Evaluating the Effects of Road Hump on Traffic Volume and Noise Level at Taman Keramat Residential Area, Kuala Lumpur

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Abstract: This paper investigates the effects of road hump on traffic volume and noise level in a residential area in Kuala Lumpur. Field surveys were administered to measure data on traffic volume and noise level at three selected roads at Taman Keramat residential area in Kuala Lumpur. Measurement on noise levels such as L_{Aeq}, L_{AFmax}, and L_{AFmin} and traffic volume were undertaken for about 12 hours. The findings show that the highest traffic volume (563 vehicles per hour) and the highest noise level (75dB(A)) was measured at Road 1. The correlation analysis indicates a similar pattern in the relationship between traffic volume and noise level especially at Road 2 and Road 3. Finally, this paper concludes in drawing attention to conduct further studies on the effects of road humps in other residential areas in Kuala Lumpur to implement measures for a pleasant, harmonious and safe living environment for the community.

Keywords: Traffic volume; Noise level; Road hump; Residential area; Living environment

1. INTRODUCTION

Healthy living environment is one of the factors vital to the positive lifestyle of a residential environment (Abdul Azeez et.al, 2006). The alignments of major roads are also running very close to the residential areas making the residents subjected to unacceptable noise level. Studies showed that noise level exceeding 75 dBA and NO_2 level more than 0.02 ppm along major road near to the residential neighbourhood (Abdul Azeez et.al, 2006). However, the concept of the street as a physical and social part of the living environment and as a place simultaneously used for vehicular movement, social contacts and civic activities, has long been argued by several authors (Schlabbach, 1997; Ben-Joseph, 2004). Local residential streets, in particular, are central to the feeling of ‘community interaction’ and ‘societal belonging’ within a neighbourhood.

Presently, living environment in many residential areas has been deteriorating mainly because of increase in traffic volume, excessive speed, road alignment and other related factors (Abdul Azeez et.al, 2006). Many factors are directly responsible for a better living environment in a residential area. Some factors may be visible and others may not. To exemplify, factors such as noise and air pollution are not clearly visible but are subjected to wide detrimental effects on human lifestyle if they are not controlled thoroughly. Hence, the purpose of this paper is to evaluate the effects of road hump on traffic volume and noise level along the residential streets.

2. LITERATURE REVIEW

2.1 Traffic Calming

Due to perceive growth in traffic flow through residential neighbourhoods, a new term has entered in transportation vocabulary; Traffic Calming. Traffic calming is the combination of mainly physical measures that reduce the negative effects of motor vehicle use, alter driver behaviour and improve conditions for non-motorized road users (Lockwood, 1997). Traffic calming can be installed as a component for improvement to an existing neighbourhood or in newly constructed neighbourhoods as a design feature (Murphy, 2003). If a residential street or housing estate road is being used by uncomfortably high volumes of potentially fast traffic, traffic calming measures may be necessary.

2.1.1Traffic calming in Malaysia

Traffic calming schemes in reducing traffic speeds and accidents have been positively received by the residents in Malaysia. However, most of these measures were implemented on an ad hoc basis without any proper standard or guidelines, but purely on the basis of experiences of the local traffic engineer and request from the residents. Based on the Traffic Calming Guidelines, published by the Highway Planning Unit (HPU) from the Ministry of Works, there are 12 speed controlling measures which are divided into two major categories as seen in Table 1.

Table 1. Traffic calming measures based on Highway Planning Unit (HPU) guidelines

Vertical measures	Horizontal measures
1. Speed bump 2. Speed hump 3. Transverse bar or alert bar 4. Speed table 5. Textured pavement 6. Raised crosswalk 7. Raised intersection	1. Traffic circles 2. Roundabout 3. Chicane 4. Choker 5. Centre island

Source: Highway Planning Unit (HPU), 2002

According to the HPU guidelines (2002), vertical shift in the roadway such as road hump is the most effective and reliable method for speed reduction. The design concept of hump is to control vehicular speed by introducing ‘shock’ while traversing through it. As such, high vibration level is expected when a vehicle passes over it at higher speed than the allowable limit. Hump geometry is a major factor in altering the level of shock in-line with the anticipated speed limit. Currently, in Malaysia there are limited studies and guidelines on the relationship between hump geometric designs, speeds and vibration incurred while passing over the road hump (Muhammad Marizwan et.al, 2009; Nor Izzah et.al, 2010). As a result, the implementations and outcomes of the traffic calming measures vary from one location to another (Muhammad Marizwan et.al, 2009). With different styles and designs that could be found along the road, it could translate into inconsistent speed reduction due to different driving reactions, and finally, may lead the public to have negative perceptions regarding traffic calming measures. The search on the literatures on traffic calming in Malaysia indicates that there are almost no studies on the effects of road hump on traffic volume and noise level. Thus, it necessitates to study on the effects of road hump on traffic volume and noise level in a residential area in Kuala Lumpur.

2.2 Living Environment at Residential Areas

Living environment today in many residential areas has been deteriorating mainly because of increase in traffic volume, excessive speed, road alignment and other related factors. Hence, as the city grows, it is important to ensure that the major arterial roads in the community accommodate the increased traffic growth and the local roads continue to serve the residential road.

2.2.1 Traffic volume at residential areas

The perception of speeding on local streets is probably the most persistent problem facing residents and traffic officials, alike. Although local or residential streets carry the lowest traffic volumes and suffer the fewest traffic crashes, they are the single largest consumer of a traffic engineer's time and energy (Institute of Transportation Engineers, 1999). Residents observe vehicles are being driven at speeds they perceive too fast and conclude that the speeds would decrease if traffic calming measures e.g. stop signs were installed. Speeds considered excessive by residents are considered reasonable by these same persons when they are driving in another neighbourhood. However, there are in some cases which showed that the implementation of traffic calming devices may cause an extreme reduction in traffic (Patterson, 2004). Significantly, the choices of design speed are also influenced by the geometric design of roadways and have been established to provide motorized efficiency which is often incompatible with the essence of residential liveability (Koorey, 2011).

Appleyard (1981) hypothesized that when traffic volumes increase beyond what is considered normal by local residents, or vehicle speeds increase because of street design, social street activities are greatly reduced, and the feeling of well being in the affected neighbourhood is threatened. Although, Ben-Joseph (1995) recommended criteria on the issues of liveability and safety on residential streets, many cities are finding themselves under pressure to further address the issues through the reduction of speed and volume of traffic in residential areas. This is due to high traffic volume which is often the result of a poorly planned street system, as safety and excessive speed are related to the street's geometrical design. The practice of constructing wider road alignment in residential streets where there is little traffic (less than 1000 trips per day) also permits and encourages high vehicle speeds (Ben-Joseph, 1990).

2.2.2 Noise levels at residential areas

Noise can be defined as an unwanted or undesirable sound whereas environmental noise is any unwanted or harmful outdoor sound created by human activities that is detrimental to the quality of life of individuals (Nadaraja et.al, 2010). Over the years, a lot of researches have been done regarding noise and its effect to human. Noise also could lead to human annoyance, reduces life quality, and might affect health and physiological well-being (Ohrstrom et.al, 2006, Nadaraja et.al, 2010).

Significantly, based on Figure 1, a study by the DOE (2008), found that the existing noise level at suburban residential area was high ranging from 69.8 to 70.2 dBA during day time whereas the acceptable noise level during day time is only 55 dBA. Furthermore, the noise level at night time also results in high value with 68.6 dBA, while the permissible noise level at night time is only 45 dBA.

In the long term, this can results in permanent damages to the residents in terms of sleep disturbance, disturbed cognitive functioning, adverse effects on mental health and so on (Botteldooren et.al, (2011).

