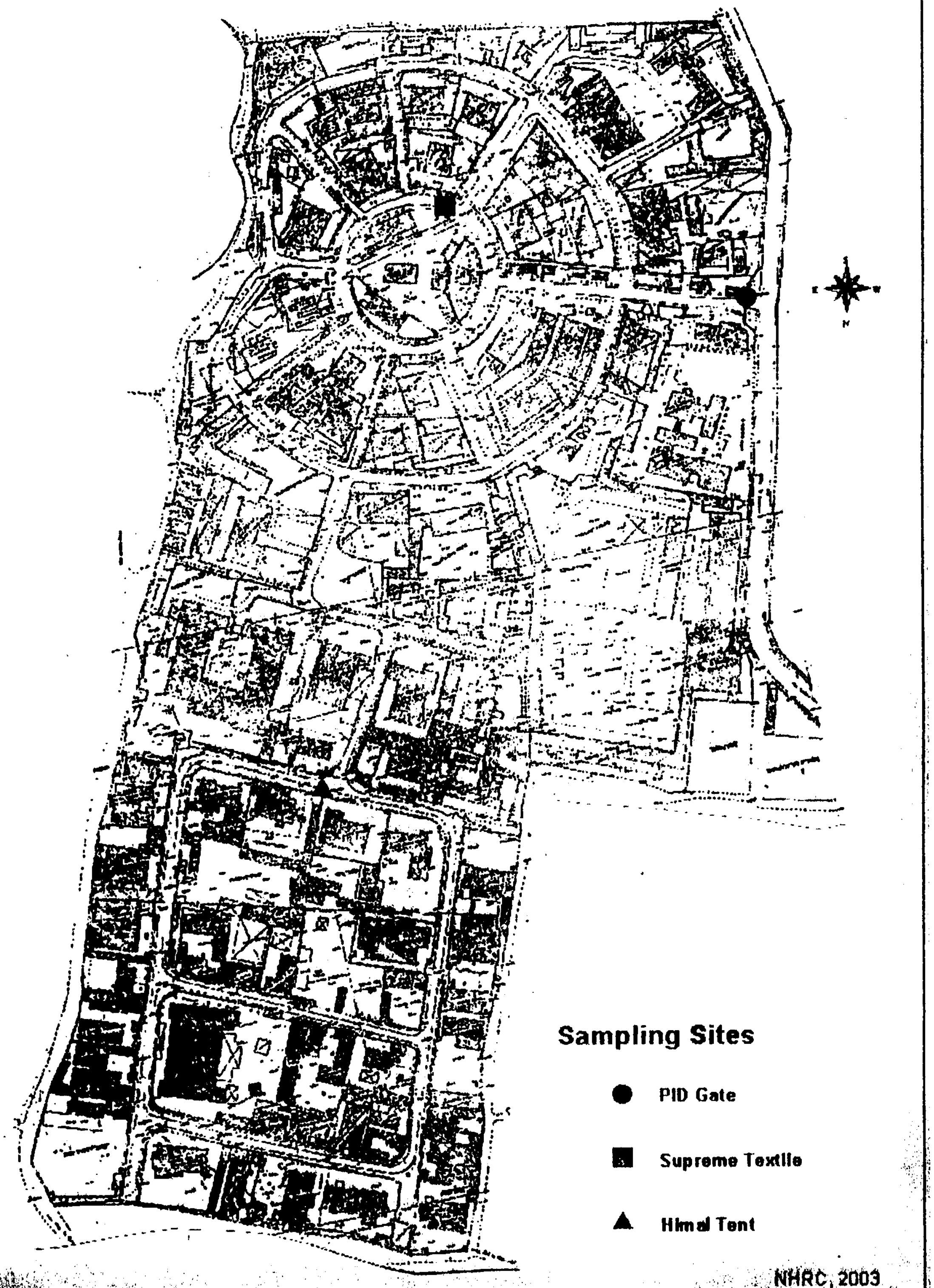
Map7: PATAN INDUSTRIAL STATE



CHAPTER 4

4. FIELD ASSESSMENT OF SOUND PRESSURE LEVEL IN DIFFERENT ENVIRONMENTAL SETTING

The assessment of sound pressure level was carried out in the five urban cities of Nepal viz. Kathmandu, Lalitpur, Bhaktapur, Kirtipur and Janakpur. The trend of community sound pressure level were assessed in different environmental settings viz. high traffic, commercial cum residential, commercial cum tourist, old residential and new residential areas of these cities. The sound pressure level was also assessed in the industrial area of Balaju industrial state and Patan industrial state. The assessment was performed on working days. The measurement was carried out for 10 minutes interval at each station in different time zones i.e. early morning hour, early office (peak) hour, early non-official (non-peak) hour, late office hour and late non-office hour altogether about 1 hour monitoring in aim each spot. In industrial area, the measurement was carried out for eight hours interval in a working day and night time. The observed data were analyzed using equivalent sound pressure level (L_{eq}), maximum sound pressure level (L_{max}) and day and night average sound pressure level (L_{dn}). The observed data were also compared with different international noise standards like WHO guideline, Japanese standard, Indian standard and US standard.

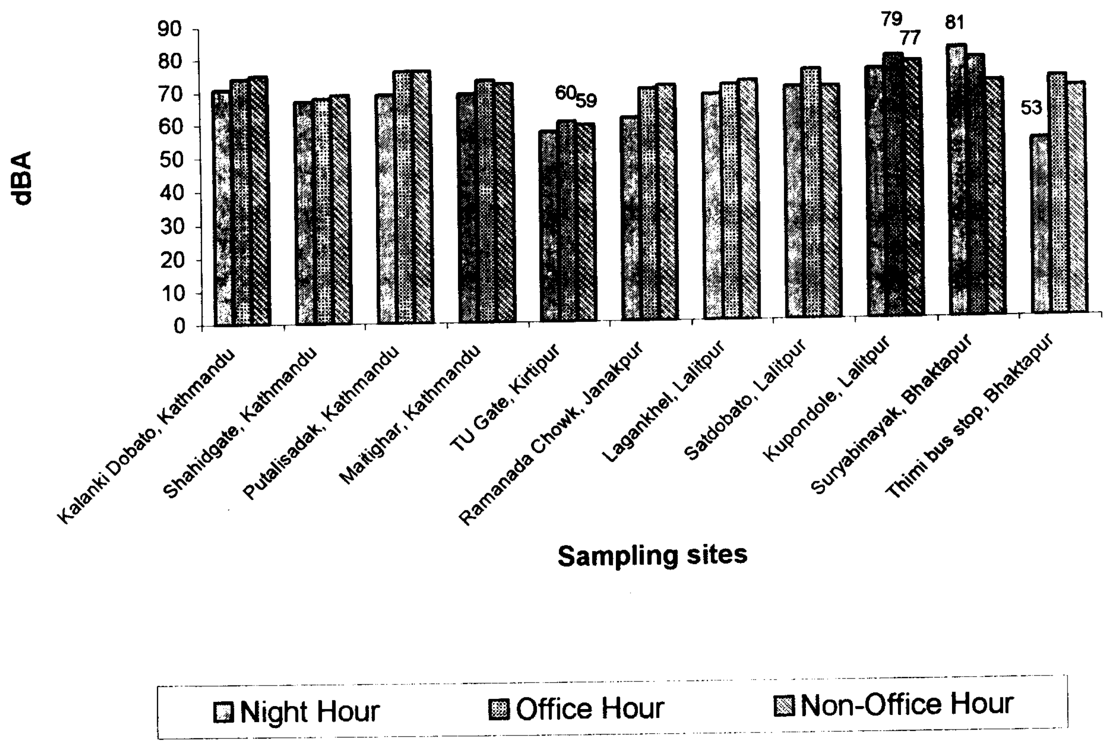
In order to obtain the public opinion upon the environmental noise and its effect in human health, noise pollution survey was consummated. Similarly, the audiometric test was applied in order determine the auditory sensitivity of the individual who is continuously exposed to high noise level in the cities in Nepal.

4.1 Equivalent Sound Pressure Level (L_{eq}) and Maximum Sound Pressure Level (L_{max}) of Different Environmental Settings

4.1.1 High Traffic Area

High traffic area is most prominent area of noise source among other environmental settings in Nepal. Literature review and the past study revealed that the unmanaged traffic flow related noises were predominating over background noise. Thus, it is included as main component under the scope of the study. Among five different cities, in this category, eleven sampling sites were identified. The Equivalent sound pressure levels (L_{eq}) of high traffic area, at different set hours were measured. Details are shown in Chart- 2.

Chart 2: Leq (dBA) of Heavy Traffic Area at Different Time Zones



Among these eleven different sites, the highest equivalent sound pressure level, L_{eq} 81 dBA was observed in Suryabinayak bus stop, Bhaktapur during night hours and the least L_{eq} 53 dBA was observed at Thimi bus stop. During office & non-office hours, the highest equivalent SPL 79 & 77 dBA was observed at Kupondole, Lalitpur. The least value of 60 dBA in office hours and 59 dBA in non –office hours was observed near TU gate.

As Maximum Sound Pressure Level (L_{max}) is taken into account, during night hour L_{max} 93 dBA was observed at Suryabinayak bus stop, Bhaktapur. During office hours and non-office hours L_{max} 89 and 88 dBA were observed respectively at Kupondole, Lalitpur. It was observed that during the day hours Kupondole, Lalitpur had high sound pressure level as compare to the other high traffic areas of survey. It was due to running of institutional vehicles usually for official activities. While Suryabinayak bus stop of Bhaktapur had high sound pressure level during night hours as compare to the other high traffic area. It is a highway linking road and the numbers of vehicles moving toward Kathmandu early in the morning were larger in number. The Thimi bus stop had lowest equivalent SPL in the night hour though it was same route to Suryabinayak. The traffic flow in Thimi bus stop was observed smooth and less traffic jam as compared to

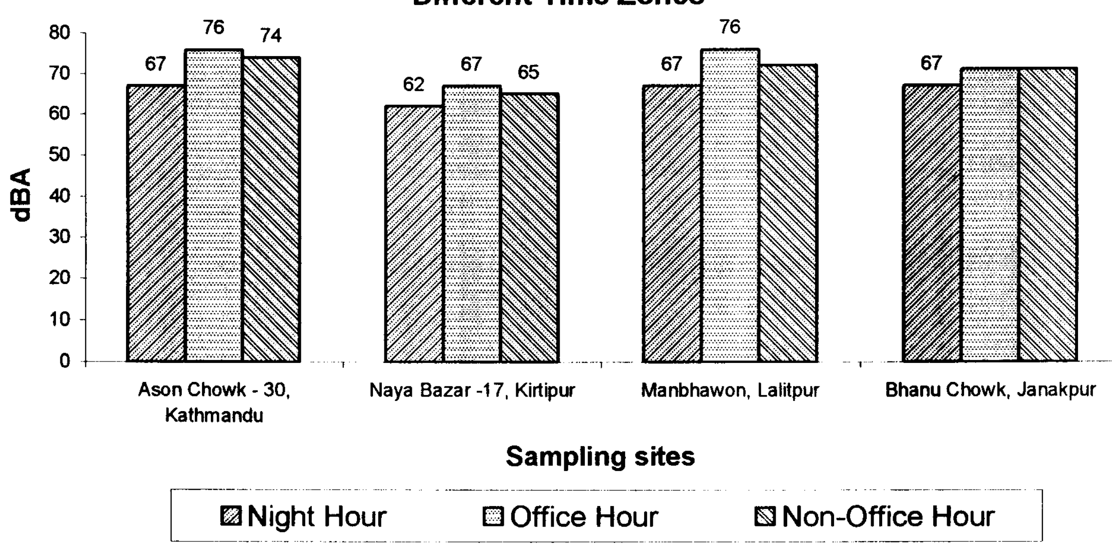
Suryabinayak Bus stop. The number of traffic flow was less in Thimi bus stop during the time of monitoring.

In traffic areas, the high sound pressure level observed was due to engine and body noise from vehicles and the high-pressure horns. In night hours, high-pressure horn of 6 times per minutes was observed in Suryabinayak alone. Similarly in office hours & non-office hours at Kupondole, the high-pressure horns of 13 times/minute & 12 times/minute were observed respectively. This proves that the high-pressure horn was the most dominant factor contributing high sound pressure level in the urban area like Kupondole.

4.1.2 Commercial cum Residential Area

The next environmental setting selected for the noise monitoring was commercial cum Residential Area. The predominating noise sources were people's voice, audio, traffic etc. Thus with purpose of obtaining types of sound and its pattern in such setting, four different sampling sites were taken into consideration for the study.

