Human Factors and Ergonomics Journal 2017, Vol. 2 (3): 39 - 45

ORIGINAL ARTICLE

MOTORCYCLISTS' HEAD CHECK BEHAVIOR DURING MERGING IN TRAFFIC: EFFECT OF DIFFERENT RANGES OF MERGING LANE LENGTH

Ahmad Taqiyuddin ABU HASSAN[1], Ammar ADNAN[1], Radin Zaid RADIN UMAR[2], Siby SAMUEL[3], Mohd Hanafi ANI[1], Malek HAMID[1]*

[1]Department of Manufacturing and Materials Engineering, Faculty of Engineering, International Islamic University Malaysia, Kuala Lumpur, Malaysia
[2]Faculty of Manufacturing Engineering, Universiti Teknikal Malaysia Melaka, Malaysia
[3]Department of Mechanical and Industrial Engineering, School of Engineering, University of Massachusetts Amherst, Massachusetts, USA
[*] Corresponding Author: abdmalek@iium.edu.my

ABSTRACT

Head check is a crucial action to anticipate potential hazards whenever a road user is about to merge onto traffic. Failing to anticipate the hazards may result a road crash. Besides road users' riding individual behavior, there are several external contributing factors that may influence the head check performances. In this study, the length of the merging lanes of urban expressway was the focus. The objective of the study is to investigate the effect of several ranges of merging lane length on motorcyclists' head check performance during merging in urban expressways. 1200 motorcyclists were observed at twelve selected scenarios around Klang Valley Metropolitan area (n=100 for each scenario). The twelve scenarios were divided into four categories based on its length – (i) 0-100 feet; (ii) 101-200 feet; (iii) 201-300 feet; and (iv) above 300 feet. Dependent variable for this study was the percentage of head checks. If a motorcyclist turns his or her head over the shoulder towards the target zones (the area in which the potential hazard may emerge – the lanes on the expressway) while in the launch zone (the area that is two seconds before the merging nose), he or she was scored 1, else 0 (i.e. binary scoring). In general, the results show that the percentage of motorcyclists who did not performed head checks (88.17%) is higher compared to motorcyclists who did performed head check (11.83%). Specifically, it was observed that the percentage of head checks among the motorcyclists was higher at the shorter merging lanes rather than the longer merging lanes (i.e. gradually decreases from range (i) to range (iv)). This indicate that the length of merging lanes does affect the head check performance among motorcyclists during merging in urban expressway. The finding may recommend for an improvement to the current riding education curricular. In addition, it also would suggest the optimal range of merging lane length for future merging lane design, in which, may influent head check performance among motorcyclists and reduce the road crashes in the merging areas.

Keywords: *Motorcyclists Behavior, Head Check, Merging Lane, Urban Expressway, Observational Study*

INTRODUCTION

Road traffic crashes is one of the major causes of death around the world. Research done by World Health Organization (WHO) shows that, in 2009, road traffic injury is the top three cause of death which affected people in the age range of 5 – 44 years old (World Health Organization, 2009). Half of the death toll in road crashes belong to the vulnerable road users (World Health Organization, 2009). Vulnerable road user is defined as the user of the road with the lack of external protection – such as pedestrian, cyclist, and motorcyclist (Institute for Road Safety Search, 2012). Due to the large extent of unprotected body parts, motorcyclist is fifty times more likely to be severely injured in a collision (Lloyd, Wilson, Tuddenham, Goodman, & Bhagat, 2013). This situation is different from one region to another. In the high-income of Americas region, 65% of casualties were involved vehicle occupant. On the other hand, in the middle and low-income countries in Western Pacific region, 70% casualties were involved vulnerable road users (World Health Organization, 2009).

In Malaysia, motorcycle is the preferred vehicle due to: (i) its high mobility cutting through traffics in the urban area; and (ii) affordable type of vehicles for the low-income individual. In 2010, majority of new registered vehicles were motorcycles with total amount of 585,304 out of 1,158,072 (Ministry of Transport Malaysia, 2010). However, this factor should not be the reason for the fact that the number of motorcyclists involved in road crashes is higher compare to other mode of transportations (Ministry of Transport Malaysia, 2010). In addition, the increasing pattern of the motorcycles crashes from the year 2000 to 2010 is also alarming with 120,156 road crashes involved motorcycles were reported in 2010 alone (Ministry of Transport Malaysia, 2010).

