Time Headway Study on Exclusive Motorcycle Lane

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Abstract: Malaysia is facing high motorcyclist fatalities each year. Motorcycles constitute more than half the total vehicles and contribute more than 47% of casualties (deaths and serious and slight injuries) in traffic crashes. Thus, safety of this form of transportation is an important issue. One of the problems that traffic engineers face all this while is that there is no international standard for motorcycle track design. This preliminary study was conducted on two different traffic geometry designed for the exclusive motorcycle lane. The sites chosen are a straight section of motorcycle lane and a stretch which leads to a tunnel. The time headways were taken for these sites at three different periods of time. ANOVA analyses were applied on the time headway and the factors that affect the variation of time headway at motorcycle lane were studied.

Key Words**:** *time headway, road safety, motorcycle lane.*

1. INTRODUCTION

Malaysia as well as other countries which have high volumes of motorcycles is facing high motorcyclist fatalities. Studies on accident trends in the country have shown that the rapid increase in level of motorization and growth in motorcycle population has also contributed towards the increase in accidents involving motorcyclists (Karim, 1995a; Karim, 1995b). Many efforts have been taken to reduce the number of these fatalities on the road every year. Yet, the number of fatal accidents involving motorcyclist is still high. Motorcycle crashes continue to be a problem in both developing and developed countries. In Malaysia, motorcycles constitute more than half the total vehicle population and contribute more than 47% of the casualties (deaths and serious and slight injuries) in traffic crashes, which recorded 48%, 47.4% and 47.7% for the year 2006, 2007 and 2008 respectively. The accident fatalities involving motorcyclists are even much higher in proportion as compared to other road users, which comes to around 60% of the total road fatalities. According to Radin Umar *et al.* (1995), a preliminary investigation on motorcycle fatalities showed that riding a

motorcycle is 17 times more dangerous than driving a passenger car. It can be inferred that in the event of a traffic accident involving a motorcyclist and other motorized vehicle, the motorcyclist will be facing the higher risk of injury/fatality because of the degree of exposure to injury is higher for the motorcyclist as compared to vehicle occupant in the event of a crash. Thus, safety of this form of transportation is an important issue.

Table 1 Malaysia motorcycle accident casualties

Year	Fatal	Serious	Slight	Total motorcycle casualties	Total number of casualties	Percentage
2006	4320	6629	14826	25775	53736	48.0
2007	3939	6001	11473	21413	45184	47.4
2008	4028	5499	10385	19912	41783	47.7

2. MOTORCYCLE ACCIDENT STUDY

One of the problems that traffic engineers face all this while is that there appears to be no international standard for motorcycle track design. Most of the design parameters and standard for motorcycle track follow the midway between the standard highway design and bicycle track design (Radin Umar *et al.*, 2000). Thus, it is important to understand the parameters involved in capacity analysis, motorcyclist behaviour and the design life of the motorcycle lane facility in order to come up with a new exclusive motorcycle lane design handbook that is suitable for Malaysia. Hussain *et al.* (2001, 2004) had conducted research studies on the design characteristics for a motorcycle lane such as the motorcycle/rider unit, motorcyclist space requirement and riding manner along motorcycle paths of various lane widths. They were trying to get the basic ideas and knowledge on the motorcycle speed-flow-density relationships and to estimate the capacity and level of service (LOS) for an uninterrupted motorcycle path in Malaysia. The outcome would be useful guidelines for designing a motorcycle lane and improving motorcyclist safety.

Road environment is a characteristic that a traffic engineer can intervene to improve and prevent crashes from occurring (Li *et al.*, 2000). A study from Li (2000) showed that urban areas possess a lower fatal risk and high density of enforcement can regulate general driver behavior. Furthermore, the likelihood of the occurrence of death was found higher for motorcycle riders at an intersection than on straight and level roadway sections. A study found that roadside objects are one of the main contributing factors to motorcyclist fatalities (Tung *et al.*, 2008). Guardrail is one of the main factors that contribute to fatal roadside object-related crashes. Therefore, Tung *et al.* (2008) suggested that a different and better design of guardrail system is needed for safer exclusive motorcycle lanes.

