

Evaluation of Urban Highway Environmental Noise Pollution (Penilaian Pencemaran Bunyi di Sekitaran Lebuhraya Bandar)

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ABSTRACT

The increase in number of urban highways constructed around residential and community areas around the city, has inevitably caused major noise pollution problems to city dwellers. The objective of the study was to assess the level of noise exposure and its impact to residents residing around the vicinity of urban highways. Noise level recording was carried out at selected areas to determine the noise pollution levels and the adequacy of mitigating measures that has been implemented. Traffic volume along the highway was recorded and categorized into six major classes of vehicles. Subsequently, the Leq, L10, L50 and L90 noise index percentiles were identified and data analyses were done on the data samples. Simultaneously, a public survey was conducted to gauge the existing public's attitude and degree of awareness with contemporary motor vehicular noise pollution. The study revealed that the noise level exposure experienced by the residents exceed the DOE's guidelines on a daily basis whilst the measures taken was inadequate to curb the noise menace emitting from the neighboring urban highway.

Keywords: Noise pollution, urban highway, assessment, noise index percentiles

ABSTRAK

Pertambahan bilangan lebuhraya yang dibina di persekitaran kawasan perumahan dan komuniti di sekeliling bandar telah secara langsung mengakibatkan masalah-masalah berhubung dengan pencemaran bunyi bising yang serius kepada penduduk bandar. Objektif kajian ini adalah untuk menilai tahap pendedahan bunyi bising serta kesannya kepada penduduk yang tinggal berdekatan dengan kawasan lebuhraya-lebuhraya yang terdapat di kawasan bandar. Pengambilan bacaan tahap bunyi bising telah dijalankan di kawasan-kawasan kajian yang dipilih untuk menentukan tahap pencemaran bunyi dan keberkesanan kaedah-kaedah kawalan yang telah dijalankan. Isipadu trafik di sepanjang lebuhraya telah direkodkan dan di kategorikan kepada enam kelas utama kenderaan. Seterusnya nilai-nilai peratus indeks bunyi bising Leq, L10, L50 dan L90 telah dikenalpasti dan analisis data dilakukan terhadap sampel-sampel data tersebut. Sehubungan dengan itu, satu tinjauan awam telah dijalankan untuk menilai sikap serta darjah pengetahuan orang awam terhadap pencemaran bunyi daripada kenderaan bermotor. Hasil kajian menunjukkan bahawa pendedahan tahap bunyi bising yang dialami oleh penduduk melebihi garispanduan harian yang telah ditetapkan oleh JAS (Jabatan Alam Sekitar, Malaysia), sementara langkah-langkah kawalan yang telah di jalankan adalah tidak mencukupi untuk menangani masalah bunyi bising yang diakibatkan oleh lebuhraya-lebuhraya bandar yang berdekatan.

Katakunci: Pencemaran bunyi bising, lebuhraya bandar, penilaian, peratus indeks bunyi bising.

INTRODUCTION

In USA during the 1960's, noise pollution was a distant cousin in the family of environmental issues and, as history will relate, it had remained outside the mainstream of the environmental movement ever since. A massive public opinion survey taken in the early 1970's revealed that the public ranked noise pollution as a serious problem, but noise control advocates were unable to develop the same type of organized constituency that developed to support clean air and water. One reason was that although "air and water pollution was shown actually to kill" the supporters of noise control could not demonstrate a "direct cause and effect relationship" between excessive noise and death.

Internationally, Scientific Committee on Problems of the Environment (SCOPE), a committee of a non governmental group of scientific organizations and the

International Council of Scientific Unions (ICSU) are among the most leading expert bodies which have established comprehensive research projects on acoustics. The body also serves as a professional guardian who also assembles edits and later publishes significant scientific findings and conclusions on the related subjects. In Malaysia, there have been very few studies and researches conducted on the subject of noise pollution. It is because the awareness towards the noise pollution is still below normal.

However, in her advances towards a developed country in year 2020, Malaysia has not been spared from environmental problems. Its population explosion and social economic changes have contributed to increasing noise levels in community. Modern technology has furnished its own funfair – an ever-increasing din that disturbs our sleep, interrupts our conversation, creates

anxiety and sometimes damages hearing. But for far too long, noise has been regarded as a necessary price of technological 'progress'. This fact is confirmed by referring to DOE annual quality report which demonstrates the accelerated growth rate of pollution complaints between 1986 to 1994. However, transportation noise is not the highest complaints. Industries and commercial is the two major causes. Wherever there are expanding technologies, new noise sources tend to appear such as transportation.