In Malaysia, poor riding behavior is one of the contributing factors for motorcycle road crashes. Speeding, riding during fatigued and sleepy, and improper overtaking and merging are among the poor behaviors of the motorcyclists. In this study, improper merging behavior will be the focus. Merging can be defined as the situation where two or more sources of traffic are streaming into a single source (Riener, Zia, Ferscha, Beltran, & Rubio, 2011). Merging lane can be categorized into two – on roads where there are visible lines marked on it, and off roads where there are no visible lines marked on it.

A standard term for turning head before merging in traffic is known as head check (Department of Transport and Main Roads Queensland, 2012). A motorcyclist should turn his or her head quickly over a shoulder before merging in traffic. This particular procedure is important to check the blind spot – the area next to the rider which is not visible in the mirrors (Insurance Corporation of British Columbia, 2014). There are two terms involve in performing the proper head check during merging in traffic – target and launch zones. The first is the area in which the potential hazard may emerge (e.g. the lanes on the expressway) while the latter is the area where it is crucial for a road user to anticipate the hazard – that is approximately two seconds before the merging nose (Hamid, Divekar, Borowsky, & Fisher, 2013).

In Malaysia, a proper and safe procedure to merge in traffic is not being specifically exposed to the rider in the riding education program. Besides, head check measures are not included in the requirement for riding test before obtaining the rider's license. The measures tested in the riding road-test are the 8-turn, bridge crossing, serpentine ride, emergency brake, handling a dangerous corner, and riding on the highway zone. Furthermore, riding education in Malaysia is also does not have a prevalence study (i.e. statistic) on the head check behavior during merging in traffic (Jabatan Pengankutan Jalan Malaysia, 2017).

As mentioned above, Malaysia does not have a prevalence study and statistic on head check behavior among motorcyclists during merging in traffic. Because this procedure is crucial for a safe riding, a prevalence of head check behavior among motorcyclists during merging in traffic is needed as a guideline for initial improvement in Malaysian riding education program. Refining riding education will help to improve road safety which is likely going to decrease the percentage of road crashes. Basic method to obtain this information is by doing an observational study at several merging areas known as scenarios.

The aim of this study was to obtain the prevalence of motorcyclists' head check behavior during merging in urban expressway. In order to achieve the aim, the following objectives were set to be done and obtained; (i) To select locations that satisfy the merging criteria to become the scenarios for the study, (ii) To do an observational study (via video recording) at the chosen scenarios, (iii) To analyze data and produce a statistic of motorcyclists' behavior on head check during merging in the urban expressway, (iv) To compare the difference of motorcyclists' behavior on head check during merging in urban expressway by several ranges of the merging lane length.

METHODS

Naturalistic observation can be defined as the observation done by researcher to study on the behavior or phenomenon or even for a long period in its natural setting while maintaining least interference towards the subject or phenomena (Medicine Net Inc., 2012). From another definition, naturalistic observation is a method that involves observing test subjects in their own natural environment with no intervention of the researcher himself (Cherry, 2014). Therefore, in this study, naturalistic observation method was chosen in order to obtain a prevalence of the motorcyclists' behavior on head check during merging in urban expressway.

Motorcyclists' behavior on head check during merging in urban expressway – in summary: At each scenario location, video recordings of the traffic were recorded. The recordings were administrated between 9:00 a.m. to 12:00 p.m., and 2:00 p.m. to 5:00 p.m. – in order to exclude the rush hours. Observational days were focused on weekdays from Monday to Thursday excluding Friday (longer lunch hour in Malaysia – due to Friday prayer). Weekends were deliberately excluded because of difference traffic condition may affect motorcyclist behavior in significantly different ways. The area of study was inside the Gombak district – from *Jalan Ipoh* to *Wangsa Melawati*. Like any other research on riding or driving, the area covered was sufficient enough to generalize motorcyclists' behavior rather than simplify on a particular population.

