**ORIGINAL ARTICLE**

# EVALUATION OF HEAD CHECK BEHAVIOR OF MOTORCYCLISTS DURING MERGING IN TRAFFIC – OBSERVATIONAL STUDY

*Muhamad Hafiz ZABIDI[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, Selangor, 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**

*Improper riding behavior is one of the leading contributors for road crashes. Not wearing helmet, speeding, riding during fatigue and sleepy, and improper procedure during merging in traffic are among the poor behaviors of motorcyclists. For this study, improper merging behavior is the focus. The objectives of the study are: (i) to evaluate motorcyclists head check behavior during merging in traffic; (ii) to evaluate the differences of motorcyclists head check behavior during merging in traffic with different environments - highway and town (with and without U-turn situations). A naturalistic observation study was done where 1091 motorcyclists were observed at eight locations (scenarios) - four of highway road environment, two of town with U-turn environment, and two of town without U-turn environment. The dependent variable is the percentage of head checks. If a motorcyclist performs head check towards the target zone (the area in which the potential hazard may merge - at the entering road) while in the launch zone (the area where a motorcyclist should turn his or her head to the target zone - on the leaving road), he or she was scored one, else he or she was scored zero. It was found that, in overall, the percentage of motorcyclists who performed the head check (39.9%) is less than those who did not performed the head check (60.1%) - $p \leq 0.001$. In term of the type of the road environment, similar results were found for the merging with highway environment (29.4% performed head check) and town without U-turn environment (31.4% performed head check). In contrast, for the merging with town with U-turn environment, the opposite result was found (75.7% performed head check). These differences were significant with $p \leq 0.001$. This study provides prevalence information about Malaysian motorcyclists' behavior in general and, more particularly, their behavior on the head check during merging in traffic. The findings shall recommend for an improvement to the current Malaysia riding/driving education system and road users awareness program in which may decrease the road crashes.*

***Keywords:*** *Motorcyclists Behavior, Head Check, Merging, Highway and Town, Observational Study*

## INTRODUCTION

According to the Association for Safety International Road Travel (ASIRT), about 1.3 million people die in road crashes each year all over the world, on average 3,287 deaths per day[1]. Similarly, the World Health Organization (WHO), also indicated the similar daily death rate – 3,400 death – and mentioned that ten of millions people are injured and disabled resulting from the road crashes[2]. Among the road users, pedestrian, cyclist, and motorcyclist are the most vulnerable road users. According to the Global Health Observatory (GHO), in 2010, 50% of deaths on the world's roads occurred among vulnerable road users – 23% of all deaths were among motorcyclist, 22% among pedestrians, and 5% among cyclists[2]. Furthermore, in African region, 38% of all road traffic deaths were among pedestrians, while in the Western Pacific region, 36% of road traffic deaths were among motorcyclists[2].

In Malaysia, motorcycles are the most preferable, convenient and affordable transportation[3]. With about 70% of the registered motorcycles is on the road, there are at least 6.2 million active motorcycles in the country[4]. Out of them, 113,962 have been involved in road accidents, causing fatalities of 3,640 riders and 430 pillions in 2011[4]. In Malaysia, motorcycle is accounted for almost 60% of all road crashes[5]. In addition, 60% of the road crashes fatalities in Malaysia are contribute by motorcycles[6]. Furthermore, it is surprising that with 60% road crashes, motorcycle has less number of registrations in comparison to the car. This statistic shows that, among the vehicles, motorcycle has a higher risk for road crashes.

Poor riding behavior is one of the contributing factors for motorcycle road crashes. Not wearing helmet[7-9], speeding, riding during fatigued and sleepy, improper overtaking and merging are among the poor behaviors of the motorcyclist. For this study, improper merging behavior is the focus. Merging is defined as the situation when a rider merges onto a motorway to build up speed to match that of the traffic already on the motorway[10]. Merging lane is categorized into two give way rules situation – on roads where there are lanes marked on the road, and on

roads where there are no lanes marked on the road. For the first situation, if the lane comes to an end, road user must give way to traffic already in the lane that he or she is moving to[10]. The later situation is when the lines of traffic merge ended, and road user must give way to any vehicle that is ahead of him. Lines of traffic refer to adjacent rows of vehicles that do not have a lane separation line between them[10].

In addition to the above rules, there are several unwritten laws of proper behaviors when motorcyclists encountering a merging situation. There are guidelines that could be followed for a safe practice. There are, in step by step: reduce a speed, ensure a safe gap with other vehicles, use a side mirror and turn on signal, and turn the head quickly over a shoulder before merging in traffic[11]. In this study, turning head before merging in traffic is the focus.