Chart 3: Leq (dBA) of Commercial cum Residential Area at Different Time Zones



The Chart-3 shows the equivalent sound pressure level of commercial cum residential area at different time zones. During night hours, among these four sampling sites, highest equivalent sound pressure level, L_{eq} 67 dBA was observed in Ason chowk, Man bhawan and Bhanu Chowk. While the least, L_{eq} 62 dBA was observed at Naya bazaar of Kirtipur. During office hours, the highest L_{eq} 76 dBA was detected in Ason chowk of Kathmandu and Man Bhawan of Lalitpur. The lowest L_{eq} 67 dBA was found in Naya Bazar of Kirtipur. Similarly, in non-office hours, highest L_{eq} 74 dBA was observed in the Ason Chowk and Lowest L_{eq} 65 dBA in the Naya Bazaar of Kiritpur.

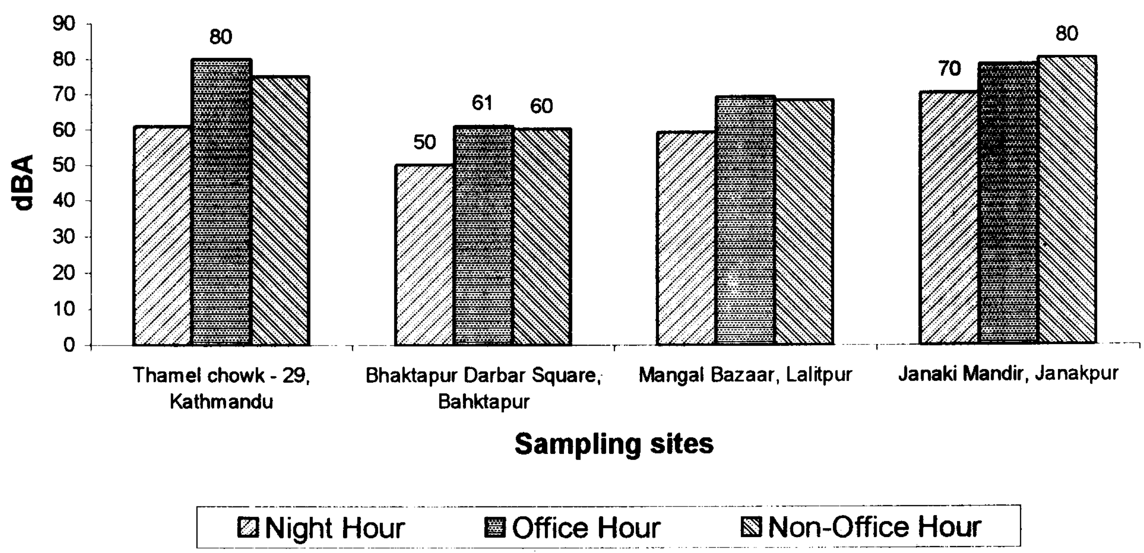
This data shows that among these four different sites, Ason chowk of Kathmandu has highest equivalent sound pressure level while Naya Bazar of Kirtipur has the least.

L_{max} is an indicator of the disturbance to sleep and other activities during night hours. The highest L_{max} 78 dBA was observed in both Ason Chowk of Kathmandu and Bhanu Chowk of Janakpur during night hours. While During both office hours and non-office hours, the highest L_{max} 88 and L_{max} 85 dBA were found in Man bhawan of Lalitpur, respectively. The noise by pressure horns noises had contributed for observed L_{max} values. The rate of honking horns during office and non-office hours in Man Bhawan were 10 times/min and 9-times/ min respectively.

4.1.3 Commercial cum Tourist Area

Commercial cum Tourist Area was another environmental setting of the study. The major noise sources were similar to that of Commercial cum Residential area. This area is even the sensitive area in term of noise because this area attracts lots of tourist from around the globe and that has great contribution in the economy of the Nation. Thus with purpose of studying types of sound and its pattern in this category, four different sampling sites were selected.

Chart 4: Leq (dBA) of Commercial cum Tourist Area at Different Time Zones



The chart-4 shows the equivalent sound pressure level of commercial cum tourist area at different hours. During night hours, L_{eq} 70 dBA was observed at Janaki Mandir of Janakpur. This was the highest L_{eq} observed among four sampling sites. While, the least, L_{eq} 50 dBA was observed in Bhaktapur Durbar Square of Bhaktapur. The highest, L_{eq} 80 dBA was observed in Thamel chowk of Kathmandu during office hours & similar L_{eq} 80 dBA in Janaki Mandir of Janakpur during non-office hours. L_{eq} 61 dBA and L_{eq} 54 dBA were observed in the Bhaktapur

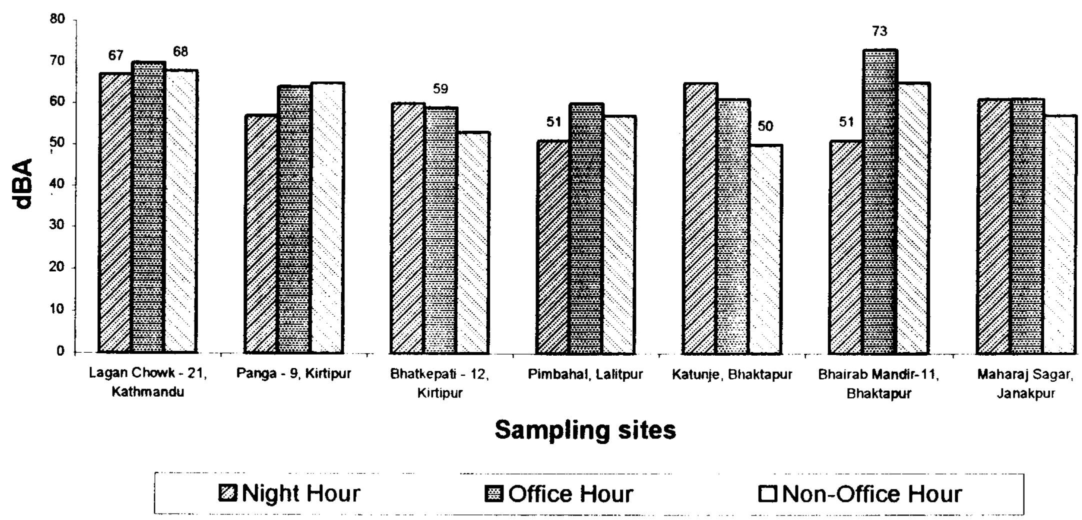
Durbar Square during office and non-office hours respectively. The observed highest equivalent sound pressure level in the Janaki Mandir was due to continuous loudspeaker noise from its periphery.

The highest L_{max} 77 dBA was observed in Janaki Mandir of Janakpur during night hours. During office hours, the highest L_{max} 88 dBA was observed at Thamel chowk of Kathmandu & during non-office hours, the highest, L_{max} 88 dBA was observed at Janaki Mandir of Janakpur. The main noise source observed in the Thamel Chowk was noise from light vehicles, blowing horns from Richsaw. While frequent musical notes through loudspeaker was predominant noise source in the Janaki Mandir of Janakpur.

4.1.4 Old Residential Area

Old Residential Area was another environmental settings selected for the noise pollution monitoring. The dominating noise sources in this setting were audio, dog barking, cycle, motorcycle, people conversation, bell ringing in temple etc. This area was the concern of the study because this is the area/setting where people need to get relax from their busy working days. Thus to get the information on present scenario of these areas, it was included in this research. Seven sampling sites were selected as old residential area in different cities.

Chart 5: Leq (dBA) of Old Residential Area at Different Time Zones



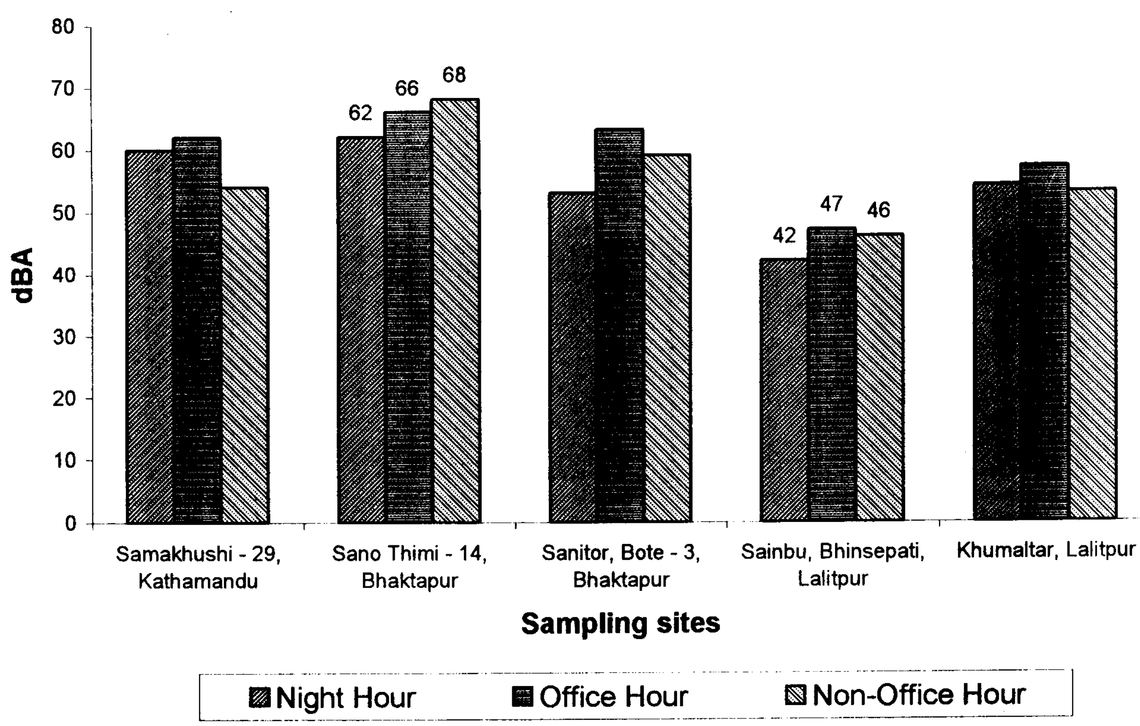
The chart-5 shows the equivalent sound pressure level (dBA) of Old Residential Area at different time zones. Among seven sampling sites, the highest L_{eq} 67 dBA was observed in Lagan Chowk of Kathmandu and the least, L_{eq} 51 dBA was observed in both Pimbahal of Lalitpur and Bhairab Mandir of Bhaktapur during night hours. During office hours the highest L_{eq} 73 dBA was observed in Bhairab Mandir of Bhaktapur, and the least, L_{eq}, 59 dBA was observed in Bhatkepati of Kritipur. During non-office hours the highest L_{eq} 68 dBA was observed at Lagan chowk of Kathamndu and the least, L_{eq} 50 dBA was observed at Katunje of Bhaktapur. The highest equivalent sound pressure level in Lagan chowk of Kathmandu as compared to other residential area was due to traffic flows, street market and motor vehicle workshops near by the chowk.

The highest L_{max} 77 dBA was observed in Katunje of Bhaktapur during night hours. The audio and people conversation were major contributing factors to these peak values. The highest L_{max} 82 dBA & L_{max} 80 dBA was observed in Bhairab Mandir of Bhaktapur & Panga of Kritipur during office hours and non-office hours respectively. The noise source like traffic flow, crowd and human activities were major contributing factors in this category.

4.1.5 New Residential Area

New Residential Area was also considered as one of the environmental settings among others. The dominating noise sources observed in this area were similar to that of old residential area. This area is of concern to this survey because in this area where people need to get relax from their busy working day. Five different sampling sites were taken under consideration for New Residential Area.

Chart 6: Leq (dBA) of New Residential Area at Different Time Zones



The chart-6 shows the equivalent sound pressure level (L_{eq}) of New Residential Area at different time zones. Among these five different sampling sites, during night hours, the highest L_{eq} 62 dBA was observed in Sano-Thimi of Bhaktapur and the least, L_{eq} 42 dBA was observed in the Sainbu Bhinsepati of Lalitpur. The highest L_{eq} 66 & 68 dBA were observed in Sano-Thimi of

Bhaktapur during both office and non-office hours respectively. While the least L_{eq} 47 & 48 dBA was observed in Sainbu, Bhinsepati of Lalitpur during office and non-office hours respectively. The highest L_{max} 77, 81 and 79 dBA was observed in Sano-Thimi of Bhaktapur during night, office and non-office hours respectively. The noise sources like traffic flow, crowd of people and local markets etc. were major cause of increase in the sound pressure level in these areas.

Among these five different environmental settings the highest equivalent sound pressure level was observed in High Traffic Areas while the lowest was observed in New Residential Areas. Thus it could be inferred that the High Traffic area had the highest ambient noise level in comparison to other environmental settings. It could be vulnerable to those people residing or working nearby that area if immediate precaution would not have taken into consideration.