NOISE POLLUTION DUE TO URBAN HIGHWAY

Part of our serious and growing noise problem is the result of our rapid population growth. Many more people are making more noise. As population increases the requirements for goods, services and transportation also increases, each of us requires transportation mainly to move from one place to another to find food, recreation and places to work. Each year there is an increase in the number of vehicles in Malaysia.

The increasingly crowded roads have prompted the building of new freeways in order to decrease traffic congestion. Unfortunately, the freeways usually end up being built beside an existing residential area, which results in they are becoming unsuitable for the people to stay in. That we are forced into such close proximity to freeways indicates that we are compressing ourselves into smaller and smaller spaces in our move towards urbanization.

One of the freeways is the Damansara-Puchong Highway, commonly known as LDP. It is a freeway connecting Puchong to Damansara, where the existing 4-lane road was expanded to a 6-lane expressway. This freeway cuts through numerous residential areas, and in many cases it sits right beside their private lawn.

There is evidence that there is a serious need for properly planned roads or highways if they were to continue to encroach into residential areas. The Government and Department of Environment (DOE) can no longer treat noise pollution from the road lightly. The authorities should remember that noise is not a measure of the progress of technology but it is a sign of regression. The requirements of having inspection and adhering to the EIA procedure should be taken seriously when building a new highway, as well as after its construction.

STUDY OBJECTIVES

The primary objective of this study is to evaluate the noise pollution impact along the urban highways. With the increase in the number of urban highways constructed around residential community areas, the level of noise pollution amongst other things has inevitably caused major problems to city dwellers. This study covers the measurement of outdoor sound levels at specific locations using a digital statistical analyzer and a formal measurement plan. This study provides basic requirements for obtaining multiple sets of data.

This study will evaluate the level of noise pollution experienced and exposure to the community affected by these urban highways. Noise level recording was carried out at selected areas to determine the noise pollution levels and to determine the adequacy of mitigating measures, which have been implemented.

The scope of this study is concerned with the investigations of motor vehicle noise along the Damansara-Puchong Highway excluding such transportation modes as aircraft, helicopters and other kind of sources of noise nearby. Aside from this, it should also be observed that air borne noise sources are similarly not studied.

The various contemporary modes of vehicles have been qualified and categorized into six major classes in order to simplify and generalize later works of studies and analyses. The six classes are as follows:

1. Motor cars and taxis
2. Motorcycles and scooters
3. Buses
4. Small vans and utilities (Light 2-axles)
5. Lorries and large vans (Heavy 2-axles)
6. Lorries with 3 axles (Heavy 3-axles and above)

These six classes of vehicles are counted to the traffic volume of the highway. Additionally, measurements of noise levels for these various classes of vehicles have been taken under cruising condition.

One long term and three short-term sites were used to provide the data necessary to fulfill the objective of this study. The short-term sites were monitored for 6 hours during the daytime and 2 hours at night for 2 weekdays and one weekend. The long-term sites were monitored for a week for 6 hours during the daytime and 2 hours at night. A week constitutes seven days i.e. Monday to Sunday. It is to determine typical noise levels that exist in the area during one week.

Data supporting L_{eq} , L_{10} , L_{50} , and L_{90} noise descriptors (noise levels exceeded 10%, 50% and 90% of the time respectively) was used to evaluate the level of noise pollution experienced and exposure to the community affected by these urban highways.

Analyses was conducted to draw various conclusions such as the level of noise pollution experienced everyday, exposure to the community affected by these urban highways compared to the recommended legislation measures, the noise pollution level distribution for the place for a week and how the traffic volume affects the noise. Aside from this, analyses was also conducted to depict the time of the day which emits the highest or lowest noise level, when is the time that have the highest or lowest vehicle of the day and other relevant observations.

The level of confidence and reliability of the readings and data collected depends to the atmosphere surrounding and the instrument will calculate the statistical analysis that was used for the data analyzing. A questionnaire survey has been conducted to gauge the existing public awareness with contemporary noise pollution problems.

