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Train Noise Level at Residential Area in Kuala Lumpur: Preliminary Study

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ABSTRACT

Nowadays, rail transport is one of the most important transport modes chosen by Malaysians. However, the noise pollution caused by the railway causes complaints from residents living near this track. Therefore, the operator needs to order their workers to conduct monthly observations and measurements of their train noise level in the selected area. The conventional method requires more time and energy as the number of areas to monitor is various and the sound level measurement tools used are also expensive. Thus, the preliminary study was conducted to determine the current noise levels by MRT trains in residential areas near Pusat Bandar Damansara station. The noise level measurements were conducted at two nearby locations: Lorong Kasah Tepi (Location A) and Jalan Kasah (Location B). The noise level was measured at each location with three different slope distances using a sound level meter tool. The total data taken are one hundred and twenty which involves off-peak and peak hours. From the results, the data shows that the noise level at slope distance for off-peak and peak hour at Location A is higher than the noise level at Location B.

Keywords: Railway, noise level, sound level meter, off-peak hour, peak hour

1. INTRODUCTION

Rail transport has been started in Malaysia in the late 19th century to speed up transportation from the tin mining areas to ports along the coast. Nowadays, rail transport is one of the most important transport modes, especially in the capital city of Kuala Lumpur, and is greatly expanding years by years. Even though rail transport is considered as an environmentally friendly transportation mode that consumed less energy and less emission to the environment and human health but the operation of rail has been identified as one of the factors for noise pollution.

Unnecessary noise is the cruelest abuse of care that can be inflicted on either the sick or the well; besides, noise pollution is also reported as a primary cause of sleep deprivation [1]. The current study points out that railway noise leads to significant sleep fragmentation and cardiovascular activations during sleep and subjective distress as well as long-term effects of prolonged exposure to noise [2] [3] [4]. Research by Indrayani *et al.*, [5] the impact of the sound intensity level at the Bandar Khalipah train station on humans is hearing loss in people around the station which usually occurs when understanding a conversation. Noise can also cause long-term hearing loss if exposed to continuous, and communication disruptions in which the sound

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source comes from the engine in the locomotive, the clashing of the wheels with the ends of the rails, notification speakers, and train horns.

The problems/issues of this work is related to the noise emitted by the train and their effects to the population living near the railway tracks [6] [7]. With the growth of cities, especially in Kuala Lumpur, societies are increasingly questioning these problems, and people living in the proximities of railway tracks consider noise the most severe environmental problem [8]. Train noise issues have been increasingly crucial to discussed and debate as an increase of development on the train's transportation system in Malaysia. When the noise becomes a concern, all the other matters related to noise will investigate so that action can be taken to overcome the complaints by the public. Hanidza *et al*. [9] have stated the average level of sound pressure at night of 40 dBA, and 55 dBA as an interim target should be the target to achieve to prevent nocturnal noise deleterious health consequences which are recommended by the WHO regional office for Europe.

In Malaysia, the Department of Environment (DOE) has recognized that the average transportation noise levels in major cities in peninsular Malaysia are 71.6 dBA and 70.4 dBA during the day and night, respectively [10]. However, a noise level above 55 dBA considers noise pollution [6]. If noise above this level lasts for an extended period, the efficiency and well-being of a person will be reduced [11]. One of the solutions to reduce noise is by using the noise barrier. However, the function of the noise barrier is only as a noise reducer but not completely block the sound annoyance [12] [13]. Higher noise barriers result in less noise pollution, but the height of the noise barrier is not as high as possible. The height of the noise barrier increases, it will increase the construction cost, and aerodynamic load on the noise barrier [14].

Through this study, the current noise level, $L_{A,max}$ will be determined at two locations at a residential area near Pusat Bandar Damansara station for the MRT line during off-peak and peak hours. The results then will be used for further study in developing the noise prediction model, it will improve the measuring works in noise assessment and will be useful to reduce time and energy of workman.