4.2 Day-Night Sound Level (L_{dn}) value of Different Environmental Settings

L_{dn} is used by Environmental Protection Agency (EPA), USA to analyze the monitored noise data, the following L_{dn} values were obtained in different environmental settings in Nepal.

Table 4.1: Day-Night Sound Level (L_{dn}) value of different Environmental Settings:

Environmental Settings	**Typical range of L_{dn}, dBA**	**Average L_{dn}, dBA**
High Traffic Area	64-86	74.36
Old Residential Area	59-73	66.28
New Residential Area	48-69	62.00
Commercial cum Residential Area	69-75	72.75
Commercial cum Tourist Area	59-76	69.25

The table 4.1 shows the present scenario of Day-Night Sound Level (L_{dn}) value from this study. Similar kinds of studies were conducted in different countries. Out of those studies carried out in Urban Areas, an example of a study conducted in US is presented here for comparison purpose.

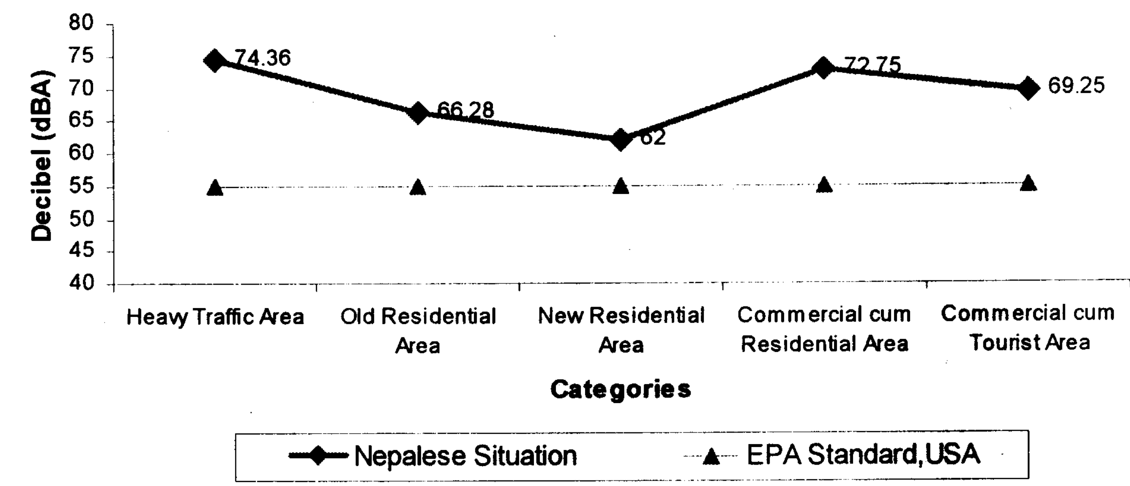
Table 4.2: Typical Day-Night Sound level in Urban Areas in the USA

Description	**Typical range of L_{dn}, dBA**	**Average L_{dn}, dBA**	**Average census tract population density no. of people/mil^2**
Quite suburban residential	48-52	50	630
Normal suburban residential	53-57	55	2000
Urban residential	58-62	60	6300
Noisy urban residential	63-67	65	20000
Very noisy urban residential	68-72	70	63000

Source: *US Environmental Protection Agency, 1974, P. B-5*

EPA-USA has identified a range of yearly day-night sound pressure levels and average day-night sound pressure level that has sufficient to protect public health and welfare from the effects of environmental noise as shown in the table 4.2. The above standards were taken into consideration for the comparative study.

Chart 7 : Comparison of Day-Night Sound Levels (Ldn) with EPA Standard, USA



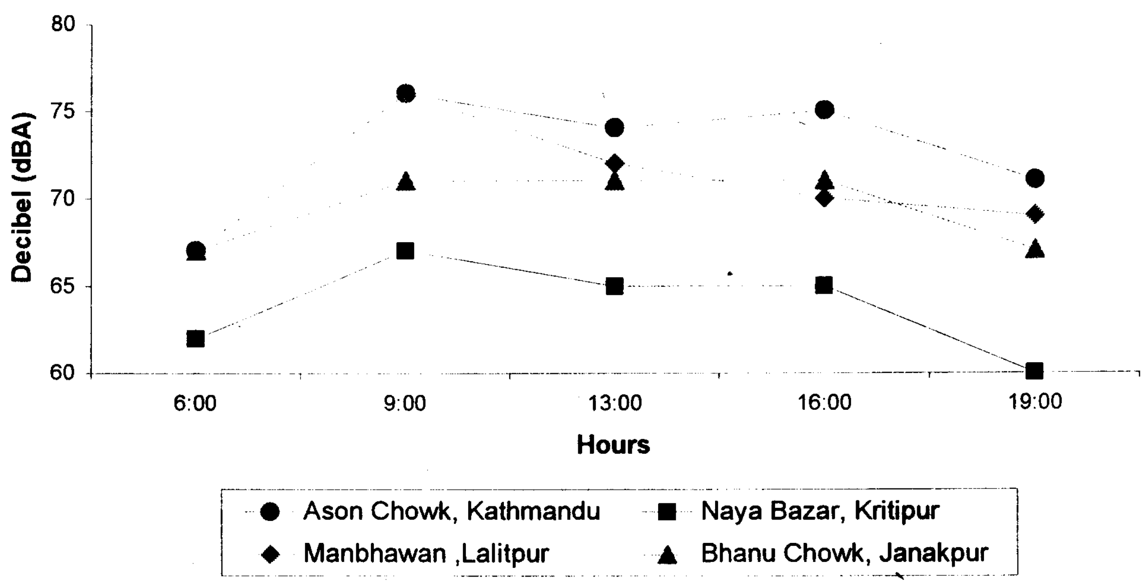
The chart-7 shows average L_{dn} values of all five different environmental settings in comparison to the recommended average value of L_{dn} of EPA-USA.EPA recommended L_{dn} 55 dBA (less than or equal to) in sensitive areas such as residences ,schools and hospitals and L_{dn} 45 dBA (less than or equal to) inside the building for protection of public health and welfare.

The result had shown that the L_{dn} values of all five different settings were exceeded above the recommended standard of the EPA. The lowest value of L_{dn} 62 dBA was found in new residential area, while the highest L_{dn} 74.36 dBA was found in heavy traffic area. It could be inferred that based on EPA standard, the high traffic area was most vulnerable to public health and welfare in comparison to other environmental settings.

4.3 L_{eq} (dBA) Variation with respect to Different Time Zones of Different Environmental Settings

4.3.1 Commercial cum Residential Area

Chart 8 : Leq (dBA) variation wih respect to different time zones of Commercial cum Residential Area

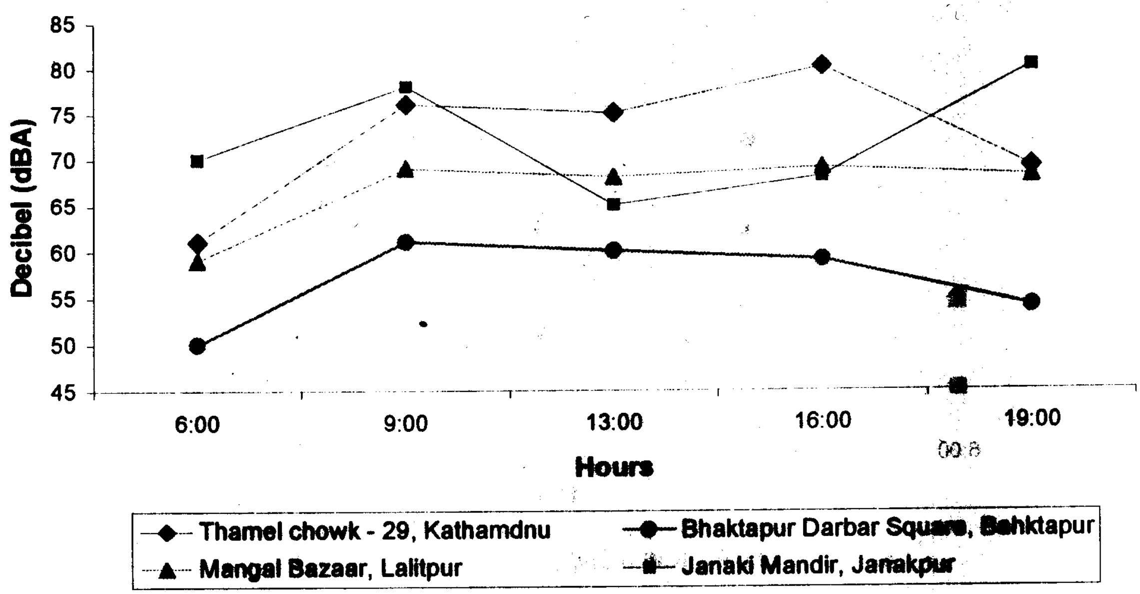


The chart-8 explains variation of the equivalent sound pressure level of commercial cum residential areas (L_{eq}) with respect to different time zones. The lowest equivalent SPL was found in Naya Bazar of Kritipur and the highest L_{eq} in Ason Chowk of Kathmandu. The sound pressure level was observed almost same during daytime while it was decreased in non-office hours (19:00) and night hours.

In Naya Bazar of Kritipur , the L_{eq} was higher during office hours in comparison to night and non-office hour. A similar kind of trend was also observed in Manbhawan of Lalitpur. In Ason Chowk, the during office hours (i.e. around at 9 am and 4 pm) the L_{eq} was observed higher in comparison to other sites and while in the evening and the night hours it was decreased. It is due to the high traffic and over-flow of people during office hours as compare to the non-office hours.

4.3.2 Commercial cum Tourist Area

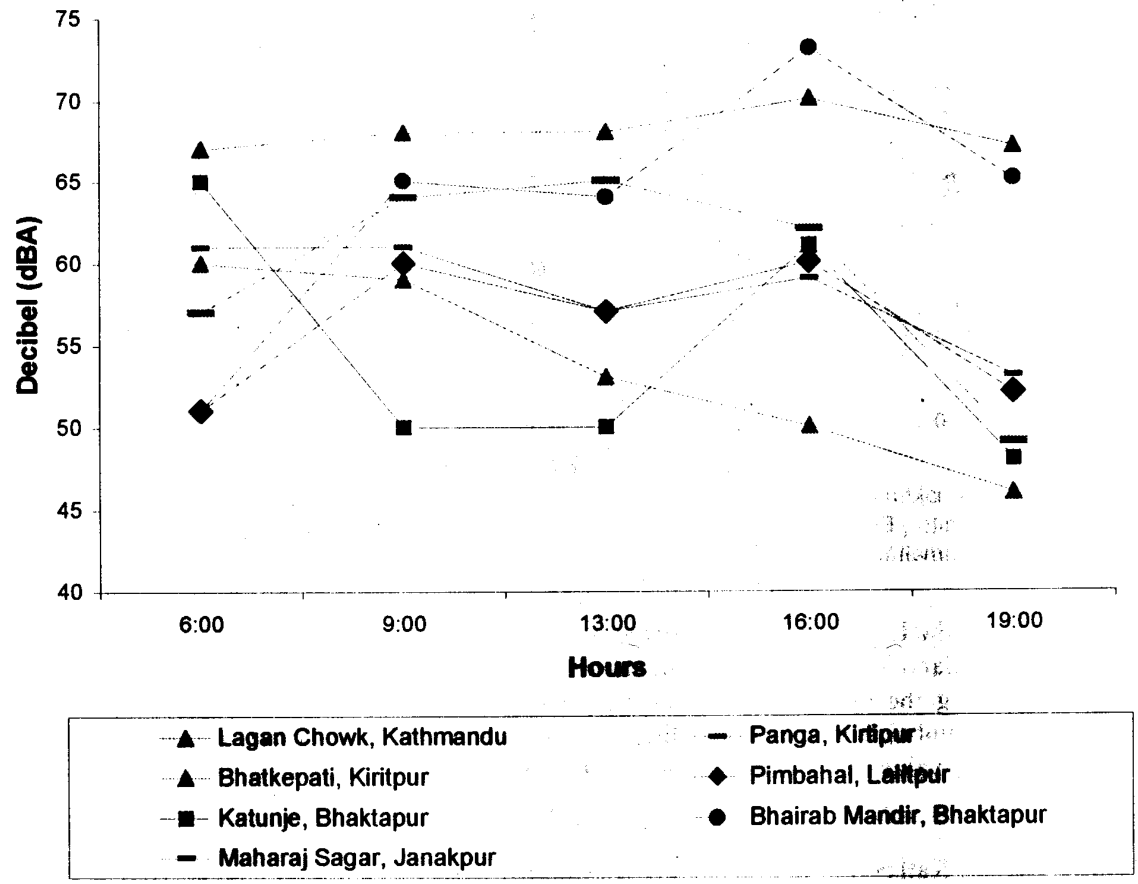
Chart 9 : Leq (dBA) variation with respect to different time zones of Commercial cum Tourist Area



The chart-9 explains variation of the L_{eq} of Commercial cum Tourist Areas with respect to different time zones. The highest L_{eq} was observed in Janaki Mandir of Janakpur, and the lowest L_{eq} in Bhaktapur Darbar Square. The highest L_{eq} value in night, office and non-office hours (19:00 pm) in Janaki Mandir was due to the continuous blasting of loudspeaker in the vicinity of Janaki Mandir. In other sites apart from Janaki Mandir of Janakpur the equivalent sound pressure level was observed low during night hours and non-office hours.

