EVALUATION OF THE TRAFFIC PERFORMANCE MEASURE FOR EXCLUSIVE MOTORCYCLE LANE AT MERGING SECTION

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ABSTRACT

Exclusive Motorcycle Lane (EML) is defined as a roadway meant exclusively for motorcycles or can be stated as motorcyclists who are compelled by law to use it and other vehicles are prohibited by law from using it. It is physically separated from the mainstreams carriageway and is grade separated from the main carriageway at intersections, interchanges or points of conflicts. Merging is one of the parts of way that motorcycle deceleration the speed from main stream lane to enter the Exclusive Motorcycle Lane (EML) with safe. The urban expressways in Malaysia have serious problems regarding the safety, efficiency and comfort ability at merging sections of an EML because of the insufficient geometric due to limited land and the right of way design configuration condition. The increase of traffic volume and demand lead towards the degradation of motorcyclist performance while on their wheels. This research is performed in order to achieve the objectives, i.e. to obtain and analyze local empirical data, such as flow rate, headway and speed on exclusive motorcycle lane at merging section that reflects on the local traffic condition on Federal Highway Route 2, and to obtain regression modeling that relates to Flow Rate with regards to the Headway 1-3, Time Mean Speed and Length of Merging Ramp section, Lm on the merging section of EML and merging ramp section. Two regression models have successfully been performed with R-Sq 94.8 % for EML section and 31.1 % for merging ramp section. Its also highlighted the attributes of EML.

Key Words: *Exclusive Motorcycle Lane, Prediction Model, Ramp Merging,Malaysia*

INTRODUCTION

Operating speed model can be define as The highest overall speed at which a driver can travel on a given road under favorable weather conditions and prevailing traffic conditions without, at any time, exceeding the design speed on a section by section basis.(Public Works Department, 2015). AASHTO (2011) Define operating speed is the speed at which drivers are observed operating their vehicles during free-flow conditions.

Generally, Malaysia is the first country to provide the exclusive motorcycle lane. This is one of the programs to reduce the numbers of fatality on the road. More than half of the motor vehicles registered in Malaysia are the motorcycles. In Malaysia, the registered motorcycle increases every year. Reported from Jabatan Pengakutan Jalan (JPJ), the registered motorcycle in Malaysia in 2002 is 5,842,617 which represented 48.6% of all registered vehicles. (JPJ, 2003). Furthermore, certain cities in our country have a critical degree level of the traffic congestion problem that causes trouble to the motorcycle. The merging section of

exclusive lanes at expressway in Malaysia is having a serious problem in term of the safety of rider, efficiency of traffics and comfort ability of the road because of the geometric design condition being not sufficient, the increasing of the traffic flow and the ability of the vehicle performance.

Therefore, it is very necessary to the development of driving assistance functions at merging section as the alternative way to achieve safer, more efficient and more comfortable of the exclusive motorcycle lanes. • To obtain and analyse local empirical data, such as flow rate, headway and speed on exclusive motorcycle lane at merging section.

• To evaluate the performance of merging section and propose to the improvement of Exclusive Motorcycle Lane (EML).

• To ascertain the attribution of motorcycle on the design of Exclusive Motorcycle Lane (EML).

Problem Statement

Merging is physically part of the way that motorcycle decelerates the speed from main stream lane to enter the Exclusive Motorcycle Lane (EML) with safe. Basically, the service volume is the maximum volume of traffic which acquire the need to design roads without any degree of congestion might falling. The degree of congestion depends on the different of traffic performance. The higher the traffic performance, probability degree of congestion is lower. We can find the parameter of flow rate, time mean speed, headway on the exclusive motorcycle lane at the merging section. The flow rate, speed and headway of motorcycle can affect safety and traffic operational performance.