2. LITERATURE REVIEW

Train development of train services in several countries has to lead to noise problems. According to Golmohammadi [15] road traffic noise can be a nuisance, particularly in residential areas, and the most significant main source of environmental noise pollution in cities. Therefore, many countries have introduced noise emission limits for vehicles and issued other legislation to reduce traffic noise. Noise legislation in Malaysia is control and monitor by the Department of Environment, Ministry of Natural Resources and Environment Malaysia, (DOE). There are three sets of legislation documents to guide acceptable noise limits for various types of land use and human activities in Malaysia. These documents provide useful guidance for planners and decision-makers at the state and local level as well as other organizations, bodies and agencies involved or having possibilities in the design and/or approval of town planning, infrastructure development.

Train noise is a type of environment that interferes in complex task performance, modifies social behavior, and causes annoyance towards passengers and the resident nearer. Train noise might come from many sources whether its own car body or the interaction with other components such as rail or wind forces. However, for a high-speed train, aerodynamic noise from pantographs becomes an important source of noise [16]. Zhenxu Sun *et al.*, [17] mentioned that the high-speed-train pantograph is a complex structure that consists of different rod-shaped and rectangular surfaces. Flow phenomena around the pantograph are complicated and can cause a large proportion of aerodynamic noise.

Tae Min Kim *et al.*, [18] stated that the aerodynamic noise of trains increased by the improvement of the speed. Based on his research, 1.7 million persons who stayed near the railway suffering from noise-damaged in Korea. Train noise can be heard inside and outside of the train. Various parts of its own body produce noise especially when it is moving on the rail. Noise can be produced from the engine, air conditioner system or HVAC, locomotive body, air space between car, and also wheel-rail contact. Table 1 shows the maximum permission or safe sound level allowed by the Department of Environment Malaysia. Usually, some railroad is located near to the residential area. So, based on the table below, the maximum allowable noise received by the resident is 50 dBA during daytime and 40 dBA during the night [10].

Table 1 Maximum permissible sound level

Receiving Land Use Category	Day Time 7.00 am -10.00 pm	Night Time 10.00 pm -7.00 am
Noise Sensitive Areas, Low-Density Residential, Institutional (School, Hospital), Worship Areas.	50 dBA	40 dBA
Suburban Residential (Medium Density) Areas, Public Spaces, Parks, Recreational Areas.	55 dBA	45 dBA
Urban Residential (High Density) Areas, Designated Mixed Development Areas (Residential-Commercial).	60 dBA	50 dBA
Commercial Business Zones	65 dBA	55 dBA
Designated Industrial	70 dBA	60 dBA

3. MATERIAL AND METHODS

This section was divided into three sections which are location identification, data collection and data analysis. The data collection involves the use of the specific procedure for noise level assessment and evaluation using special types of equipment. The data collection was carried out during normal working days at off-peak and peak hours. Lorong Kasah Tepi and Jalan Kasah near Pusat Bandar Damansara Station were the selected locations to collect the data.

The specific location for the MRT train noise data collection was held near Pusat Bandar Damansara Station. Before that, an earlier observation and survey of the location in the residential area had been done. The location was chosen according to the factors of the distance between the residential area and the elevated MRT track, which include the availability to access the area, set up the tools for measurement, and also the visibility of the train's traffic flow. Two locations that are near Pusat Bandar Damansara Station were selected in this study. These two locations were labeled as A and B, where Location A is located in residential areas, while Location B is located close to the shophouses. Location A and B are located at Lorong Kasah Tepi and Jalan Kasah, respectively. Both locations have high potentials to get exposed to the train noise. The descriptions of the locations are given in Table 2.

Table 2 The selected locations for the works

Area	Name	Condition
Location A	Lorong Kasah Tepi	Residential areas
Location B	Jalan Kasah	Shophouses

The locations A and B can be viewed in detail from the satellite images which are presented in Figure 1.

Figure 1. Location A (Lorong Kasah Tepi) and location B (Jalan Kasah) [19].

The data collection was carried out during normal working days. The total measurement of noise $L_{A,\ max}$ for data collection was 120. For each location, ten measurements of train noise for every slope distance of 35, 40, and 50 meters from the edge of the track were recorded. Different slope distances were chosen to show the pattern of data collected.