4.3.3 Old Residential Area

Chart 10 : Leq (dBA) variation with respect to Different Time Zones of Old Residential Area



The chart-10 illustrates the L_{eq} variation with respect to different time zones of Old Residential Areas. Seven different sites were chosen as old residential area .Among them, the highest L_{eq} was observed in Lagan chowk of Kathmandu in all time zones except in 16:00 hours. The highest L_{eq} was observed in Bhairab Mandir of Bhaktapur during office hours (16:00) as compared to others. In all of the sampling sites except in Katunje and Bhatkepati of Kritipur the sound pressure level was lowest during nighttime as compared to the daytime.

4.3.4 New Residential Area

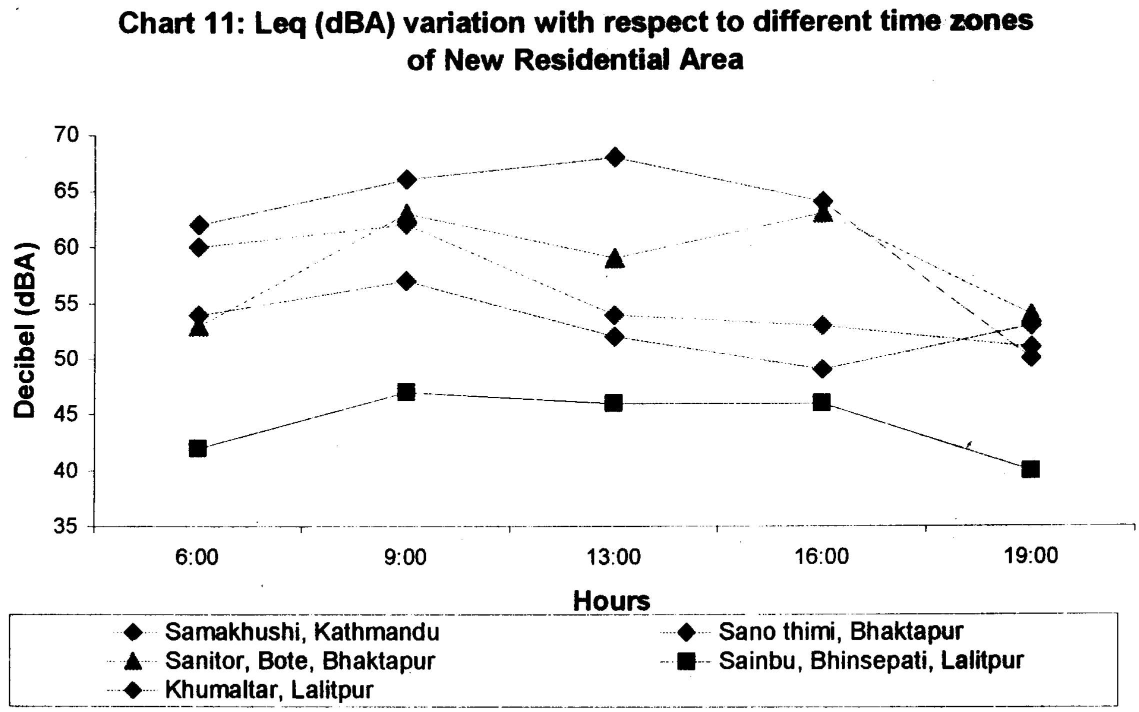


Chart-11 exhibits the L_{eq} variation with respect to time of New Residential Area. The highest L_{eq} was observed in Sano-Thimi of Bhaktapur during office hours, non-office hour (13:00pm) and night hours among the other sampling sites of new residential area. While, the low L_{eq} was observed in the Sainbu, Bhinsepati of Lalitpur during in day and night hours. In Sanitor/Bote of Bhaktapur, the L_{eq} value was found low during night and non-office hours (19:00pm) as compare to the day hours.

In Samakhushi of Kathamandu & Khumaltar of Lalitpur, the sound pressure level was relatively high in night hours than office and non-office time. The frequent air plane flights on that route, continuous playing of tape-recorder and dog barking were main noise source of increasing the L_{eq} in these areas.

4.4 Comparison of Equivalent Sound Pressure Level (L_{eq}) with International Standards

4.4.1 High Traffic Area

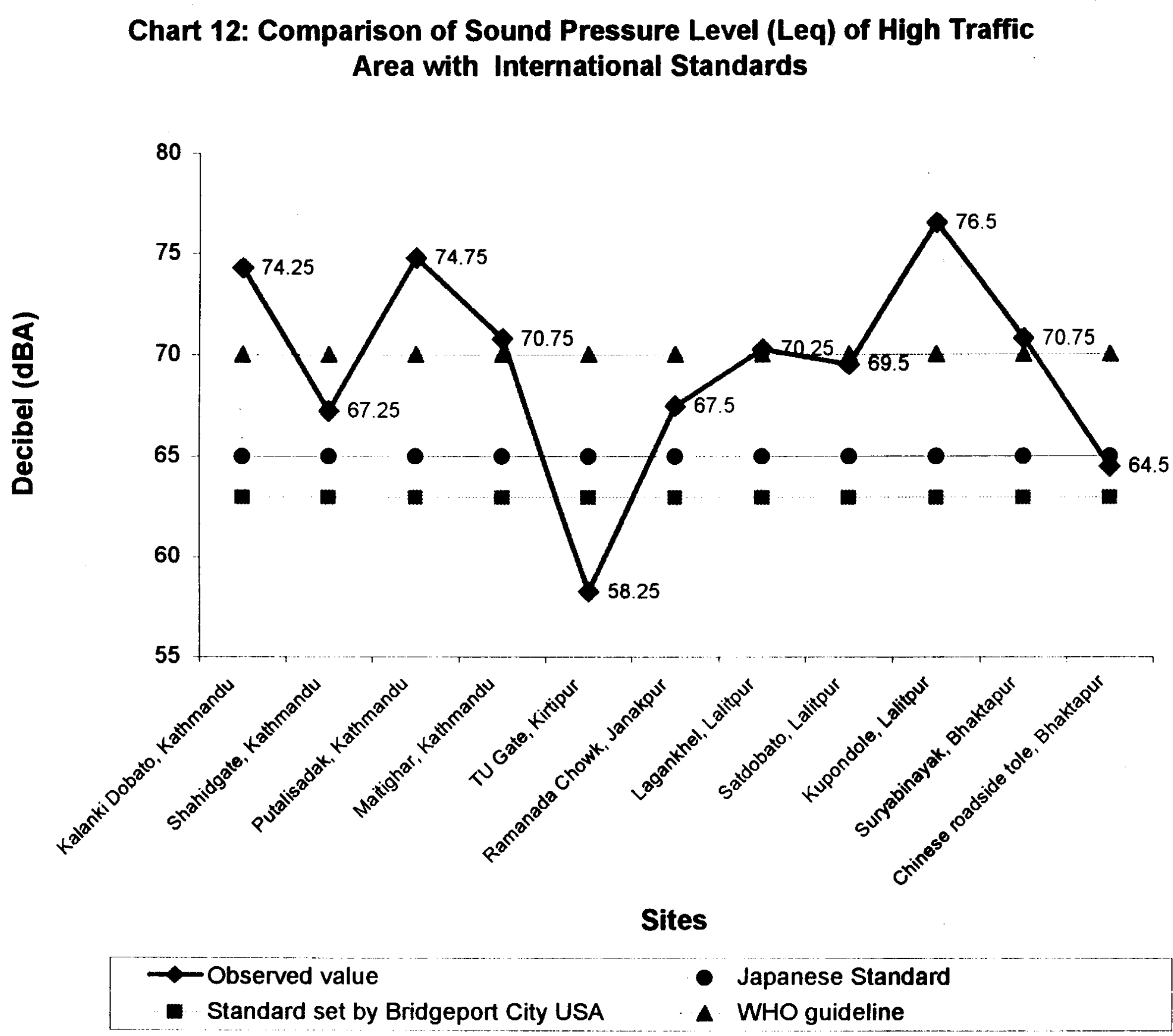
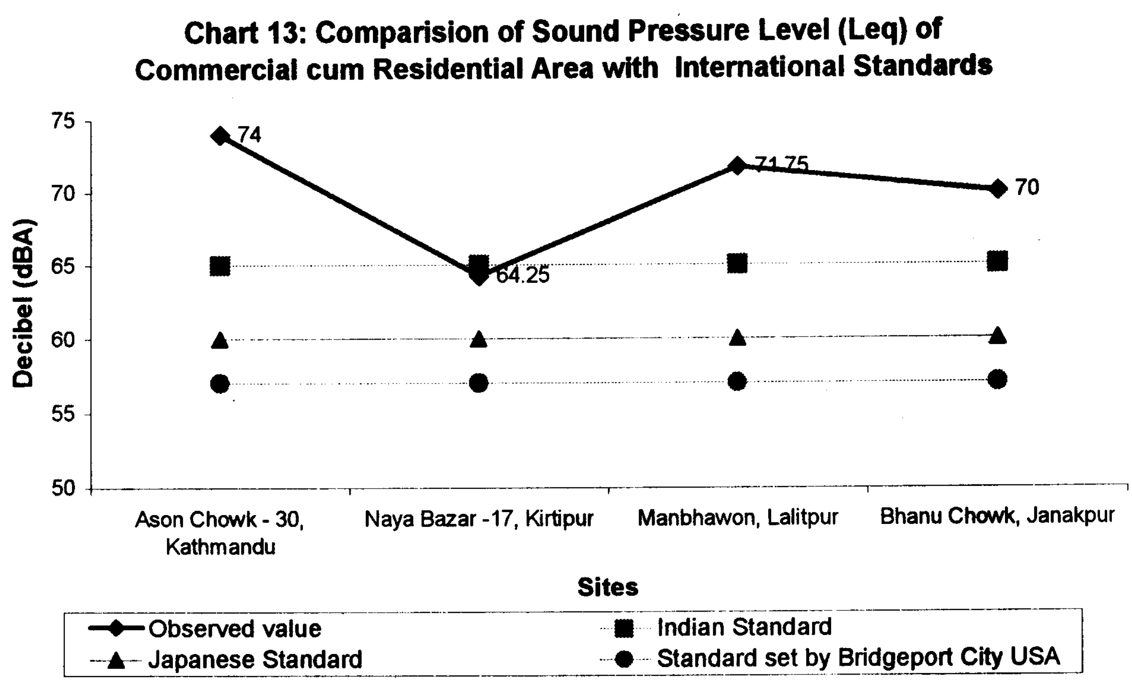


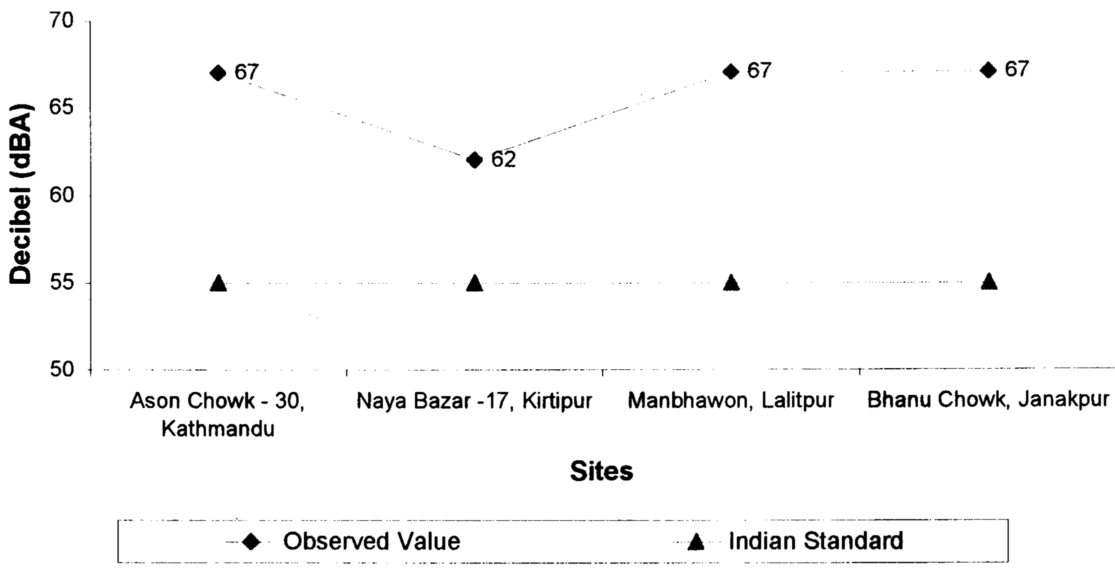
Chart-12 shows the comparison of observed value with the other International standards namely; WHO guidelines, Japanese Standards, and USA standards, and Indian Standards. It is explicitly seen that among all the sites monitored, with exception of Tribhuvan University (TU) gate at Kritipur, the observed value of high traffic areas were observed higher than L_{eq} 65 and 63 dBA of Japanese and USA Standard respectively. While, L_{eq} value was observed below all the above-mentioned standards in TU gate, Kritipur. Six high traffic areas mentioned in the chart-12 have exceeded WHO recommended guideline (L_{eq} 70 dBA) .WHO has recommended that exceeding 75 dBA L_{eq} might cause the risk for hearing impairment. However, it was observed even higher than that limit in Kupondole of Lalitpur.