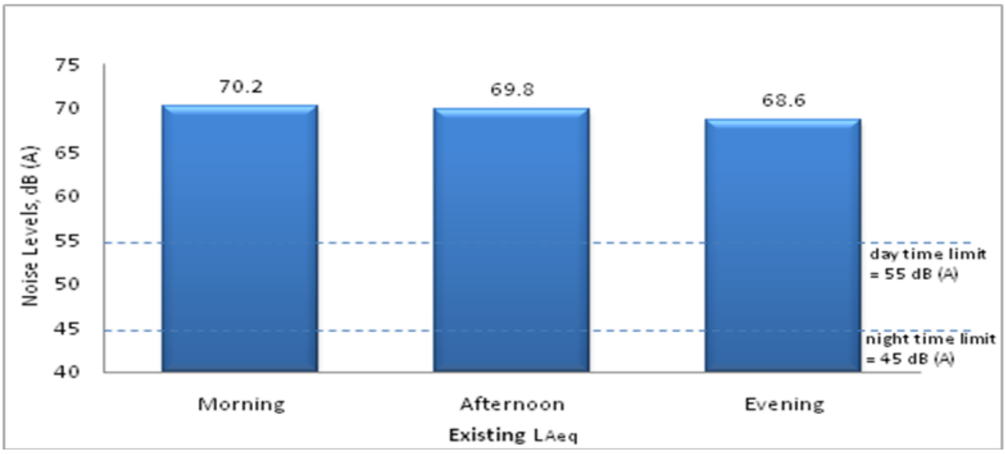

Figure 1. Existing Noise Level in Suburban Residential Areas (Medium Density)
Source: Department of Environment (DOE), 2008

2.2.3 The relationship between traffic volume and noise level

Development of residential areas surrounding the city increases construction activities and traffic movement leading to increase in noise pollution at neighbourhood areas. Nowadays, the benefits of accessibility are taken for granted and traffic is perceived as having a negative impact on the satisfaction level of the residents in the neighbourhood (Botteldooren et.al, 2011).

Study conducted by Ellebjerg (2008) proved that when there is a reduction on traffic volume, the noise consequently reduces as shown in Table 2. Given that the traffic composition, speed and driving patterns are unchanged, the logarithmic nature of the dB scale means that a 50 % reduction of the traffic volume results in a 3 dB reduction in noise level, regardless of the absolute number of vehicles. However, when there is a reduction in the traffic volume on a road, it will often lead to increases in speed and with more room for driving it may also lead to harder accelerations, which will hence increase the noise emissions.

Table 2. The effect on noise levels due to changes in traffic volume.

Reduction in traffic volume	**Reduction in noise (L_{Aeq})**
10	0.5 dB
20	1.0 dB
30	1.6 dB
40	2.2 dB
50	3.0 dB
75	6.0 dB

Source: Ellebjerg (2008). Noise Reduction in Urban Areas from Traffic and Driver Management, p. 11

Traffic influences the quality of life in a neighbourhood in many different ways and it is also recognized as the most widespread source of environmental noise. Exposure to traffic noise is often associated with a wide range of effects on human health and well-being. The World Health Organisation (WHO) recognises community noise, including traffic noise, as a serious public health problem, prompting it to publish guidelines on community noise in 1999 (Botteldooren et.al, 2011). Therefore, by studying the relationship between traffic and noise, it can be used to assess the effects of various traffic management measures toward the traffic flow and noise and its impact to the community. One example of this could be improvements in public transportation or conditions for bicyclists, which may lead to a shift in people's choice of transport modes and thereby decrease in car traffic (Ellebjerg, 2008).

2.3 Impact of Traffic Calming Measures toward Environment

The environmental effects need to be considered carefully for measuring the effectiveness of traffic calming devices as the environmental impacts neither be positive nor negative. They are dependent on the changes in traffic volume and vehicle speeds after using the traffic calming devices. Numerous studies have demonstrated that most traffic calming schemes have successfully achieved the objectives set in terms of reduction in accidents, speeds and volumes, and there is ample evidences of the general positive response to traffic calming by the public (Schroll, 1999; Morrison et.al, 2003 Patterson, 2004). However, despite the significant benefits of such schemes there is considerable professional and community opposition towards the use of physical traffic calming devices. Opinion surveys have shown that motorists feel disadvantaged by speed humps or raised platforms and that residents living near the devices often complain of deterioration of, rather than improvement in, environmental conditions (Hidas et.al, 1997).

There have been cases where some devices were even removed because of community complaints (Cline and Dabkowski, 2005). Notwithstanding the overall success of traffic calming in local streets, these claims suggest that, while physical speed control devices are very effective in improving the safety and amenity of the street environment, they also produce undesirable side-effects to the community. It seems quite reasonable to assume that these effects may become more important if such devices are installed on routes with higher traffic volumes. Hence there is a need to investigate any possible side-effects associated with these traffic management techniques.

Some studies indicated that residents are often concerned that vertical measures such as humps, tables, and especially textured surfaces will raise noise levels in the community (Hidas et.al, 1997). However, a study conducted in the United States (Clark, 2000) indicated that the lower speeds resulting from the proper design and application of traffic calming measures tend to lower noise levels. European studies have reached similar conclusions, for example, a study of British traffic-calming schemes in villages (Cline and Dabkowski, 2005) found that, alongside the speed reduction, there was a reduction in noise of around 10%. Conversely, Hidas et.al (1997) reported that the effects of traffic calming measures have positive outcomes, although traffic calming devices can result in some undesirable side effects in relation to traffic noise of individual cars that are due to decreased traffic volumes. However, no previous attempts have been made to research other possible side-effects.

3. RESEARCH APPROACH

3.1 Background of Study Area

Taman Keramat is a township in Ulu Klang, Selangor, Malaysia. This township is located between Kampung Datuk Keramat and Setiawangsa in Kuala Lumpur. Taman Keramat is a major residential neighborhood with an estimated 4,000 residents living in an area of about 1.5 sq. km. It is located at less than 4 kilometres from the Kuala Lumpur city centre. Taman Keramat houses 1,520 household and it is served by two light rail transit stations (Jelatek and Setiawangsa station) along the Kelana Jaya Line.

With the increase in the car ownership in Kuala Lumpur from 1.43 million in 2011 to 1.56 million in early 2013 (8% increase) (Ministry of Transport, 2013), it shows that residents in Kuala Lumpur are subjected to traffic problems. This study area is selected because it encompasses diverse types of residential units including terrace houses, semi-detached house, bungalows, and apartment-type houses. The alignment of an arterial road running very close to the neighbourhood and the location of a railway station which may cause detrimental effects to the living environment of the residents if not controlled properly, were the other reasons for selecting Taman Keramat as the study area. The physical and environmental settings in Taman Keramat is very similar to other residential areas in Kuala Lumpur.

3.2 Field Survey

A field survey was conducted on traffic volume and noise level along three different roads. The roads were chosen based on the characteristics of the road which are long and wide roads and provision of road hump having same length and height. Road 1 and 2 was located at a collector road, while Road 3 was a local road. These roads were also chosen as it encompasses different types of residential units such as: Road 1 was located near terrace houses; Road 2 in the vicinity of apartment-type house and bungalow; and lastly Road 3 close to semi-detached houses. The survey was conducted at the study area for three days (from 9th to 11th January 2013). The details of the measurement on each of the elements are explained in the following subsections.

3.2.1 Measurement of traffic volume

A 12-hour, 7.00am to 7.00pm at every 30 minutes time interval, traffic volume count at the three selected traffic count stations was conducted. The traffic count stations include 2 collector roads and 1 local road. The composition of traffic volume consists of four categories: category A includes motorcars; category B motorcycles; category C four-wheel and vans; category D buses and lorries. The traffic count covered both directions at the selected roads, however, the count was only administered for vehicles that passed the chosen road hump.