METHODOLOGY

Readings were taken every one-minute on the site investigation and the highest in two hours are taken as the peak and so on. The average velocity of the flow of the traffic volume is obtained by taking a lot of samples of data by using radar gun: shooting the vehicles at one point to take the velocity of the car and take the average of the data as the value for the traffic velocity flow. Another requirement was to count the traffic volume in order to relate the noise with the traffic volume. Counting procedure is as follows: first the vehicles are divided into six categories, i.e. Cars, buses, motorcycles, commercial vans, trucks (more than 2 axles) and medium lorries. The traffic volume is converted into "Passenger Car Units" (pcu) by multiplying the traffic volume of the car by 1, motorcycles 0.75, medium lorries 2.5, commercial van 2 and bus together with trucks by 3.

All sound pressure level readings have been taken under the A-weighted network, as scientific researchers have proven that the A-weighted network weights the contribution of sounds of different frequencies as simulated by the response of an average human ear. The dosimeter parameters were set up in line with the IEC Noise Monitoring standard.

Sound pressure level readings collected were analyzed and four most commonly adopted noise rating methods in environmental noise studies which are L_{eq} , L_{10} , L_{50} and L_{90} have been identified and calculated where:

1. L_{eq} is the Equivalent Sound Level in dBA
2. L_{10} are the noise level in dBA exceeded only 10% of the time or Peak Sound Level.
3. L_{50} is the noise level in dBA exceeded only 50% of the time or Mean Sound Level.
4. L_{90} is the noise level in dBA exceeded only 90% of the time or Background or Residual Noise Level.

Calculation of L_{eq} is already pre-programmed into the instrument. Similarly, there was no need to calculate the standard statistical analysis to determine their respective reliability or levels of confidence in order to verify their compatibility as a statistical sample with their respective population as a whole, as this was already performed by the instrument.

SITES SELECTION FOR FIELD INVESTIGATION

Three different locations along the LDP Highway were selected as site study. They were Bandar Sunway, Kelana Jaya and Taman Megah., Petaling Jaya.

Two type of noise monitoring sites was selected to fulfill the survey objectives, i.e. Short-term sites and long-term sites. Short-term sites were anticipated to show typical daytime and nighttime noise levels at specific locations, thus not requiring much data collection. Three sets of 2-hour continuously monitored samples were collected during the daytime rush hour traffic. Similarly, 2-hour continuously monitored samples were collected for nighttime, where 2 sets of data were collected for weekdays and one set of data was collected for weekends].

A long-term site was necessary to conduct detailed noise monitoring for a week at a specific location. The schedule for measurement called for daily three-2-hour periods during the rush hours and one 2-hour period at night, for seven days. The data were used to calculate average levels for daytime and nighttime periods, as well as providing a noise profile at each location including the quietest and noisiest hours and the effects of rush hour traffic noise. The long-term site was limited to residential use premises, recognizing the fact that the community noise complaints is the major problem which will affect their daily life. The long-term site was not randomly selected and is therefore not necessarily reflective of typical noise environments in residential areas. The long-term site was zoned for residential use, and was specifically selected using the following criteria.

1. Locations with a long history of noise complaints.
2. Locations where citizens have expressed a particular interest in their neighborhood noise levels and requested to be part of the survey.
3. Locations along busiest traffic corridors.

All field investigations and tests were conducted early in the morning (7.30 – 9.30a.m.), in the afternoon (12.00 - 2.00 p.m.), in the evening (4.30 – 6.30 p.m.) in order to take the all rush hour readings. Other than that, readings were also collected at night for two hours as a baseline reference for quietest period.

All of the noise monitoring was accomplished using a Quest Technologies Model Q-400 Noise dosimeter which employed an 8 mm omnidirectional ceramic microphone. A Quest Calibrator was used to routinely calibrate the system. The microphone was inserted into microphone windscreen as to improve the accuracy. At all locations the microphone was adapted with a random incidence corrector and mounted on a tripod which placed the microphone at a height of at least five feet above the ground and the microphone was pointed upward at an angle of approximately 70 degrees to the source noise. The tripod was normally placed at the property line separating the public premise (street or sidewalk) and the monitoring site and at least ten feet from any large reflecting surface (wall, building etc.)