LITERATURE

The Operating speed is the 85th percentile of the distribution of observed speeds is the most frequently used measure of the operating speed associated with a particular location or geometric feature. Although there are numerous model for operating speed developed world wide (Misaghi & Hassan, 2005) but localize model for operating speed is very limited. Some of previous research on Operating Speed for Malaysia focused on Motorcyclene (Syed Abbas, Adnan, & Endut, 2010; AB Rahim, Adnan, Sulaiman, & Tuan Besar, 2016a; Tuan Besar et al., 2016; Tuan Besar, Muhammad Akram, Sulaiman, & Syafiq, 2013; AB Rahim, Adnan, Sulaiman, & Tuan Besar, 2016b; Faezi, Hamid & Davoodi, 2011). This study only focus on the operating speed reflects on motorcyclist as represent driver in handling the motorcycle speed.

Exclusive Motorcyclelane

The exclusive motorcycle lane is the separating right of way from the main roads that is established to be solely used by motorcyclist. The motorcycle lanes are designed to separate motorcyclist from another motorist and avoid unintended occurring. The motorcycle lanes are not developed from the existing carriageway in the original width of main roads. The motorcycle lane helps by reducing the conflicts from the main road. Basically, the reducing of the conflicts happens at the cross intersection such as at the merging section. Figure 2.1 shows the Exclusive Motorcycle Lane (EML)

Figure 2.1 : The Exclusive Motorcycle Lane (EML)

Merging.

The merging process is the process to slow down or the deceleration of the motorcycle from main stream to enter the

exclusive motorcycle lane safely. Figure 2.2 and Figure 2.3show the merging section at the exclusive motorcycle lane.

Figure 2.2 : Merging section on Exclusive Motorcycle Lane

Design of Motorcycle.

The low-to-medium sized motorcycle is the specific design of the motorcycle-vehicles. Basically, in Malaysia, most common types of motorcycles used is less than 250 c.c. The view of the side and front are shown in Figure 2.4 and Figure 2.5 respectively. (Hussein .H et al, 2007)

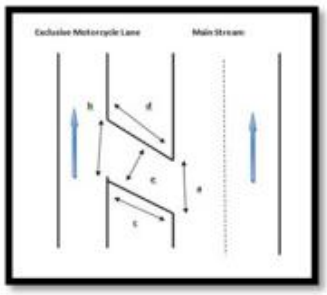

Figure 2.3 : Merging section between EML and Stream

Figure 2.4 : Design of Motorcycle (less than 150 c.c.) –Side view. (Hussein .H et al, 2007)

Figure 2.5 : Design of Motorcycle (less than 150 c.c.) – Front view.(Hussein .H et al, 2007)

Static Space of Motorcycle-Rider Unit Basically, the physical length is 2.0 m while the breadth is 0.8 m and the total area of 1.60m2 (0.8 m x 2.0 m) is the occupied physical space for a one person of static motorcyclist. Figure 2.6 and Figure 2.7show the dimensions and the simplified outline for the single motorcyclist. The note of the figures shows that a typical motorcycle with side-mirrors on both sides, and presenting a maximum width. (Hussein .H et al, 2007)

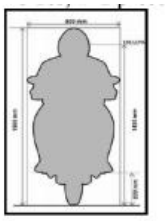

Figure 2.6 : Front Outline of a Static Motorcyclist – Breadth of 0.8 m. (Hussein .H et al, 2007)

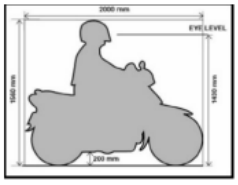

Figure 2.7 : Side Outline of a Static Motorcyclist – Length of 2.0 m. (Hussein .H et al,2007)

Motorcyclist Side by Side Operating Space.

The distance of separation value of the position of side-by-side motorcyclist, flow rate and speed along the motorcycle lane are 0.50 m, 60 km/hr, and 1200

motorcycles/hr/lane is respectively, and is described in Figure 2.8. (Hussein .H et al, 2007)

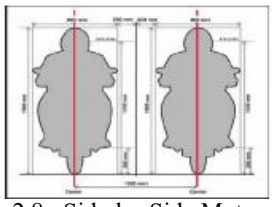

Figure 2.8 : Side-by-Side Motorcyclist Separation Distance of 0.50 m. (Hussein .H et al, 2007)

