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Review on Traffic Noise Problem in Malaysia

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Abstract. Malaysia is now experiencing rapid improvements in fulfilling its goal of achieving the status of a developed nation by year 2020. The nation's economy has grown rapidly with the opening of many new industrial and residential areas as well as infrastructure which in turn influence the ease in transportation and mobility. The Ministry of Transportation Malaysia has reported increases in the number of registered vehicles by a rate of 45 percent per annum from 2012 to 2014. All these have undoubtedly add to the road traffic noise that is linked to various health diseases, even though the Malaysian government has made tremendous efforts to improve the noise environment by introducing new guidelines. This paper presents the extent of the traffic noise problem in Malaysia together with the development of a traffic noise model and the current steps taken for traffic noise mitigation. The paper also discusses the challenges in overcoming this problem and concludes with a proposed traffic noise control plan for further consideration by town planners and land developers

1. Introduction

Transportation is a key factor to the growth of Malaysia's economy in fulfilling the nation's goal of achieving the status of a developed nation by year 2020. The importance of transportation is shown by the increase in the quantity of registered vehicles by 11% from 22,616,106 in 2012 to 25,101,192 in 2014 [1] with a rate of 45% per annum. The demand for transportation is likely to increase in the future as the population is estimated to grow from 28.6 million in 2010 to 41.5 million people in 2040 at a rate of 0.8% per annum [2]. There will be many new urban cities and high transportation demands which may consequently lead to vehicular increase, congestion of roads and intensified traffic noise pollution. This means that problems associated with traffic noise are expected to be more significant in the future. On the other hand, Malaysia had promulgated its first guidelines to improve environmental noise by introducing the DOE Guideline on Noise in 2004 [3]. Prior to this, the United Kingdom's standard which is the noise indicator of L_{10} 18h limit of 68 dBA where the level exceeds 10% of the time measured hourly between 0600 and 2400 hrs was utilised [4]. References were also made to the World Health Organization's [5] noise limit.

The DOE 2004 guideline has laid down a mechanism to control noise. An obvious benefit of the mechanism is its use in determining the effect of noise during environmental impact assessment (EIA) which does affect people's tranquillity. The guideline has listed the permissible noise levels in different types of land areas in the effort to curb the startling rise of environmental noise pollution, including road traffic as stated in Schedule 1 [4]. The DOE uses the equivalent sound pressure level over a period of time, L_{Aeq}, T as an indicator of noise pollution. For example, during the day people are sensitive towards loud noises in places such as low density residential areas, schools, worship places and hospitals ; thus, these places have a limit exposure to noise at 50 dBA over a 15-hour period from 7:00 to 22:00 ($L_{Aeq15hrs}$) and 45 dBA for 9 hrs from 22:00 to 7:00 ($L_{Aeq9hrs}$). These limits increase by 5 dBA for suburban areas. This limit is in agreement with the WHO standards [5] which stated that during the day, people start to get moderately annoyed by noises above 50 dBA L_{Aeq}, and seriously annoyed at noises above 55 dBA L_{Aeq} [6]. In some circumstances, the DOE also refers to the increment in noise level based on the relative limit, for example L_{90}+3 in which L_{90} is the ambient noise level or the level exceeding 90% of the time measured over a period of time. Annoyance is a common human reaction which comprises of emotions such as anger, distraction, depression, anxiety, exhaustion and stress-related symptoms [7, 8]. Annoyance estimation due to road traffic noise was obtained subjectively using social surveys [9] and objectively using the characteristic of impulsivity and low frequency noise. Although the latter is difficult to measure and quantify [10], it is an important criterion for the detection of annoyance and hence, should be accounted for L_{Aeq} determination.

Traffic noise is generated by individual vehicles and the volume of traffic. For individual vehicles, noise is a combination of sounds produced by the engine, transmission, exhaust, the interaction between the tyres and road pavement, air turbulence, and body and load rattles. From these, tyre noise is a component of vehicle noise which significantly increases with speed. Studies suggest that at speeds between 30 and 50 km/hr, the tyre noise of a car is increased to a level which dominates the overall vehicle noise, while for trucks, this happens between 40 and 80 km/hr. The tyre noise component is highly dependent on the tyre/pavement design and vehicle speed. Apart from individual vehicle noise, traffic noise also depends on traffic volume, traffic speed, traffic composition (i.e. number of commercial vehicles), road gradient, and pavement surface type and texture. Reducing 50% of the traffic volume will reduce 3 dBA [11], while reducing 50% and 75% of traffic speed will reduce 3 dBA and 6 dBA, respectively [6]. Heavy vehicles such as lorries, buses and containers contribute significantly to the average noise level [12]. In particular, trucks produce more noise due to their axle loads. If the axle load of a truck is reduced from nearly 2000 kg to 500 kg, a 15 dBA decrease in noise level can be obtained.