The data collected from the field measurement at two selected areas have generated the train noise, $L_{A,\ max}$. This variable was used to develop the noise prediction model using linear regression analysis. The other data that have been collected were the speed of the MRT train, the slope distance, the wind speed, and the relative humidity during the off-peak and peak hours. The train operation, from 7 am to 9 am and 5 pm to 7 pm, were considered as peak hours while from 6 am to 7 am, and 9 am to 5 pm were considered as off-peak hours for weekdays [20]. Ten samples of generated train noise for every slope distance at each location (A and B) were taken. There were three distances for each location, which means 120 samples of noise $L_{A,\ max}$ were taken for off-peak and peak hours. Ten samples of noise measurement for each distance were completed in about one hour.

There are some tools used to make the measurement. Firstly, the slope distances of 35, 40, and 50 meters from the edge of the track line were measured using an UltraLyte Laser Gun. Figure 2 shows the schematic diagram for slope distance measurement using the tool.

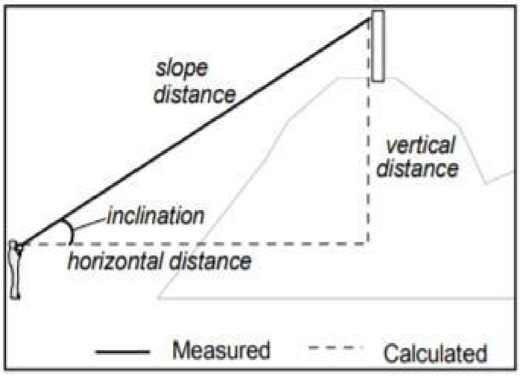

Figure 2. The schematic diagram for slope distance measurement.

Secondly is Sound Level Meter (Optimus Green) that used to measure the noise level. Then is a stopwatch that is needed to record the time taken for the head of a train to pass by a point to the end of the train (tail). The length of the MRT train was 89.56 meters, with four carriages. The purpose of recording the time taken was to calculate the speed of the train by using the formula below:

$$Speed \ = \frac{\underline{Length\ of\ MRT\ train}}{Time\ taken\ to\ pass\ by\ from\ head\ to\ tail\ at\ a\ point}$$

Data for speed taken because the train speed is a major influence parameter for noise emission. Another two tools used to measure the wind speed and relative humidity are Digital Anemometer MS6252A and YES Air Quality Monitoring, respectively. The arrangement of the equipment for the measurement of train noise at difference slope distance is illustrated in Figure 3. In the noise measurement process, few precautions need to be considered. The windscreen should always be used during the measurement. For the validity of data, two aspects have to be considered; background noise must be low, and the sound level meter should be held at arm's length, usually mounted on a tripod, to minimize disturbance of the sound field due to the operator's body. The sound level meter should be at a height between 1.2 to 1.5 meters from the ground and should have a distance of at least 0.5 meters away from the body of the observer to avoid reflections, which can cause an error up to 6 dB [21].

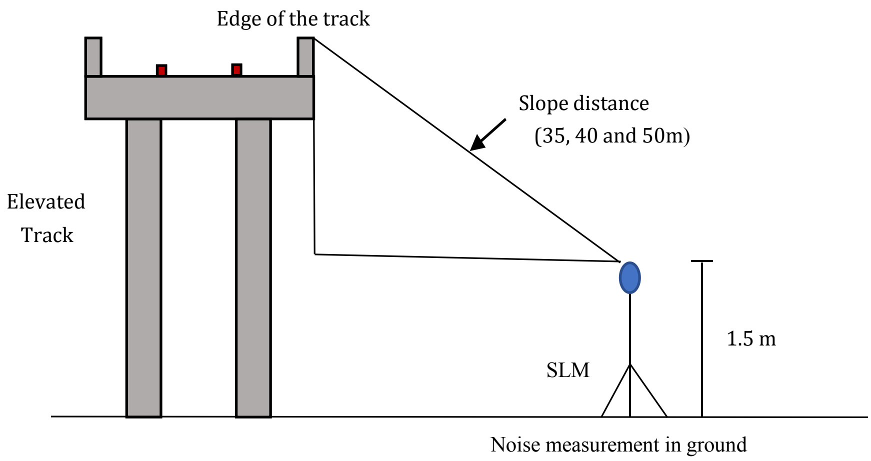

Figure 3. The schematic diagram for field measurement set-up.