METHODOLOGY

The TraxApollyon is the instrument to measure the traffic performance parameter. The data will be collected by the movement of the motorcycle passing through on the pneumatic road tube. The same tools were applied by previous studies to perform data collection for the road traffic.(Tuan Besar & Adnan, 2016)(Tuan Besar et al., 2016) The data are collected from TraxApollyon continuously without considering the weather condition, whether dry day or raining day. This is another advantage compare to laser gun tool(Syed Abbas et al., 2010). The installation of the TraxApollyon on the exclusive motorcycle lane at the merging section is to count the speed and the number of motorcycle that passes through the pneumatic road tube. The geometric of the merging area and the exclusive motorcycle lane need to be measured by the length of the merging section, the width of the merging section and the width of the exclusive motorcycle lane. The data are recorded within three days whether on the peak hour or non-peak hour. The data collected can be analysed by using the MINITAB Software to develop the traffic model equation.

RESULTS

Table 1 shows the flow rate of the motorcycle at the merging section

Date	Direction 1	Direction 2
23/4/21013	15,052	21,293
4/4/2013	6,082	6,501
5/10/2013	2,853	5,935
6/10/2013	1,504	4,828
7/10/2013	5,553	7,868
Grand Total	31,044	46,425
ADT	6,209	9,285

Table 1 shows the flow rate of the motorcycle at the merging section. This table shows the data from two different sites on the Federal Highway Route 2. Both the direction is used by the motorcyclist. On 3/4/2013 and 4/4/2013which are during weekdays, the data showed a high number of flow rate and on 5/10/2013 and 6/10/2013 which are the weekends, the number of flow rate is lower. This show that the people rarely use the Exclusive Motorcycle Lane (EML). On 7/10/2013 of a week day,the number of motorcycle increases. The Grand Total of Direction 2 is greater than Direction 1. The Average Daily Traffic (ADT) of Direction1 is 6,209 and Direction 2is 9,285. For the conclusion, the number of flow rate on Direction 1 is less than Direction 2.

Table 2: Headway 1 To 3 Second At Merging Section

Date	Direction 1	Direction 2
3/4/21013	7,795	12,892
4/4/2013	3,805	4,750
5/10/2013	623	1,733
6/10/2013	186	1,219
7/10/2013	2,070	4,179
Grand Total	14,479	24,773
ADT	2,896	4,955

Table 3: Headway 4 And 5 Second At Merging Section

Date	Direction	1 Direction 2
3/4/21013	2,259	3,730
4/4/2013	820	868
5/10/2013	238	743
6/10/2013	82	530
7/10/2013	590	1,263
Grand Total	3,989	7,134
ADT	798	1,427

Table 2 shows the headway 1 to 3 second of the motorcycle and Table 3 shows the headway 4 to 5 seconds of the motorcycle at the merging section. This table shows the data from two different sites on the Federal Highway Route 2. The number of headway 1 to 3 seconds and 4 to 5 seconds on Direction 2 is greater than Direction 1. The high number of motorcycle from main stream entering the exclusive motorcycle lane (EML). On 3/4/2013, 4/4/2013 and 7/10/2013 which is weekdays, the number of headway is higher than the headway on the 5/10/2013 and 6/10/2013 which are weekends. For the conclusion, the number of headway 1 to 3 seconds is greater than headway 4 to 5 seconds because the people are in the speeding movement of the motorcycle during week days, faster than weekends.

Table 4: Average of 85th Percentile of Speed

	85th Percentile of Speed
Direction 1	58.14 km/h
Direction 2	55.47 km/h

Table 4 shows the average of 85th percentile of speed. 85th percentile speed are shown of its optimal speed. For Direction 1, the 85th percentile speed is 58.14 km/h and the Direction 2 is 55.47 km/h.

Table 5: Average of Time Mean Speed

Time	Mean Speed
Direction 1	50.09 km/h
Direction 2	46.93 km/h

Table 5 shows the average time mean speed (TMS). It shows the average of speed of vehicles that passes through the exclusive motorcycle lane for the some specified time period. The time mean speed for Direction 1, 50.09 km/h is greater than Direction 2, 46.93 km/h.