The pavement type and road slope are also important factors of traffic noise. Porous pavements produce 3 to 5 dBA less noise than hot mix asphalt [13]. In extreme cases, two layers of porous asphalt are used as a noise-reducing strategy in lieu of noise barrier walls. When a vehicle travels upslope, its engine and exhaust noise levels gradually increase [14]. Speed breakers such as rumble strips of thermoplastic can increase noise up to 4 dBA [15]. This paper describes a review on the extent of the traffic noise problem in Malaysia and the challenges faced in reducing noise pollution.

2. Extent of roadside noise problem in Malaysia

Several works on roadside noise levels in the country have been conducted. Studies started in the early 1970s by focusing on noise problems in two major cities of Malaysia, Kuala Lumpur and Penang. At that time, the noise levels for both cities were lower than that found in many other Asian cities. In some areas, however, the levels were as high as those found in Los Angeles and New York [4]. Sulaiman and Saion then measured the average daytime noise level during normal traffic conditions on working days in Kuala Lumpur, Johor Bahru and Seremban without considering the peak hours of 0800-0900 hrs, 1200-1400 hrs and 1600-1800 hrs. The mean noise level in Kuala Lumpur was found to be the highest (67.4-73.6 dBA) compared to in Johor Bahru (61.8-65.7 dBA) and in Seremban (61.9-65.5 dBA). The levels were seen to decrease for roadsides farther away from the town centre.

Two decades ago, Sumiani and Asila [16] performed noise measurements for 6 hours during the daytime and 2 hours at night on the Damansara-Puchong Highway (commonly known as LDP) that passes through numerous residential areas such as Kelana Jaya, Taman Megah, and Bandar Sunway. The L_{Aeq} for three locations had exceeded 65 dBA, with the highest reading detected at a roadside near Taman Megah. More than a decade later, Halim et al. [17] found that on three other expressways such as Sungai Besi expressway, DUKE and KESAS, the noise levels exceeded 70 dBA during both the day and night peak hours. They found that the heavy traffic flow on the Sungai Besi highway had recorded a higher noise level compared to the low traffic flow on the Duke Highway. It was also observed that when the traffic volume goes beyond 1000 vehicles/h, the noise level stabilises.

The noise level at the roadside of Tanjung Malim Town, Perak was assessed by Luqmanulhakim , Mohmadisa & Nasir [18] during both day and night rush hours. The average noise level obtained was 71.6 dBA. Recently, Sulaiman et al. [19] assessed the roadside noise levels at three suburban roadways in Johor Bahru which pass by Taman Universiti, Taman Sri Skudai, and Bandar Baru Kangkar Pulai. The average L_{Aeq} reading over a 12-hour period (7 am to 7 pm) of all locations was 59.4 dBA, with the Skudai road [19] recording a lower L_{Aeq} level due to its lower traffic volume. Haron et al. [20] observed that the L_{Aeq} 1hr for the suburban Skudai-Pontian highway with traffic safety device transverse rumble strips (TRS) increased as much as 12 dBA during the rush hour. Moreover, Haron et al. [15] also observed the influence of three TRS types on individual vehicles and found out that traffic noise depends on the TRS design. The triple layer TRS design produces the highest sound, indicating that it is potentially the source of traffic noise.

The DOE also records the yearly day and night noise levels in all states around the country. In 2015, the noise levels ranged between 56 dBA to 82 dBA during the day, while night time monitoring had recorded readings between 50 dBA to 81 dBA. The daytime recordings were more or less equal to the night time readings due to the increasing number of motor vehicles on the road during the night time. Malaysia, though, is not alone. Figure 1 shows a comparison between Malaysia with its neighbouring countries and the megacities in USA. Although the data obtained were from different periods of measurement, nevertheless it shows the extent of traffic noise in Malaysia compared to other countries.

All data obtained on Malaysian cities were higher than those in the mega cities in the United States such as New York City, Los Angeles, and Atlanta which recorded 69.2, 66.4, and 65.1 dBA, respectively [21]. The readings were however at a similar intensity with other ASEAN cities like Ho Chi Minh and Hanoi [22]. The noise levels in Hanoi and Ho Chi Minh Cities are dominantly caused by motorbikes (honking) (Figure 2) at 91% and 94 % of the total traffic volume. In Malaysia, Halim et al. [17] reported that the maximum number of motorbikes on Malaysian expressways is estimated at 34% of the traffic volume (Figure 3). The reading from the Phillipines is higher due to the higher volume of tricycles (Figure 4), while Thailand and Singapore had comparatively lower noise levels than Malaysia [23-25].

