

Effect of Posted Speed Limit On Drivers Speed Choice During Off-Peak Period

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Abstract. Determining appropriate posted speed limits for each road type is important to enhance the safety of roads and the roadside environment for all users. Therefore, this study is aimed at investigating the effect of posted speed limit on speed choice during morning off peak hours. Traffic data were collected using radar meter method at three sites located at Jalan Harmoni, Lebuhraya Skudai-Pontian and Lebuhraya Senai. Each site has different posted speed limit which varies from 60 km/h to 80 km/h. A total of 1674 spot speed data was obtained and these data were then analyse for each site and compared to see the effect of different posted speed limit on speed distribution, driver's degree of compliance to speed limit based on distribution of speed and driver's degree of compliance based on category of vehicle. The results show that the speed distributions of vehicles at various posted speed limit are different for all sites. However, 15th and 85th percentile speeds increase with the increase of posted speed limit and almost 85% of drivers are travelling at or below the posted speed limit at each selected site. Drivers degree of compliance is also seen to reduce as the posted speed limit is increased. From the results, it was found that light vehicles consisting of motorcycles, private vehicles and taxis are the main contributors to vehicles travelling above the speed limit. Therefore, it can be concluded that driver speed choice during off-peak hour is influenced by posted speed limit even though they have their own style and attitude towards speed choice.

Introduction

Malaysia has achieved successes in many fields including in economic activities. As a developing country, transportation and road network has become an important tool in building the nation as it connects between the different states in Malaysia. Therefore, there is a need for a safe and modern road infrastructure to be used for all road users. A set of road law has been imposed to ensure a road system which is systematic and regulated for all types of road conditions and the ever increasing volume of traffic form year to year. One of those law implemented is by regulating the speed limit which has also long been introduced to regulate the speed of vehicles in any developing country.

Speed limits are used in most countries to set the maximum speed at which road vehicles may legally travel on particular stretches of road. In Malaysia, the highest speed limit is 110 km/h assigned to expressways, while 90 km/h for both federal roads and states roads and is regulated to 60 km/h if it is near town areas. These speed limits may however from time to time decreased to accommodate to certain circumstances such as festive seasons where there will be a large volume of vehicles travelling within states and both the drivers and passenger's safety is important [1]. The failure to abide to the speed limit is an offence as stated in the Malaysian Road Safety Act 1987. The Public Works Department of Malaysia either wise known as Jabatan Kerja Raya Malaysia (JKR) is the government agency that is responsible for setting the speed limits of roads in Malaysia. Speed limit is set at a maximum or minimum depending on the road design to ensure a smooth and safe travel of the road users and also non road users. Speed limit also provide drivers with indication and information of the surrounding road stretch on traffic conditions on whether the road is located near residential areas, hospitals or school areas where there are a lot of pedestrian's activities which needs the driver's extra attention.

Previous study

Relationship Between Speed and Safety In a fast paced economy especially in a developing country such as Malaysia, vehicular travelling speed can bring a positive impact in bringing down the travelling time. However, there are also the downsides of travelling at a high speed for vehicles as there is a tendency to risk the safety of road users. Based on the World report on traffic injury prevention done by World Health Organisation (W.H.O)[3], it is identified that speeding is one of the key factors in road traffic injuries and plays major roles in influencing road crash risk and also the condition of the injuries as the result of the accident. The W.H.O also states that excess speed as exceeding the posted speed limit which is inappropriate to drive at this speed with respect to the road and traffic conditions which causes and is responsible for the injuries and death resulting from road crashes.

A study by Ossiander and Cumming [4], on posted speed limit and traffic fatalities in Washington finds that analysis of the impact of the increased speed limit to ensure highway safety have come out with conflicting results. In 1987, the Washington state decides to increase the speed limit of rural highways. Accident rates and fatalities due to it has increased by two times.

Noted that a higher speed increases the likelihood of an accident, a study conducted by Terje [5] states that it is necessary that road user attitude is taken into consideration for road safety improvement. Since relationship between road user attitude and accident risk is however not well known, the study was performed to find out if driver's attitude is important to road safety with the assumption that road users who complies to the traffic rules contributes to a lower accident risk. The attitudes of the sample of licensed drivers were obtained through a set of questionnaire in two phases. It is found that drivers background such as age and annual driving mileage that pose accident risk as compared to attitude. The relationship between attitude and accident risk runs deeper which is more complex and is more related to demographic

Lahaussa et al [6] also conducted a study related to driver's attitude in order to get a better insight on the Australians community attitude towards the current posted speed limit and proposed speed limit. An online survey was conducted with its questions mainly focussing on attitudes towards speed limits for four different road types, with the samples stratified into demographics according to age, gender, and area of residence whether urban areas or rural areas. Results shows that most of the respondents are able to identify the posted speed limit posted in their neighbourhood, especially roads in urban areas. But knowledge on posted speed limit in rural areas are low.

While Othman et al [7], a study on evaluation of traffic characteristics highlights that safety, time, comfort, convenience and economics are important transportation consideration since it is relating with speed. To determine the traffic characteristics, spot speed study was performed to determine the speed distribution of road section at a specific location. In this study, its intention is to investigate whether as traffic volume increases and public financial resource decreases, it is important to have improvement projects to predict traffic growth pattern.