Table 6: Regression Analysis For Flow Rate, QEML Versus Headway 1-3 And Length, LM

Predictor	Coefficient	Standard Error	T-Value	P-Value
Constant	-458.0	208.7	-2.19	0.030
H (1to 3)	1.39166	0.03777	36.85	0.000
LM	21.598	8.119	2.66	0.009

Flow Rate, QEML = - 458 + 1.39 H 1-3 + 21.6LM……...(1)
S = 103.497 R-Sq = 94.8% R-Sq(adj) = 94.7%

Table 7: Regression Analysis For Flow Rate, QM Versus Time Mean Speed, TMS and Length,LM

Predictor	Coefficient	Standard Error	T-Value	P-Value
Constant	-4680.7	809.4	-5.78	0.000
TMS (km/hr)	12.050	3.753	3.21	0.002
LM	175.93	31.11	5.65	0.000

Flow Rate, QM =-4681 + 12 TMS+ 176LM……....….(2)
S = 446.154 R-Sq = 31.1% R-Sq(adj) = 29.8%

Table 6 and Table 7 show the regression analysis of the flow rate. Eq. 1 and Eq. 2 show the similarity between Flow Rate. In the Eq. 1, Flow Rate, Qemlis related with Headway 1-3 (H1-3) and Length of Merging Section, (Lm). While in the Eq. 2, Flow Rate, QM is related with Time Mean Speed (TMS) and Length of Merging Ramp Section, (Lm). The same correlation on Eq. 1 and Eq. 2 is Flow Rate and Length of Merging Ramp Section (Lm).

For the Eq. 1, the Headway 1-3, (H1-3) and Length of Merging Ramp, (Lm) is independent variable to predict Flow Rate whereby the P-value was less than 0.05, meaning that the null hypothesis was rejected and the alternative hypothesis was accepted. The P-value for constants is 0.030, H 1-3 is0.000 and Lm is 0.000. The T-value for the constants is -2.19, H 1-3 is 36.85 and Lm is 2.66 whereby the T-value must be greater than 0.05.

For both H-3 and Lm having positive relationship with Qml with the Eq.1 shows the negetive constant of 458. The model fit for the Eq 1 S values which represent the

residual for the equation with the value of 103.497

For Eq. 2, the Time Mean Speed, (TMS) and Length of Merging Ramp Section(Lm) is independent variable to predict Flow Rate whereby the P-value was less than 0.05, meaning that the null hypothesis was rejected and the alternative hypothesis was accepted. The P-value for constants is 0.000, TMS is 0.002 and Lm is 0.000. The T-value for the constants is -5.78, TMS is 3.21 and Lm is 5.65whereby the T-value must be greater than 0.05. The R-Sq both equations are more than 30% whereby Eq. 1 is 94.8% and Eq. 2 is 31.1%. The RSq(adj) for Eq. 1 is 94.7% and Eq. 2 is 29.8%

For both TMS and Lm having positive relationship with Qm with the Eq.2 show the negative constant of 4681. The model fit for the Eq 2 S values which represent the residual for the equation with the value of 446.154

PRACTICAL IMPLICATION

The developed models are significant with speed prediction model, this model focus on Exclusive Motorcycle Lane (EML). In directly the establishment of the model will contribute to may bodies, mainly it involves with Authority such Public Road Department. This can be an adding section mainly on EML with currently not available on the guide. (REAM, 2002)(Public Works Department, 2015) the construing of this model also consider as complement for prediction sped mainly for Malaysia model as developed by previous research. (Rahim, Nurul Iman, Tuan Besar, Tuan Badrol Hisham, Adnan, Muhammad Akram, Sulaiman, Norliana, & Zakaria, 2016), (Tuan Besar et al., 2013), (AB Rahim et al., 2016a), (Tuan Besar & Adnan, 2016) , (Tuan Besar et al., 2016)

As not many study on speed prediction model especially on EML, this model would add on color to the number of model the made available especial on EML in reflect to Malaysia road condition. This can be as part of benchmarking for EML speed prediction study for Malaysian.

A correct design of EML will reduce the load thinking and miss behave of vehicle handling, indirectly this will reduce in number of case that involve in the road accident.