4.4.2 Commercial cum Residential Area



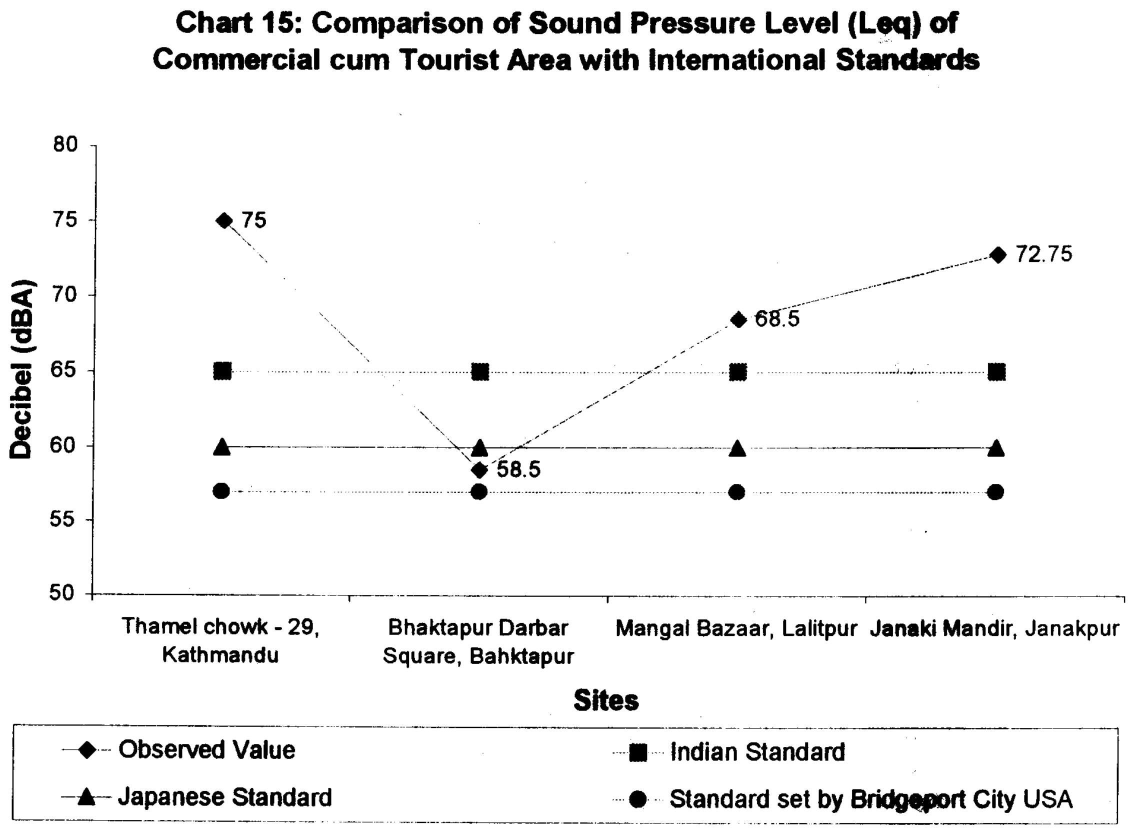
The chart-13 shows the equivalent sound pressure level measured at different sampling sites and its comparison with the available international standards. L_{eq} values in all sampling sites were exceeded the L_{eq} 60 and 57 dBA of Japanese and USA Standard respectively. Except, Naya Bazar of Kirtipur, all sites exceeded the L_{eq} 65 dBA, Indian standard. Among those four sampling sites, Ason Chowk of Kathmandu was found the highest value showing most vulnerable in terms of noise induced health hazard.

Chart 14: Comparison of Sound Pressure Level (Leq) of Night Hours of Commercial cum Residential Area with Indian Standard



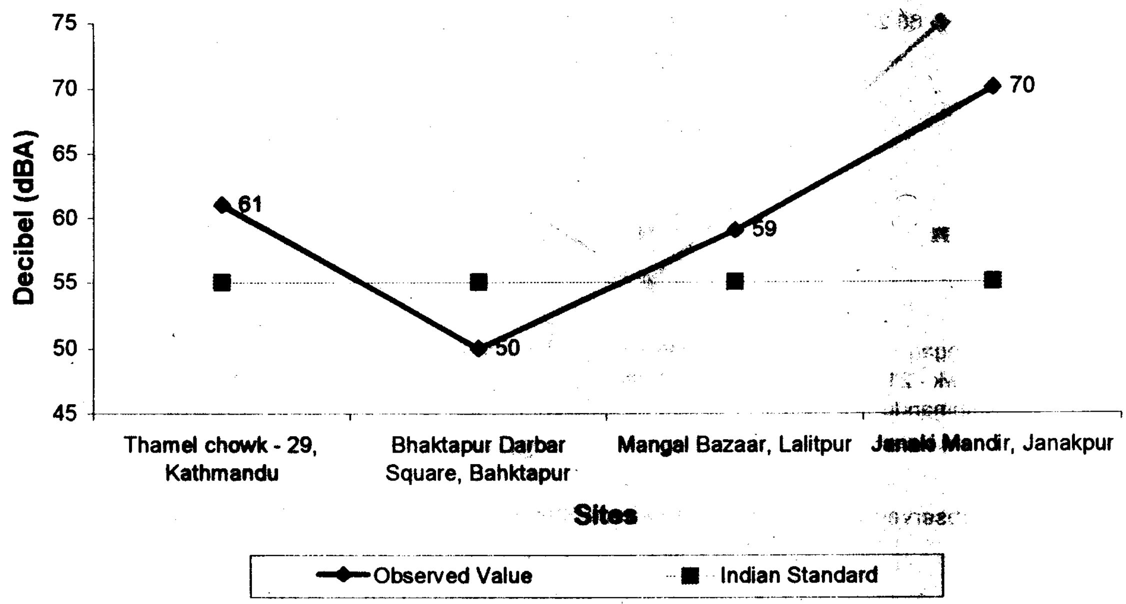
The chart-14 illustrates the value of equivalent sound pressure level (L_{eq}) of different sampling sites of commercial cum residential area during night hour in comparison to the Indian Standard. The L_{eq} of all the sampling sites were highly exceeded the prescribed Indian standard of L_{eq} 55dBA. This has concluded that commercial cum residential areas in urban cities were much risk from noise induced health hazards.

4.4.3 Commercial cum Tourist Area



The chart-15 shows the value of equivalent sound pressure level observed at different sampling sites of commercial cum tourist areas and its comparison with international standards. International standards like Indian (L_{eq} 65 dBA), Japanese (L_{eq} 60 dBA) and USA (L_{eq} 57 dBA) standards were taken into account for the comparison. Based on the comparison, L_{eq} values of sampling sites were found above the referred International Standards except that of Bhaktapur Darbur Square. However, L_{eq} of Bhaktapur Darbur Square was also exceeded above the standard set by Bridgeport City of USA. It shows that Thamel Chowk, Kathmandu was highly peril from the noise induced health hazards.

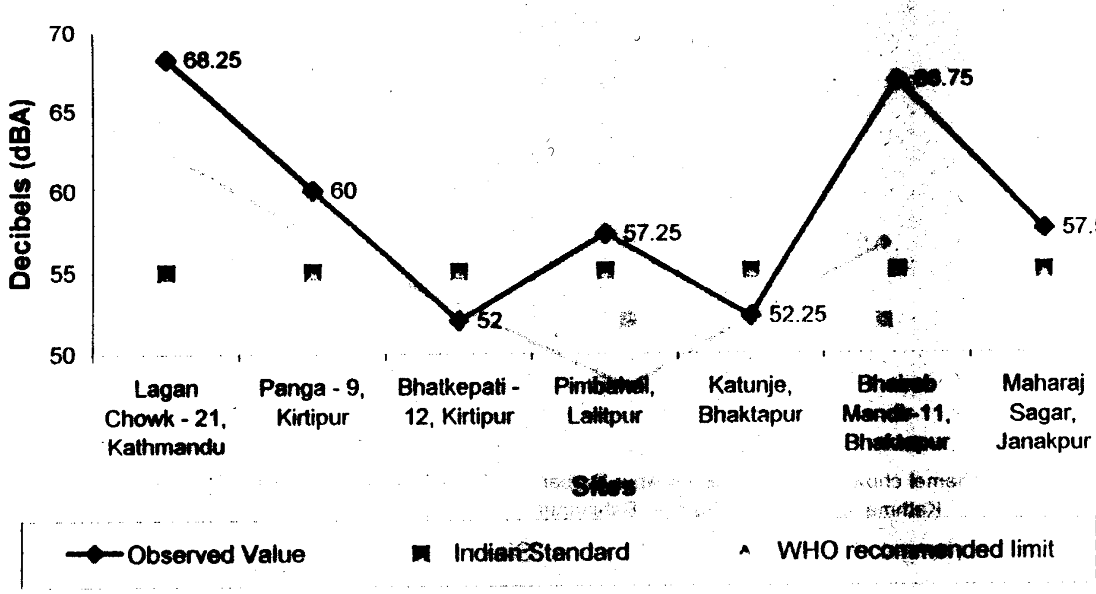
Chart 16: Comparison of Leq of night times at Commercial cum Tourist Area with respect to Indian Standard



The chart-16 gives the L_{eq} comparison of night hours with Indian standard (L_{eq} 55 dBA). Except Bhaktapur Darbur Square, L_{eq} of the remaining sampling sites exceeded the recommended limit. Among all of these sampling sites, the highest L_{eq} was observed in Janaki Mandir of Janakpur. This was basically due to the continuous loudspeaker noise at the vicinity of the Janaki Mandir. Thus, it could be inferred that Thamel chowk, Mangal Bazaar and Janaki Mandir were peril in terms of noise induced health hazards.

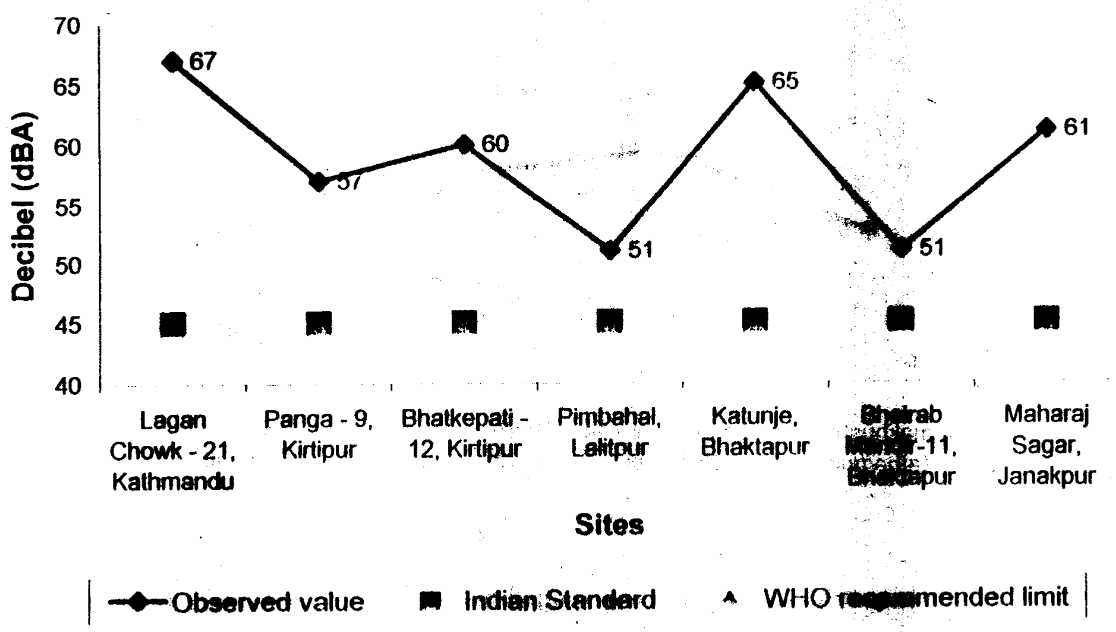
4.4.4 Old Residential Area

Chart 17: Comparison of Leq of Day Time of Old Residential Area with International Standards



The chart-17 figures out that except Bhatkepati of Kritipur and Katunje of Bhaktapur, L_{eq} of all the remaining site exceeded the noise pollution standard set by both Indian (L_{eq} 55 dBA) and WHO (L_{eq} 55 dBA) for day hours. Among the entire sites, Lagan Chowk of Kathmandu was found with highest sound pressure level value. This result interprets that among the seven sampling sites of old resident area, five of them had exceeded the recommended limit that might lead to health hazards to the local community.