A standard term for the turning head before merging in traffic is known as the head check[10]. As mentioned above, a safe motorcyclist should turn his or her head quickly over a shoulder before merging in traffic. This procedure is crucial in order for a motorcyclist to check his or her blind spot. Blind spot is defined as the area next to a motorcyclist that is unable to be seen in the motorcycle's side mirrors[10].

The timing for turning head (to anticipate the hazard) involves the launch zone and the target zone. Launch zone is defined as the area where it is crucial for a motorcyclist to turn his or her head, while target zone is defined as the area where the motorcyclist should turn his or her head to anticipate the potential hazards while in the launch zone. These two terms are widely used in other driving literatures especially in the hazard anticipation research[12-20].

In Malaysia, a proper and safe procedure to merge in traffic is not specifically being exposed to the rider – i.e. in driving/riding education system. Currently, there are three levels of tests in obtaining a motorcycle driving license – KPP01 (theory test), KPP02 (skill test), and KPP03 (road test – controlled track for B2 license)[21]. In KPP01, the blind spot is introduce, however, is it not specifically mentioned about its importance at the merging lane rather than just generally mentioned as an awareness procedure during changing lane, overriding traffic, and entering interection[21]. In KPP02, the measures that only be tested are include the 8 turn, bridge crossing, serpentine ride, and emergency break. There is no input in regards to the merging lane[21]. In KPP03, head check is only being tested at the beginning of the test – before start riding the motorcycle. There is no head check or blind spot requirement in the rest of the KPP03 rather than to test on handling dangerous corners, and normal riding activities on the road. In addition, failing to perform head check is not considers as a mandatory failed for the test[21]. Furthermore, Malaysia also does not have a prevalence study and statistic on the head check behavior during merging in traffic. Because this procedure is crucial for a safe riding, a prevalence of the head check behavior of Malaysian motorcyclists during merging in traffic is needed so that it can be recommends for an improvement to the current Malaysia riding/driving education system. Refining the riding/driving education system will improving the awareness among the road users in which would decrease road crashes.

The basic method to obtain this information is by doing a naturalistic observational study at several merging areas that is known as scenario. Naturalistic study is defined as a type of study in which the researcher very carefully observes and records some behavior or phenomenon, sometimes over a prolonged period, in its natural setting while interfering as little as possible with the subjects or phenomena[22]. In naturalistic observation, the technique involves are by observing subjects in their natural environment. Naturalistic observation differs from structured observation in that it involves looking at a behavior as it occurs in its natural setting with no attempts at intervention on the part of the researcher[23]. Therefore, in this study, naturalistic observation method was chosen in order to obtain a prevalence of the motorcyclist head check behavior during merging in traffic.

The purpose of this naturalistic observation study was to determine motorcyclists head check behavior during merging in traffic. From the study, we have learnt the following: (i) motorcyclists head check behavior during merging in traffic; (ii) differences of motorcyclists head check behavior during merging in traffic with different environment – highway and town (with and without U-turn situations).

## METHODS

*Area of the Study*

Area of the study is in the Gombak district – from Taman Melati to Batu Caves – in the State of Selangor, Malaysia. Like any other riding or driving research, in general, the area covered is sufficient enough to generalize the motorcyclists' behavior on head check during merging in traffic rather than to generalize to the Malaysian population. Within this observational area, eight scenarios were selected.

*Scenarios*

There are eight scenarios in total were included for this study. In general, each scenario is involved a leaving road – the road that motorcyclists are coming from – and the entering

road – the road that motorcyclists will merge onto. The launch zone - the area where it is crucial for motorcyclists to turn his or her head - and the target zone - the area where motorcyclist should turn his or her head to anticipate potential hazards while in the launch zone - for each scenario were also determined. The scenarios were classified into two categories namely highway (four scenarios) and town (four scenarios), in which were categorized based on the type of the entering road. Among the town merging scenarios, two scenarios have a U-turn and the other two did not have a U-turn. The details example of the scenario for each environment types will be described below.

Scenarios with Highway Environment: In general, the speed limit of the highway road is 90 km/h[24]. However, the speed limit of one highway road to another may be different depends on several factors – e.g. number of lanes, traffic congestion, and road conditions. There are four scenarios with a highway environment were included. There are named as (i) Gombak Toll (ii) Golek Golek, (iii) Melati, and (iv) Auto City – the scenarios were named based on the surrounding area of the scenarios.