A case study for two-lane rural highway by Khairy et al [8] was conducted to develop the 85th percentile operating speed models at mid-curve. The speed data measurement is based on spot speed data at several points on the highway. By developing 85th percentile operating speed prediction model using multiple linear regression analysis, it could be integrated into current guideline and standard practice in Malaysia especially for horizontal alignment for two-lane rural highway in Malaysia.

Determination of Speed Limit The proposed posted speed limit must be suitable with the situation and condition of the road. Excessive posted speed limit happens only when the majority of the driver complies with the speed limit and this could be achieved when the posted speed limit is reasonable [9].

The maximum and minimum speed limit of a particular road section is designed by traffic engineers based on evaluations done especially during the construction of the road or already available road section. According to Rose [10], some of the criteria's that is evaluated to determine speed limit is as follows:

- a) Speed at the 15th and 85th percentile
- b) Geometry design of the road (sidewalk, visibility, type of road, etc)
- c) Function of road segment, effect of the driveway and condition of the surrounding area of the road.
- d) Past accident records.

Drivers Behaviour and Perception Towards Speed Limit In a traffic system, the three main components are the driver, vehicle and road, the driver is the most flexible component but tends to be the most unstable component. The drivers behaviour is linked directly with the vehicles speed and safety. Speeding among other things, has been identified for decades as a significant and highly complex safety issue. A study conducted by the Federal Highway Administration (FHWA) finds that 7 out of 10 drivers are guilty of speeding in urban areas, compliance towards the posted speed limit is low especially when the posted speed limit is low (Graham) [11].

An investigation by Gabany [12] to find the factors that affect the predispose, enable and reinforcing drivers speeding behaviour. The perceptual inventory was developed that covers drivers from a college through questionnaires. Since the questions asked are to be answered by the drivers themselves, results obtained shows drivers are aware of the speeding issue. The study also finds that the perception and attitude of the road users towards speeding can be summarized into five main factors which are ego, the tendency to take risk, time pressure, reckless driving, and the need for attention. They also find out that gender and the socioeconomic background of the road user can be the mechanism that triggers those factors.

This is closely related to the results of the study which shows that 8% of male drivers are more prone to speeding. A study done by Warner and Aberg [13] shows that the tendency for a driver to drive exceeding the speed limit is closely related to the behavioural control and the way the driver controls the speed. The result from the study done on 112 drivers, by using a structured equation model to obtain the effect of one of the factor of increased speed is the behaviour and the habits of the driver as the main reason on why drivers tends to exceed the speed limit.

This is further proved by a research done by Letirand and Dolhomme [14]. From what they observed, the choice made by the driver to exceed the posted speed limit can be predicted with a reasonable accuracy by just taking in the account of the habit and attitude of the driver. The driver's ignorance of the posted speed limit is directly correlated to the attitude problem of the driver from the engineering design of the road to the design principle, posted speed limit could be done through taking in several factors such as visibility, stopping distance and other counter measures [15].

If all the posted speed limit is designed using these safety design principals, a good perception from the road users towards the posted speed limit could be achieved. It needs to be pointed out that the attitude and the discipline of the road user's needs to addressed as the rate of accidents that occurs are closely related with the factors.

Methodology

In order to investigate the effect of posted speed limit on driver's speed choice, several procedures in term of collecting data and interpretation of data need to be followed. The research flow is as shown in Figure 3.1.