Some of the standards and design guidelines used locally are those that come from abroad and may not necessarily be suited to local traffic conditions. There is a necessity to embark upon creating and establishing design guidelines based on local traffic characteristics, especially involving the exclusive motorcycle lanes. This study aims to contribute towards achieving this goal. Through the current study, the vehicle speed and time headway on various external conditions such as obstacle on the road, weather and other auto vehicles could be further analysed. These data are useful to improve and enhance motorcyclist safety and motorcycle traffic system.

3. METHODOLOGY

3.1 Data Collection

A traffic surveillance system was set up on the chosen site for the purpose of capturing motorcycle traffic data. A camera mounted on a portable poll is raised to the height of 10 meters above the road level. The camera was adjusted to shoot perpendicularly above the roadway. The entire recorded traffic video stream is stored in the hard disk of the data logger.

The study was conducted on two different traffic geometry designed for the exclusive motorcycle lane. The sites chosen are a straight section of the motorcycle lane and a section which leads to a tunnel. The data was obtained for 3 different sessions which are morning, afternoon and evening. The morning session is from 8am, afternoon session is from 12pm while the evening session starts from 4.30pm. All the data are recorded for a 50 minutes duration.

3.2 Data Extraction

The recorded traffic video stream was brought to the laboratory for analysis. The video was extracted from the data logger using TRAIS software. Using the same software, all the required traffic parameters such as motorcycle speed and time headway can be extracted out from the recorded video. In this paper, the traffic data that we would like to study is the motorcycle headway under different geometric design condition. For the time headway study, the data that was considered in the analysis are set below four seconds. Any time headway that exceeds four seconds will not be included in the analysis.

3.3 Statistical Analyses

Descriptive statistics were obtained for the entire sample. Univariate analyses were performed. Factors considered having significant influence on the time headway were time of day (morning, afternoon, evening) and the geometric design (straight road, entering tunnel). All statistical analyses were performed using the PASW package version 18.

4. RESULTS AND DISCUSSION

Table 2 Time headway recorded for different geometric design conditions

Road Geometric	Time	Mean	Std. Deviation	N
Straight Road	Morning	1.0816	0.7980	977
	Afternoon	1.8512	1.1196	302
	Evening	1.7085	1.0621	405
	Total	1.3704	0.9907	1684
Entering Tunnel	Morning	1.5480	0.9921	581
	Afternoon	1.7638	1.0604	202
	Evening	1.7670	1.0836	193
	Total	1.6360	1.0295	976

Table 2 showed that the mean time headway for motorcycle recorded on the straight road and entering tunnel road path are 1.37 seconds and 1.63 seconds respectively.