3. Extent of traffic noise problem in sensitive areas

Several works have been carried out to measure noise levels in sensitive areas such as residential areas, schools and hospitals due to the dominant use of transportation. Measurements in the Klang Valley at several residential areas located close to expressways are shown in Figure 5. Damavandi and Nowrouzi [26] observed the Herritage Condominum's noise level during peak hours, while Elfaig et al. [27] observed the noise levels at the Blueboy Mansion for a period of 24 hours. Herritage Condominum's noise levels were up to 66 dBA during peak hours, while the Blueboy Mansion experienced 52-1 to 67.6 dBA at night and 64.3 to 73.7 dBA during daytime. Recently, Herni et al. [28] found that Desa Tun Razak, Kinrara Court and Taman Sentrul Utama had higher L_{Aeq} levels exceeding 70 dBA during peak hours. According to the period of measurement and the limits given by the DOE, it is evident that traffic noise has become a threat to the community at Blueboy Mansion as the noise levels measured have exceeded the permissible limits by Malaysian Guidelines 55dBA during the days and 45dBA during nights. Even so, according to the WHO guidelines [5], L_{Aeq} levels exceeding 55 dBA without any time limit reference will cause annoyance. Moreover, the Blueboy Mansion's noise level during the day time was comparatively higher than the highest noise levels (L_{Aeq} = 59.2 dBA) recorded by Chui, Heng and Ng [24] measured at ground, mid and high-floor of four residential areas which are Clementi Block 426, Sengkang Block 183D, Punggol Block 137, and West Block 711.

Noise in school areas is a concern of many researchers as loud noises can decrease children's hearing capabilities and decrease their learning concentration. In Malaysia, most studies conducted since the 1980s have shown that noise levels at all selected schools had exceeded the 55 dBA level limit by the WHO with no reference to time for outdoor school areas (Figure 6). Such levels may affect teachers' and students' performance. These include noise levels recorded at schools located in Klang Valley such as the SM Victoria Institution, SM St John, SM Convent Bkt. Nanas, and SRK St John [27].