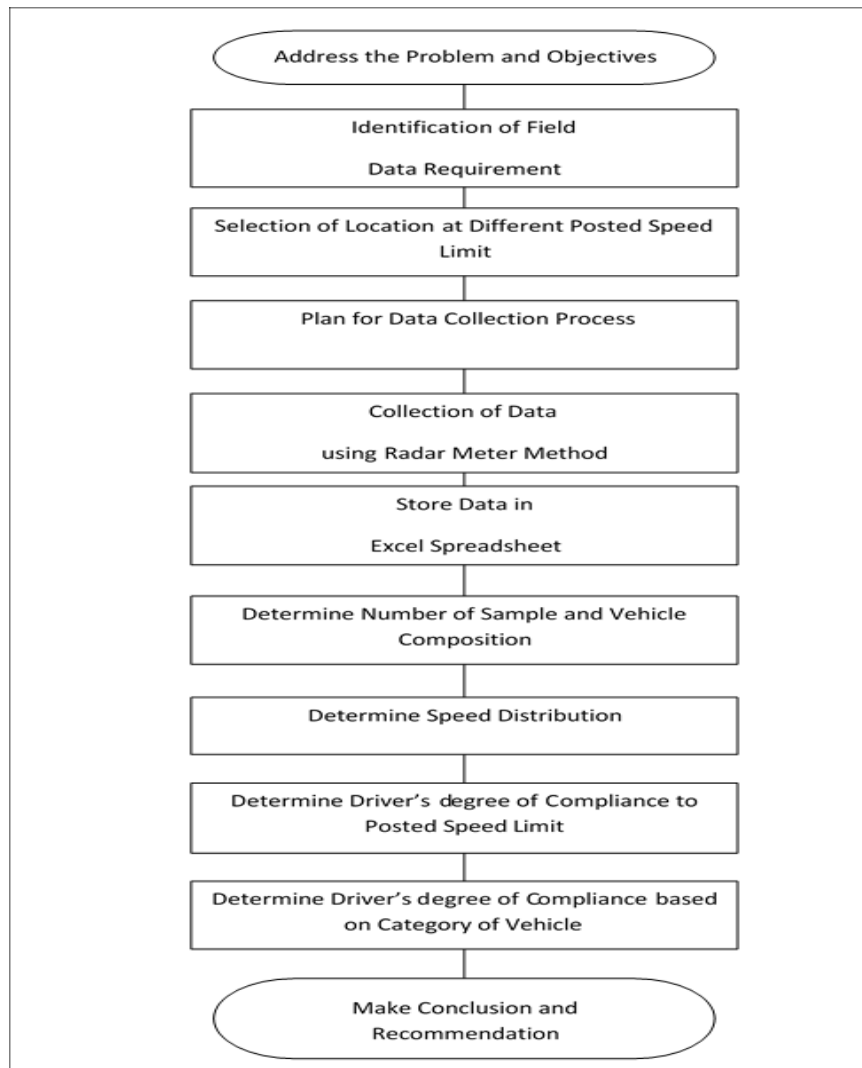


Figure 3.1 Research Flow

Selection of Study Location The selection of study location is important to gather sufficient data that would lead to conclusions regarding the selection of speed at different posted speed limit. Site selection criteria of this study is based on the following criteria:

- a)The road section must be straight to avoid factors affecting the speed of the vehicle
- b)There is no obstacle blocking the observation instruments.
- c)The current stretch of road is not under some kind of repair works or under construction works as this may affect the driver’s movement and affect the free flowing speed of the vehicle.
- d)The road condition is well maintained and does not have any sort of defects which may affect incoming road vehicle speed such as pot holes or deformations.
- e)The selected roads must have different posted speed limit as the aim of this study is to study the degree of compliance of driver to the posted speed limit.
- f)There are no major junctions within the selected road stretch.
- g)Visible posted speed limit signage for the road users to see.

Based on above criteria, three sites were selected as shown in Table 3.1. Each site has different posted speed limit which is 60km/h located at Jalan Harmoni, 70 km/h at Lebuhraya Skudai-Pontian and 80 km/h at Lebuhraya Senai.

Table 3.1 Selected Study Sites

Site	Name of road	Posted Speed Limit (Km/h)	Number of lane per direction
1	Jalan Harmoni	60	1
2	Lebuhraya Skudai-Pontian	70	2
3	Lebuhraya Senai	80	3

Data Collection Method and Equipment There are several ways to gather spot speed data at site such as stopwatch method, radar meter method, and pneumatic road tube method. In this study, a radar meter method was chosen since it is a common method used for directly measuring speeds in spot speed studies. Therefore, three types of equipment which are speed radar gun, digital camera and observation data sheet were used in the data collection process as shown in figure 3.2, 3.3 and 3.4.



Figure 3.2 Speed Radar Gun



Figure 3.3 Digital Camera

Observation Data Sheet										
Observer's Name		Date								
Time		Posted Speed Limit								
Location		Class of Vehicle	Small/Medium/Large							
Speed	0	1	2	3	4	5	6	7	8	9
30										
40										
50										
60										
70										
80										
90										
100										
110										
120										

Figure 3.4 Observation Data Sheet

The layout of radar meter spot speed study is illustrated in Figure 3.5. This study was conducted by two observers where one observer will capture the spot speed while the other takes down the observed spot speed to be marked in the data sheet.

Detail steps to conduct radar meter spot speed study are as follows:

1. Select proper location and placement of radar meter.
2. Determine an appropriate selection strategy to observed spot speed.
3. Record observations on the prepared observation data sheet.

