CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

8.1 GENERAL

The transportation sector is one of the major contributors to noise in an urban area. Road traffic noise is most irritating pollution which has a major concern on communities living in the vicinity of highway corridor. Studies have shown that some of the most pervasive source of noise in our environment today is those associated with transportation. Traffic noise tends to be a dominant noise source in our urban as well as rural environment. It is observed in Delhi Urban Area that the traffic noise levels at different categories of roads are above the prescribed limit according to Ministry of Environment and Forest (MoEF), Government of India.

Though there is a broad classification for noise standards with respect to different types of landuse as recommended by MoEF, noise standard with respect to different types of roads has never been prescribed by any agency so far. This is of paramount importance primarily because most of the people in urban areas do not like to be exposed near the high traffic roads. In the contrary, major section of people prefer to live in residential area other than high trafficked arterial roads. This has necessitated having a re-look on the perception effect of traffic noise in different categories of road in urban areas. Therefore, it is felt that after making an in-depth review of the studies on traffic noise, there is a need to develop a methodological framework to find out acceptability level of traffic noise with respect to types of roads according to different housing category, as no past noise studies address this component so far. The present study aimed at evolving the acceptability of traffic
noise levels with respect to three type of residential areas along arterial and collector roads in Delhi and assessment of impact of traffic noise on the residents. Various primary surveys viz. classified traffic volume survey, noise survey and residents’ perception survey have been conducted in the study. The acceptability of traffic noise has been estimated by developing Noise-Annoyance models using conventional regression technique.

8.2 CONCLUSIONS

8.2.1 Study Specific

i. Various studies identified many parameters with a view to determining the annoyance caused to residents due to exposure of traffic noise. But these studies are salient with respect to evolving the acceptability of noise levels for different types of residential areas under various categories of urban roads.

ii. Three types of residential communities exposed to traffic noise are selected for the study under two categories of road viz. arterial and collector road, so that different categories of people can be represented.

iii. Three types of primary surveys have been carried out to conduct the research work viz. classified traffic volume count; noise measurement survey and residents’ perception survey.

iv. The traffic volume of arterial roads varies from 70 thousand to 188 thousand vehicles per day, whereas collector roads vary from 31 thousand to 62 thousand vehicles per day.

v. Traffic noise levels are above the prescribed noise norms according to MoEF [55 dB(A) & 45 dB(A) for day time and night time respectively] at every survey location, except at CR Park; where $L_{eq}$ for night time are observed as 42.2 dB(A), which is within the limit set by MoEF.
vi. The day time equivalent Traffic noise levels ($L_{eq}$) of arterial roads vary from 65.8 dB(A) to 68.1 dB(A), whereas collector roads range from 61.6 dB(A) to 65.8 dB(A).

vii. The night time equivalent Traffic noise levels ($L_{eq}$) of arterial roads vary from 64.0 dB(A) to 64.5 dB(A), whereas collector roads range from 42.2 dB(A) to 56.7 dB(A).

viii. The residents living along the roads are annoyed on account of traffic noise levels as Noise Annoyance Index (NAI) at study area locations vary from 3.04 to 4.05 (with respect to 5 point annoyance scale). The annoyance levels are determined at five point verbal scale ranging from ‘Tolerable’ (scale 1) to ‘Extremely Intolerable’ (scale 5).

ix. People living along the arterial and collector roads in the study area are constantly exposed to high level of traffic noise leading to health complications. Maximum residents are found suffering from irritation/psychological sufferings of the order of 35% followed by sleeping disorder and blood pressure of the order of 8% each. It is also to be noted that 49% residents reported that they are not having any health problems due to traffic noise.

x. Residents living along study area roads are observed to have been affected due to constant exposure to high traffic noise level leading to hampering of activities within home. Maximum residents revealed that the constant exposure to traffic noise is the key factor to disturbance while watching TV, followed by disturbance in conversation, disturbance in sleep and startling of the order of 22.7%, 19.7%, 8.1% and 6.5% respectively. The 43% residents informed that their activities are not hampered by traffic noise.

8.2.2 Results Specific

i. Strong correlation has been observed between noise and health problems as estimated coefficient of correlation is 0.71.
ii. Strong correlation has been observed between noise and annoyance at various study area locations of the order of 0.725, 0.666 and 0.548 at Madangir, New Friends Colony and CR Park respectively.

iii. Association of annoyance with socio-economic variables has been determined through ‘chi square’ test with respect to age, gender, marital status, occupation and monthly income. It is observed that ‘chi square’ is highest with respect to age and its corresponding ‘p-value’ is also less than 0.05. It reveals that age has a maximum association with annoyance level.

iv. Strong correlation is also observed between annoyance and old age groups as coefficient of correlation is 0.74 for day and 0.87 for night.

