Disturbance of Traffic Noise: Evaluation on the Effects and Management on Road Corridors

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Abstract. Several adverse of stimuli can cause annoyance due to the characterized by such effects of distraction on health and delay in activities. Noise annoyance mainly due to the increasing in traffic volume has recognized as important environmental stressor which associated to anxiety and depression. In this manner, it can impose serious damage to human wellbeing, human comfort ability and reduces labour productivity. Hence, this paper aims in evaluating the effects on traffic noise and managing the precaution on road corridors in order to reduce the traffic noise. This case study had been conducted at residential area which is located at Taman Mutiara Rini, residential area located in the southern region of West Peninsular Malaysia. The traffic noise index (TNI) and noise pollution level (NPL) were recorded for a whole day in order to evaluate noise performance with different time durations. From the study, it was shown that the noise level at the Mutiara Rini is above than 75 dBA at most of time which is exceed the permissible limit from the guidelines recommended by the World Health Organization (WHO) and Department of Environment (DOE). According to the guidelines, the maximum limitation for noise pollution during daytime at residential area is about 55 dBA. From the interviewed conducted, it shows that reduction on the traffic noise can be improved by proposing and providing the noise barrier which includes the restoration of trees and concrete wall which can reduce the effects on the traffic noise.

1. Introduction

Noise is one of the pollution that has always been an important environmental problem for human. It is characterized as 'undesirable sound', and it is seen as a natural stressor due to the annoyance from human daily activities [1]. The major form of noise is including transportation, industrial and neighbourhood sector. Transportation noise can come from a variety of sources including motorcycles, vehicles, aircraft and rail transport. Road traffic has become an important factor in societal development and economic progress due to increasing number of vehicles [2]. Traffic noise has a tendency to be a dominant noise source in urban and rural environment, which has turned into a developing public concern. Based on the Report of World Health Organization, sound may cause hearing disability, sleep disturbance, performance loss, cardiovascular impacts, and interferences with social behaviour which are aggressiveness, protest and helpfulness. Traffic noise has also relates to the obstruction in speech communication and annoyance. Another perspective view on the economic consequences of these health impairments are property value. Loss in areas subjected to noise impact can bring down work performance of those influenced by noise [3] and medical expenses of improving the condition of health of those influenced by noise [4]. Its adverse effects on health and economy have forced communities to seek solutions to improve quality of life by reducing traffic noise. According to previous research [5] in figure 1, shows that 73\% has pointed that traffic noise are the main source that contributes in urban area.
2. Characteristic, Effects and Factors Affecting Traffic Noise on Human Behavior

2.1 Traffic Noise

Traffic noise typically results from the intersection of the sources of moving vehicle and the roadway. Traffic is the dominating source of noise [10] and is the major source of irritation and inconvenience. A considerable portion of traffic noise gets from the sound discharged by the ignition motors of these vehicles from the source to the receiver; noise varies both in level and frequency. The increasing number of living people and vehicles lead to the appearance of a noise pollution. Many noise reviews treating the issue of noise pollution in numerous urban communities through the world have been conducted. The noise impact was treated with as a stress inductor, and in consequence the part of sound as a risk factor for human health [11].

2.2 Traffic Noise Index

This building research survey is an analysis of the social nuisance caused by urban motor way sand their noise. The Traffic Noise Index is used to indicate traffic noises and their effects on architectural designs and planning, while suggesting the need for more and better window insulation and acoustical barriers [12]. Overall concern is for finding unacceptable noise levels, discovering how traffic noise is propagated, and determining effective traffic noise control for buildings. Graphs and charts are used to distinguish the relationship between noise levels and distances.

2.3 Noise Pollution Level

The environmental sound levels measured at a given location depend on a number of specific variables. In particular, many authors have found that the observed sound levels are mainly related to road traffic characteristics, and especially traffic volume, vehicle horns, rolling stock and tires, unruffled vehicles, etc. There is variation in the noise levels with the period of the day and the nature of the location. In general, there are high noise pollution levels (LNP) in the daytime compared with the night time except in the residential areas where the majority of the residents are not always at home during the working days of the week [13].

Figure 1. The histogram of road traffic noise in an urban setting [5].
2.4 Effect on the traffic Noise on Human behaviour.