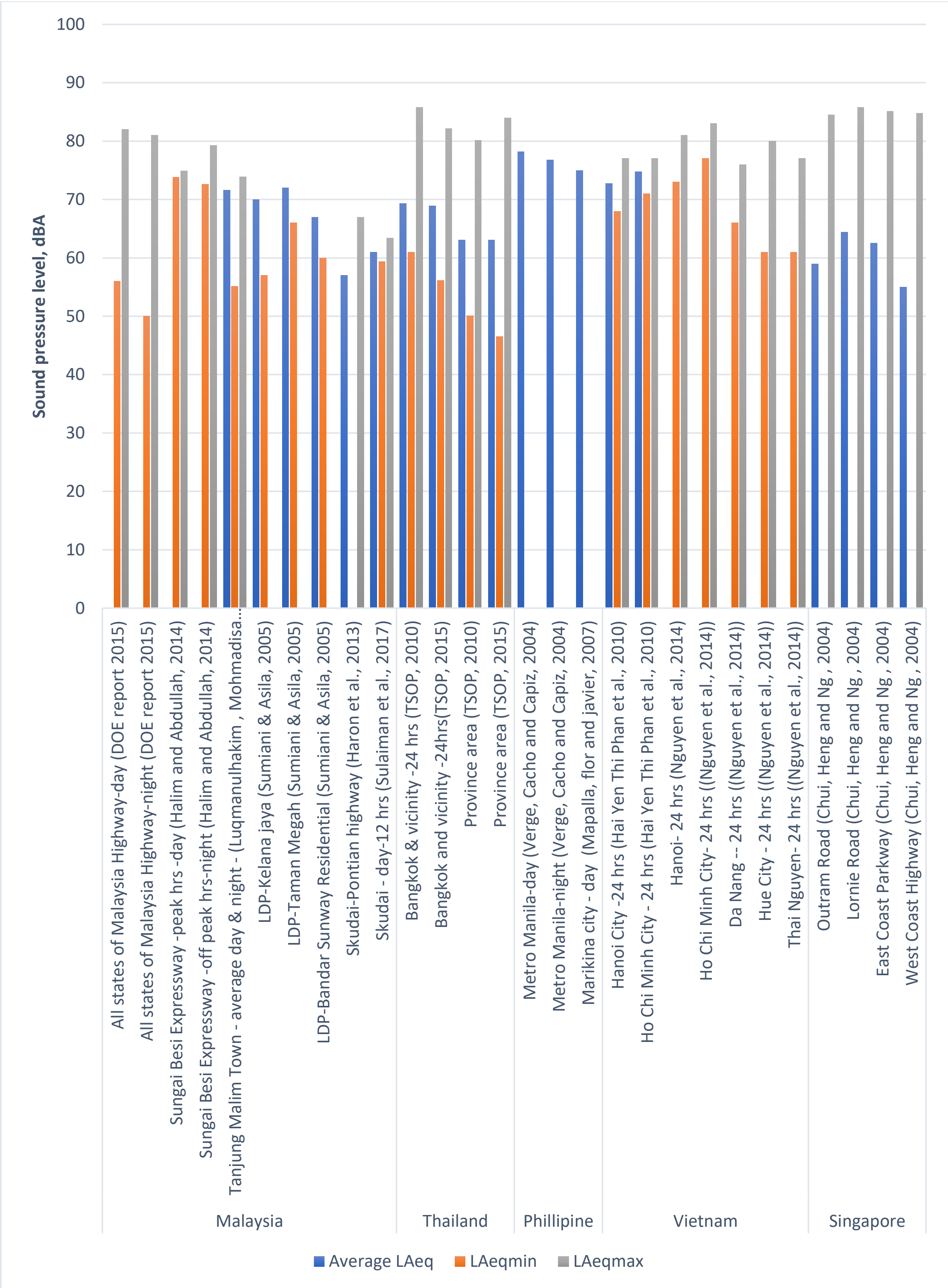

Figure 1. Comparison with other ASEAN cities

The trend remains similar for the next ten years as shown by Elfaig et al. [27] whom observed that the LaSalle Secondary School which is located in the busiest part of Klang Valley recorded a L_{Aeq} range of between 68.2 dBA to 73.7 dBA. A similar finding was obtained for the Johor Bahru area for schools located near to the busy roads as shown by a study by Zulkepli and Hazel [29]. Further, Mohmadisa et al. [30] further found that the noise levels for all schools in the Batu Pahat area are in the range of 59.9 to 71.3 dBA. Moreover, in a more recent study, Thong et al. [31] found that the noise levels in the classrooms and laboratories of SMK Convent had exceeded the permissible limit by the WHO. In Kuala Terengganu, Ismail, Abdullah and Fong [32] reported that the noise level in three primary schools with different surrounding activities i.e. industrial, commercial and residential had all exceeded the permissible level for noise-sensitive areas. The main source for noise pollution is the high composition of traffic which consists of 64% cars and vans, 24% motorbikes and 12% heavy vehicles.

Figure 2. Road traffic conditions in Hanoi and Ho Chi Minh which are dominated by motorbikes