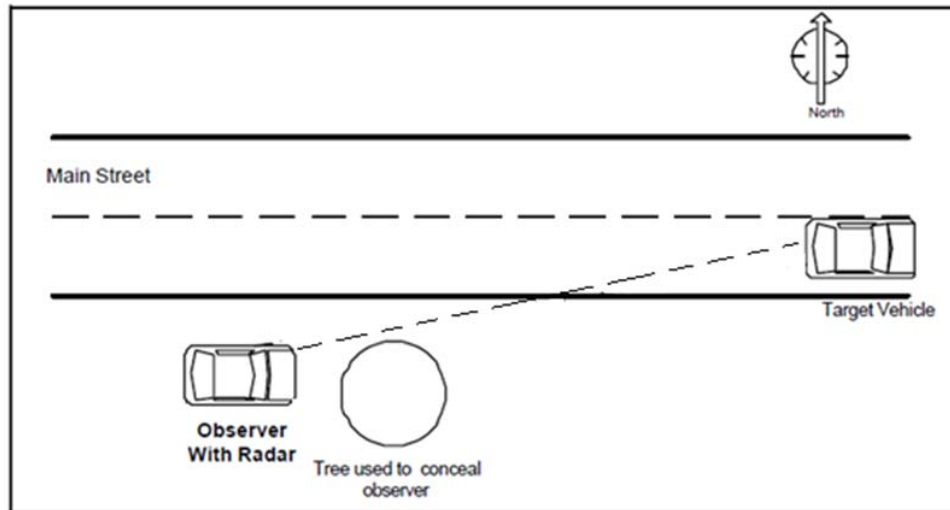


Figure 3.5 Positioning of Observer

Data Collection Time It is known that selection of time to conduct the study depends on the purpose of the study. In this study, data were collected during weekday’s periods in the morning for about two weeks in order to ensure that the minimum sample size is achieved. Noted that, the preliminary study was conducted during the first week and the second week was for real data collection for spot speed study. Specifically, observation was conducted during off peak hours from 9.00 am to 11.00 am in order to obtain spot speed data in free-flowing condition. However, there are some criteria that need to be avoided during data collection process such as inclement weather and unusual traffic condition. It is because these situations will affect the driver’s choice of speed and driving behaviour.

Minimum Sample Size Based on the equation 3.1 developed by Cochran [16], a sample size is calculated by using an accuracy level of ±5 percent.

$$n_0 = \frac{z^2 pq}{e^2}$$

Whereby, n_0 = Sample Size

Z^2 = is the abscissa of the normal curve that cuts off an area α at the tails ($1 - \alpha$ equals the desired confidence level, e.g., 95%)

p = Estimated ratio, estimated = 0.5 (maximum change)

$q = 1 - p = 1 - 0.5 = 0.5$

e = Precision level which is = 0.05

These values were then substituted into equation 3.1 which is shown in equation as follows:

$$n_0 = \frac{1.96^2(0.5)(0.5)}{0.05^2} = 384.16 \approx 385$$

Thus, the minimum number of sample size for vehicle count to be observed is 385 vehicles.

Data analysis

For the purpose of analysis, it is important to ensure that the data collected achieve minimum sample size. Data that have been recorded in observed data sheet were then transferred into Excel spread sheet to determine speed distribution of vehicles at various speed limits, driver's degree of compliance to speed limit based on distribution of speed and driver's degree of compliance based on category of vehicle.

In the Excel spread sheet, data were recorded based on the location of the study which are sites 1, 2 and 3 represents Jalan Harmoni, Lebuhraya Skudai-Pontian and Lebuhraya Senai, respectively. According to Arahan Teknik (Jalan) 8/86, type of vehicles can be classified as follows:

- a) Motorcycle
- b) Individual car and taxi
- c) Light transport vehicle and small van
- d) Medium sized vehicle and medium sized lorry
- e) Heavy vehicle, large lorry and Bus

However, these type of vehicles in this study were classified into three major types:

- 1) Light - Motorcycle, Individual car and taxi
- 2) Medium - Light transport vehicle, small van, Medium sized vehicle and medium sized lorry
- 3) Heavy - Heavy vehicle and large lorry Bus

Then, the traffic composition of light, medium and heavy vehicles for each site was calculated as well as the number of sample size per site.

Speed Distribution of Vehicles at Various Speed Limits From the data obtained, frequency distribution graph and cumulative speed distribution were developed to evaluate the distribution pattern as well as to obtain 15th and 85th percentile speeds. Both percentile speeds can be explained as below:

- a) 15th percentile speed

The 15th percentile speed is the minimum speed value on the road whereby at this speed there is the potential for an accident to occur as it posed as an obstacle to the traffic flow [17].

- b) 85th percentile speed

The 85th percentile is the speed at which 85 percent of the traveling vehicles at the particular road stretch is travelling below the posted speed limit. This value is usually used to set the speed limit [17].

The value of 15th and 85th percentile speeds were then evaluated based on posted speed limits for each site.

Driver's Degree of Compliance to Speed Limit From the spot speed data obtained for every vehicles travelling in each site, bar charts were developed to indicate whether the travelling vehicles is adhering to the posted speed limit or not. For this study, drivers are considered exceeding the speed limit when their spot speed are recorded at above the posted speed limit.

Driver's Degree of Compliance Based On Category of Vehicle In order to study the effect of posted speed limit on speed choice based on category of vehicle, the vehicles are further classified into light, medium and heavy categories. It is not much different with the analysis of driver's degree of compliance where each spot speed of the travelling vehicles based on category of vehicle were obtained and bar charts were developed to observe their level of compliance.

