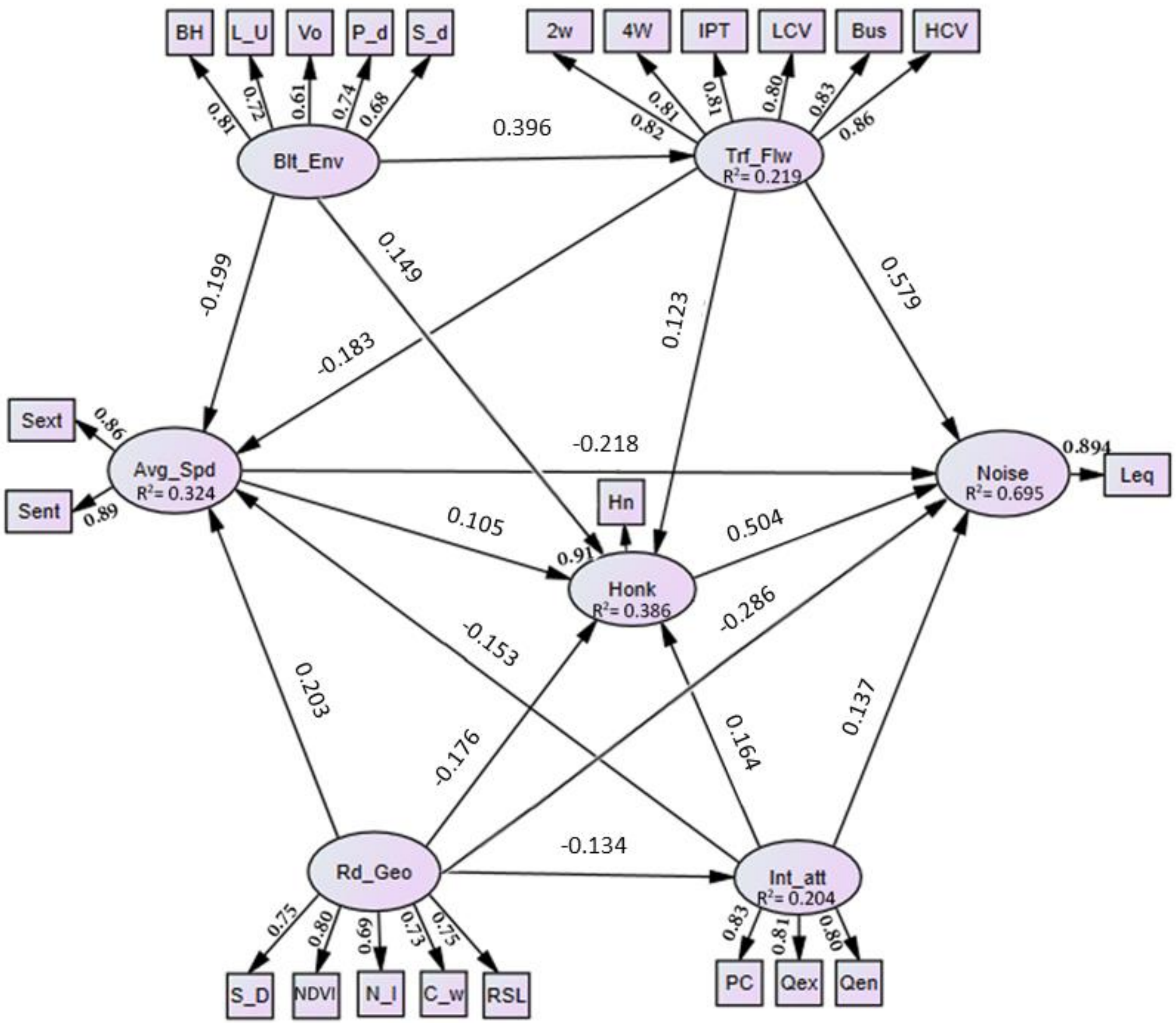
If No > Refine measures and draw a new study

Latent Variable	CR	AVE	Type
Trf_Flw	0.91	0.87	Endogenous
Blt_Env	0.73	0.64	Exogenous
Avg_Spd	0.89	0.73	Endogenous
Honk	0.90	0.86	Endogenous
Road_Geo	0.81	0.79	Exogenous
Inter_Att	0.85	0.80	Endogenous