3.2.2 Measurement of noise level

The noise level was measured at fixed points that were located at the three selected roads. Fixed point was chosen to measure noise level at different period of the day and to ascertain disparity in noise level during the measurement period. The noise level was measured at every 15 minutes time interval for about 12 hours from 7.00 am to 7 pm by using a noise level meter. The noise level meter was stationed near the roadside of the chosen speed hump at a distance of 1.2m from the ground level. The noise level values such as L_{Aeq}, L_{AFmax}, and L_{AFmin} were measured. The terminology of the noise is given in Table 3. The maximum permissible sound level (L_{Aeq}) for high density residential area during day time is 60 dB(A) while during night time is 50 dB(A) (refer to Table 4).

Table 3: Explanation of noise terminology

Term	**Meaning**
L_{Aeq}	Equivalent continuous sound pressure level. A measure of the average sound pressure level during a period of time, in dB with 'A' weighting
L_{AFmax}	The maximum Sound level with 'A' Frequency weighting and Fast Time weighting
L_{AFmin}	The minimum Sound level with 'A' Frequency weighting and Fast Time weighting
dBA	A measurement unit of sound pressure level which closely matches the frequency of the human ear

Source: Cirrus Research plc (2013)

Table 4: Maximum Permissible Sound Level (L_{Aeq}) of receiving land use for planning and new development

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

Source: Department of Environment (DOE), 2008

4. RESEARCH FINDINGS

The data on each of the selected variables were analysed and the findings are reported in the following subsections.

4.1 Traffic Volume

4.1.1 Road 1 (Jalan AU 2a)

The hourly fluctuation of traffic volume along Road 1 (collector road) was high. Figure 2 illustrates the hourly fluctuation of traffic volume for the directions heading to residential area, while figure 3 shows the hourly fluctuation of traffic volume for the directions heading to main road. The vehicles heading to the residential area show a steady increase especially during peak hour from 1.00 to 2.00 pm with total numbers of vehicles 313 and at evening time from 5.00 to 6.00 pm with 366 numbers of vehicles. This can be inferred that most of the residents are heading back home for lunch and also after work. Moreover, figure 3 shows that the highest total number of vehicles (628 vehicles per hour) was from 7.00am to 8.00am which is the peak hour in the morning. It can be inferred that most of the vehicles are heading to the main roads for work purpose. Motorcars constitute as the highest number of vehicles with an average of 51% heading to residential area and 55% to the main road.

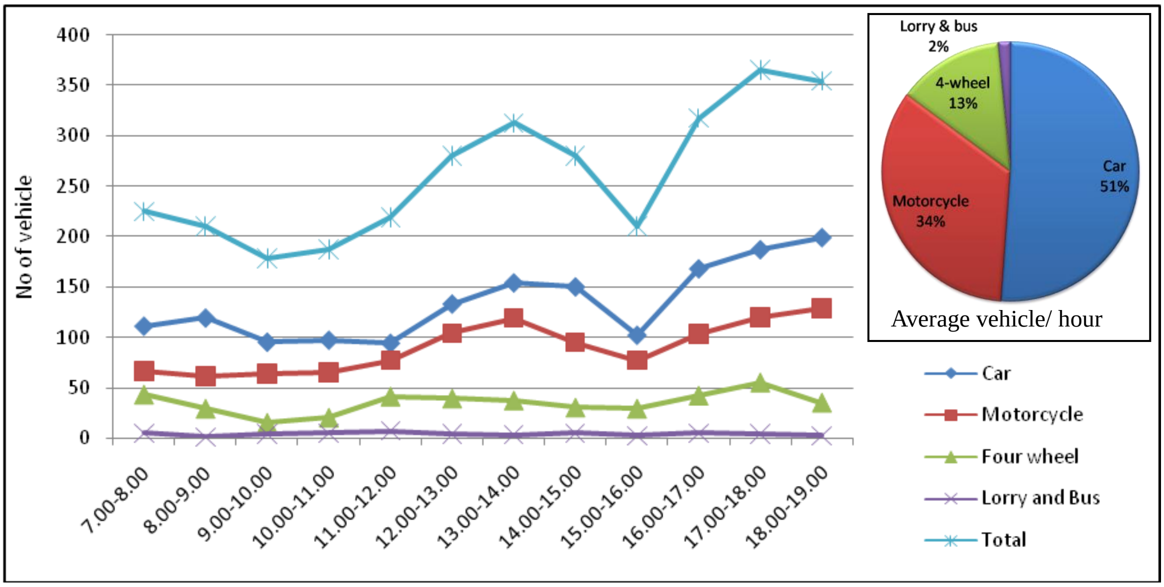

Figure 2. Hourly Fluctuation of Traffic Volume (Jalan AU 2a-heading to residential area)

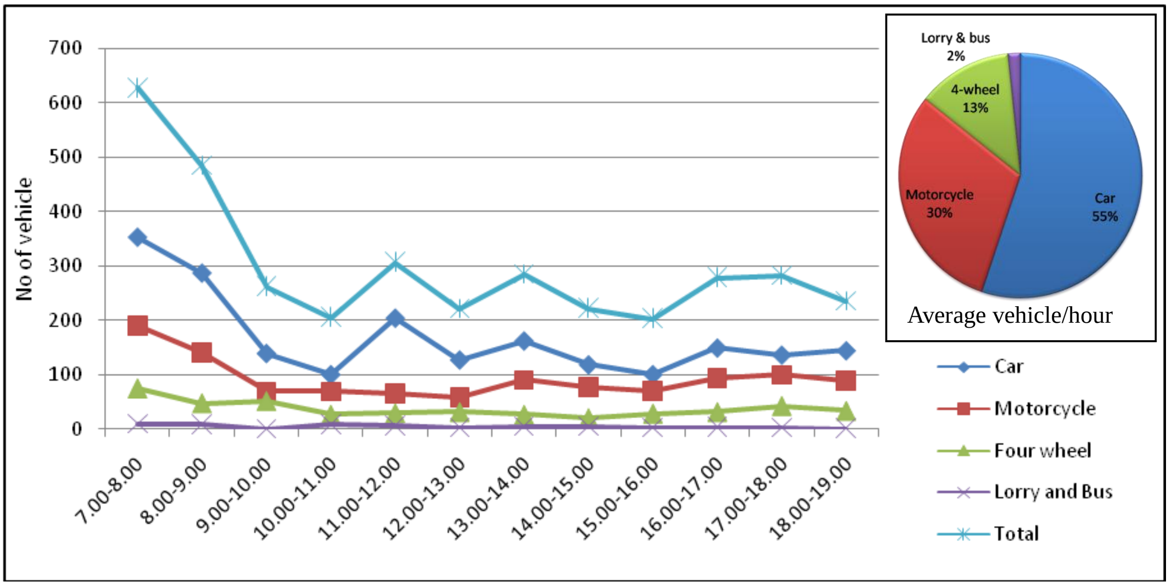

Figure 3. Hourly Fluctuation of Traffic Volume (Jalan AU 2a-heading to main road)

4.1.2 Road 2 (Jalan AU 1b/1)

Figure 4 and 5 show the hourly fluctuation of traffic volume along Road 2. The total traffic volume along both directions during peak hour (7.00 to 8.00 am) was high. About 340 vehicles per hour were heading to main road whereas 222 to the residential area. It can be deduced that most of the vehicles were found using this road in the morning was to avoid the traffic congestion along Jalan Jelatek (arterial road), a major road which adjoins to the residential area. Furthermore, cars constitute the highest percentage of vehicles (44%) heading to the residential area followed by motorcycle 39%, four-wheel vehicles 15% and lorry and bus 2%, while the percentage of vehicles heading to main road consists of car (50%), motorcycle (33%), four-wheel vehicle (14%) and lorry and bus (3%).