Scenarios

For this study, there were twelve scenarios in total. In each scenario, there were generally two types of road: (i) Leaving road – the road that the motorcyclists are coming from; and (ii) Entering road – the road that the motorcyclists will be merged into. There were two zones namely target zone (labeled as A), and launch zone (labeled as B) in Figure 1-4 and 6-9. Target zone can be defined as the area from which the potential hazard could emerge, and launch zone is the area where it is crucial for a road user to anticipate the hazard - that is approximately two seconds before the merging nose (Hamid, Divekar, Borowsky, & Fisher, 2013). Therefore, in a merging situation, a safe motorcyclist should do the head check (to the target zone) while he or she is in the launch zone.

In general, all selected scenarios were located at the urban expressway area – dependent variable in this study. The speed limit of urban roads in Malaysia is 90 km/h (Department of Road Transport Malaysia, 1989). The scenarios were classified into 4 ranges according to their entering road length. The ranges were: (i) 0 – 99 feet; (ii) 100 – 199 feet; (iii) 200 – 299 feet; and (iv) 300 feet and above. Below, an example of each range will be described in details.

Scenarios of Range 1 (0 – 99 feet)

In the first range – shortest range, there were three scenarios observed. They were named as: (i) Saville; (ii) Wangsa Melawati; and (iii) KL-Selangor Boundary. Wangsa Melawati scenario (93.05 feet of merging lane length) will be used to describe the scenarios in this range. This scenario is situated in town called Wangsa Melawati. Figure 1 illustrates the motorcyclists' view and Figure 2 shows the plan view of the scenario. The leaving road consists of one lane and the speed limit is 60 km/h. On the other hand, the entering road consists of three lanes and the speed limit is 90 km/h.

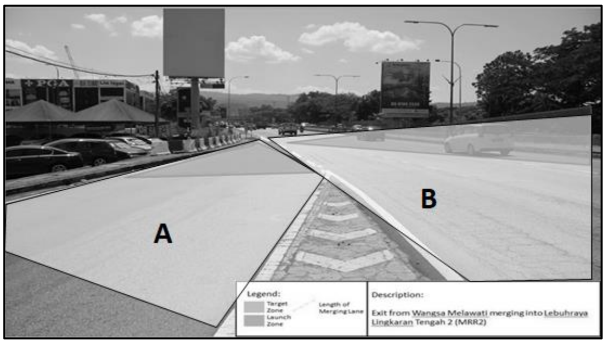

Figure 1: Wangsa Melawati scenario – motorcyclist's view

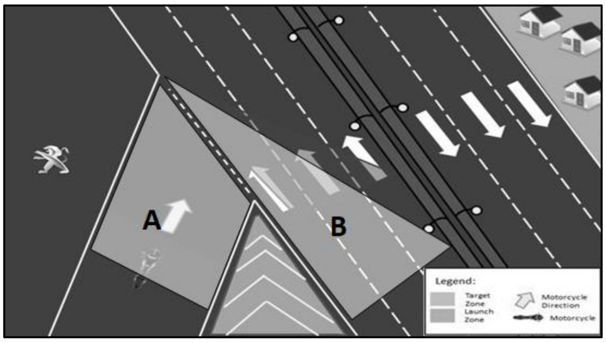

Figure 2: Wangsa Melawati scenario – plan view

Scenarios of Range 2 (100 – 199 feet)

There were three scenarios included in Range 2. They were named as: (i) Taman Melati; (ii) Lorong Sekolah; and (iii) Gombak Toll. Taman Melati scenario (135.17 feet of merging lane length) will be used to describe the scenarios in this range. The scenario was named as Taman Melati after the nearby Taman Melati residential area. Figure 3 illustrates the motorcyclists' view and Figure 4 illustrates the plan view of the scenario. The leaving road consists of one lane and the speed limit is 60 km/h. The cue available to the road user was the 'give way' signage as shown in Figure 5. The speed limit of entering road is 90 km/h. Surrounding environment includes trees on left side of the leaving road and divider between the leaving and entering road.