The noise level recorded from Optimus Green sound level meter was downloaded to Noise Tools Cirrus Software. This software came along with the device, which makes it easier to extract all the data needed. In this software, the time history graph and detail report can also be obtained. Data noise $L_{A,\ max}$ then were manually extracted from the noise tools software to be transferred to Microsoft Excel 2019. The Optimus Green sound level meter device must be connected to a laptop by using the USB cable to transfer all the data into Noise Tools Cirrus Software.

4. RESULTS AND DISCUSSION

There were two locations selected as field measurements, which are at Lorong Kasah Tepi and Jalan Kasah. For each location, thirty samples of noise were collected, which represents three different distances. Data of noise $L_{A,\ max}$ were measured, at peak and off-peak hours, thus, the total samples were 120 for both locations. There were three different distances taken to ensure the accuracy of measurements where ten data samples were recorded for each distance.

The significant trend of the result that fluctuated over time (from 9 am to 1 pm) and decreases gradually in terms of noise value (dB) is displayed in Figure 4. Based on the reading measured by SLM at Location A during an off-peak hour, the noise level indicates that the surrounding noise was at a range of 68 – 70 dB without the presence of the MRT train. This is because Location A is close to the traffic road. The maximum data recorded is 72.2 dB, and this means the noise contribution of the MRT train is small (2 dB). Location A is close to the Sprint Expressway, E23, which is the main expressway network in Klang Valley, Malaysia that consists of three links, Kerinchi Link, Damansara Link, and Penchala Link. There were several traffic volumes during the data collection, which contributed to the noise level because the location is an area of high population density. Large residential areas such as Taman Bukit Damansara, Damansara Heights, and Bukit Bandaraya exist. Apart from that, this expressway is also the main route to the shopping mall, Damansara City Mall, IKEA, and 1 Utama Shopping Centre. Besides, this location becomes the central area that connects the city of Kuala Lumpur.

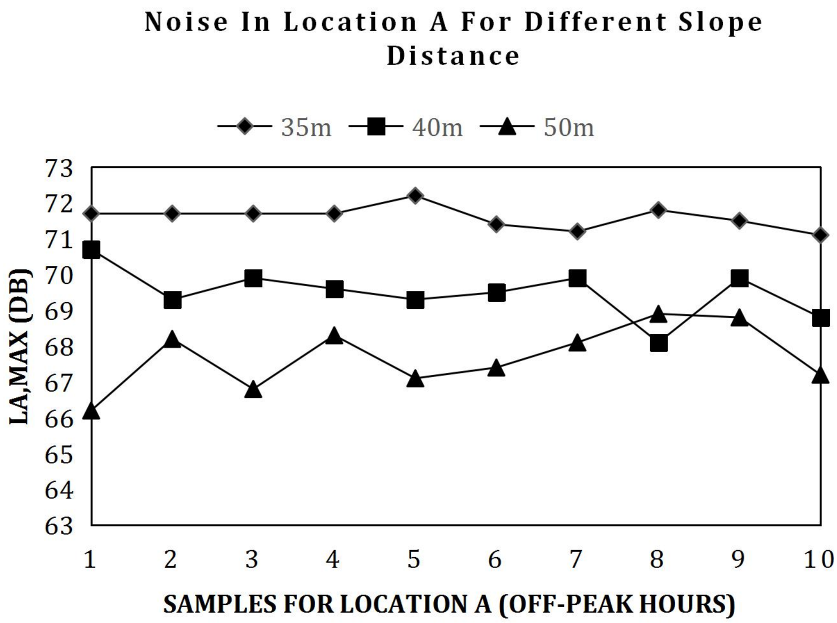

Figure 4. Noise graph for samples in Location A (off-peak hours).

The results for peak hours at Location A are shown in Figure 5. The noise data recorded without the MRT train at this location is within the range of 63 - 67 dB, which means the noise contribution from the train is small. The maximum noise, $L_{A,\,max}$ value for slope distance of 35 m, 40 m and 50 m exceeds the maximum permissible noise which is 60 dB.