QUESTIONNAIRE SURVEY

The importance of social survey in acoustical studies has been pointed out by various experts in the past. The most common way which this may be observed and measured is by the method of questionnaire field studies and for the purpose of this study, these have been carried out on a very extensive scale in homes, hospitals and schools (the area that has been selected).

Questions in the questionnaire have been drafted in such an intricate fashion so as to detect the public's degree of tolerance and awareness to highway noise with consideration to various parameters such as location, age of respondent, occupation and a number of general psychological, personal as well as physical aspects. In

addition, an attempt was made to investigate the major sources of noise of the area, when it occurs and whether the mitigation carried out by the private agency is effective or not. Aside from the above questions, the respondent was also requested to air his or her own suggestions, if any, on methods to control the current status of noise pollution. This was done in order to obtain a better and more complete as well as direct comprehension of the public's opinion on noise pollution.

RESULTS AND ANALYSIS

The result of the study indicated that almost 72% of the vehicles observed consisted of cars, followed by motorcycles (15%), vans and small lorries (12%) while the remaining 1% consisted of buses and trucks of more than 3 axles. From this, it can be deduced that cars are the major contributor to noise pollution. To reduce noise from this source, therefore, various improvements to the cars exhaust or muffler system, or to the highway speed limits, could be carried out by the relevant authorities.

The graphs attached show the Leq versus time of day during weekdays for predetermined locations along the LDP. This graph shows that the Sunway residential area gets less noise compared to the Kelana Jaya Secondary School. The noisiest selected area for the study is the Megah Medical Center in Taman Megah. The causes and the hypothesis why this location is the noisiest will be discussed.

Bandar Sunway Sunway Residential Area is the major area for the study, as the LDP cuts right through this area, splitting it into two. Before the LDP, the existing 2-lane road did not have much traffic and the few roaring cars did not disturb the residents. When the LDP materialized, residents of some corner lot houses suddenly found themselves only 2-5 meters away from the highway. Until a sound barrier was built, these residents' peace and quiet had been constantly disturbed by noise coming from the highway.

From the graph showing the Leq versus Days of Week for Sunway Residential Area, it can be seen that there is not much difference between the noise levels in the morning, afternoon, evening, night, weekdays and weekends. While a relatively constant noise level is less stressful, it should be noted however that the average noise level still exceeds the DOE guideline, which states that the Leq for residential areas should not exceed 55 dBA.

The sound level measurements done during this study measured the various levels i.e. L_{eq} , L_{10} , L_{50} and L_{90} throughout the week. The everyday sound level versus time of day in Sunway Residential area shows that the majority of the residual noise for all data taken is above 60dBA. Only at night does the residual noise (L_{90}) fall between 56 to 60 dBA. On Sunday mornings the meter reads 55dBA. This is the lowest noise level (L_{90}) collected. This means that the lowest rate of noise level in Sunway Residential area still exceeds the allowed figure by the DOE.

From the resultant graph showing the sound level

versus time of day during weekdays for Sunway Residential area, it is observed that the residual noise (L_{90}) which is the minimal noise level for the weekday is 58 dBA. The noisiest level which has been taken from the Leq readings is 67 dBA. Such a noise level is considered very high for a Residential Area (according to the guideline by DOE).

The traffic volume was converted into PCU, and from there, was analyzed and plotted. Results shows that PCU versus days of week for Sunway Residential Area, where the highest PCU volume recorded is during the evenings followed by the mornings, afternoons and nights.

Kelana Jaya The study shows that Kelana Jaya is the second noisiest site with the graphs showing the sound level versus time of day during weekdays and weekends respectively. The minimal sound level (L_{90}) is 57dBA. Usually the noise level (Leq) at that particular site is 70dBA and above. The noise level stays the same even though there is an increase in traffic volume.

Taman Megah Data collected at Taman Megah shows it to be the noisiest site. The graphs shows the sound level versus time of day during weekdays and weekends. Minimal sound level (L_{90} , representing residual noise) stands at 66 dBA, for nights of both weekdays and weekends. Meanwhile the noise level (Leq) at that particular site is generally 72 dBA and above. Only on weekend nights, the noise level decrease to below 72 dBA. There is not much difference in the noise level discovered at this site. This means that the noise stays the same even though there is an increase in traffic volume as it has been shown that the correlation between traffic volume and noise level is basically exponential. This phenomenon may also be due to the masking phenomenon, inconsistent data collection, or due to uncontrollable parameters such traffic volume, overlapping vehicles, etc.