Data Analysis

Sample Size and Traffic Composition For spot speed studies conducted at three selected locations, 1674 data were obtained for the purpose of analysis as stated in the first chapter. Table 4.1 shows sample size and traffic composition at each site during morning off-peak hours. Even though the

number of sample size is different for each site, but it is fulfilling the requirement for the minimum sample size needed for this study which is 385 vehicles. It is also seen from this table that the type of vehicle was classified into 3 classes as below:

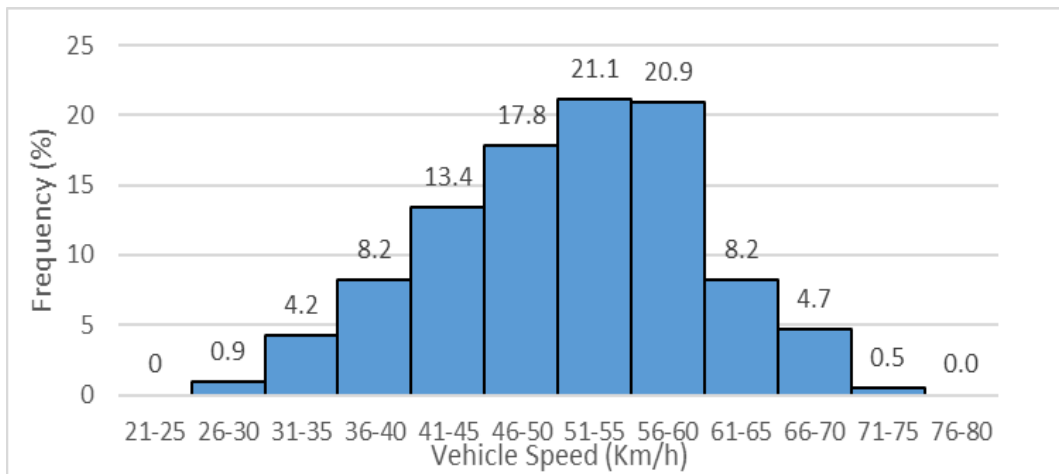
Table 4.1: Sample size and traffic composition

Site	Posted Speed Limit (Km/h)	Vehicle Count	Vehicle Composition		
			Light	Medium	Heavy
1	60	426	375	43	8
2	70	390	301	52	37
3	80	858	777	21	60

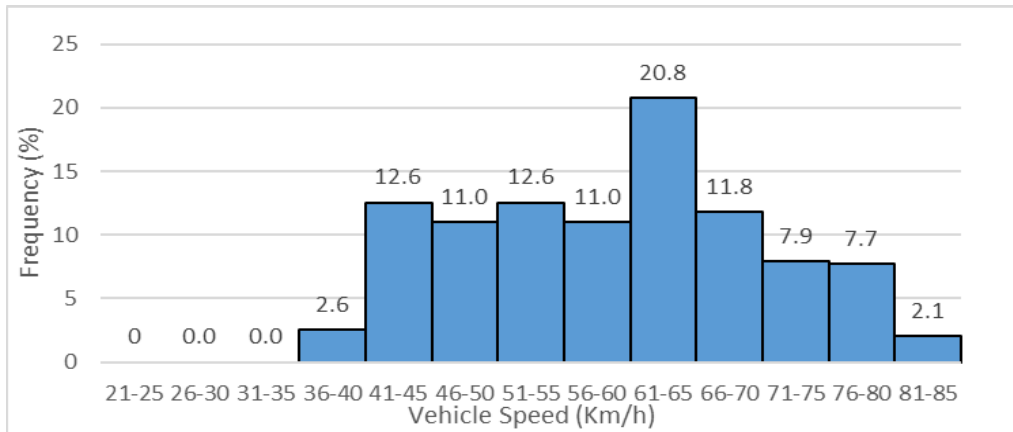
Vehicle Speed Distribution As shown in Figure 4.2(a), the lowest speed of vehicles travel at selected road section is between 26 km/h and 30 km/h. As the range of speed class increases, the frequency of vehicle also increases. The highest percentage of vehicle found during the speed range of 51-55 km/h, which contribute for about 21.1%, followed by the speed range of 55-60 km/h at 20.9%. Surprisingly, both ranges represent the speed of vehicles below the posted speed limit. However, number of vehicles is seen to drop sharply as the speed range increases above the posted speed limit. In general, it can be described that frequency distribution graph not resembles the shape of a normal distribution but represents the distribution that negatively-skewed or skewed to the left.

While, Figure 4.2(b) shows vehicle speed distribution at Site 2. As can be seen from this figure, vehicles at the 70 Km/h speed limit zone moves almost consistently from the range of 41-45 Km/h to the range 76-80 Km/h with the percentage of vehicles in each speed interval plateauing at almost the same frequency. The highest percentage of vehicles travelling is at the speed interval of 61-65 Km/h with 20.8 % of vehicles, whereas the lowest percentage of vehicle travelling in both speed intervals which are 36-40 Km/h and 81-85Km/h at 2.6% and 2.1% respectively.