The 'Gombak Toll' scenario will be used as an example to explain the details of the Highway environment scenarios. Figure 1 and Figure 2 illustrates motorcyclists' and plan view of the Gombak Toll scenario respectively. In both figures, the launch zone and the target zone are labelled as A and B respectively.

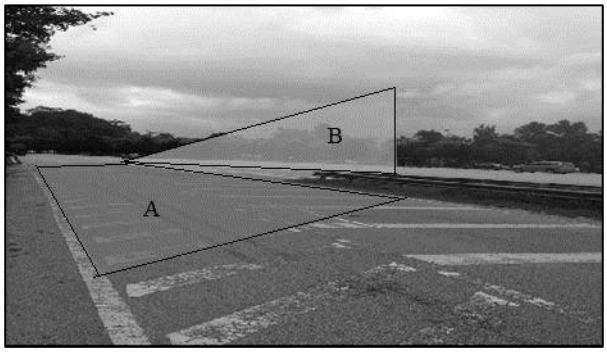



Figure 1: Motorcyclists' View of Gombak Toll Scenario

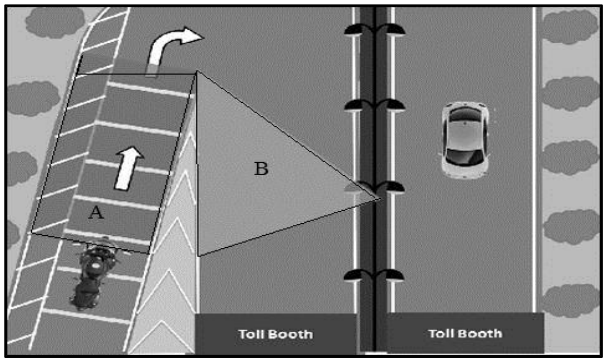



Figure 2: Plan View of Gombak Toll Scenario

The leaving road consist of two lanes and the speed limit is 60 km/h. The cue available to the road users is the yellow lines on the leaving road as he or she approaching the merging area. A safer road user would recognize these lines as a warning to be more careful. On the other hand, the entering road consists of unlined wide lanes (because the traffic is coming out from the Expressway toll booths). The speed limit of the entering road is 90 km/h. The surrounding environments are includes trees on the left side of the leaving road, divider between the leaving and entering road, and a tollbooths far behind on the entering road.

Scenarios with Town Environment: In general, the speed limit of the town road is 60 km/h[24]. However, the speed limit of one town road to another may be different depends on several factors – e.g. number of lanes, traffic congestion, and road conditions. Town road is a major road that connecting one area of the town to another. There are four scenarios with a town environment were included, two for scenario without U-turn – named as Banjaria and Sri Gombak – and two with U-turn – named as Giant and Sungai Cincin. The 'Sri Gombak' and 'Sungai Cincin' scenarios will be used as an example to explain the details of the Town environment without and with U-turn scenarios respectively.

Sri Gombak Scenario: Figure 3 and Figure 4 illustrate the motorcyclists' and plan view of the scenario respectively. In both figures, the launch zone and the target zone are labelled as A and B respectively.

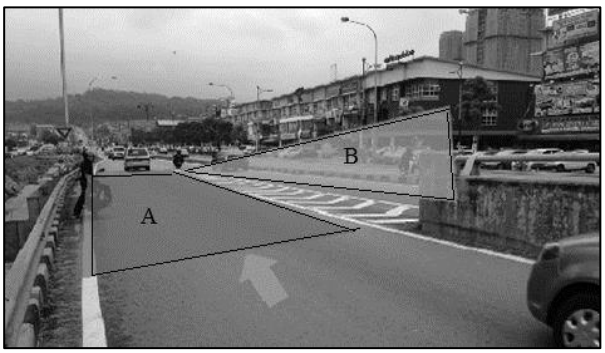



Figure 3: Motorcyclists' View of Sri Gombak Scenario

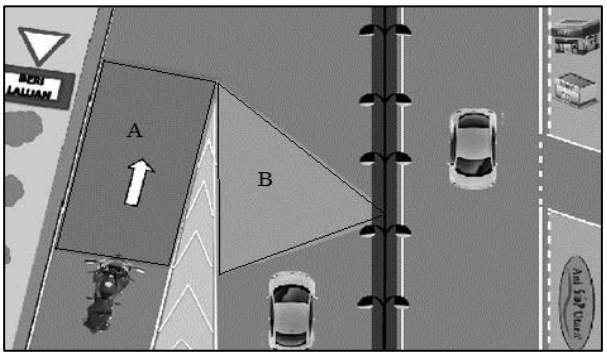



Figure 4: Plan View of Sri Gombak Scenario

The leaving road consist of one lane and the speed limit is 60 km/h. However, the speed limit is reducing into 30 km/h due to the two-way-lanes flyover before the entering road. The cue available is the 'give way' signage. The entering road consists of one lane and the speed limit is 30 km/h. The surrounding environments are includes businesses buildings on both left and right of the roads.