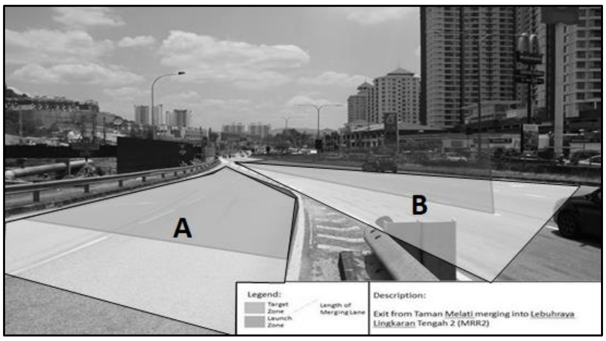

Figure 3: Taman Melati Scenario – Motorcyclist's View

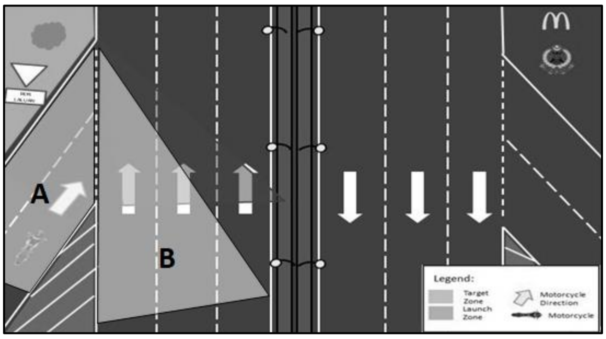

Figure 4: Taman Melati scenario – plan view

Figure 5: Keep way signage

Scenarios of Range 3 (200 – 299 feet)

In Range 3, there were also three scenarios included and named as: (i) Ayer Panas Toll; (ii) Autocity; and (iii) Batu Caves. Ayer Panas Toll scenario (297.70 feet of merging lane length) will be used to describe the scenarios in this range. The scenario was named as Ayer Panas Toll after the location of the Ayer Panas toll gate. Figure 6 illustrates the motorcyclists' view and Figure 7 illustrates the plan view of the scenario.

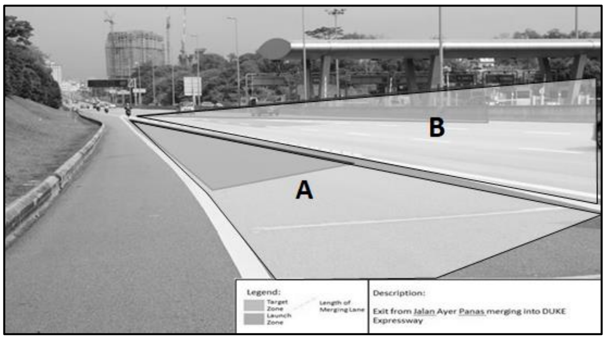

Figure 6: Ayer Panas Toll scenario – motorcyclist's view

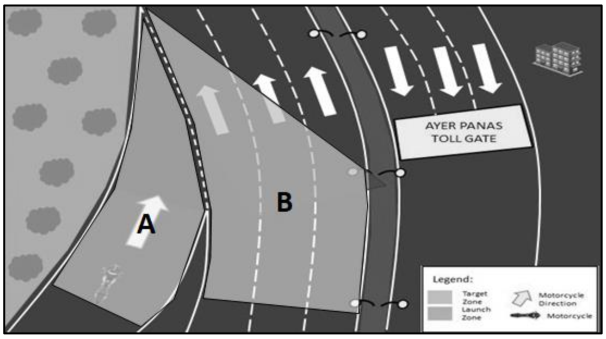

Figure 7: Ayer Panas Toll scenario – plan view

The leaving road consists of one lane and the speed limit is 60 km/h. The speed limit of entering road is 90 km/h with three lanes. Surrounding environment includes trees, toll gate, toll office, and divider between entering and leaving road.

Scenarios of Range 4 (≥300 feet)
In the last range – the longest range, there were three scenarios included and named as: (i) Selaseh Commercial; (ii) Taman Pelangi; and (iv) Depot 91. Selaseh Commercial scenario (645.01 feet of merging lane length) will be used to describe the scenarios in this range. The scenario was named as Selaseh Commercial after the nearby Selaseh Business Center. Figure 8 and Figure 9 illustrates the motorcyclists' view and the plan view of the scenario respectively. The leaving road consists of one lane and the speed limit is 60 km/h. The speed limit of entering road is 90 km/h with three lanes. The cue available to the road user is the 'give way' signage. Surrounding environment includes trees, a business area, and residential area.