Figure 3. Malaysia's road traffic is dominated by cars

Figure 4. Road traffic conditions in Manila which dominantly features tricycles

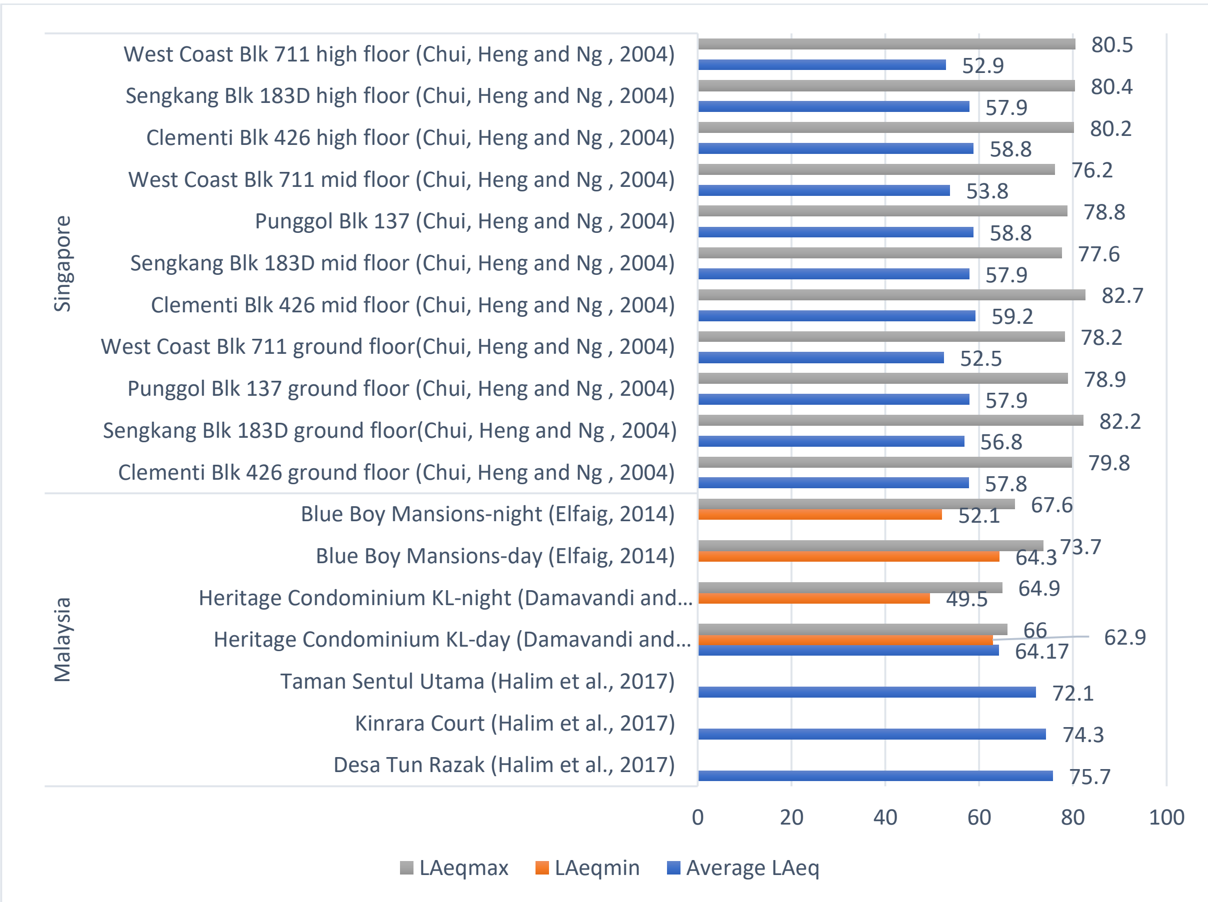

Figure 5. Noise pollution at residential areas

Furthermore, studies have also found that the high traffic volume also affects the Kuala Lumpur Hospital (KLH) and the Tung Shin Hospital (TSH) in Kuala Lumpur [33]. The L_{Aeq}16 hours had ranged between 72.4 and 80.3 dBA at the KLH and between 76.8 and 86.6 dBA at the TSH. Since the DOE's noise pollution limits were still not available at that time, they compared their results with the WHO limits for outdoor hospital areas and found that the noise levels at these hospitals had exceeded the recommended level 45 dBA. Finally, the results showed significant differences in noise levels between the KLH and TSH (P<0.001) due to differences in land use pattern and traffic volume at the two sites.