CONCLUSION

The aim of this study is to determine the traffic performance measure for exclusive motorcycle lane (EML) on merging sections of the Federal Highway Route 2.The analysis has been done and the outcomes from analysis are as follows:

i. From our finding, the flow rate of motorcycle either on exclusive motorcycle lane or on merging ramp section is increasing on peak hours because the people are going to work and back from work. ii. The headway and time mean speed are influenced by the flow rate. This is because, when the flow rate increases, the headway between the motorcycles also increases on exclusive motorcycle lane and when the flow rate increases, the time mean speed of motorcycle also increase on merging ramp section. iii. The analysis and findings included in this study is to provide the proof and valuable information to be used in the future to develop the sustainable and comfortable lane for a user upon using the exclusive motorcycle lane on the merging section

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REFERENCES

AASHTO. (2011). A Policy on Geometric Design of Highway and Streets. AASHTO (6th ed.).

AB Rahim, A. M., Adnan, M. A., Sulaiman, N., & Tuan Besar, T. B. H. (2016a). Modeling Operating Speed with Regard to Pavement Roughness Index (IRI) at Two-Lane Highway. In InCIEC 2015 (pp. 971–982). Singapore: Springer Singapore. http://doi.org/10.1007/978-981-10-0155-0_81

Faezi, S. F., Hamid, H., & Davoodi, S. R. (2011). Predicting Speed Model of Horizontal Curves on Exclusive Motorcycle Lane in malaysia. Australian Journal of Basic and Applied Sciences, 5(5), 590–598.

Hussain et al, (2007), "Exclusive Motorcycle Lane"MRC Draft, 1-8.

Misaghi, P., & Hassan, Y. (2005). Modeling Operating Speed and Speed Differential on Two-Lane Rural Roads. Journal of Transportation Engineering, 131(6), 408–418. http://doi.org/10.1061/(ASCE)0733-947X(2005)131:6(408)

Public Works Department. (2015). A Guide on Geometric Design of Roads, (Arahan Teknik (Jalan) 8/86), 2000.

Rahim, Nurul Iman, Tuan Besar, Tuan Badrol Hisham, Adnan, Muhammad Akram, Sulaiman, Norliana, & Zakaria, A. (2016). Relevancy of the Installed Posted Speed Limit Based on the Operating Speed Study on Multilane Highway, 2016.

REAM. (2002). A Guide on Geometric Design of Roads, 2000.

Syed Abbas, S. K., Adnan, M. A., & Endut, I. R. (2010). Exploration Of 85th Percentile Operating Speed Model On Horizontal And Vertical Alignments: A Case Study For Two Lane Rural Highways Syed. In IET Road Transport Information And Control Conference And The ITS United Kingdom Members' Conference (RTIC 2010). Better Transport Through Technology (Pp. P01–P01). IET. Http://Doi.Org/10.1049/Cp.2010.0396

Tuan Besar, T. B. H., & Adnan, M. A. (2016). Modelling Malaysian operating speed prediction model at two - lanes rural highway while exiting curve. International Journal of Advanced and Applied Sciences, 2(12). Retrieved from http://www.science-gate.com/IJAAS/Articles/2015-2-12-2/13 2015-2-12-pp.67-72.pdf

Tuan Besar, T. B. H., Adnan, M. A., Abu Bakar, A. ., Abdul Rani, M. S. N., Mohamed, R., Sani, N. ., & Jalal, N. (2016). Evaluation of 85 th Operating Speed and Posted Speed Limit Based on Horizontal , Vertical Alignments and Traffic Conditions : A Case Study of Two Lane Sub- Standard Urban Roadway Curve. Engineering Challenges for Sustainable Future - Proceedings of the 3rd International Conference on Civil, Offshore and Environmental Engineering, ICCOEE 2016, (3), 5–10.

Tuan Besar, T. B. H., Muhammad Akram, A., Sulaiman, N., & Syafiq, I. (2013). A Case Study of 85 th Percentile Operating Speed at Horizontal Curve on Two-Lane Rural Highway. In 2013 IEEE Symposium on Business, Engineering and Industrial Applications (ISBEIA).