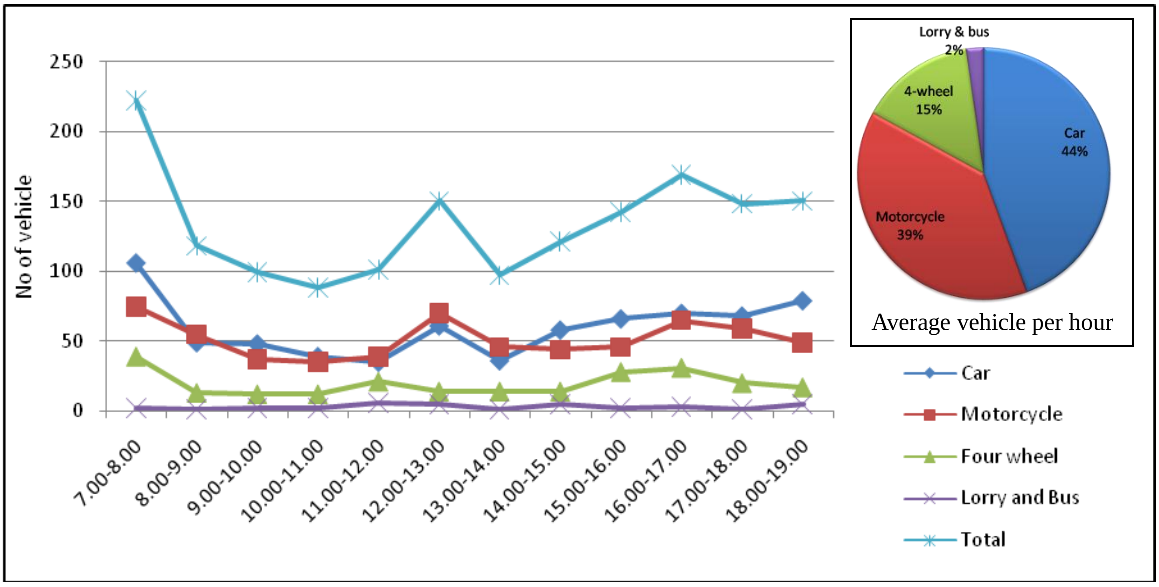

Figure 4. Hourly Fluctuation of Traffic Volume (Jalan AU 1b/1-heading to residential area)

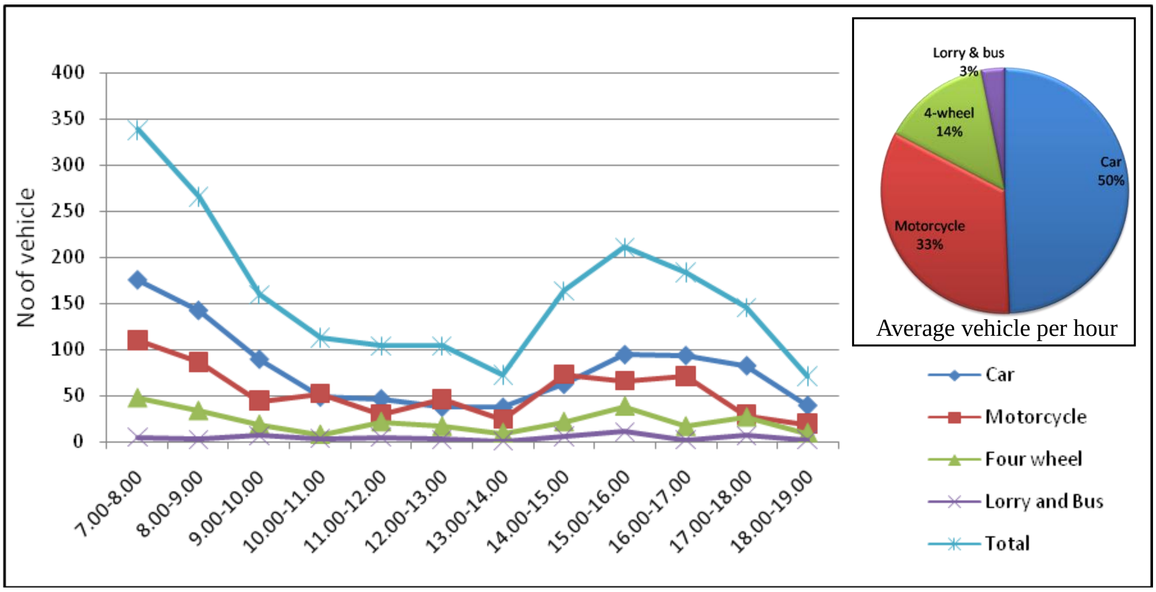

Figure 5. Hourly Fluctuation of Traffic Volume (Jalan AU 1b/1-heading to main road)

4.1.3 Road 3 (Jalan AU 2b)

Figure 6 and 7 illustrates the hourly fluctuation of traffic volume along Jalan AU 2b. The graph illustrates that the highest number of vehicles was heading to main road during morning hours with 409 vehicles per hour, while to the residential area was 475 vehicles per hour during evening hour (6.00 until 7.00pm). It indicates that most of the vehicles are residential users as they are most likely heading back to their house during evening peak hour. Cars also accommodate the highest percentage of vehicles with 45%, motorcycle

(39%), four wheel vehicles (15%) and lorry and bus (1%) along the direction heading to residential area. On the other hand, vehicles heading to main road show that cars constitute the highest percentage with 46%, motorcycle (34%), four wheel vehicles (18%) and lorry and bus (2%)

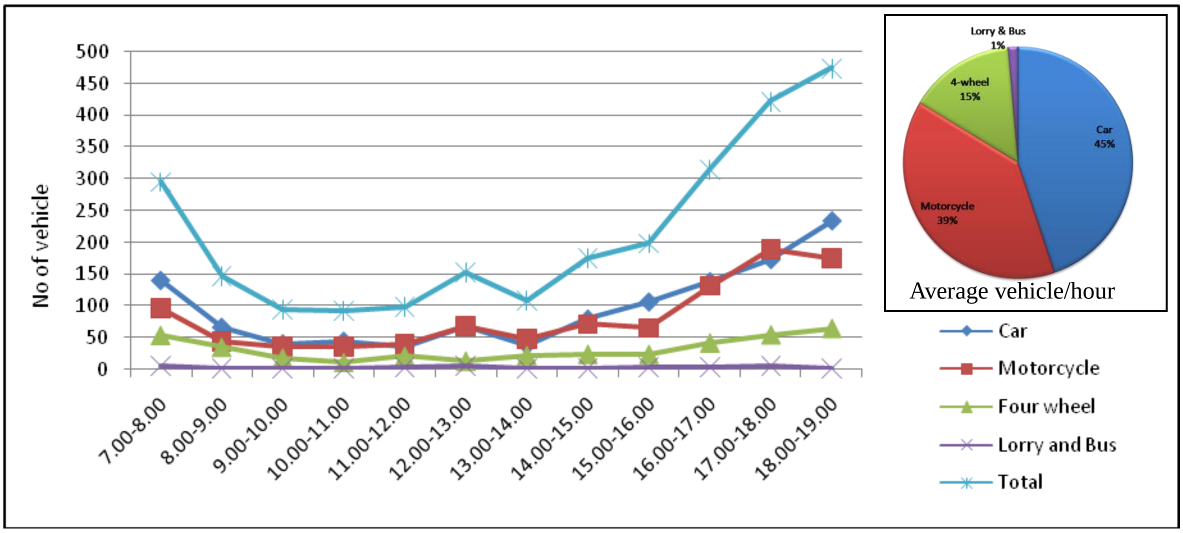

Figure 6. Hourly Fluctuation of Traffic Volume (Jalan Jalan AU 2b -heading to residential area)