The Road traffic has turned an important factor in social improvement, especially in terms of living comfort and economic progress. With the expanding number in vehicles in Malaysia, traffic noise represents the most general source of community noise (Zannin et al., 2003). Besides, exposure to the noise can give some effect to human such as health problems, disturbance, and annoyance that probably can also affect work performance and quality of life. For instance, sleep disturbance is generally associated with low noise levels, and levels higher than 70 dB (A) can induce hearing impairment and ischemic heart disease (Nijland and Wee, 2005). According to (Marathe, 2012), effect of traffic noise can be classified under following categories. This includes subjective, behavioural, and physiological effect.

3. Case study: Taman Mutiara Rini

The main research focus is to identify TNI that is near to sensitive area in order to assess public annoyance. Once the highest level is being identify, a propose mitigation is being conducted in order to reduce the traffic noise. The data had been collected near the roadside residential areas at Taman Mutiara Rini, Johor. In the beginning, eight sites have been chosen in order to identify the most critical sites to be investigated. The critical three sites most had been selected which are Sekolah Agama Mutiara Rini (Site A), Presint Utama (Site B) and Taman Mutiara Emas (Site C). The data had been collected using sound level metre to measure noise level These site were chosen because of the data noise level is above than 55dBA which is exceeded the permissible limit as specified from the DOE and WHO. It can conclude that the average noise levels from three sites are above than 75 dBA. Besides that, these sites have four junctions which are possible the noise level will increase. Figure 2 site layout illustrates the location of the three surveys from A to C.

![Site Layout](image_url)

**Figure 2.** Site Layout illustrates the location of the three surveys from A to C
4. Methodology

4.1 Noise Data Collection

Sound level measurement will be performing by using the Sound Level Meter (SLM) starting from 7.00 am until 7.00 pm. The sound level meter is mounting on tripod closet to the noise source. SLM indicate as a sound pressure level (SPL) meter, decibel (dB) meter, noise meter or noise dosimeter. SLM use a microphone to capture sound. The sound is then assessed within the device and sound measurement values are shown. The most common unit of sound measurement is decibel (Db. It also can be permanently installed for constant monitoring of sound levels at a work or job site. The noise parameter are to measure in LAeq.

![Figure 3. Installation of sound level metre (SLM)](image)

4.2 Assessment of Traffic Noise

The equivalent noise (LAeq) values were converted in term of noise pollution level (LNP) and traffic noise index (TNI) in order to identify the noise pollution experienced by the residents in that areas. The LAeq and LNP were compared with Department of Environment (DOE) and World Health Organization (WHO) limits which is within 55 Dba. The TNI values were also compared with the limit of 74 dBA for residential area. The measurements were calculated using the equation as follows [22].

\[
TNI = 4(L_{10} - L_{90}) + L_{90} - 30 \quad \ldots \ldots \ldots \ldots \ldots (1)
\]

\[
L_{NP} = L_{Aeq} + (L_{10} - L_{90}) \quad \ldots \ldots \ldots \ldots \ldots (2)
\]

4.3 Semi Structured Interview

Interview will be conducted with the panel expert in this case study in order to purpose the mitigation to reduce the traffic noise annoyance. This interview targeted to to Jabatan Kerja Raya (JKR), Majlis Perbandaran Johor Bharu Tengah (MPJBT) and Senior Lecturer from Faculty of Civil Engineering Universiti Teknologi Malaysia, (UTM). The focus interviewee is especially for exploring’s people knowledge and experience on the research issue. Table 1 shown the interviewee profile background
Table 1. Interviewee Profile

| Questions          | Respondent 1 | Respondent 2 | Respondent 3 | Respondent 4 |
|--------------------|--------------|--------------|--------------|--------------|
| Name of the Company | Majlis       | Majlis       | Jabatan Kerja | Faculty Civil |
|                    | Perbandaran  | Perbandaran  | Raya (Daerah) | Engineer      |
|                    | Johor Bahru  | Johor Bahru  | Johor Bahru,  | Universiti    |
|                    | Tengah (MPJBT)| Tengah (MPJBT)| JKR(D)JB      | Teknologi     |
|                    |              |              |              | Malaysia, UTM |
| Type of Organization | Pihak Berkuasa | Engineering  | Senggara Jalan | Education   |
|                    | Assistant    | Technician   | Facility Civil | Senior Lecturer |
|                    | Engineer     |              | Engineer      |              |
| Position in Company |              |              |              |              |
| Year’s Working Experience | 10 years       | 10 years      | 9 years       | 20 years      |
| Gender             | Female       | Male         | Female       | Male         |

5. Result and Discussion

5.1 Noise Level Variation

Figure 4 is clearly indicated that the most of peak noise happened during morning peak hour afternoon peak hour and evening peak hour as stated by [25]. It can say that the average mean level of traffic noise at site A is 74.50 dBA. At site B, it indicated the mean level of traffic noise is 70.0 dBA. The average mean level of traffic noise at site C is 73.3 dBA. This particular scenario indicated that the increasing noise level can be respectively associated with some driver behaviour.