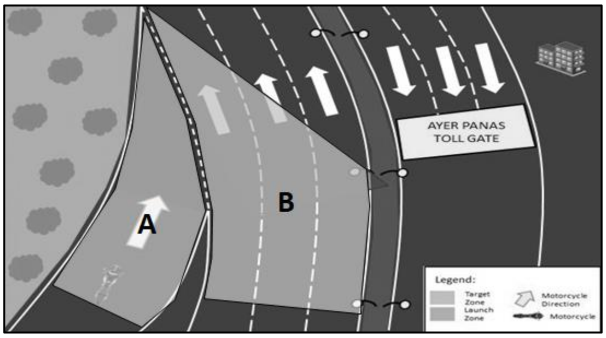

Figure 8: Selaseh Commercial Scenario – Motorcyclist's View

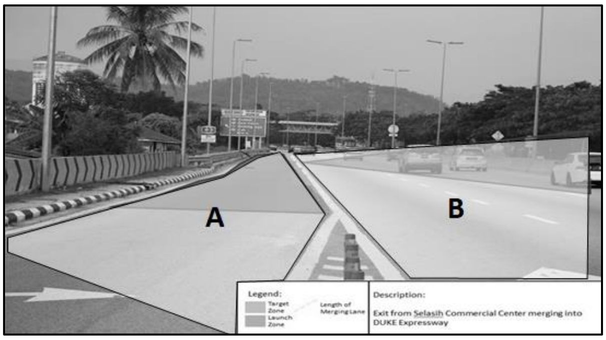

Figure 9: Selaseh Commercial Scenario – Plan View

Apparatus
Apparatus used in this study include the measuring wheel, safety cone, safety jacket, video recording system, duct tape, and video storage system.

Measuring Wheel: In this study, the length of merging lane was measured by the telescopic handle measuring wheel.

Safety Cone and Safety Jacket: A safety cone was placed during the measuring period and a safety jacket was used by the observer during the observation.

Video Recording System: In this study, Panasonic HC – V210 was used to record the video. During the playback, data analysts were being able to see all the video output (just like any other regular video recording system) of a certain location or time during the observation period. A tripod – DiGiEye TR-37 – was used to acquire better quality video. The battery lifetime of the system was 2 hours. Therefore, a spare battery – of the same model was prepared as a backup. The system also includes a memory card – Sandisk for video recording. The size of the memory card was 32 gigabytes, and a spare memory card of the same model and size for the system was prepared as a backup.

Duct Tape: A duct tape was used to mark the launch zone of each scenario. This is to ensure that the scoring phase become easier and standardized. Duct tape used was red in color to make sure it contrasts with the surrounding environment – e.g. green for grass, or white for road's lines. A scoring sheet was designed to administrate the scenario during the observation. On the particular scoring sheet there were columns for scenario name, date, time taken, and column to score the observation.

Video Data Storage: Seagate external drive was used to store the recorded video data. The capacity of the storage was 1 terabyte and estimated to be able to store about 63 hours of videos.

Design of the Study
The study was conducted on Monday, Tuesday, Wednesday and Thursday. Friday and weekends were excluded to avoid any factoring effects on the motorcyclist behavior (i.e. mood and alertness level among motorcyclists). The recordings were administrated between 9:00 a.m. to 12:00 p.m., and 2:00 p.m. to 5:00 p.m. (i.e. in order to exclude the rush hours).