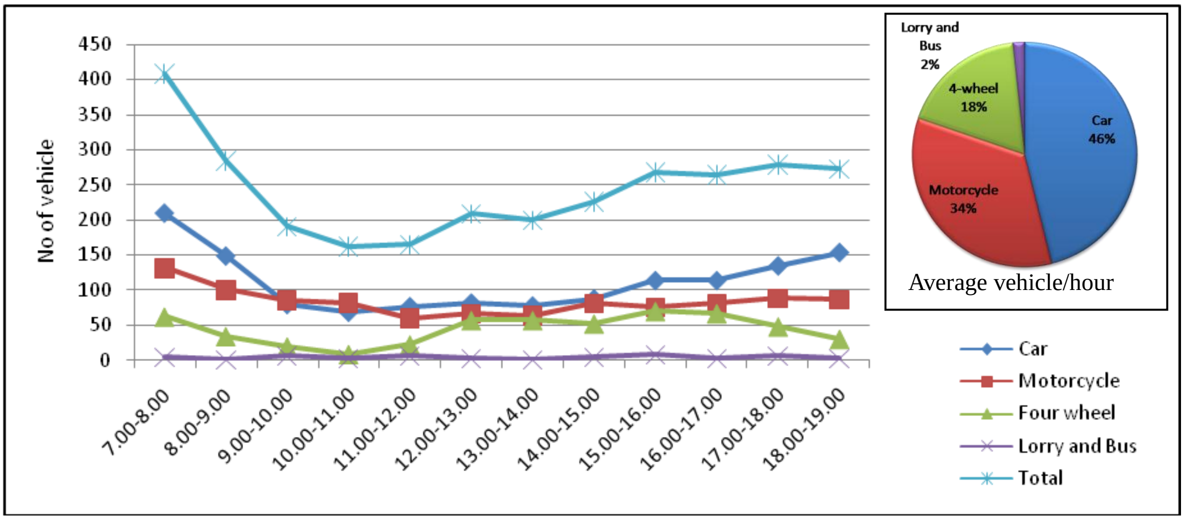

Figure 7. Hourly Fluctuation of Traffic Volume (Jalan Jalan AU 2b -heading to main road)

4.1.4 Average Traffic Volume

The average traffic volume along Road 1 (Jalan AU 2a) was higher (563 vehicles per hour) than average traffic volume along Road 3 (Jalan AU 2b) (446 vehicles per hour) and Road 2 (Jalan AU 1b/1) (295 vehicles per hour). The high traffic volume, especially cars, along the residential streets is attributed to the increasing number of vehicles registered in Kuala Lumpur which is 3.3 million as of December, 2012 (Road of Transport Department). The vehicles registration to population ratio in Kuala Lumpur is estimated to be 2,232 vehicles to 1,000 persons. Additionally, at present, the operation of public transport services in Kuala Lumpur is ranked at low level, hence people prefer to use car as their main mode of transport for various trip purposes. The average traffic volume (vehicles per hour) along each of the selected roads at Taman Keramat is shown in figure 8.

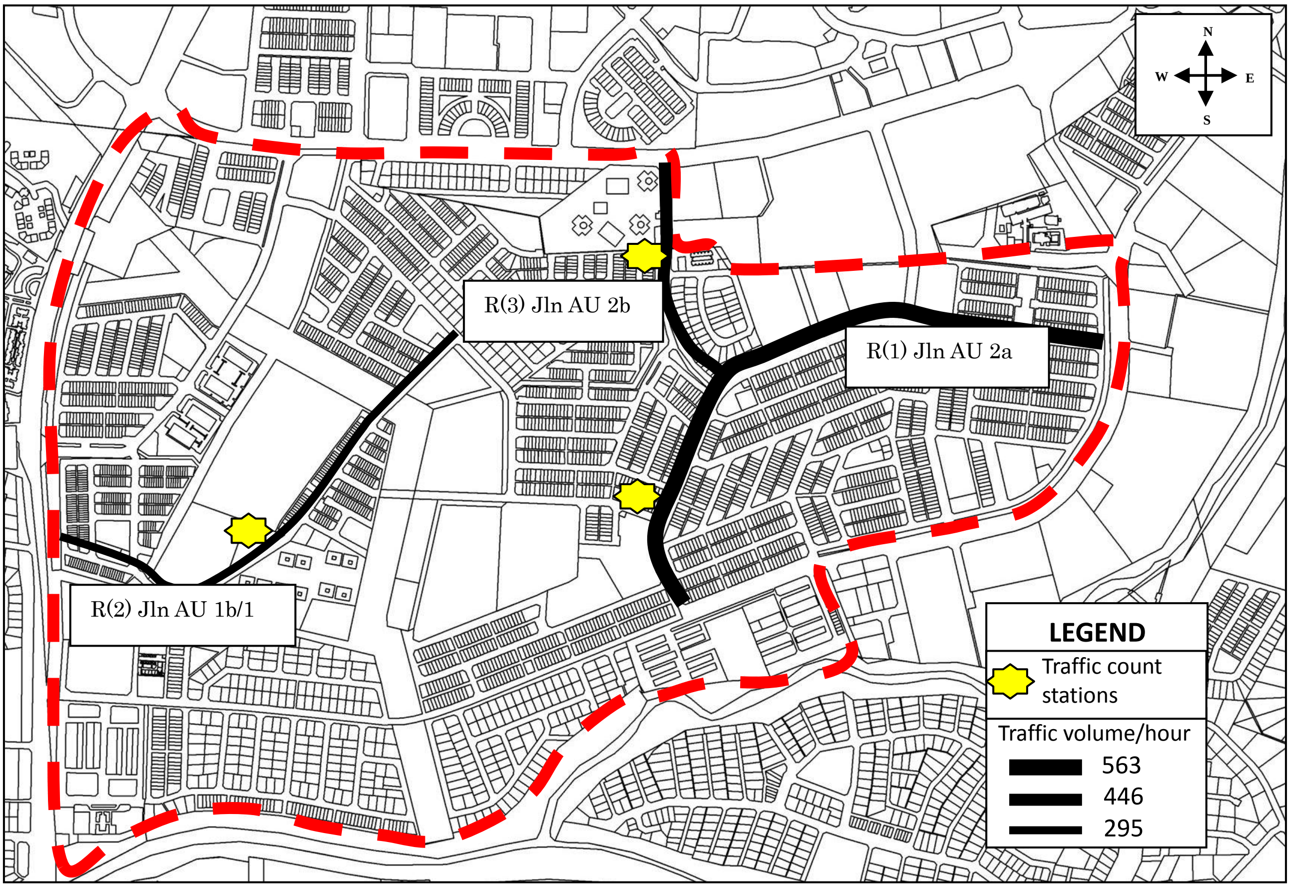

Figure 8. Average Traffic Volume (in vehicles per hour)

4.2 Noise Level

4.2.1 Road 1 (Jalan AU 2a)

Regarding the noise level along Road 1, the analysis of L_{Aeq}, L_{AFmax} and L_{AFmin} shows an interesting pattern. The noise level meter which was located beside road side, measures the vehicles approaching and passing the speed hump. The fluctuation of noise level along Road 1 at 15 minutes time interval is shown in figure 9. Analysis shows that the maximum fluctuation of L_{Aeq} was 10 dB(A), and the average noise level along this road was 75.6 dB(A). It indicates very high noise levels and exceeds the recommended noise level as the maximum permissible noise level for urban residential area (according to Department of Environment) is only 60 dB(A) during day time. Generally, the noise level during morning hours was found to be higher than other time on measurement day. It is properly due to high traffic volume that occurred when the residents travelling to work. However, there is a slight unexpected increase of noise level at 3.00pm where the fluctuation of L_{Aeq} was 4 dB(A) which is due to movement of several lorries and buses.