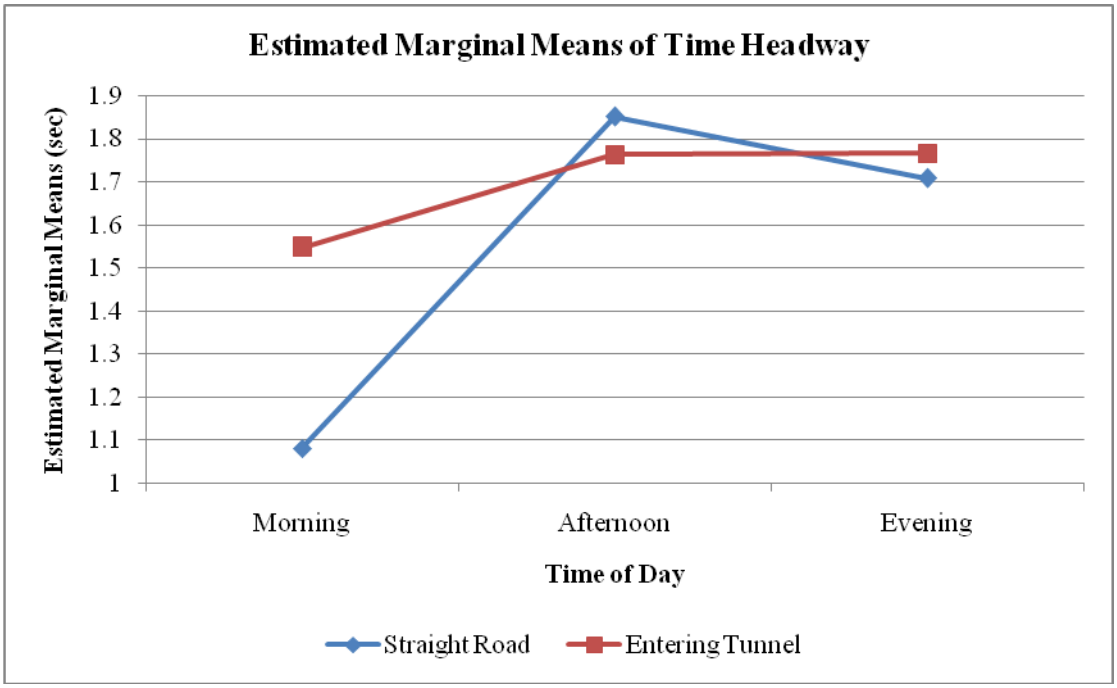

Figure 1 Mean time headway compare on morning, afternoon and evening session

Figure 1 shows the mean time headway for both locations in three different periods of time. We can see that the mean time headway for the morning session is clearly different from the other two sessions. The average time headway for the morning session is lower compared to other period time for both locations. It means that riders at the morning session seem to ride closer to each other compared to other times.

This study attempts to find out the relationship between the motorcyclists time headway on the exclusive motorcycle lane in different geometric design condition. As expected, the riders are found to have smaller time headway in the straight road path then at the road path leading to the tunnel. This is understandable as the riders are taking extra caution as they are approaching and entering the tunnel as they do not exactly know what the road surface condition inside the tunnel is. In the morning period, the time headways recorded on the straight road part is the smallest indicating that the riders ride faster rushing to their office.

4.1 ANOVA Analysis

An ANOVA analysis was done for both data sets of straight road path and entering tunnel road path. The first analysis test is done on comparing the time headway between the two paths at the different periods of day.

Table 3 shows that the both “time” and “location” are significant factors on the time headway since p values for both factors are found to be less than 0.05. Besides, our results also indicate that there is a significant interaction between the two factors, road geometry and time factor, which the $F(2, 2654) = 18.949$, and $p < 0.001$. From the result above, both location and time of day factors show significantly difference in the time headway recorded in the exclusive motorcycle lane.

Table 3 Tests of between-factors effects for both locations

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	252.271(a)	5	50.454	54.066	0.000
Intercept	5064.139	1	5064.139	5426.668	0.000
Location	10.258	1	10.258	10.992	0.001
Time	125.294	2	62.647	67.132	0.000
Location * Time	35.367	2	17.683	18.949	0.000
Error	2476.700	2654	0.933		
Total	8460.169	2660			
Corrected Total	2728.971	2659			

a. R Squared = .092 (Adjusted R Squared = .091)

4.2 Time Headway Analysis on Straight Road Path

The results of time headway analysis for the straight portion of the motorcycle lane are given in Table 4. From the result in Table 4, the time is a significant factor, where it is found that $F(2, 1681) = 114.182$ and $p < 0.001$. Since $p < 0.001$, this indicates that there is a highly significant difference between the three periods of times. However, these results provide no further information on the significance of effects of the various time periods. The above issues can be further investigated and clarified through post hoc test.

Table 4 Tests of between-factors effects for straight road path

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	197.583[a]	2	98.791	114.182	0.000
Intercept	3166.113	1	3166.113	3659.359	0.000
Time	197.583	2	98.791	114.182	0.000
Error	1454.418	1681	0.865		
Total	4814.558	1684			
Corrected Total	1652.001	1683			

a. R Squared = .120 (Adjusted R Squared = 0.119)

Table 5 Post hoc test result for straight road path

Tukey HSD

(I) TimeSR	(J) TimeSR	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Morning	Afternoon	-0.76960*	0.061241	0.000	-0.91326	-0.62594
	Evening	-0.62685*	0.054972	0.000	-0.75580	-0.49790
Afternoon	Morning	0.76960*	0.061241	0.000	0.62594	0.91326
	Evening	0.14275	0.070720	0.108	-0.02315	0.30864
Evening	Morning	0.62685*	0.054972	0.000	0.49790	0.75580
	Afternoon	-0.14275	0.070720	0.108	-0.30864	0.02315

Based on observed means.