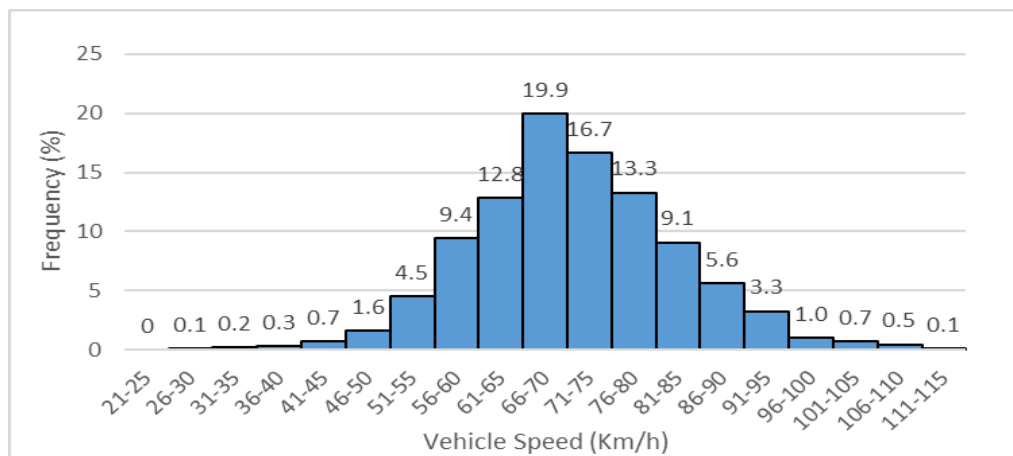
As can be seen from Figure 4.2(c), the observation for the spot speed distribution at Site 3 clearly shown a normal distribution with the highest frequency of vehicle speed is at interval of 66-70 Km/h which contribute for about 19.9 %. From the Figure, it could also be seen that as the speed interval starts to increase towards the posted speed limit, the frequency of the vehicle speed also increases until it reached the range of 66-70 km/h. Then, the frequency of speed decreases after 70 km/h until the range of 111-115 km/h.



(a) Vehicle speed distribution at Site 1 (Posted speed limit: 60 Km/h)



(b) Vehicle speed distribution at Site 2 (Posted speed limit: 70 Km/h)



(c) Vehicle speed distribution at Site 3 (Posted speed limit: 80 Km/h)

Figure 4.2: Vehicle speed distribution at three sites (a), (b) and (c)

Table 4.2 shows the results for 15th and 85th percentile speeds obtained from spot speed study at three study sites. As presented in this table, results indicated that both 15th and 85th percentile speed increases with the increase of posted speed limit since drivers alter their speed to conform to speed limits by increasing vehicle speed. For site 1, it was found that the posted speed limit is equal with 85th percentile speed. While for sites 2 and 3, the 85th percentile speeds slightly increase from the posted speed limit, which is around 2 km/h. Therefore, it can be deduced that almost 85% of drivers are travelling at or below the posted speed limit at each selected site.

Table 4.2: 15th and 85th Percentile Speed at Various Site and Posted Speed Limit

Site	Speed Limit (km/h)	15 th Percentile	85 th Percentile
1	60	41.4	60
2	70	44.5	72
3	80	59	82.3

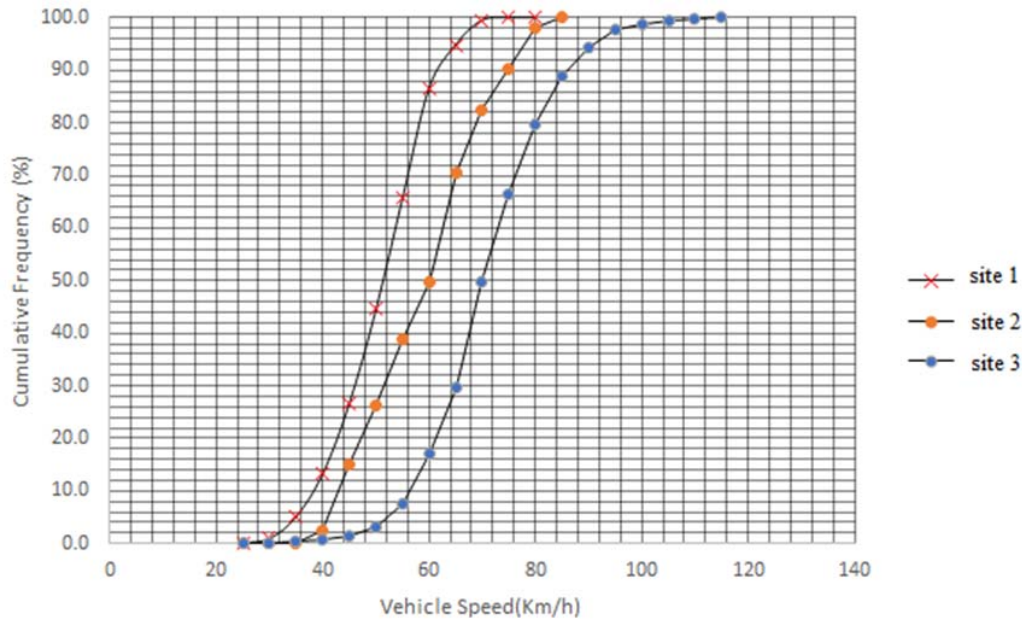


Figure 4.3: Cumulative speed distributions for each site

Drivers Level of Compliance Drivers are considered not complying to the speed limit when they drive above the posted speed limit. Figure 4.5 shows the overall level of compliance of the drivers towards the posted limit at all sites. From the analysis, results showed that changes in posted speed limits led to changes in driver compliance. It can be seen from Figure 4.4 that driver speed compliance decreases with the increase of posted speed limit. Therefore, it can be reported that 13.38% of vehicles travelling at site 1 exceeds the posted speed limit. Whereas, 17.69% and 20.78% of drivers did not comply with the posted speed limits at Sites 2 and 3 respectively.