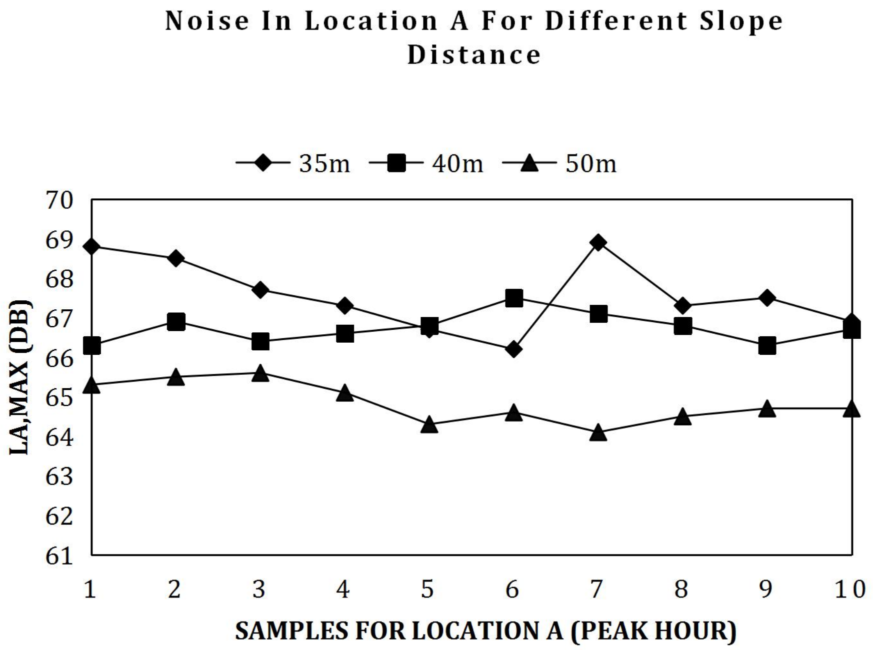

Figure 5. Noise graph for samples in Location A (peak hours).

Figure 6 displays the highest noise $L_{A,\,max}$ is 71.9 dB, and the lowest value is 65.3 dB. The highest noise $L_{A,\,max}$ for 40 m slope distance is 69.9 dB while the lowest is 67.3 dB. Different from the slope distance of 50 m, the highest noise $L_{A,\,max}$ is 67.5 dB, and the lowest value is 65.3 dB. Although all the values for Location B show reduction when the distance increases, the surrounding noise recorded in the absence of MRT train is in the range of 66 - 70 dB. These show that the noise contribution from the MRT train is small at just 2 dB. The MRT track at Location B is also near Sprint Expressway.

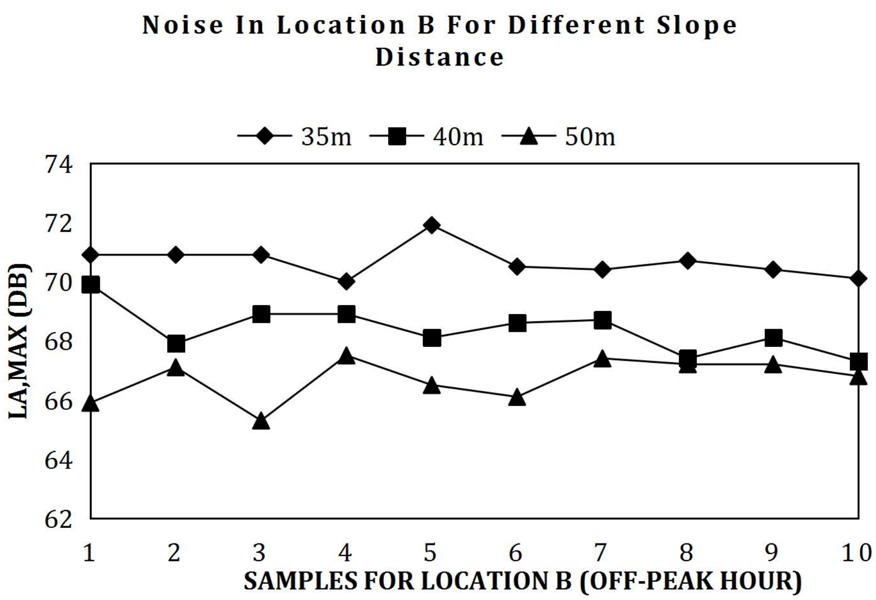

Figure 6. Noise graph for samples in Location B (off-peak hours).