DISCUSSIONS AND CONCLUSION

Result of the Leq versus days of the week for Sunway Residential area in relation to the DOE's guidelines, clearly show that the noise levels here exceed DOE's guidelines on a daily basis. When noise level values are compared between Kelana Jaya, Taman Megah and Sunway Residential Area, the latter shows the lowest noise levels among them. This can be attributed to the unbroken/uninterrupted sound barrier in the Sunway Residential Area, behind where the readings were taken. However, the current sound barrier is not high enough to reduce the noise level to the acceptable level of 55 dBA as advised by DOE. In order to enhance its effectiveness, the existing sound barrier should be built higher.

Studies have suggested that to avoid a reduction in the performance of parallel reflective noise barriers, the width-to-height ratio of the roadway section to the barriers should be at least 10:1. The width is the distance between the barriers, and the height is the average height of the barriers above the roadway. As an example, this means

that two parallel barriers 3 meters tall should be at least 30 meters apart. To provide standard structural design criteria for the preparation of noise barrier plans and specifications, the American Association of State Highway and Transportation Officials (AASHTO) Subcommittee on Bridges and Structures developed "Guide Specifications for Structural Design of Sound Barriers," which was published in 1989 and amended in 1992.

Roadside vegetation can be planted to create a psychological relief, if not an actual lessening of traffic noise levels. The planting of trees and shrubs provides only psychological benefits and may be provided for visual, privacy, or aesthetic treatment, not noise abatement. Vegetation, if it is high enough, wide enough, and dense enough that it cannot be seen through, can decrease highway traffic noise. A 61-meter width of dense vegetation can reduce noise by 10 decibels, which cuts in half the loudness of traffic noise. However it is usually impossible, however, to plant enough vegetation along a road to achieve such reductions.

Kelana Jaya has the second highest noise pollution level. Even though the sound barrier is slightly higher than the Sunway Residential Area, the noise levels in that particular area is slightly higher than Sunway Residential Area. This is due to the way the sound barrier was built, whereby the sound barrier at this site has a gap that allows noise to travel to the area it is supposed to protect. The gap was designed to allow a dedicated road to be used for the school in that area. While the intention may be well-placed, this design reduces the effectiveness of the noise

barrier.

In the case of Taman Megah, the total absence of sound barriers can easily explain its highest sound level among the three sites investigated. It is only logical that a proper sound barrier should be built here.

Analysis of Social Noise Survey A social noise survey had been conducted, with the majority of responses coming from the Sunway Residential Area. The resulting data was compiled and consolidated into pie charts.

From Pie Charts 1 and 2, it can be seen that air pollution and smoke disturb people with the percentage of 54.2% and 62.9%. From Pie chart 3 noise pollution also disturbs people surrounding with 60%.

The results of Pie Charts 3 and 4 indicate that residents feel there has been an increase in the noise level along the LDP highway. The increase is estimated to be up to 60 – 100%. This shows that the highway that has been constructed through this residential area has caused an increase in the level of noise.

From pie chart 5 the effects of noise pollution on the people who live nearby can be seen. A lot of people attribute increased headache and stress to the excessive noise levels.

The mitigating measures to address noise on the LDP that have been taken by the highway agency are the construction of sound barriers. Fortunately, this barrier, according to the residents, is quite effective.