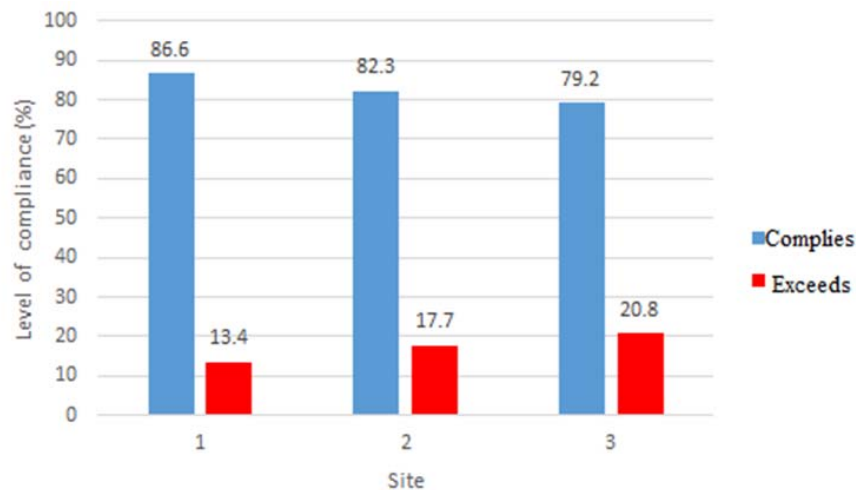
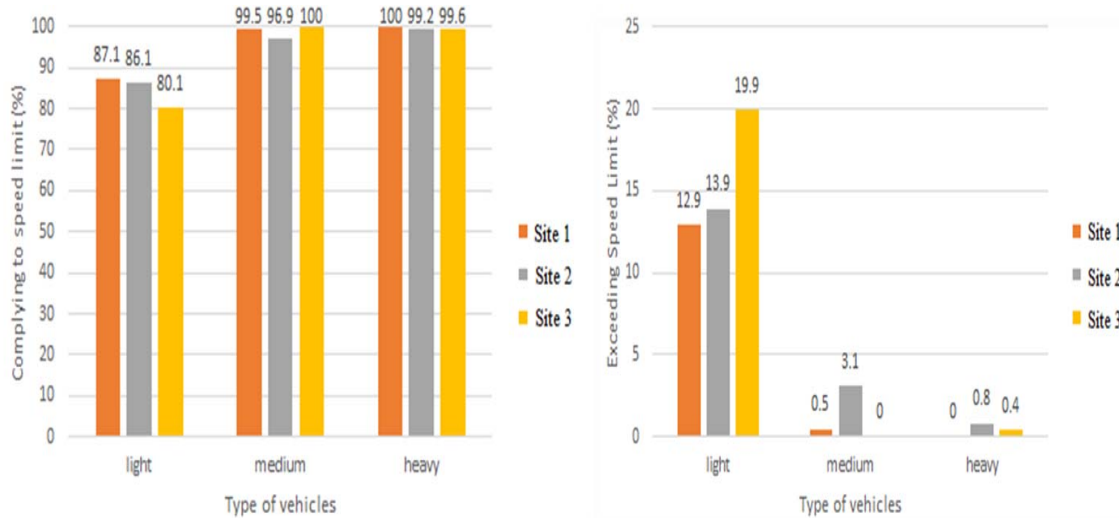


Figure 4.4 Drivers level of compliance towards posted speed limit

Level of Compliance Based on Type of Vehicles As can be seen from Figure 4.5(a), for site 1, 87.1% of light vehicle complies with the posted speed limit, and for site 2 and site 3 the percentage of compliance towards speed limit steadily decrease to 86.1 % for site 2 and to 80.1% for site 3. For site 1, 100% of heavy vehicles complies with the posted speed limit and this level of 100% compliance is also achieve by medium class vehicles at site 3. As can be seen also from Figure 4.5(a), the medium and large vehicle class contributes to the most level of compliance towards speed limit.

While, according to Figure 4.5(b), out of 13.4% of non-compliance drivers for site 1, 12.9% of the light vehicles exceed the posted speed limit and the rest is medium categories of vehicles. This means that no heavy vehicles exceed the posted speed limit at site 1 during observation. For site 2, it was found that 13.9% of light vehicle and 3.1% of medium vehicles exceed the posted speed limit. Thus, only 0.8% of heavy vehicle did not comply the posted speed limit which is very low compared to the others. Site 3 also shows the similar pattern where the highest percentage of vehicles exceeding the posted speed limit is light categories (19.9%). The rest which did not comply posted speed limit represents heavy vehicles which contribute for about 0.4%.



(a) Complying to speed limit

(b) Exceeding speed limit

Figure 4.5 Type of vehicles and compliance towards speed limit

Conclusion

The effect of posted speed limit on speed choice during off peak hours has been investigated in this study. Three objectives which have been explored which includes speed distribution of vehicles at various speed limits, driver's degree of compliance to speed limit based on distribution of speed and driver's degree of compliance based on category of vehicle. Among the factors that affect drivers speed choice and compliance towards posted speed limit is attitude, behaviour, style of driving, type of vehicle driven and the type of traffic flow.