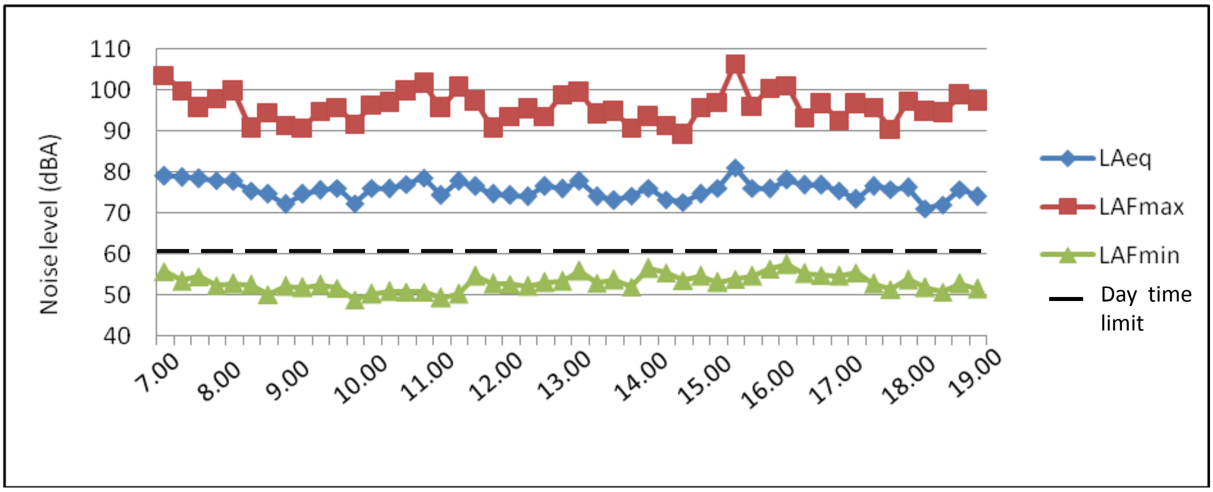

Figure 9. Fluctuation of Noise Level at 15 minutes Time Interval (Jalan AU 2a)

4.2.2 Road 2 (Jalan AU 1b/1)

Figure 10 shows the fluctuation of noise level at 15 minutes time interval along Road 2. The average of L_{Aeq} was calculated to be 69.6 dB(A); the highest noise level was observed in the morning (7.00-7.15 am) measuring 79.7 dB(A) and the lowest was during lunch hour (1.45-2.00 pm) measuring 55.8 dB(A). This also exceeded the permissible allowable noise level in the residential areas. Coincidently, the traffic volume during morning peak hour was the highest while during lunch break, it was the lowest.

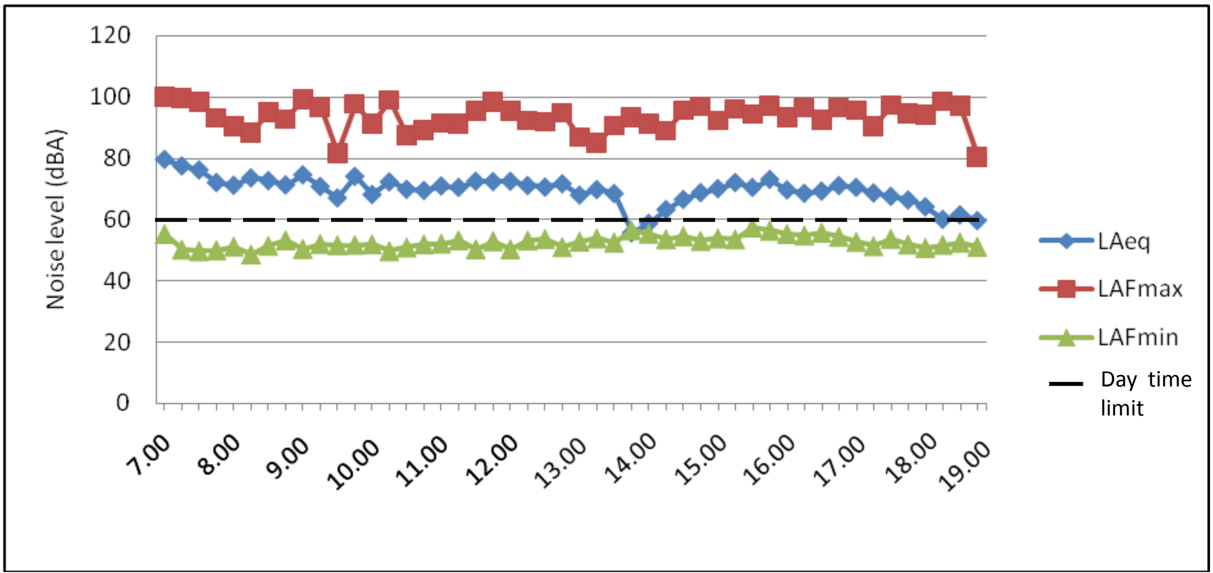

Figure 10. Fluctuation of Noise Level at 15 minutes Time Interval (Jalan AU 1b/1)

4.2.3 Road 3 (Jalan AU 2b)

Figure 11 illustrates the fluctuation of noise level at 15 minutes time interval along Road 3. The average of L_{Aeq} was calculated to be 72.9 dB(A) which also exceeded the recommended noise level in the residential areas. The findings also indicated the highest noise level was measured from 6.45 to 7.00 pm, measuring 81.3 dB(A), while the lowest was measured from 1.45 to 2.00 pm measuring 67.6 dB(A).

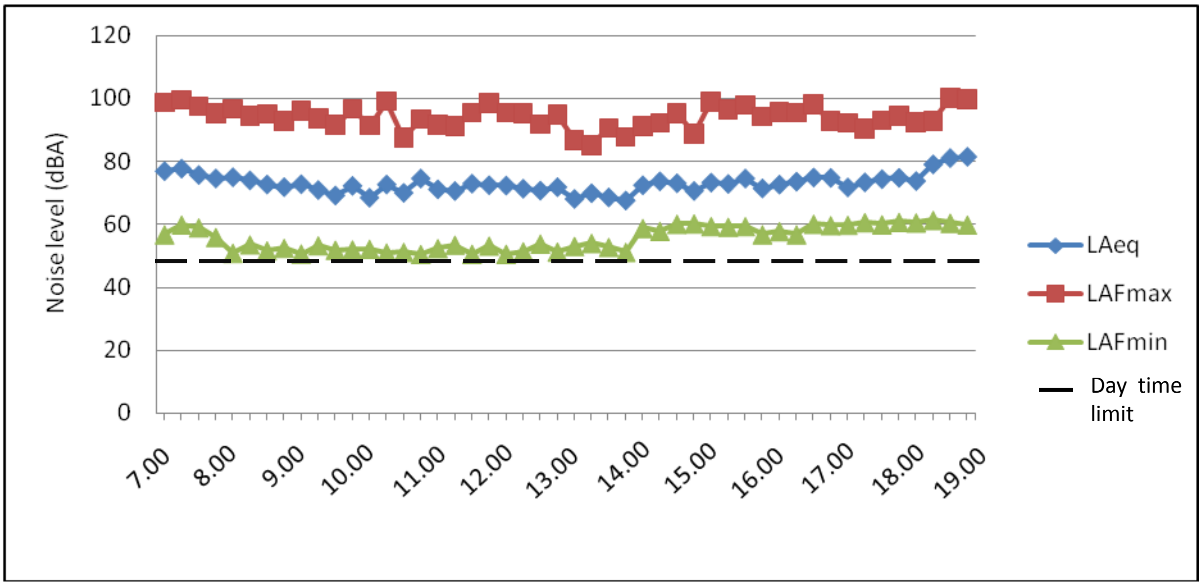

Figure 11. Fluctuation of Noise Level at 15 minutes Time Interval (Jalan AU 2b)