![Figure 4. LAeq over 12 hour’s period of sampling locations.](image-url)
5.2 Percentage Noise Level in Study Area

Figure 5 shows the noise level at site A is high during morning off peak hour but it slightly increase 3% from the morning peak hour and 1% from afternoon peak hour which is 26%. At site B, the range from 65 dBA to 70 dBA the noise level is approximately same this is around 47%. This can be concluded that Mutia Rini area has fewer cars on the road commence from 8.00 a.m to 9.00 p.m. The noise level during morning peak hour is very high at range 70 dBA to 75 dBA which is 60% at site B. The pattern of the data at site C is likely same as at the site A. At the range 70 dBA to 75 dBA the noise level is almost same but it low during afternoon peak hour which is 13.33% [26] also proved that the noise level low during afternoon peak hour at residential area especially in low density residential areas because of majority of the residents are not always at home during the working days of the week.

![Figure 5. Histogram of percentage vs noise level](image)

6. Mitigation to Reduce Traffic Noise from An Expert Interviewee

A proper mitigation to reduce traffic noise, interview survey had been done directly from an expert interviewee. The interviewee was selected among Jabatan Kerja Raya, JKR (D) Johor Bahru, Majlis Perbandaran Johor Bahru Tengah (MPJBT) and Senior Lecturer from Faculty of Civil Engineering Universiti Teknologi Malaysia, (UTM). Table 5 shows the different perspective from the expert in order to managing noise annoyance due to traffic noise. The results show that the installation concrete barrier, planting trees and providing the lush absorbent is the best method to be used.
Table 2. Analysis for the Best Mitigation That Can Reduce Traffic Noise

| Theme : Mitigation | Respondent | Frequency | Percentage | Remarks |
|--------------------|------------|-----------|------------|---------|
| Code               | 1 2 3 4    |           |            |         |
| 1.a Noise barrier  | 1 1 1 1    | 4/4       | 100%       | This question indicates the best mitigation that can reduce the traffic noise. The practitioners have concluded one of the mitigation that they can apply |
| 1.b Travel speed reduction | 1 1/4 25% |           |            |         |
| 1.c Signage        | 1 1/4 25%  |           |            |         |
| 1.d Quitter rumble strips | 0/4 0%   |           |            |         |
| 1.e Travel Demand Reduction | 0/4 0%   |           |            |         |

7. Conclusion

Traffic noise impact (TNI) near to sensitive area has identified. There is a significance evidence of difference noise level produce in different peak and off peak hour. The noise level, noise pollution level (LNP) and TNI in residential area did not satisfy the road traffic noise limit recommended by WHO and DOE. This particular scenario indicated that the increasing noise level can be respectively associated with some driver behaviour such as honk from the vehicles, speed of the vehicles and also their vehicles itself has a turbo engine that can contribute to high noise level.

Second objectives stated that to assess public annoyance among residents. The analysis shows that, the respondents are agreeing with the level annoyance and sensitivity. Based on the traffic noise impact at all sites is moderately concern of worry even all the measured values are exceeding the permissible limits. This might be they are seldom in their house. Some of them are working from the morning until night. For them, there are not too seriously about the higher noise level. Furthermore, they just stay in their house and not effected too much. They are also feeling normal with this sound just sometime they feel annoyed when they are in the house. Moreover, this road is the main road to them drive to go everywhere.

From the third objectives, which is develop a proper mitigation that can reduce traffic noise annoyance from an expert interviewee has identified. They have same perspective that restoration of concrete barrier and trees are the best mitigation to reduce the traffic noise. However, they said that by installation this barrier it will give costs benefits that improve of the environmental performance. It means that, it can reduce the noise pollution. But, it has own barrier from this mitigation. They agreed that to install this barrier is very high in cost especially in installation of concrete barrier.
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