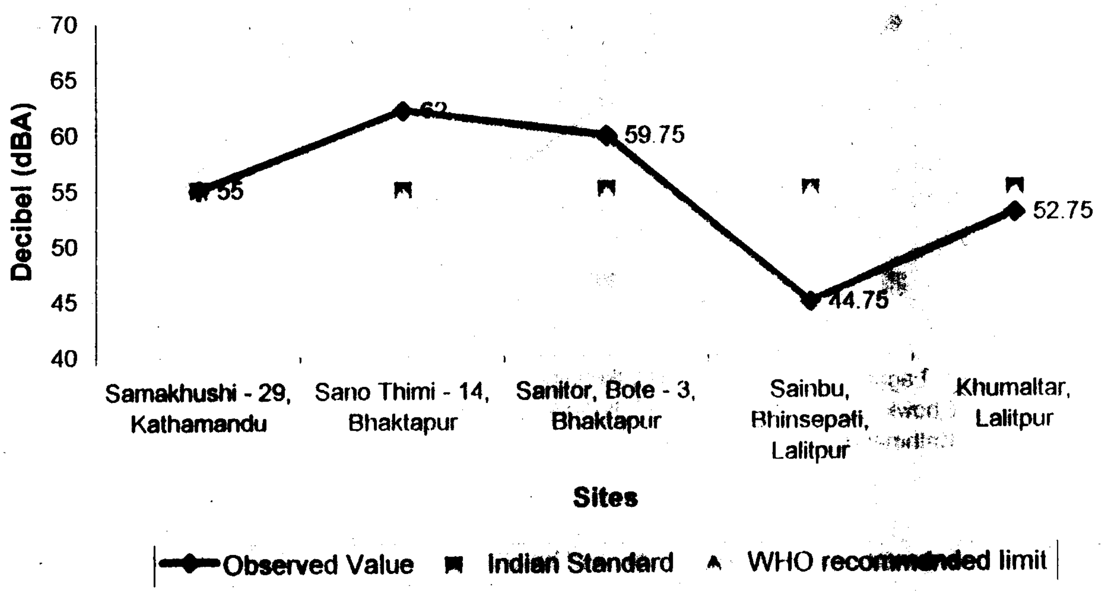
Chart 18: Comparison of sound pressure level (Leq) of old residential area during night times with International Standards.



The chart-18 exhibits that the entire sampling site of old residential area exceeded the safe limit of L_{eq} 45 dBA for night hours set by both India and WHO. Among these, Lagan Chowk of Kathmandu had the highest L_{eq} where as Pimbahal of Lalitpur and Bhairab Mandir of Bhaktapur had lowest L_{eq}. It shows that Lagan Chowk, Kathmandu was more peril from the noise induced health hazards than that of Pimbahal and Bhairab Mandir.

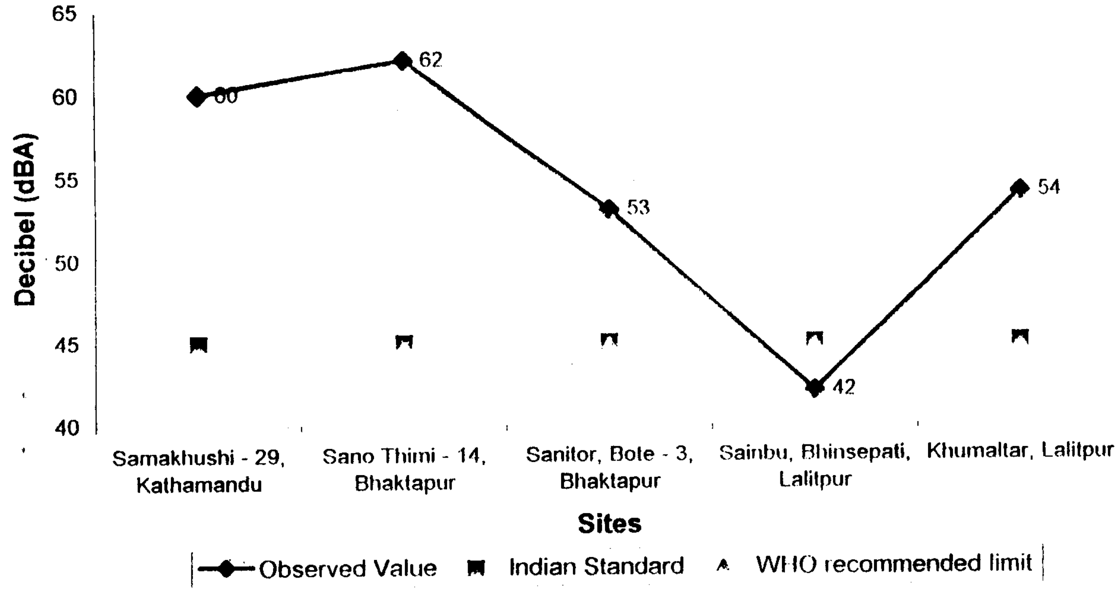
4.4.5 New Residential Area

Chart 19: Comparison of sound pressure level (Leq) of Day Time of New Residential Area with International Standards



The chart-19 exhibits that equivalent sound pressure level (L_{eq}) of Sano-Thimi and Sanitar of Bhaktapur were exceeded the recommended limits set by India and WHO where as those of Sainbu and Khumaltar of Lalitpur were below the limits. Among the entire sites, L_{eq} of Sano Thimi of Bhaktapur was found as the highest sound pressure level & lowest in the sanibu, Bhinsepati of Lalitpur. There were few variations in monitoring data in comparison to the standards. Thus it could be inferred that New Residential areas were quite safe from noise-induced health hazards.

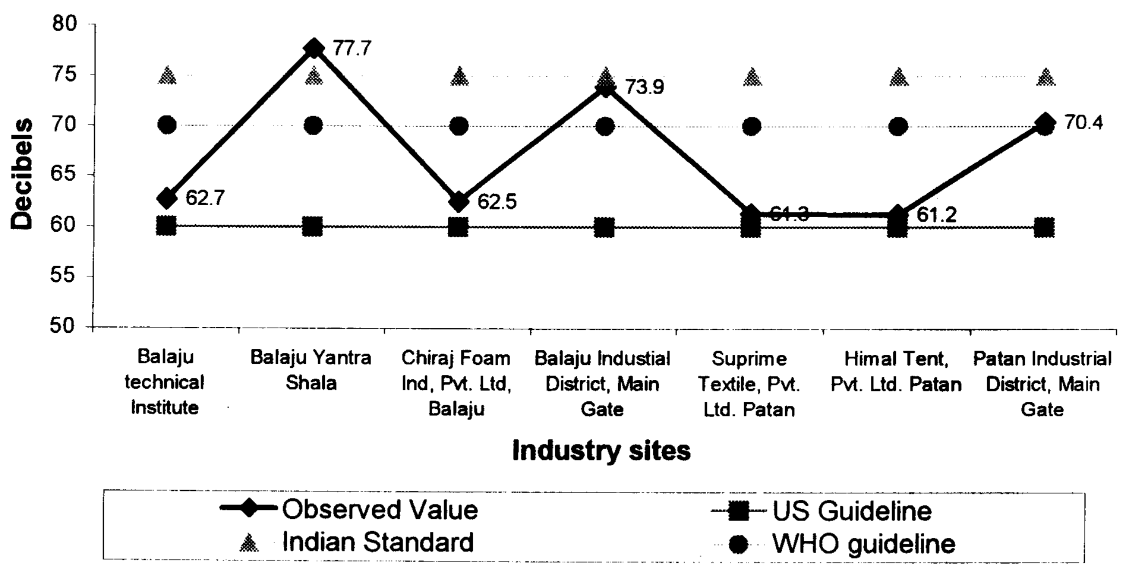
Chart 20: Comparison of Leq at Night Time of New Residential Area with International standards



The chart-20 illustrates L_{eq} of New Residential area at nighttime in comparison to the International standards. L_{eq} of all samling sites except that of Sainbu of Lalitpur were exceeded the recommended limit (L_{eq} 45 dBA) set by India and WHO. Sano-Thimi was found to have highest equivalent sound pressure level where as Sanitor of Bhaktapur was found to have least. It could be inferred that there were higher chances of occurring noise induced health impacts in Sano-Thimi of Bhaktapur.

4.5 Noise Level in Industrial Areas

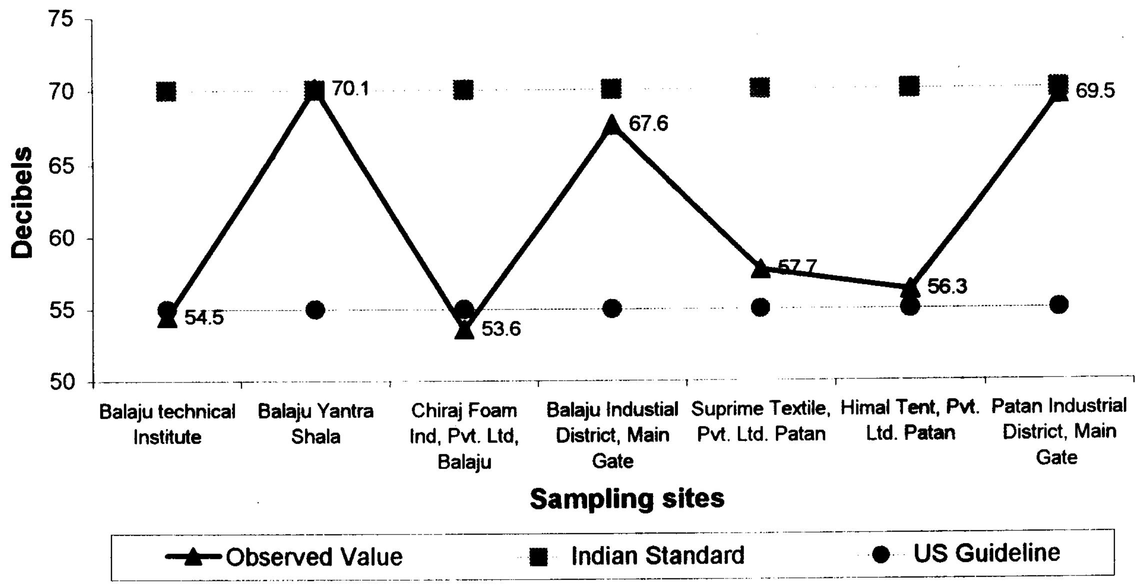
Chart 21: Comparison of Day time Leq of Industrial area with International Standards



The chart- 21 shows the ambient sound pressure level (L_{eq}) of daytime and its comparison with the International Standards in the industrial districts. L_{eq} of all of the sampling sites were exceeded above the US Recommended Guideline Value. L_{eq} of all sample sites were found below Indian standard except Balaju Yantra Shala. It concludes that ambient sound pressure level of the industrial district was within the safe limit when Indian standard of ambient sound pressure level was considered. WHO Guideline for Community Noise has recommended L_{eq} 70 dBA as standard noise level in vicinity of Industrial area. L_{eq} of Balaju Yantra Shala, Main Gate of Patan Industrial District and Main Gate of Balaju Industrial District were exceeded the WHO standard while rests were within the limit. The traffic flow, high-pressure horns, shops, restaurants and people's activities near the gate of Industrial areas were the chief noise source causing increase in the noise level in these areas.

Thus considering Indian standard & WHO guideline, the ambient noise levels in industrial states in Kathmandu valley were still within the safe limit and less hazardous from noise pollution perspective.