Scenario counterbalancing: The scenarios were arranged such that the sequencing of the scenarios to be observed is counterbalanced. In this study, the scenarios were classified into 4 ranges – Range 1, Range 2, Range 3, and Range 4. Therefore, in order to minimize the effect that the ordering of scenarios might have on observation, a Latin Square was used to counterbalance all the scenarios. The scenarios were labeled as 1A, 1B, 1C, 2A, 2B, 2C, 3A, 3B, 3C, 4A, 4B, and 4C for easy development of the Latin Square. The numbers 1, 2, 3, and 4 represents the merging lane length ranges – 1 for Range 1, 2 for Range 2, 3 for Range 3, and 4 for Range 4. The letters – A, B, and C – are simply assigned to distinguish the three scenarios in each range. For each scenario, four cycles of observation were done. The complete arrangement of the scenarios observed is shown in Table 1 below. For example, for scenario 1A, there were four cycles of observation were done – two in the morning time and the other two in the evening time. In addition, the day of the observations were also done in different day of the week – one observation for each Monday, Tuesday, Wednesday, and Thursday.

Table 1: Arrangement of the Scenarios Counterbalancing

Scenario	Cycle 1	Cycle 2	Cycle 3	Cycle 4
1A	Monday (AM)	Tuesday (PM)	Wednesday (AM)	Thursday (PM)
1B	Thursday (AM)	Monday (PM)	Tuesday (AM)	Wednesday (PM)
1C	Wednesday (AM)	Thursday (PM)	Monday (AM)	Tuesday (PM)
2A	Monday (AM)	Tuesday (PM)	Wednesday (AM)	Thursday (PM)
2B	Thursday (AM)	Monday (PM)	Tuesday (AM)	Wednesday (PM)
2C	Wednesday (AM)	Thursday (PM)	Monday (AM)	Tuesday (PM)
3A	Monday (AM)	Tuesday (PM)	Wednesday (AM)	Thursday (PM)
3B	Thursday (AM)	Monday (PM)	Tuesday (AM)	Wednesday (PM)
3C	Wednesday (AM)	Thursday (PM)	Monday (AM)	Tuesday (PM)
4A	Monday (AM)	Tuesday (PM)	Wednesday (AM)	Thursday (PM)
4B	Thursday (AM)	Monday (PM)	Tuesday (AM)	Wednesday (PM)
4C	Wednesday (AM)	Thursday (PM)	Monday (AM)	Tuesday (PM)

Procedure
The procedure for this study was categorized into three phases – pre-observation, during observation, and the post-observation.

Pre-observation: On any particular day of the study, a scenario was chosen based on the Latin Square designed. At the scenario location, duct tape was pasted to mark the launch zone of the scenario to ensure that the data analyst was able to analyze the data and score the observation. Video recorded system was set up and the tripod was placed on the flat surface for better quality video and the angle of the video were checked so that it covers all the needed areas – launch and target zones.

During observation: Firstly, scoring sheet was prepared. Next, information of the observation – name of scenario, day, time, and date – was filled in. Then, the observation was started.

Post-observation: The recorded video was transferred to video data storage, and kept safely in the laboratory for analyzing purposes.

Variable and Hypothesis
Dependent Variable: Percentage of Head Checks. If a motorcyclist turns his or her head (perform head check) towards the target zone (the area in which the potential hazard might emerge, e.g. traffic on the expressway) while in launch zone (the area where it is crucial for a motorcyclist to do a head check, e.g. 2 seconds from the merging nose), he or she was scored 1, else 0 (i.e. binary scoring).

Hypothesis 1: The motorcyclists will perform head check less (a smaller number of head check) while in the launch zone because lack of knowledge - insufficient training - or experience (General for Energy and Transport, 2009; Zabidi, et al., 2016).

Hypothesis 2: The motorcyclists will perform head check less (a smaller number of head check) in the longer range of merging lane rather than in the shorter merging lane (Zabidi, et al., 2016).

RESULTS

Head Check Behavior in Overall
Figure 10 below shows the percentage of head check performance during merging in urban expressway for each scenario. On average, the percentage of motorcyclists who did performed the head check during merging in urban expressway is less (yes: n = 142; % = 11.83%) than those motorcyclists who did not perform head check (no: n = 1058; % = 88.17%). At Pelangi and Depot scenarios, none of the motorcyclists had performed head check during merging into the urban expressway, while the scenario that had the most motorcyclists performed head check is Wangsa scenario with 28%. The data was then analysed by using the chi-square goodness of fit test. Thus, the difference between motorcyclists who performed and did not performed the head

check are significant different, $\chi^2(1) = 699.213$, $p = 0.000$.