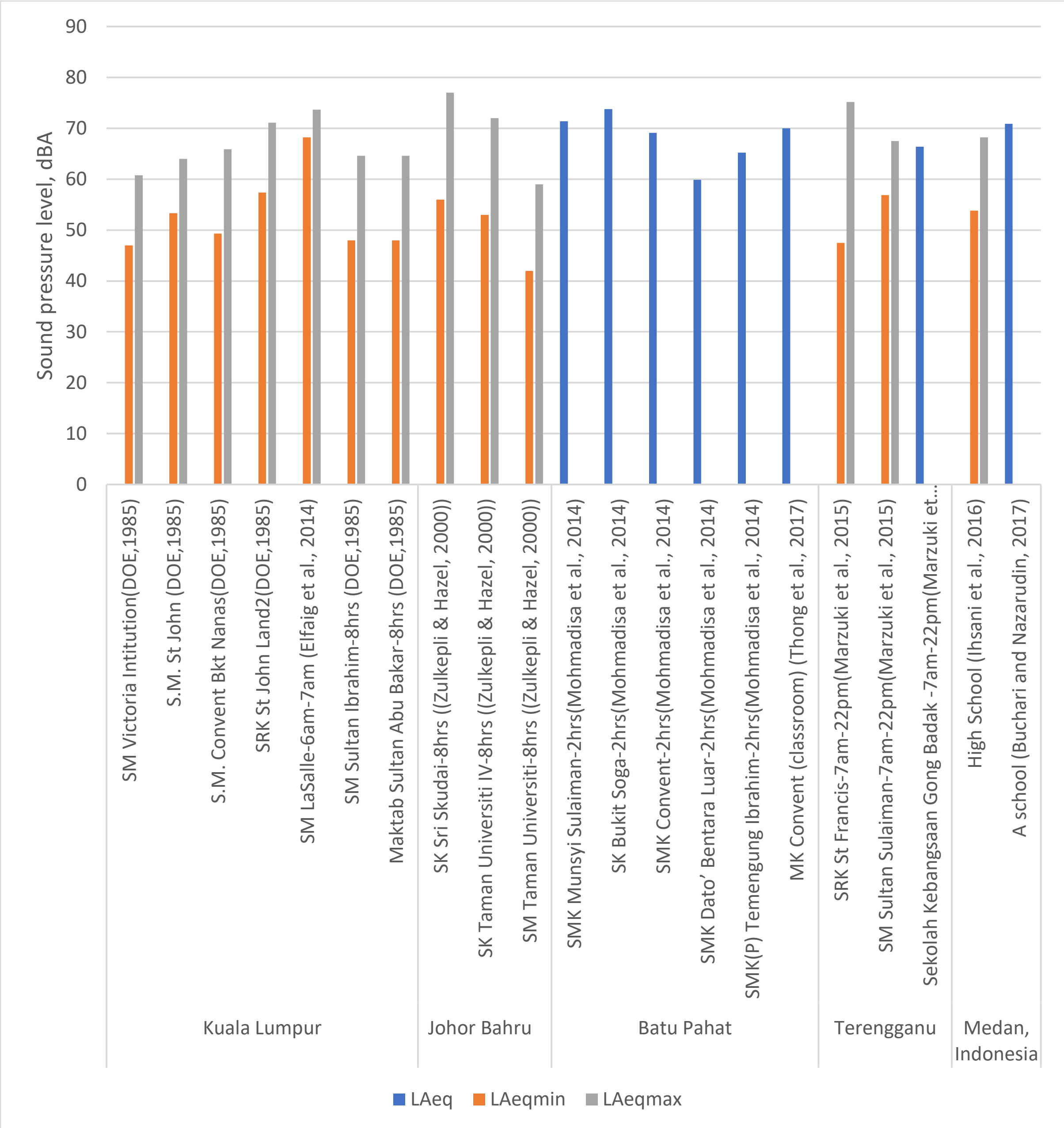

Figure 6. Noise levels at school areas

3. Development of traffic noise modelling

The development of traffic noise models is needed in order to evaluate traffic noise levels. Many countries have developed traffic noise prediction models. The prediction tool used worldwide is the ‘‘Calculation of Road Traffic Noise (CRTN)’’ which was developed in Britain and published in 1975. It predicts the L_{10} level and is able to predict noise levels similar with other measurement values taken. This is an important criteria in determining the right mitigation measures, including the size of noise barriers. However, the CRTN does not account for motorcycles as they are simply treated as passenger cars ([34]). However, in Malaysia, motorcycles account for 35%-75% of total vehicles on road depending on state [35]. In less developed states such as Perlis, motorcycles account for more than three-quarters of the total vehicle population, while in more developed states such as Kuala Lumpur, motorcycles form one-third of the total vehicle population and is the major mode of personal transport for the low-income urban community. Halim et al. [28] found that seven roads with 30% motorcycle composition showed traffic noise levels (L_{10}) at just satisfactory conditions, and the correlation value for the relationship between the predicted and measured values is 0.7109. The average overestimation of the CRTN model on traffic noise level is 3.6 dBA. Ni Sheng, Zherui Xu and Min Li [34] measured and predicted traffic noise levels at 31 roadsides with an average motorcycle percentage of 57.9%, and found that the noise levels did not exceed 3 dBA.

The NAISS, Burgess and Ferragotti models are other models which produce equivalent noise level measurements with the L_{Aeq} of road traffic at a distance of 7.5 m from a traffic lane. The NAISS model was developed to reflect the specificities of traffic flow and traffic infrastructure in the city of Nis, Serbia. Aziz et al. [36] tested the traffic noise of the expressway in Bukit Mertajam, a developing town in Malaysia within the Arumugam Pillai and Permatang Pauh area to see whether the obtained data fitted with estimations by the NAISS, Burgess and Ferragotti models. They found that the NAISS model represented the field measurements better than the Burgess and Fagotti models and had hence proposed that the NAISS may be utilised to estimate noise levels in the Bukit Mertajam region.

Burgess

$$L_{Aeq} = 55.5 + 10.2 Log\, Q + 0.3P - 19.3\, Log\left(\frac{L}{2}\right) \quad (1)$$

Fagotti

$$L_{Aeq} = 10 Log(N_C + N_m + 8N_V + 88N_b) + 33.5 \quad (2)$$

NAISS

$$L_{Aeq} = 10 Log(N_c + 3.7N_{hv} + 1.9N_b) + 38.2\ for\ 55\ dBA \le LAeq < 65\ dBA \quad (3a)$$

$$L_{Aeq} = 10 Log(N_c + 11.7N_{hv} + 3.1N_b) + 44.3\ for\ 65\ dBA < L_{Aeq} < 75\ dBA \quad (3b)$$

where N_c is the number of passenger vehicles, N_{hv} is the number of freight vehicles (light or heavy vehicles carrying goods), and N_b is the number of buses.