CR – Composite Reliability, Prob = <0.001, AVE – Average variance Extracted



Structure equation modelling



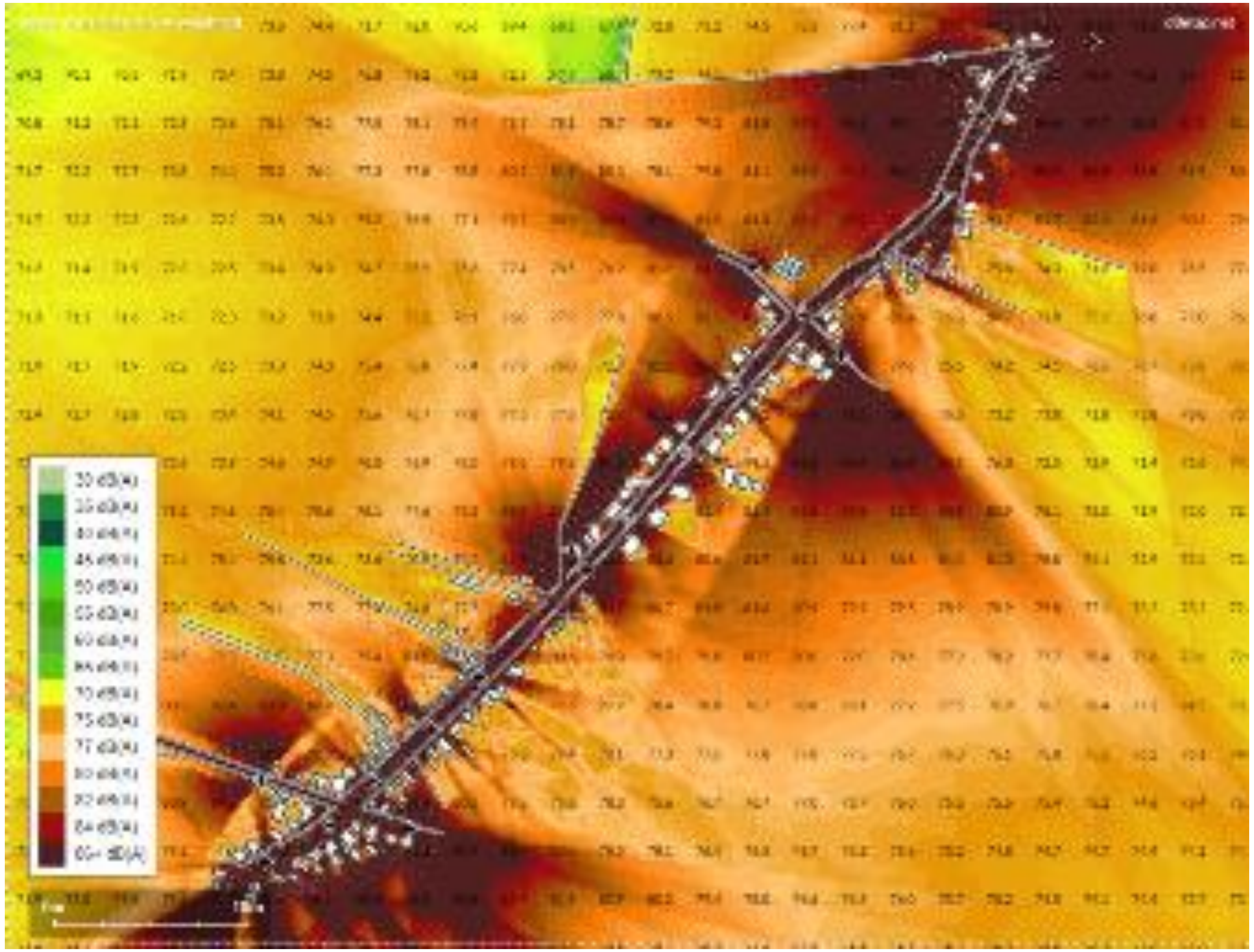
Factor	Direct effect	Indirect effect	Total effect
Traffic_Flow	0.579	0.116	0.695
Built_Env	0.000	0.382	0.382
Speed	-0.218	-0.052	-0.27
Honking	0.504	0.000	0.504
Road_Geom	-0.286	-0.171	-0.457
Intersec_attr	0.137	0.082	0.219

Table 8 : Direct and Indirect effect of the variables on the equivalent traffic noise.