v. Overall nineteen noise-annoyance models and seven traffic-annoyance models have been developed in the present research work to estimate annoyance due to traffic noise.

vi. Six location specific noise-annoyance models for day time, one noise-annoyance model for night time have been developed. Nine noise-annoyance models for three age groups each have been developed for arterial roads, collector roads and all roads combined for day time. Three noise-annoyance models for three age groups have been developed with respect to all roads combined for night time.

vii. Multiple regression analysis has also been carried out by considering annoyance as dependent variable and hourly passenger & goods traffic as independent variables with respect to each study area and one for combined locations.

viii. The traffic noise-annoyance models developed are checked with Ministry of Environment and Forest (MoEF), Government of India and World Health Organisation (WHO) norms and found that the estimated annoyance with respect to 55 dB(A) [day time] and 45 dB(A) [night time] is ‘tolerable’. It demonstrates that the developed models are sensitive to the observed data and working satisfactory.

ix. The estimated acceptability level of traffic noise of residents living along arterial road is more than the collector road as 57.5 dB(A) and 56.2 dB(A) respectively
for the day time. It is estimated to be 2.5 dB(A) and 1.2 dB(A) above the day prescribed limit [55 dB(A)] for arterial and collector road respectively. It may happen because of high traffic intensity at arterial roads than collector roads and residents have adopted relatively higher value of equivalent traffic noise at arterial road.

x. The acceptability level of traffic noise of residents in night time is estimated to be 46.0 dB(A), which is 1 dB(A) higher than night time traffic noise limits of 45 dB(A) as set by MoEF.

xi. The estimated traffic noise acceptability of residents living in category III houses (i.e. 1-2 bedroom with floor area ≤100 yards) is highest followed by category II houses (i.e 2-3 bedroom with floor area ≥100 yards and ≤200 yards) and category I houses (i.e. Plotted Houses with Plot area ≥ 200 yards) respectively of the order of 60.1 dB(A), 59.0 dB(A) and 57.5 dB(A) respectively at arterial roads.

xii. The acceptability of traffic noise with respect to old age people is minimum among different age groups as 54.7 dB(A) and maximum with respect to young age group as 60.3 dB(A) living along arterial roads.

xiii. In the light of above conclusions, null hypothesis is rejected and alternate hypothesis is accepted.

**8.3 RECOMMENDATIONS**

The traffic noise acceptability of residents living along arterial road is more than that of the collector road as 57.5 dB(A) and 56.2 dB(A) respectively for the day time. It is 2.5 dB(A) and 1.2 dB(A) above the day prescribed limit [55 dB(A)] for arterial and collector road respectively. The estimated acceptability level of traffic noise of residents in night time is 46.0 dB(A), which is 1 dB(A) higher than night time traffic noise limits of 45 dB(A) as set by MoEF and WHO.

Few Asian countries like Japan & Malaysia and one European country like Germany have adopted higher standards of traffic noise for residential areas. Israel
has adopted higher noise standards for night time i.e. 50 dB(A). Japan and Malaysia have adopted two standards. In case of Japan, the noise standards for general residential areas are 55 dB(A) and 45 dB(A) for day and night time, but separate standards are adopted for residential areas facing roads with two or more lanes as 60 dB(A) and 55 dB(A) for day and night time respectively. The noise standards for low density areas in Malaysia are 50 dB(A) and 40 dB(A), but for high density mix use areas, the noise standards are higher as 60 dB(A) and 50 dB(A) for day time and night time respectively. Germany has adopted higher standards of traffic noise for residential areas as 59 dB(A) and 49 dB(A) for day and night time respectively.

In view of above, the recommended traffic noise acceptability levels for residential areas facing roads located along collector and arterial roads are presented in the following Table 8.1.

**Table 8.1: Recommended Noise Level Acceptability at Residential Areas Facing Roads**

<table>
<thead>
<tr>
<th>Type of Area facing roads</th>
<th>Type of Road</th>
<th>Limits in dB(A) L&lt;sub&gt;eq&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collector Road</td>
<td>56</td>
<td>46</td>
</tr>
<tr>
<td>Arterial Road</td>
<td>57</td>
<td>46</td>
</tr>
</tbody>
</table>

Therefore, the Government of India may explore the possibility to adopt two different traffic noise standards, one for residential areas facing roads in particular and other for residential areas in general.

**8.4 FURTHER WORKS**

Comprehensive data collection with respect to various groups and various categories of roads should also be taken up in other cities in order to access the greater degree of perception of people with respect to noise levels in other cities.

As the framework of analysis of noise study has primarily developed using conventional analytical tool, this kind of study where greater degree of subjectivity of noise is associated, application of Fuzzy Logic can be explored to arrive at the acceptability of noise levels.
APPENDICES