Chart 22: Comparison of Night-time Sound Pressure Level (Leq) of Industrial Area with International Standards



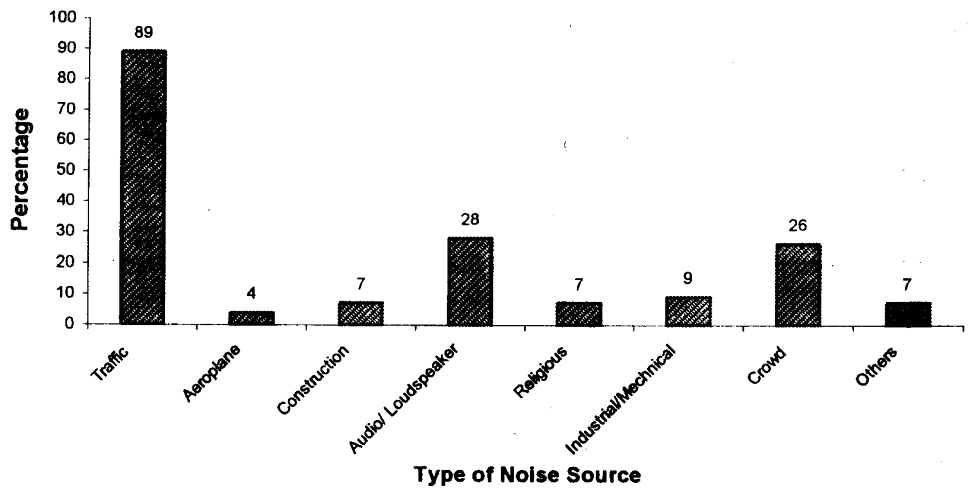
The chart -22 depicts the equivalent sound pressure level of Industrial States during nighttime and its comparison with the International Standards. L_{eq} of Balaju Technical Institute and Chirag Form were found below the US recommended value (L_{eq} 55 dBA during nighttime) while L_{eq} of rest of the remaining sampling sites were exceeded this limit. As Indian standard (L_{eq} 70 dBA for nighttime) for industrial area is taken into consideration, then L_{eq} of all of the sampling sites except Balaju Yantra Shala were exceeded this recommended limit. This shows the L_{eq} of Industrial areas are within the limit of Indian Standard and above the US standard. This result, the noise levels during the night hours are within the threshold limit of hearing impairment.

4.6 Noise Pollution and its Health Effect

4.6.1 Noise Pollution Survey Analysis

Altogether 150 samples covering different environmental settings were surveyed. During survey, the entire respondents had shown familiarity in relation to noise pollution. Out of total respondents, 30% had shown ignorance on health effect of noise pollution.

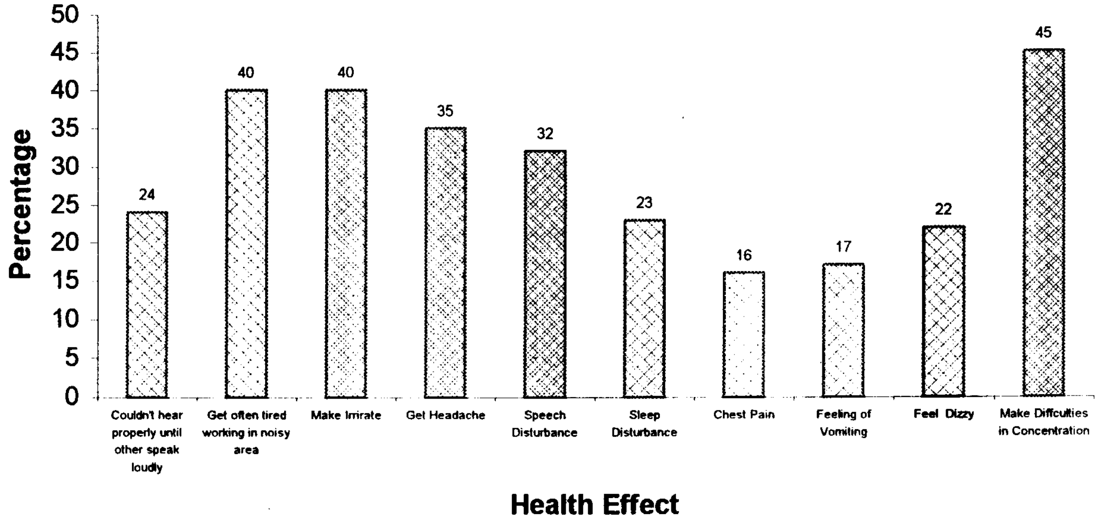
Chart 23:Percentage of People responded to Noise Sources



4.6.2 Noise Source

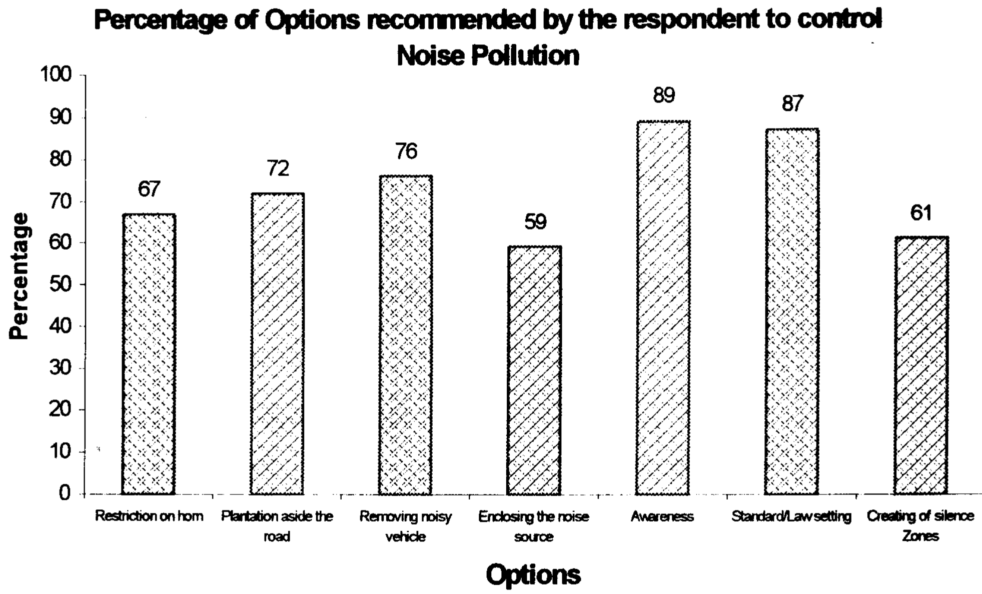
The chart –23 shows the percentage of people responded to the noise source.Respondents had perceived different noise sources like traffic, aeroplane, construction, audio/loudspeaker, religious (Bhajan/Bell), industrial/mechanical, crowd and others (hooligans, animals) at their environments where they lived. The traffic noise was observed as the most dominant noise exposed by the respondents. 89% of the respondents had responded that traffic noise as the major noise source that they were exposed. 28% of respondents had complained about audio/ loudspeaker and 26% explained about public crowd and voice as the noise sources. 7-9% of respondents claimed about the construction, religious and Industries or mechanical as the noise sources.

Chart 24: Weightage Percentage of Respondents contemplated to Noise Induced Health Effect



The chart -24 shows the weightage percentage of respondent contemplated to different psychological and physiological effects induced by the noise. The major health effect induced by the noise pollution was observed as making difficulties in concentrations. Being irritated, getting often tired in working in noisy environment, getting headache were also the other major health effects caused by noise pollution. Chest pain and feeling vomiting were the least health effects observed according to respondents. The respondents had also felt the speech and sleep disturbance due to the noise.

This shows that most of the residents in the urban cities have been facing the noise induced health effects. It could lead awful health hazard in near future if noise pollution could not control on time. Some of previous incidents published in the newspaper like cows living near the Tribhuvan Airport had given less milk and one of the young kid died during take off of the helicopter were some of the incidents that could have effects due to noise. These kinds of incidents and above results from the survey bring the conclusion that immediate attention need to be given for research on noise induced health effects.



The Chart-25 illustrates the percentage of respondents recommending options for the noise pollution control. The majority of respondents said that the awareness on noise pollution and its health hazards must be essential at present to combat the noise pollution. Similarly, the respondents had also emphasized that there should be urgent need of the Legislation and standards related to noise pollution. The respondents had also given priority to the restriction on horns, removing old vehicles and plantation aside the road for the noise pollution control. Enclosing the noise source & creating of silence zone were the least recommended options given by the respondents.

4.6.3 Clinical Analysis

4.6.3.1 History of respondents, behaviors, attitude, health effect, occupational environment.

All together 61 samples were taken for the clinical analysis. Sample from two different groups namely exposed and non-exposed groups were selected. Exposed groups were those residing or having regular activity near the main road where sound pressure level exceeds 70 dBA where as the non-exposed group were those reside, lives or performs their activity away from the noisy environment where the sound pressure level do not exceeds 55 dBA. Voluntary participation to perform above test was called in both the communities. 61 samples were collected in total. 25 samples from the non-exposure area and 36 samples from the exposed area were collected. Out of the entire sample 28 were male and 33 were female.

The survey conducted that 14.75 % of the total sample that were in exposed groups had mild noisy working environment. 6.56 % & 8.20 % of the total sample, categorized in exposed groups had moderate and severe noisy working environment respectively. As in non-exposed groups only 1.64 % each of total sample had mild and moderate noisy working environment and none of sample in non-exposed category had severe noisy working environment.

Health effect of people under survey found that in the category of non-exposed groups none of the sample has respiratory and intestinal tract disease where as only 2 % out of total sample had cardio vascular and genitourinary disease. In exposed groups, 5 % of the entire sample had cardio vascular disease, in 3% respiratory disease, in 2 % genitourinary disease, and in 7% intestinal tract disease were found.

4.6.3.2 Audiometric test

Audiometric test had been conducted to the entire sample comprising of 25 sample from non-exposed groups and 36 from exposed groups. The results obtained are highlighted below:

Chart 26: Age wise comparison to noise induced hearing loss in non-exposed group

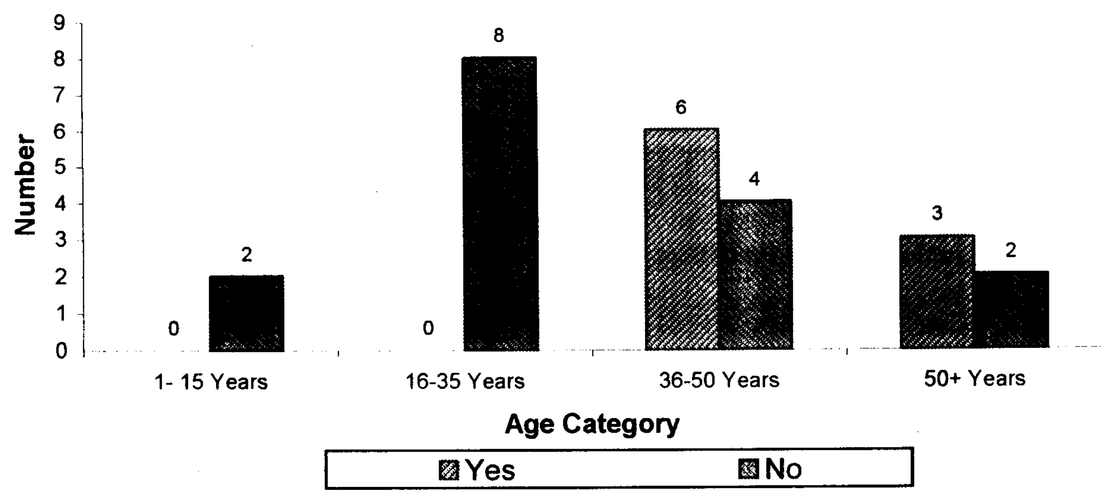


Chart-26 indicates that in non-exposed groups, the noise induced hearing loss was observed in a age group of 36 years and above. No evidences of noise induced hearing loss were observed below 36 years of age. This may be due to the symptom of presbycusis (lifetime progressive deafness occurrence) and its effect might be due to working in the certain noisy environment. In 14.75% of the total sample surveyed had the noise induced hearing loss. However, the magnitude of the health effect was very less in comparison to that in exposed group. Most of them had found with negligible, mild and moderate noise induced hearing loss.