Furthermore, Kok and Sulaiman [37] also used the NAISS and Burgess models to predict the traffic noise of a four-lane stretch of an uninterrupted flow of vehicles on the Tun Dr Lim Chong Eu Expressway in Penang which connects George Town city to Batu Maung. Similar to results from Aziz et al. [36], it was shown to depict better predictive capability compared to the Burgess model. Kok and Sulaiman then developed a new model called the Penang Noise Model (PNM) according to the features and characteristics of traffic flow on Penang’s expressways by using a linear multiple regression model according to the data taken on traffic volume and noise. The PNM is as following:

$$L_{Aeq} = 81.9 + 0.0071N_{hv} \quad (4)$$

They determined that light weight vehicles and buses were not significant, and a further two sample *t*-test done on the PNM proves its capability in giving better predictions of the traffic noise levels at the Tun Dr Lim Chong Eu Expressway compared to the NAISS model.

For suburban areas, Sanik et al. [38] developed models based on the traffic conditions along the FT50 Federal Route at Taman Kelisa, Taman Gading and Taman Gading 1, Keluang, Johor. They found that the most reliable noise model had an adjusted R^2 of 60.7 percent. The model is;

$$L_{Aeq} = 54.9 + 0.00310C1 - 0.00406C2 + 0.00355C3 + 0.0188C4 \quad (5)$$

where Class 1 (Cl) is for passenger cars, Class 2 (C2) is for medium-sized lorries, Class 3 (C3) is for large trucks and buses, and Class 4 (C4) is for motorcycles.

4. Traffic noise mitigation and policy

The most popular mitigation measure in Malaysia is the control of path by means of construction of noise barriers. The requirements for the noise barrier's design and method for installation on highways are documented in LLM [39]. An obvious benefit from the guideline is the provision of the comfort for residents lining the highway if the traffic noise exceeds the permissible limit given by the DOE 2004 guidelines [2]. For example, the installation of a 4 metre hollow block concrete masonry noise barrier at Bukit Setiawangsa is to protect the residents from the intense traffic noise coming from the Duta Ulu Kelang Expressway (DUKE) highway [39]. The construction of the DUKE highway has raise the noise level to about 15 and 19 dBA during day, and 9 dBA and 7 dBA during night. The construction of barriers with sufficient height and length can give comfort to residents although relatively expensive (RM 800 to 1000 per square metre). There are many types of noise barriers constructed in this country. The first type is the simple walls constructed along several highway boundaries, and the second type is the roof noise barriers used for shielding from LRT and MRT projects. The requirement for noise barrier installation is based on the Environmental Impact assessment (EIA) approved by the Department of Environment (DOE). The design of the noise barrier must consider current and future traffic volume together with traffic composition, speed, and road surface.

Halim et al. [40] performed a study on the effectiveness of two types of barriers which are the concrete hollow block and panel concrete utillised to shield residential areas from the Sungai Besi Highway, DUKE Highway, and KESAS Highway. The insertion losses for both barriers are due to the diffraction and reflection of noise waves by the flat and solid surfaces of the concrete hollow blocks facing the highway. It was found that the cavities inside both the concrete hollow block and concrete panel noise barriers help absorb the noise from the highway traffic. For the concrete hollow block noise barrier, the existence of many joints between the blocks cause sound leakage which in turn reduces the insertion loss of the concrete hollow block noise barrier. The concrete panel has a more stable and sufficient insertion loss (5.8 to 8.2 dBA) recorded during the measurement session, while concrete hollow blocks were shown to be fairly effective (4.5 and 9.4 dBA).

5. Challenges to Noise Control and Proposed Strategies

Research on traffic noise was initiated since the early 1970s, even before guidelines on noise was published. Results show that traffic noise has been regarded as a main source of noise pollution in Malaysia. From the literature, it can be concluded that several factors do influence the traffic noise condition in the country, including noise regulation, distance to source, traffic volume, and traffic composition. Before the DOE had come up with its guidelines, limits from UK standards and the WHO were referred to. According to the LLM [39], noise is considered to be heightened if the levels of exposure for 15 hrs (day) and 9 hrs (night) exceed the limits specified by the DOE guidelines. It is stipulated that measurements must be carried for the required durations for day and night for the identification of mitigation measures. According to the previous researches that have been discussed above, except Elfaig et al. [27], many of the researchers had carried out measurements of noise levels only during peak hours. On the other hand, for school areas, the noise level permissible by the WHO [5] is 55 dBA without reference to time limit. Thus, it can be seen that the noise pollution levels at most schools in the country measured by previous researches did exceed the limits given by the WHO. The protection of schools from environmental noise as an integral part of environmental protection policy must be prioritised.