DISCUSSION - MOTOR VEHICLE NOISE AND ABATEMENT
 Surveys consistently show that, of all the impacts of



Chart 1. Public Awareness to the Smoke and Its Effects

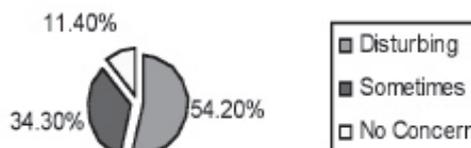


Chart 2. Public Awareness to the Air Pollution and its Effects

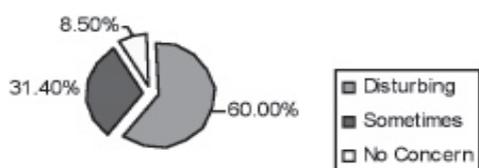


Chart 3. Public Awareness to the Noise Pollution and Its Effects

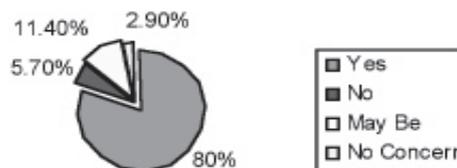


Chart 4. An Increment in Noise Level Around the Area

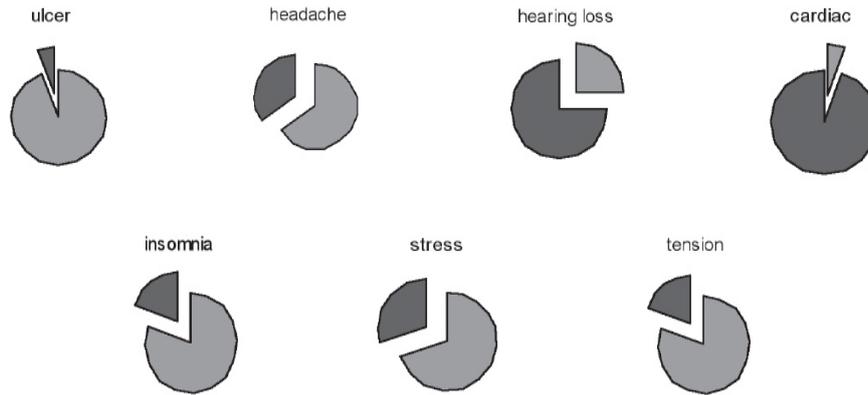


Chart 5. The effects of noise pollution

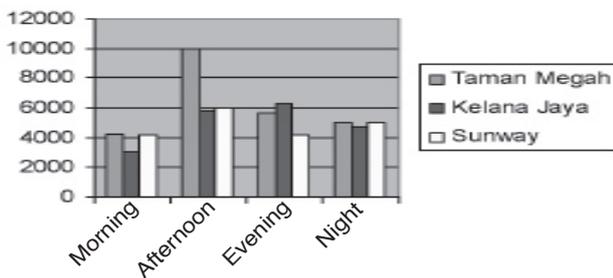


FIGURE 4A. PCU versus time of day during weekend for predetermined locations along the LDP

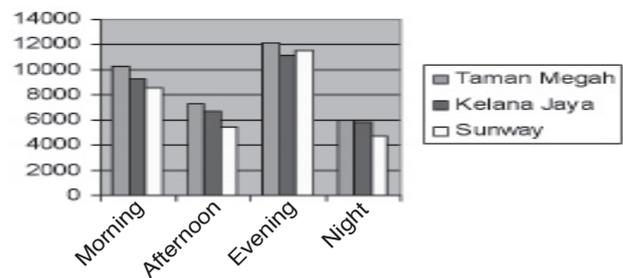


FIGURE 4B. PCU versus time of day during weekend for predetermined locations along the LDP

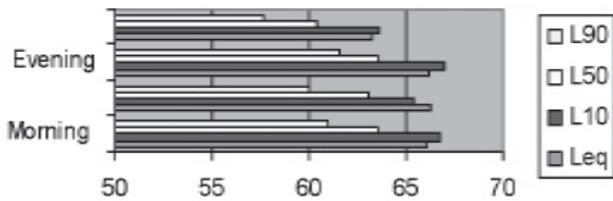


FIGURE 4.1A. Sound versus time of day during weekday for Sunway Residential Area

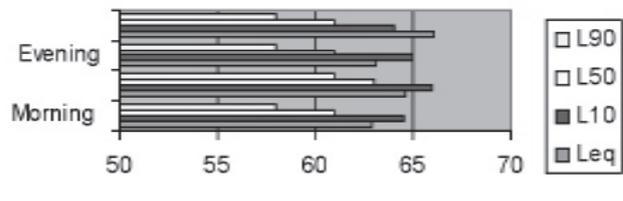


FIGURE 4.1B. Sound level versus time of day during weekend for Sunway Residential Area