Refer to Figure 7, it can be concluded that the maximum noise, $L_{A,\ max}$ value for the 35 m slope distance is 68.8 dB, while for slope distance of 40 m, and 50 m the value is 67.2 dB and 65.6 dB, respectively. For Location B during peak hours, the noise recorded for surrounding without the presence of the MRT train is between 63 – 65 dB. These mean the noise from road traffic contributes to large noise compared to the noise generated from the MRT train. The installation of the noise barriers along the MRT track is also a factor that contributes to a lower noise level emitted from the MRT train. However, the main factor that determines the effectiveness of the noise barrier is its design.

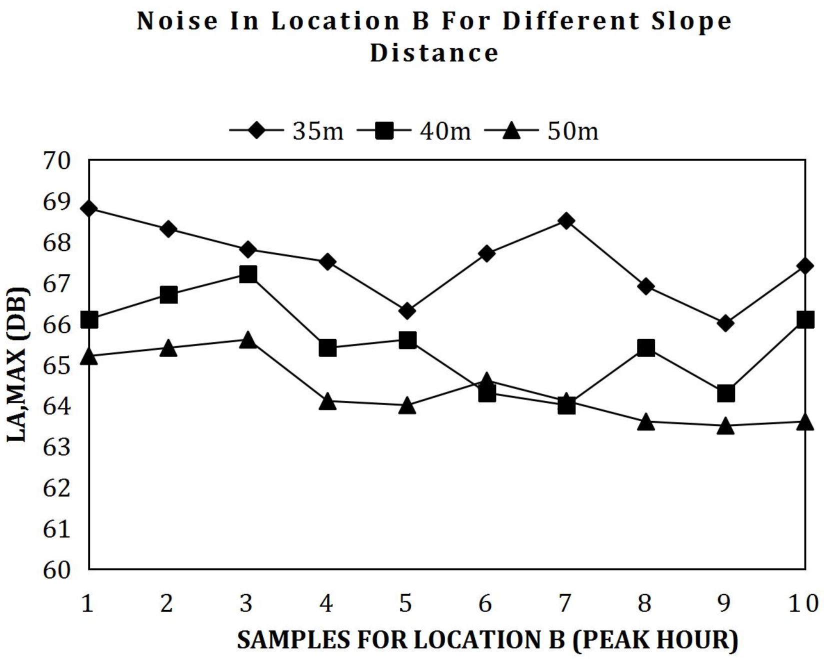

Figure 7. Noise graph for samples in Location B (peak hours).

5. CONCLUSION AND RECOMMENDATION

Two locations were selected which are at a residential area near to Pusat Bandar Damansara station and were labeled as Location A and B. the field measurement was conducted in three different slope distances for each location, which are at 35m, 40m and 50m from the edge of the track. The objective was achieved through the field measurement completed at Lorong Kasah Tepi (Location A) and Jalan Kasah (Location B). Based on the data recorded, the highest noise level, $L_{A,\ max}$ emitted from the MRT train was 72.2 dB at Location A during an off-peak hour. The general noise level, $L_{A,\ max}$ at both locations were at a range of 65 to 72 dB. This study was conducted to improve the measuring works in noise assessment, and it is also helpful to reduce the time and energy of a workman during the field procedure. For further study, the noise prediction model using linear regression will be developed, so that it is very useful to predict or estimate the value of noise level from the MRT train during its operation at off-peak and peak hours.

There was some recommendation identified for further studied to discover the information and theory of train noise level. This study was conducted on the elevated track, so there is a constraint to calculate the noise from double train crossing. Thus, for future study, the location to collect data should be at the top of the building and near to the MRT track. So, the observer can record the noise level if there are double trains at one time. Besides that, for future studies should carry out during night-time and identify the characteristic during the night. So that, the comparison can be made either the weather or the temperature might be the influence to the noise level.

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