The error term is Mean Square (Error) = 0.865.

* The mean difference is significant at the 0.05 level.

From the post hoc test results in Table 5, it clearly shows that there are differences for the results comparing the three sessions. Afternoon period and evening period showed no significant difference on the speed since the p value is bigger than 0.05. For the morning session, since the $p < 0.001$, it indicates that there is significant difference between the morning period to both afternoon and evening period.

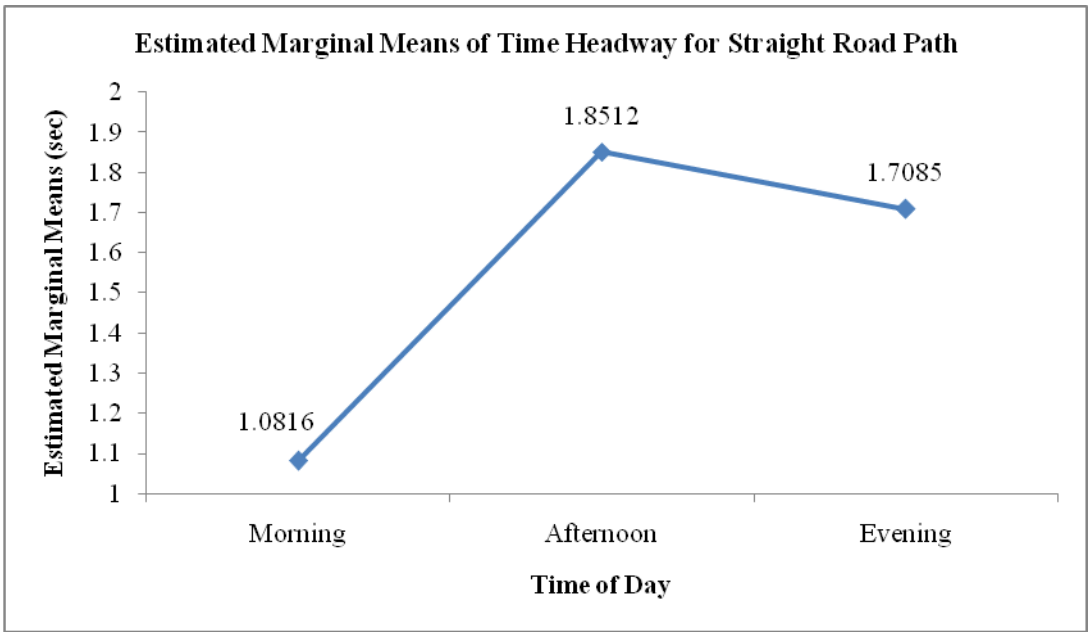

Figure 2 Average time headway in three different periods for straight road path

Figure 2 shows that the mean time headway computed for the three different time period of a day. Both mean time headways for afternoon and evening period are 1.85 seconds and 1.70 seconds respectively. While the mean time headway caught on the evening period is the lowest compared with the other periods, which is found as 1.08 seconds. Riders are found riding slower and keep more time headway with the rider in front can be as rider are taking extra cautious as they may feel tired and may need to more focus in the dangerous road part such as entering tunnel.

5. CONCLUDING REMARKS

The findings indicate that motorcycle rider seems to ride faster and keep smaller time headway at straight road path as compared to the path entering tunnel. From the comparison between location and time of day, ANOVA analysis showed that the location is a significant factor in affecting time headway between motorcyclists travelling on motorcycle lane while there is no significant difference of time of day factor on the recorded time headway.

From the time headway analysis on straight road path, the result showed that there is a significant effect of time of day factor on the motorcycle time headway. This study enables a design engineer to know more on motorcyclist time headway characteristics on different geometric features of the motorcycle lane such as on straight road path and entering tunnel path, and the design of the motorcycle lane geometrics can incorporate the findings from this study.

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