Therefore, the results of this study can be summarized as below:

- The speed distributions of vehicles at various posted speed limit are different for all the sites. However, 15th and 85th percentile speeds increase with the increase of posted speed limit and almost 85% of drivers are travelling at or below the posted speed limit at each selected site.
- As the posted speed limit increases the compliance towards posted speed limit decreases.
- Light vehicles composing of motorcycles, private vehicles and taxis are the main vehicle class that contributes to non-compliance posted speed limit

Therefore, it can be concluded that driver speed choice during off-peak hour is influenced by posted speed limit even though they have their own style and attitude towards speed choice.

Recommendations

Based on the problems and results of this study, the following are several recommendations and improvements that can be made for future studies:

- a) Other than just using the radar gun to observe the spot speed of the vehicles, the automatic traffic counter could also be used as this equipment can take the data of vehicles travelling in groups. The automatic traffic counter can also be left at site for longer period of time especially in the case where there is limited number of manpower to assist in carrying out the study.
- b) For accuracy purposes, a more advanced type of radar gun can be purchased by the transportation laboratory such as the ones being used by the local authorities like the Trucam or the DigiCAM used by Polis Diraja Malaysia (PDRM). These equipment does not only capture the spot speed of travelling vehicles with higher accuracy and speed but also shows the picture of the type of vehicle travelling making the taking down of observed data easier for the observer.
- c) For further studies, the demographic of the drivers and road such as age, sex, type of traffic flow and number of lanes could be taken into account. Since Malaysia has developed its road infrastructure, different types of road is available to conduct a spot speed study such as expressways, primary roads, secondary roads and minor roads.
- d) Since this study is conducted in sub urban road area during off peak hours, traffic volume is still high making vehicles travelling at a lower speed, for further studies, this could be done at rural areas where it is assumed traffic volume is lower.
- e) Weather patterns could also be used as a factor in which how it affects drivers speed choice, for this study, the weather is not rainy as it is easier for the observer to take down the data. For future studies, rainy time could be used as a gauge to see driver's compliance towards posted speed limit.

References

- [1] Attorney General's Chambers of Malaysia (2006). *Road Transport Act 1987*. The Commissioner Of Law Revision, Malaysia.
- [2] Jessica Edquist, Christina M.Rudin-Brown, Michael G.Lenne.2009. *Road Design Factors and Their Interactions with Speed and Speed Limits*. Australia: Monash University Accident Research Centre.
- [3] World Health Organisation (W.H.O) 2004."Road Safety:Speed". Retrieved from http://www.who.int/violence_injury_prevention/en/(accessed on 28th November 2015)
- [4]Eric M. Ossiander & Peter Cummings (2000). *Freeway speed limits and traffic fatalities in Washington State*. Accident Analysis & Prevention.
- [5]Terje Assum (1995). *Attitudes and Road Accident Risk*. Institute of Transport Economics, Oslo, Norway.
- [6]Julie A. Lahaussa, Nicole van Nesb, Brian N. Fildes c and Michael D. Kealld (2010). *Attitudes Towards Current and Lowered Speed Limits in Australia*. Accident Analysis and Prevention. Australia.
- [7]Arash Moradkhani Roshandeh, Mahmood Mahmoodi Nesheli, and Othman Che Puan (2009). *Evaluation of Traffic Characteristics: A case Study*. UTM.
- [8]Syed Khairi Syed Abbasa1, Muhammad Akram Adnana and Intan Rohani Endut (2011). *Exploration of 85th Percentile Operating Speed Model on Horizontal Curve: A Case Study for*

Two-Lane Rural Highways. 6th International Symposium on Highway Capacity and Quality of Service. Stockholm, Sweden.

[9] Manual on Uniform Traffic Control Devices, MUTCD (2009). Department of Transportation.

[10] Veronica Rose (2003). *Speed Limits*, Volume No 2003-R-0673. Old Research Report.

[11] Graham, S. Will Higher Speed Limits Kill? *Traffic Safety*, Vol. 96, No. 3, 1996, pp. 6–10

[12] Gabany S, Plummer P, & Grigg P (1997), Why drivers speed: The Speeding perception inventory, *Journal of Safety Research*, 28 (1), 29-36.

[13] Warner, H. W., & Aberg, L. (2006). Drivers' decision to speed: A study inspired by the theory of planned. *Transportation Research Part F-Traffic Psychology and Behaviour*, 9, 427-433.

[14] Letirand and Dolhomme (2005). Speed Behaviour as A Choice Between Observing and Exceeding the Speed Limit. *Transportation Research Part F*. 8 (2005) 481-492.

[15] Mannering, Washburn & Kilareski (2009). *Principles of Highway Engineering and Traffic Analysis*. 4th Edition.

[16] Cochran, W.G. (1963). *Sampling Techniques*, 2nd Ed., New York: John Wiley and Sons, Inc.

[17] Center for Transportation Research and Education (2002). *Handbook of Simplified Practice for Traffic Studies*.