In the future, the challenge lies in the city planner's hands as noise annoyance from traffic must be considered at the planning stage. New cities must be well planned by taking into account the proper layout of roads, highways and buildings, and industrial, residential, and commercial areas. The local authorities can implement zoning controls and land-use policies to limit noise to noise-sensitive uses. Developers should also avoid planning residential areas to be close to highways if possible, unless a mitigation scheme is also carefully implemented. Although the CRTN is normally used, it is suggested that a traffic noise model for local road conditions which accounts for the high number of motorbikes and variation of traffic volume is built. Reports show that the CRTN only represents 70% of the variation in noise level when the motorbikes consist of 34% of the traffic composition. In Malaysia, the volume of motorbikes is estimated to be between 30 to 75%. Thus, it is suggested that traffic noise should be predicted using a local model to identify potential noise mitigation measures. Many new local models that consider the increasing traffic flow and many interruptions such as junctions, traffic lights and hump installations need to be developed.

Noise barriers are very expensive and sometimes not effective due to the diffraction on the top of their edges. Natural barriers using plants like the hibiscus and Eugenia can be placed at a sufficient height and density to absorb sound together with serving aesthetic purposes [41]. According to Loretta Gratani and Laura Varone [42], hedges with a mean height of 1.50±0.5 m, length 25 m and leaf density of more than 1000 g/m3 can provide more than 10 dBA noise pollution reductions from heavy traffic volume. Moreover, Fang and Ling [43] found that a dense belt of trees and shrubs (30 m wide) could reduce sound levels by as much as 4-8 dB. Such hedges, trees and shrubs can be planted adjacent to highways in order to reduce traffic noise. Noise barriers, especially those with perforated surfaces require maintenance along its design life so that it is free from defect and can still be effective in shielding traffic noise. Any defect should be fixed and the effectiveness of the barrier against the increases in traffic volume must be checked from time to time. This is the biggest challenge in managing noise. The lack of maintenance can be seen for many barriers as reported by Jamaludin [44].

Perhaps it is high time to include treatment at the source that is by implementing the use of porous pavements rather than installing noise barriers. Porous pavements reduce noise as much as 3 dBA when compared with hot asphalt pavements. A reduction of 3 dBA is as effective as doubling the distance from the noise, reducing traffic volume by 50%, or reducing traffic speed by 25%. Beside noise reduction, incorporating grounded scrap tires into a bituminous mixture of an open-graded system provides efficient drainage and good skid resistance. The Malaysian first open-graded pavement which incorporates rubberised bitumen is laid at Batu Hitam, Kuantan in September 2002 with a total length of 200m [45].

Other than that, pavements with upper surfaces made of rubberised bituminous waste tyres and a dense graded mixture with a thickness of 0.05 m yield up to 7 dBA noise reduction [46]. Malaysia has implemented rubber road construction in several places (Figure 7), but it is in the trial stages. Unlike other rubberised asphalts concocted with crumb rubber, rubber roads using cup lump which is freshly coagulated rubber combined with bitumen produces a Cup lump Modified Asphalt (CMA) to be used for paving road surfaces [47]. CMA requires an estimated 4.2 tonnes of coagulated rubber for every kilometre of road. The cost of road construction using CMA is higher at RM53.60 per metre compared to RM29.90 a metre using the conventional method, but it is proven to be more economical as it will last longer and is cheaper to maintain. It is expected that the use of CMA can reduce the road noise level by three to five decibels. However, further investigation is needed on its acoustic performance.

Figure 7. Cuplump Modified Asphalt (CMA) road along Sungai Kerawai in Teluk Intan, Perak [48]

Last but not least is the enforcement of vehicle emission limits as per the enforcement for vehicle emissions. For example, the noise level permissible for motorbikes should not greater than 80 dBA. Perhaps in the future, a noise label for motor vehicles can be used as it has various advantages [49]. It would raise awareness about the sound intensity of vehicles during purchasing decisions. Moreover, the label is likely to encourage manufacturers to develop quieter motor vehicles.

6. Conclusion
Malaysia is experiencing rapid improvements in fulfilling its goal of achieving the status of a developed nation by year 2020, and transportation is a key factor to the growth of a nation’s economy. Thus, this causes the quantity of motor vehicles to increase drastically which will undoubtedly increase traffic noise, although Malaysia has made tremendous efforts in improving its noise environment. This paper presents the extent of the traffic noise problem in Malaysia together with the current traffic noise mitigation measures and policies. It also discusses the challenges encountered and concludes with proposals of noise control strategies for the further consideration of town planners and land developers.

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