4.3 Correlation between Traffic Volume and Noise Level

4.3.1 Road 1

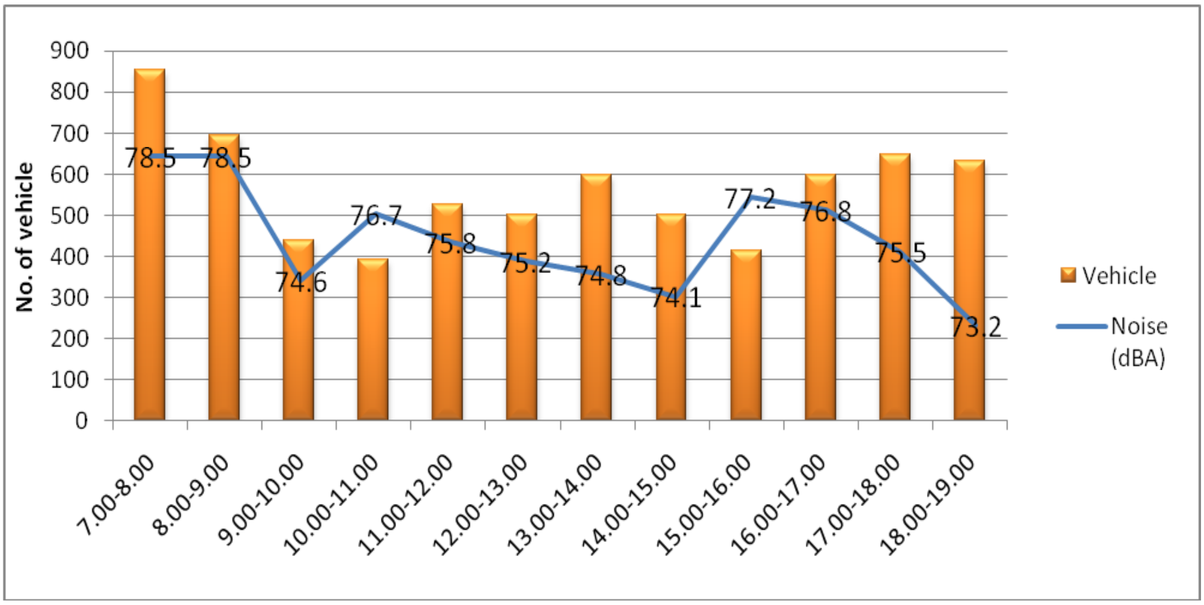

Figure 12. Relationship between Noise level and Traffic volume (Jalan AU 2a)

Figure 12 illustrates the relationship between noise level and traffic volume for road 1. The average noise levels are higher than the permissible noise level during day time. Morning peak hour from 7.00 to 9.00 am indicated the highest noise level with 78.5 dB(A) which also shows the highest traffic volume. While the lowest noise level was from 6.00 to 7.00 pm, measuring 73.2 dB(A), but the traffic volume was high (634 total numbers of vehicles) during that time period. The reason could be due to movement of slightly high number of motorcycles in the evening hours than morning hours. Ellebjerg (2008) stated that on most local roads, light vehicles usually dominate the noise emissions as the speed of the light vehicles is considerably higher, and therefore contributes to the noise emission. However, the noise level from 10 am to 11 am was high measuring 76.7 dB(A) but the traffic volume was the lowest as compared to other time period on the measurement date. The reason is due to the increase number of heavy vehicles with 15 lorries were passing during that time period which consequently increase the noise level.

A study by Ellebjerg (2008) concluded, at 60 km/h for instance the LAmax level from a truck with more than three axles is 83 dB(A), from a truck with up to three axles it is 80 dB(A), for a public bus transport it is 79 dB(A), for vans it is 75 dB(A), for motorcycles 74 dB(A) and for passenger cars it is 73 dB(A). It means that a public bus transport at 60 km/h makes as much noise as 4 passenger cars, a truck with up to three axles as much as 5 cars and a truck with more than three axles as much as 10 passenger cars. This showed there are clear differences in noise levels depending on the size of the vehicles.

4.3.2 Road 2

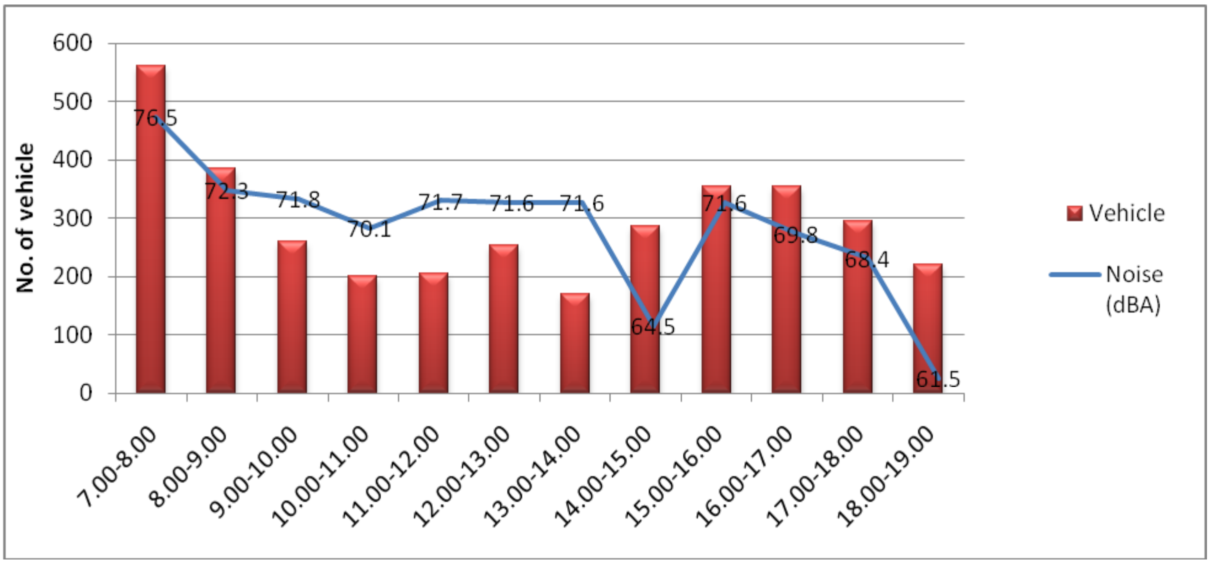

Figure 13. Relationship between Noise level and Traffic volume (Jalan AU 1b/1)

The relations between noise and traffic volume for Road 2 is shown in figure 13. From the graph, it can be concluded there is consistent pattern between the two factors as when the traffic volume decrease so does the noise and when the traffic volume increase, the noise volume also increase. However, the findings showed, from 2.00 pm to 3.00 pm, when there is an increase in traffic volume, the noise level drops measuring 64.5 dB(A). It can be inferred that the vehicles during that hour were moving at low speed with less intensity of accelerations. The location of the selected road hump along road 2 also played a role as the geometry of the hump is smaller as compared to others and the presence of an intersection near this road hump also can affect the speed of the vehicles.