Chart 27:Age wise comparison of noise induced hearing loss in an exposed group

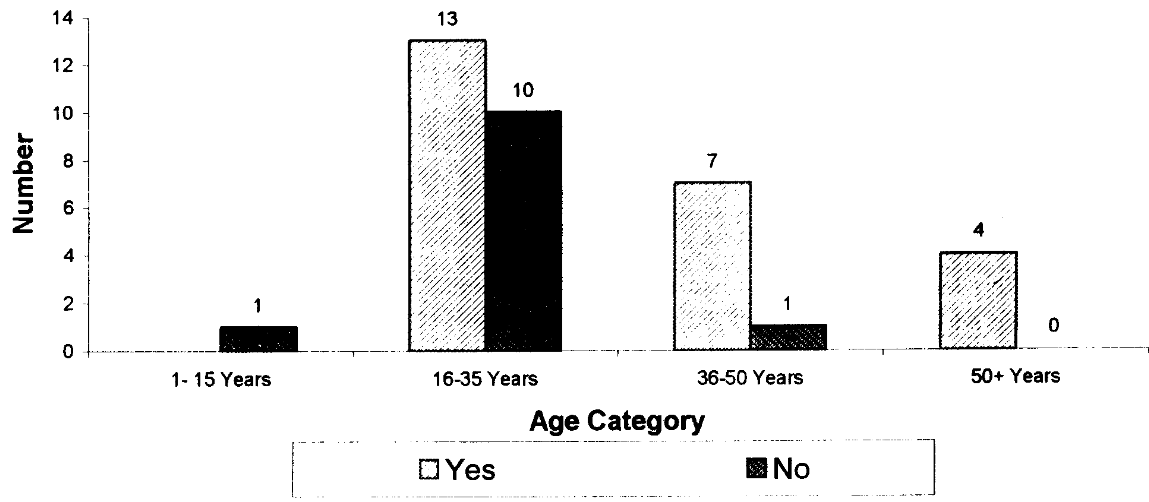


Chart-27 shows age wise noise induced hearing loss in exposed group. In total 39.34 % of the sample were found noise induced hearing loss through the audiometric test. Most of them were having moderate and severe noise induced hearing loss. The cases were found mostly in the age of 16-35 years. The health effect was also found in the age of 36-50 years and least number of effects was found in the over 50 years of age.

4.6.3 Health Risk (Odds Ratio) of getting hearing loss due to exposure to environmental noise

Audiogram and medical examination in area of both exposed and non-exposed groups in Kupondole were performed. By applying logical regression tools it has been found that the risk of getting noise induce hearing loss is 4.250 times higher in exposed group than in non-exposed group. Excluding the occupation noise, in this scenario the risk factor of getting noise induces hearing loss of exposed category is still 4.032 times higher than non-exposed groups. This shows that the environmental noise highly dominant by the traffic noise is the major factor. This study has shown that there are many high traffic areas where the sound pressure level exceeds above 70 dBA. The people staying at that environment might also have hearing loss induced by traffic noise. Thus before it gets too late the concern authority must take a strong step to minimize the noise pollution.

Considering the above aspects, we can conclude that traffic noise dominates the spectrum of environmental noise. Particularly high traffic noise is contributed through excessive sound pressure level above 70 dBA and is a continuous factor for major noise induced hearing loss. The people staying in noisy area especially above 70 dBA should take precautionary measures in order to avoid noise induced hearing loss.

CHAPTER 5

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusions

This study highlight the sound pressure level at different environmental settings of five different cites in Nepal. The study concluded that among the five different environmental settings, high traffic areas experiences high sound pressure level while new residential areas experiences the lowest one.

Sampling was done at 38 different sites. Among the entire sampling sites, the highest sound pressure level (Lmax) of 93 dBA was observed during night hours in Suryabinayak, Bhaktapur. Similarly during Office hours the highest sound pressure level of 89 dBA was observed in Kupondole and during non-office hours the highest sound pressure level of 88 dBA was observed in Kupondole of Lalitpur and Janaki Mandir of Janakpur respectively.

Among High Traffic Areas, the highest sound pressure level was observed in Suryabinayak of Bhaktapur and Kupndole of Lalitpur. In Commercial cum Residential Area, the highest sound pressure level was observed in Ason Chowk, Kathmandu. In Commercial cum Tourist Area, the highest was observed in Janaki Mandir, Janakpur. Similarly in Old and New Residential Area the Highest Sound Pressure Level was observed in Lagan Chowk of Kathmandu and Sano Thimi of Bhaktapur respectively.

The day-night average sound pressure level (L_{dn}) value observed in different environmental settings have shown that there exist problem of noise pollution in urban areas of our country. The Environmental Protection Agency (EPA) of USA has recommended that the L_{dn} scale should not exceed 55 dBA to protect public health and welfare. However, the most of the values observed in this research have exceeded this limit. The highest L_{dn} value was observed at High Traffic Area of 74.36 dBA and the Lowest L_{dn} was observed at New Residential Area of 62 dBA.

In Industrial Districts, the sound pressure level observed during daytime in all sites were high above the US Guidelines. The result compared with WHO guidelines also found that 42% of the sample had exceeded the guideline value. Similarly, 28% of the sampling sites had exceeded the Indian Standard. Sample taken in night hours had also exceeded by 14 % with respect to Indian Standard and 71% with US Guidelines for the Industrial Area for nighttime monitoring.

Questionnaires surveys among 150 people have shown familiarity in relation to noise pollution Out of them, 30 % have shown ignorance on health effect by noise pollution. It has found that traffic, crowd, audio/loudspeakers are the major source of pollution. Irritations, difficulties in making in concentration, getting tried in noisy environment are the major noise pollution health effect. Thus to combat this noise pollution awareness, formulation of laws/standard are the best options recommended by the respondent. Apart from this restriction on horns, removal of noisy vehicles, plantation aside the roads are the other options.

Audiogram and medical examination were performed for 25 samples from non-exposed and 36 from exposed group. It was found that 32 % from non-exposed category and 66% from exposed category had noise induce hearing loss where as 8.20 % out of total sample were found noise related medical problems. This result shows that noise induce hearing loss is high in exposed group than of the non-exposed group. Applying the logical regression tools predicted that there is 4.250 times higher chance of getting noise induces hearing loss in exposed group than that of non-exposed group. Excluding the occupation noise, the risk factor of getting noise induces hearing loss of exposed category is still 4.032 times higher than non-exposed groups.

In conclusion, noise pollution is emerging as an environmental problem in majority cities of areas in Nepal .This can cause negative impact to public health and welfare. Considering it, the rules framed in keeping noise level low should be implemented strictly.

5.2 Recommendations

This research shows that noise pollution is an emerging problem in majority of cities in Nepal. This is the right time to tackle with this problem so as to reduce the noise menace. The following options are recommended in order to minimize or mitigate noise pollution.

5.2.1 Awareness Raising Option

A part of the strategy to cut noise level, public awareness about their ill effects should be created through radio, TV, the press, posters, symposia and demonstrations. Also administrative measures making licensing of public address system compulsory restricting their use at night and limiting the amplifier power can be adopted to keep the noise level low.

The aim is to raise environmental awareness at all the areas of concern. Increasing the level of awareness within the industry can bring some changes in habits of using earplugs. Various methods could be used to persuade the companies to install less noisy equipment.

Training and education to motor vehicles operators should focus on demonstrating the possibilities for noise reduction. Awareness raising materials could be designed and promoted effectively.

5.2.2 Legislative Option

There is no specific plan, policy and law related to the noise pollution. This research shows that there is indispensable need of legislation and policies regarding to Noise pollution.

Presently, Valley Traffic Police had created silence zone from Shaid gate to Jamal. This is good initiation. Similar strategies must be adopted to other parts of busy streets in town.

5.2.3 Operational Option

The best way to control the noise pollution is to control it at the source. It has been observed that the noise pollution is the result of high-pressure horns & vehicle's engine. Thus high-pressure horns must be replaced by other low horns and there must be periodically maintenance of the vehicles.

The responsible authority must encourage the installment of noise pollution control equipment & sound absorbency in the industries.

The other way of reducing the noise pollution is to cut the transmission path from source to the receptor. This means to put the absorbent at the path. For this purpose, we can grow plants at the side of roads. The green belt is very effective in shielding and absorbing the noise.

Various available noise control devices can be used effectively to control noise pollution to the extent needed.

Hospitals, Schools, should be built far away from the busy areas at quite places where as the industrial should be kept at different location away from residential areas.

Substitution of low noise level processes for noisy operation such as welding instead of riveting, metal & pressing instead of rolling or forging should be practiced as far as possible to reduce noise.

Use of personal protective equipment's (like earplugs) in noisy areas must be followed strictly.

Trees, concrete wall etc were found to be a good noise absorbent. This technique should be used in practice where highways are close to residential area. The study done by Shrestha *et al.* (1998) had shown that bushy tree (*Tupidenthus sp.*) has high efficiency of absorbing sound relative to pine (*Juniperus recurva*). Similarly Neem (*Azadirachta indica*) & *Tecoma stans* is also found as the noise absorbance.

Noise level is found to increase due to high density of traffic in the context of Kathmandu. So, excessive traffic density should be either reduced or controlled.

5.2.4 Promotion of Information exchange on Noise pollution controlling techniques

Promotion of information exchange between companies must be encouraged in the sector of noise control. Government institutions, companies, international organizations could play a major role to materialize it. Technologies to reduce or control noise should be promoted by this exchange.

5.2.5 Realization of demonstration project

"Seeing is believing" Demonstration projects aimed at key industries to demonstrate the successful implementation of noise pollution control devices are useful.

5.2.6 Health effect of noise pollution

The study revealed that there is a strong correlation between noise pollution and noise induced hearing loss. There has to be a regular monitoring protocol to be established for measuring health effects due noise pollution. More weightage should be given to the study of exposure at various noise levels and its controlling method.

CHAPTER 6

6.1 CRITERIA FOR FORMULATION OF NATIONAL POLICY AND GUIDELINES FOR PREVENTION AND CONTROL OF NOISE POLLUTION

In Nepal there exists no guideline, laws that exclusively deal with problem of noise. National noise standards can usually be based on a consideration of international guidelines, such as these guidelines for community noise, as well as national criteria documents, which consider dose-response relations for the effects of noise on human health. It is very important to note that Nepalese standards should take into account the technological, social, economic, political factors of the country.

There are various models that could be used for developing and implementing guidelines, policies, and legislations in Nepal. As highlighted below, each component needs to be dealt properly.

Legal Measures	Examples
Control of Noise Emissions	Emission standards for road and off-road vehicles, emission standards for construction equipment, emission standards for plants, national standard
Control of Noise Transmissions	Regulations on sound-obstruction measures
Noise Mapping and Zoning Around Roads, Airport, Industries, Hospitals, Schools etc	Initiation of monitoring and modeling program
Control of noise Emissions	Limits for exposure levels such as national emission standards, noise monitoring and modeling, regulations for complex noise situations, regulations for recreational noise
Speed Limits	Residential area, hospitals
Enforcement of Regulations	Low noise implementation plan
Minimum Requirements for Acoustical Properties of Building	Construction codes for sound insulation of building parts
Engineering Measures	Emission reduction by source modification, new engine technology, transmission reduction, orientation of building, traffic management, implementation of land use planning
Education and Information	Raising public awareness, initiation of research and development, behavior changes etc

The above process can start with the development of noise standards and guidelines. Since there were no generic data available on noise pollution of cities in Nepal, this particular project has attempted in identifying and mapping of noise sources. In addition to this survey, all the researches done so far in this field were analyzed to obtain the situation of noise pollution in major cities in Nepal. Based on the outcomes of these analyses, noise standards and model outputs are proposed. In such a way that it will assist the planners and policy makers, legislators in formulating noise pollution guidelines, standards and legislation in Nepal.

6.2 RECOMMENDED GUIDELINE FOR EQUIVALENT SOUND PRESSURE LEVEL IN CONTEXT TO NEPAL

Noise Area Classification	Daytime (Leq)	Nighttime (Leq)	Ldn
1	50 dB(A)	40 dB(A)	45 dB(A)
2	55 dB(A)	45 dB(A)	47 dB(A)
3	57 dB(A)	50 dB(A)	52 dB(A)
4	60 dB(A)	55 dB(A)	54 dB(A)
5	60 dB(A)	52 dB(A)	53 dB(A)

Noise area classification is based on the land use activity at the location of the receiver and determines the noise standards applicable to that land use activity. Details are highlighted below.

Noise Area Classification	Land Use Activity
1	Sensitive Areas (Schools, Hospitals, Telephone Exchange etc)
2	Residential Area
3	Commercial, Tourist Area
4	Industrial Area
5	High Traffic Area

6.3 Recommendations

1. A uniform law should be introduced for controlling and abatement of noise.
2. The law should provide different rules for regulating different kinds of noise arising from different sources
3. Noise level of industries, motor vehicle, construction equipment, aircraft should be standardized.
4. In noisy cities in Nepal, we should construct noise-free zones around schools, colleges, hospitals etc.
5. A complete ban (except in emergencies) should be promulgated for the use of loudspeakers and other noise producing activating during night hours.
6. Provisions of incorporation of articles in the act, regarding the limits of noise in terms of decibels is recommended. Some remedies based on scientific calculations should be added to the law. Making some specific legislation can do it.
7. Public awareness of the hazards of noise should be aroused so that they should encourage to control /use noise friendly devices.

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ANNEXES