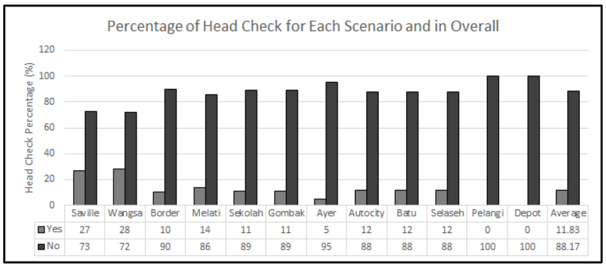

Figure 10: Percentage of Head Check for Each Scenarios and in Overall

Head Check Behavior by Different Range of Merging Lane Length

As described earlier, the twelve scenarios were categorized into four ranges based on its merging lane length: (i) 0-99 feet; (ii) 100-199 feet; (iii) 200-299 feet; and (iv) ≥300 feet. Figure 11 illustrates the percentage of head check performance for each range of length.

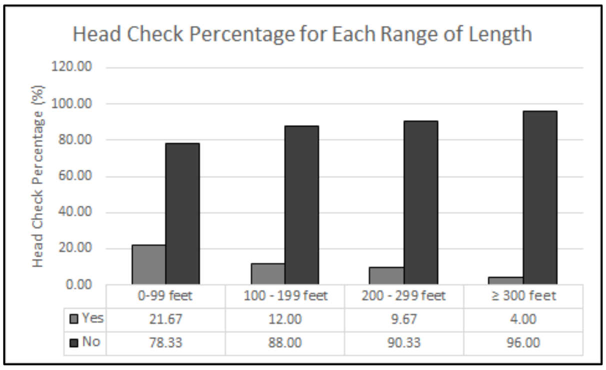

Figure 11: Percentage of Head Check for each Range of Length

The percentages of motorcyclists who performed head check during merging in traffic for Range 1, 2, 3, and 4 are 21.67%, 12%, 9.67%, and 4% respectively. This result shows that, as the Range of length of the merging lane increase, the head check performance is decreases. A one-way ANOVA was conducted to compare the effect of the *Range* of length of merging lane on head check performance among the motorcyclists. An analysis of variance showed that the effect was marginal significant, $F(3,8) = 3.838$, $p = 0.057$.

DISCUSSION

It was observed that, in overall, most of the motorcyclists did not perform head check (88.17%) during merging in urban expressway traffic. This finding is parallel to Zabidi (2016) in which he found that 70.40% of motorcyclists did not perform head check during merging in highway road environment (same road environment). One particular reason for this finding is that, in Malaysia, a proper and safe procedure to merge in traffic is not being specifically exposed to the rider in the riding education program. Besides, head check measures are not included in the requirement for riding test before obtaining the rider's license. The measures tested in the riding road-test are the 8-turn, bridge crossing, serpentine ride, emergency brake, handling a dangerous corner, and riding on the highway zone (Jabatan Pengankutan Jalan Malaysia, 2017). Thus, there is a need to improve the current Malaysian Riding Curricular, in which by addressing the importance of the head check procedure during merging in traffic.

The second finding showed that the percentages of head check is disproportionate with the Range of length of the merging lane, in which the longer the range of the merging lane length, the less percentages of head check were observed. This is parallel with the discussion in Zabidi (2016) in which he stated that motorcyclists tend to perform higher percentage of head check at the shorter merging lane. One particular reason is that; the shorter acceleration lane would result in fewer opportunities for vehicles to merge into the main lane ((Kou & Machemehl, 1997); (Wang, Liu, & Montgomery, 1999)). Thus, motorcyclists tend to perform more percentage of head check at the shorter merging lane so that they could merge into traffic safely. On the other hand, whenever the length of the merging lane is longer, the less percentage of head check was observed. The reason is that motorcyclists are prone to merge into traffic at the end of the acceleration lane (Jia, Tan, & Yang, 2011), thus, they – the motorcyclists – would have more time in monitoring the side mirror instead of performing the head check. Therefore, the merging lane should be design such that it is not too long in which would discourage the act of performing the head check among the motorcyclists. However, the length of the merging length also should not be too short that would require an urgent merge that would compromise the chance for motorcyclists to have a good control on their maneuver in merging onto traffic.