4.3.3 Road 3

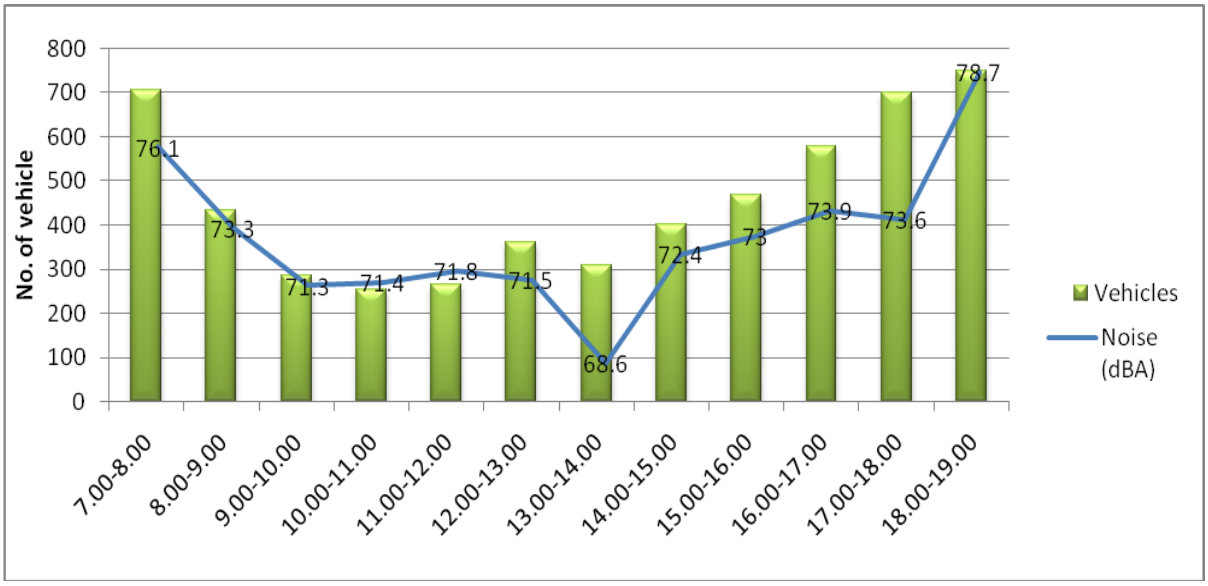

Figure 14. Relationship between Noise level and Traffic volume (Jalan AU 2b)

Figure 14 shows the relationship between noise and traffic volume for Road 3. The traffic volume and noise level are consistently related with each other. Generally, the graph shows that an increase in traffic volume also increases the noise level. The highest traffic volume was counted to be 748 vehicles per hour from 6.00 to 7.00 pm indicating the highest noise level measuring 78.7 dB(A). The noise level drops to 68.6(A) from 1 pm to 2 pm as the traffic volume decreases. With most of the residents working outside, there involves not many vehicles using this road for lunch in the afternoon and the number of buses and lorries were also the lowest during this time period (only 2 vehicles), thus contributing to decrease in the traffic volume and noise level.

5. DISCUSSION

Healthy and harmonious living environment in a residential area are basic yardstick for well-being of a community. It will encourage effective involvement of the working population to further develop economy of the nation. Moreover, it enhances the visual quality of the area. The findings of this study are expected to inculcate general awareness of the residents on the existing conditions of each of the selected environmental factors.

Notwithstanding the overall success of road hump, however, it does not have an effect on lowering both traffic volume and noise level on the residential streets. The increase in traffic volume especially during morning peak hour, where the cars travelling along the selected residential streets were driven not only from the residents staying in that area but also from the outsiders as they want to avoid the traffic congestion along the major road (Jalan Jelatek). However, with the increase in traffic volume, the impact of vehicles approaching and passing the road hump will also increased, and consequently increased the noise level along the streets. The findings showed that the noise levels measured at different times during the observation period were relatively high which need to be dealt with immediately to prevent long-term damages.

There are several ways to overcome the problem of traffic noise. Among them is to understand the concept of noise reduction (Luqmanul hakim et.al, 2011).The problem of noise pollution will not be resolved and removed entirely but it can be overcome through sound control based on the understanding of the concept of noise reduction. To overcome the problem of traffic noise in a residential area, it is advisable to implement road construction barrier method or medium sound absorbers such as tree planting which can be located between the sound source and the sound receiver, in this case between the streets and the residential houses.

Law enforcement is also another medium that can be used to overcome and avoid traffic noise problems. Department of Environment (DOE) is the law enforcement agency responsible for environmental issues in Malaysia. Noise-related legislation is under the Environmental Quality Act 1974 and Environmental Quality (Motor Vehicle Noise) Regulations 1987 (DOE, 2007). Luqmanul hakim et.al (2011) explained that the Environmental Quality Act 1974 was comprehensively designed according to the requirements and basis of environmental legislation in the country. These legislative provisions have listed three vehicle noise emission standards, Standard A, B and C. Section 4 (1) clarifies the maximum noise levels that are limited by motor vehicle two or three wheels are given in Standard A, while Section 4 (2) explains the sound level maximum can be released by a motor vehicle with two or three wheels that are manufactured or assembled on or after January 1, 1990 are as given in Standard B. Hence low enforcement also played a role in maintaining and monitoring the vehicle emission standard in reducing the traffic noise.

6. CONCLUSIONS

Traffic volume along the residential streets was found to be high. The average traffic volume along Road 1 was 563 vehicles per hour, Road 2 was 295 vehicles per hour and Road 3 was 446 vehicles per hour. Generally, car traffic was observed to be the highest than other mode of vehicles along each of the selected roads during the survey periods. This is due to increase in car ownership especially in the Klang Valley area and also commuters prefer to use cars as their main mode of transport for various trip purposes. The high traffic volume leads to high noise level along the streets provided with road hump, measuring 75.6 dB(A) along road 1, 69.6 dB(A) road 2 and 72.7 dB(A) road 3. According to DOE standards, the noise levels along the residential streets exceed the permissible noise levels (60 dB(A)) in a residential area. As a result, in long term, it will cause permanent damages and disturbances to the residents living near the residential roads.

Correlation between traffic volume and noise level shows consistent pattern especially for Road 2 and Road 3 in which the increase in traffic volume causes increase in noise level and vice versa. However for Road 1, the relationship between traffic volume and noise level shows inconsistent pattern as an increase in the traffic volume does not result in increase in noise level. The reason is due to substantial number of vehicles especially motorcycles were found speeding because of the location of Road 1 which is located at the main entrance to the residential area as well as it is being used as an alternative road by the vehicles to avoid traffic congestion along the major road (Jalan Jelatek). The geometrical design of road 1 could be another reason where it has a wide width and long straight stretch, which eventually encourages vehicle to speed although the road hump were located at every 500 meters.

A reduction in the traffic volumes on a road will often lead to increases in speed because the vehicles can drive more freely, unless measures are taken to keep the speed down. Increase in speed will work against the reductions in noise level. If traffic flows more freely, there will also a change in driving pattern such as decrease in the number of accelerations and decelerations which are likely to result in lower noise levels and at the same time also provides more room to drive at increased accelerations, thereby increasing the noise emissions. However, the reduction in traffic volumes is a measure which is mainly applicable along local road. On major roads, it is hardly ever realistic to reduce traffic to an extent that it will significantly reduce noise levels. Some reduction may be achieved through long-term town and traffic planning which aims at shifting people from using cars to other modes of transport.

Despite the fact that this paper is being focused on only one residential neighbourhood at a district level, it provides a greater insight and understanding on the existing environmental conditions that the residents are subjected to. However, further studies at other residential neighbourhoods in Kuala Lumpur will help to further understand the effects of speed hump on traffic volume, noise level and other factors to arrive at measures in making the community to live in a peaceful, conducive, harmonious and safe living environment.

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