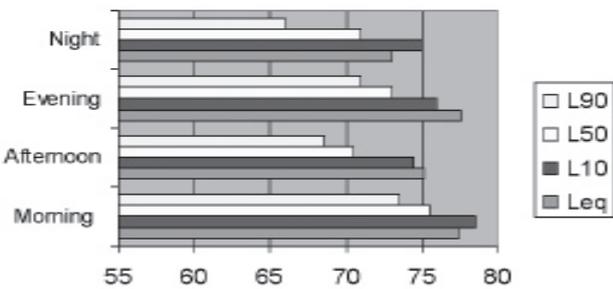


FIGURE 4.2A. Sound level versus time of day during weekday for Taman Megah

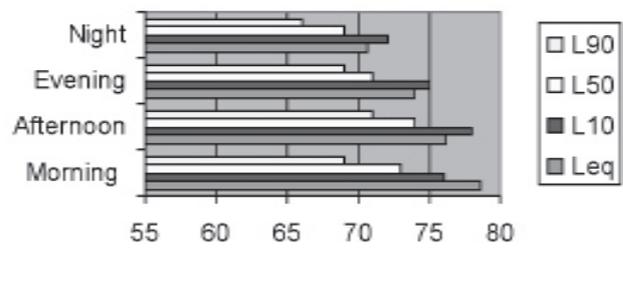


FIGURE 4.2B. Sound level versus time of day during weekday for Taman Megah

highways, noise disturbs the public the most. Based on a requirement in environmental Impact Assessment, all federal-aid projects must be examined with the environmental effects towards the area before, throughout the project and after the project is completed.

The World Health Organization (WHO) recommended noise limits for community environment is 55 dBA (Leq)

daytime and 45 dBA (Leq) nighttime. The Malaysian DOE guidelines are 55 dBA daytime and 50dBA nighttime. The WHO recommended noise limits for indoor/domestic areas are 45 dBA daytime and 35 dBA nighttime. There is currently no Malaysian recommended indoor noise limits.

Although law directed highway agencies to consider the problem of noise during the development of highway

projects, they are generally limited measures that can be taken during the planning and design phases of a highway project, and those measures do not always solve the noise problem. Substantial reductions in noise will require coordinated efforts to reduce sound at the source (the motor vehicle), to control the use of land in the vicinity of the highway, and to include noise abatement measures in planning and design of highways.

Unless improvements are made in source control and land use control noise abatement efforts by highway agencies will produce meager results at great public cost.

This does not mean that highway planners and designers can abandon their noise abatement efforts in the development of highway projects. On many freeway projects, noise reductions can be obtained by shifting the horizontal alignment, depressing the roadway or constructing noise barriers. On other types of roadways, noise abatement may be possible through 'soundproofing' public buildings. Traffic operation controls on vehicle types and hours of operation on selected roads and streets may be feasible.

There are constraints, however, on using these solutions. Usually horizontal alignment cannot be shifted, particularly on existing roads that are to be improved. In other cases, important natural or man-made features govern the vertical alignment and prevent depression of the roadway. Noise barriers cannot or should not always be constructed for example, when a noise barrier conflicts with safety, aesthetics, or local community desires. In addition, noise barriers are expensive.

The only environmental noise related legislation with noise limits is the Environmental Quality (Motor Vehicle Noise) Regulations 1987. This regulation stipulates permissible noise emission from motor vehicle, and has been enforced, from time to time by the authorities (Department of Environment, Road Transport Department and the Police). Current opinion also suggests that the Environmental Quality (Motor Vehicle Noise) Regulations 1987 be strictly complied to by some motor vehicle users (typically commercial vehicle, and motorcycles with illegal muffler modification or removal). The enforcement of these regulations appeared to be limited to the periodic

checks and campaign.

Highway traffic noise should be reduced through a program of shared responsibility. Thus, State and local governments should practice compatible land use planning and control in the vicinity of highways. Local governments should use their power to regulate land development in such a way that noise-sensitive land uses are either prohibited from being located adjacent to a highway, or that the developments are planned, designed, and constructed in such a way that noise impacts are minimized as the prevention of future impacts is one of the most important parts of traffic noise control. This can ensure the compatibility of the highway and its neighbors essentially for the continuing growth of local areas.

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