CONCLUSION

As a conclusion, most of the motorcyclists did not performed head check during merging into urban expressway (88.17%), and the percentage head check performance is decreases as the Range of the length of the merging lane is increase with 21.67%, 12%, 9.67%, and 4% for Range 1(0-99 feet), Range 2 (100-199 feet), Range 3 (200-299 feet), and Range 4 (≥300 feet) were observed respectively.

ACKNOWLEDGMENTS

The research was supported by the Malaysian Ministry of Higher Education through the RAGS 2015-1 grant to International Islamic University

Malaysia (Malek Hamid, PI). This study was also supported by the Department of Manufacturing and Materials Engineering, International Islamic University Malaysia, Malaysia.

REFERENCES

Cherry, K. (2014). *About Education*. Retrieved 20 April, 2015, from psychology.about.com: http://psychology.about.com/od/nindex/g/naturalistic.htm

Department of Road Transport Malaysia. (1989). *Motor Vehicles (Speed Limit) Rules*. Kuala Lumpur: Department of Road Transport.

Department of Transport and Main Roads Queensland. (2012). Queensland Motorcycle Riders' Guide. Queensland: Department of Transport and Main Roads, Queensland.

Department of Transport and Main Roads Queensland. (2012). Section 5 Saferiding. 1-3.

General for Energy and Transport. (2009). Driver Training and Traffic Safety Education.

Hamid, M., Divekar, G., Borowsky, A., & Fisher, D. L. (2013). Using Eye Movements to Evaluate the Effect of Total Awake Time on Attention Maintenance and Hazard Anticipation in a Driving Simulator. *Transportation Research Board 92nd Annual Meeting*. Washington DC.

Institute for Road Safety Search. (2012). SWOV Fact Sheet - Vulnerable Road Users. Leidschendam, Netherlands.

Insurance Corporation of British Columbia. (2014). Rules of the Road. In *Learn to Ride Smart - Your Guide to Riding Safely* (pp. 64, 68-69). North Vancouver: Insurance Corporation of British Columbia.

Jabatan Pengankutan Jalan Malaysia. (5 5, 2017). *Buku Kurikulum Pendidikan Pemandu*. Retrieved from Jabatan Pengangkutan Jalan Malaysia: http://www.jpj.gov.my/web/guest/buku

Jia, H., Tan, Y., & Yang, L. (2011). Modeling Vehicle Merging Behavior in Urban Expressway Merging Sections Based on Logistic Model. *International Conference on Transportation, Mechanical, and Electrical Engineering (TMEE)* (p. 657). Changchun, China: College of Transportation, Jilin University, Changchun, China.

Kou, C., & Machemehl, R. B. (1997). Modelling Driver Behavior during Merge Maneuvre. *Texas Center for Transportation Research*.

Lloyd, D., Wilson, D., Tuddenham, F., Goodman, G., & Bhagat, A. (2013). *Reported Road Casualites Great Britain 2012*. London: Transport Statistics - Department for Transport.

Medicine Net Inc. (14 June, 2012). *MedicineNet.com*. Retrieved 19 April, 2015, from medicinenet.com: http://www.medicinenet.com/script/main/art.asp?articlekey=30957

Ministry of Transport Malaysia. (2010). *Transport Statistics Malaysia 2010*. Putrajaya: Ministry of Transport, Malaysia.

Riener, A., Zia, K., Ferscha, A., Beltran, C. R., & Rubio, J. J. (2011). Traffic Flow Harmonization in Expressway Merging. In *Personal and Ubiquitous* (p. 1). Madrid: 2005.

Wang, J., Liu, R., & Montgomery, F. (1999). A Simulation Model for Motoway Merging Behavior. 14-15.

World Health Organization. (2009). *Global Status Report on Road Safety*. Switzerland: WHO Press.

Zabidi, H, Adnan, A, Radin Umar, R.Z, Samuel, S., Ani, M. H., Hamid, M. (2016). Evaluation of Head Check Behavior of Motorcyclists during Merging in Traffic - Observational Study. Human Factors and Ergonomics Journal, Vol1(2). p.29-38.