Legend

Blt_Env = Built Environment
Avg_Spd = Average speed
Trf_Flw = Traffic Flow
Rd_Geo = Road Geometry
Int_att = Intersection Attributes
Vol/Capacity= Total volume per minute/total capacity of road.
BH = Building Height
L_U = Land use
Vo = Vehicle ownership
P_d= Pedestrian Density
S_d = Street Density
2W = % composition of 2 wheeler
4W= 4 wheeler
IPT = Intermediate public Transport
LCV = Light commercial Vehicle
Bus = Roadways and School Buses
HCV = Heavy commercial vehicles
Sext = Speed at exit arm
Sent = Speed at entrance arm
S_D = Distance of sound level meter from signal stop line
NDVI = Normalized Difference vegetation Density
N_l = No. of lanes
C_w = Width of carriageway
RSL = Road segment Length
PC = Pedestrian crossing during Green signal phase
Qext = Queue length at exit arm
QLent = Queue length at entrance arm

Discussion and Conclusion



Spatial noise mapping evaluates and illustrates noise in particular regions. Noise maps are created with Sound Plan and "Noise tool" software. High noise (75-80 dB) near intersection reduces to 70-74 dB[A] at 46.5m. Noise reaches 65-70 dB[A] at 63.5m, exceeding pollution control standards as shown in figure 6 below.

To minimize adverse acoustic impacts on adjacent communities and environments, comprehensive land-use strategies should consider the proximity of residential and mixed-use developments to these highways. Such developments are recommended to be strategically situated at a considerable distance, typically falling within the range of 100 to 150 meters from the highway's edge.

Therefore, when evaluating the performance of an intersection, it's essential to consider not only the volume-to-capacity ratio (v/c ratio) but also the relationship between traffic flow and noise levels.

Reference

1. Can, A., & Aumond, P.. Estimation of road tra ffi c noise emissions : The in fl uence of speed and acceleration. 58, 155–171(2018)
2. Debnath, A. and Singh, P.K. ‘Environmental traffic noise modelling of Dhanbad township area – A mathematical based approach’, Applied Acoustics, 129, pp. 161–172 (2018).
3. Gilani, T.A. and Mir, M.S. ‘Modelling road traffic Noise under heterogeneous traffic conditions using the graph-theoretic approach’, Environmental Science and Pollution Research, 28(27), pp. 36651–36668 (2021).
4. Han, X. et al. ‘Analysis of the relationships between environmental noise and urban morphology’, Environmental Pollution, 233, pp. 755–763 (2018).
5. Kalaiselvi, R. and Ramachandraiah, A. ‘Honking noise corrections for traffic noise prediction models in heterogeneous traffic conditions like India’, APPLIED ACOUSTICS, 111, pp. 25–38 (2016).
6. Khajehvand, M., Abbas, A. and Mirbaha, B. ‘Modeling traffic noise level near at-grade junctions : Roundabouts , T and cross intersections’, Transportation Research Part D, 93(February), p. 102752(2021).
7. Rajakumara, H.N. and Mahalinge Gowda, R.M. ‘Road traffic noise prediction model under interrupted traffic flow condition’, Environmental Modeling and Assessment, 14(2), pp. 251–257 (2009).
8. Thakre, C. et al. ‘Traffic noise prediction model of an Indian road : an increased scenario of vehicles and honking’(2020).
9. Torok, A. Theoretical Comparison of the Effects of Different Traffic Conditions on Urban Road Traffic Noise (2018).
10. Yadav, A. et al. ‘Modelling of traffic noise in the vicinity of urban road intersections’, Transportation Research Part D, 112(October), p. 103474 (2022).
11. Yadav, M., & Tandel, B. Structural Equation Model-Based Selection and Strength Co-Relation of Variables for Work Performance Efficiency Under Traffic Noise Exposure. 46(1), 155–166 (2021)
12. Khan, J., Ketzel, M., Jensen, S. S., Gulliver, J., Thysell, E., & Hertel, O.. Comparison of Road Traffic Noise prediction models: CNOSSOS-EU, Nord2000 and TRANEX. Environmental Pollution, 270, 116240 (2021).

Thankyou