Sungai Cincin Scenario: Figure 5 and Figure 6 illustrate the motorcyclists' and plan view of the scenario. In both figures, the launch zone and the target zone are labelled as A and B respectively.

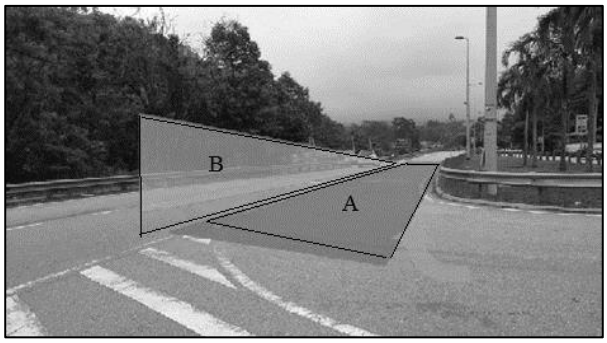


Figure 5: Motorcyclists' View of Sungai Cincin Scenario

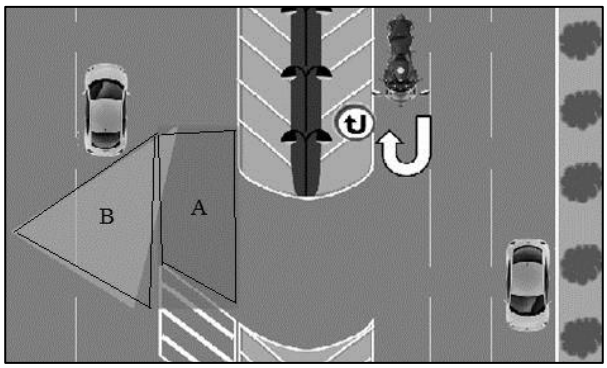


Figure 6: Plan View of the Sungai Cincin Scenario

The leaving road consist of three lanes (including the U-Turn lane) and the speed limit is 60 km/h. However, the speed of the motorcycle may reduce due to the U-turn before the entering road. The cue signage (U-turn) is located 250 meter behind the U-turn. The entering road consists of three lanes (including the U-Turn lane) and the speed limit is 60 km/h. The surrounding environments are includes trees on the left side of the leaving road, and several shops and houses on the leaving and entering road.

*Video Recording System*

In the study, a video recording system – Panasonic HC-V210 was used. During the playback, a data analyst will be able to see all the video output (just like other regular video recording systems) of a certain location or time during the run. Time stamp and date will be on the output video. In addition, a tripod DigiEye TR-37 was used to stand the video recorder so the recording will be static (no moving during recording). The battery lifetime of the system is about two hours. Therefore, a spare battery – of the same model – for the system was prepared as a backup. The system also includes a memory card – Sandisk – for the recording. The size of the memory card is 32 gigabytes. Therefore, a spare memory card – of the same model and size – for the system is prepared as a backup.

*Other Apparatus*

Video data storage – Seagate - was used to store the recorded video data. The capacity of the storage is 1 terabytes in which is estimated to be able to store about 63 hours of video recording of the system used. A duct tape was used in this study to mark the launch zone of each scenario. This was to make sure that the scoring phase become easier and standardize. The chosen color of the duct tape is red because it will be contrast to the major background colors – e.g. green for grass, gray for road, white for road's lines. A scoring sheet was designed to administrating the scoring during the observation. On the scoring sheet there are a column for scenario name, date and time taken, and a column to score the observation.

*Design of the Study*

In general, the study was only conducted on Monday, Tuesday, Wednesday, and Thursday. Friday and weekends were excluded. This is to avoid any potential factoring effect that may affect motorcyclists behavior (i.e. the traffic congestion would be different). The time of a day that the observations were conducted is classified into two three-hours-slots – namely morning and evening. The morning and evening slots will be from 9:00 a.m. to 12:00 p.m. and 2:00 p.m. to 5:00 p.m. respectively. Other periods of time of the day were excluded. This is to avoid any potential factoring effect that may affect the motorcyclists behavior (i.e. the effect of the alertness of motorcyclists, night/day-time condition, and traffic congestion would be different).

Scenario Counterbalancing: Observations of the scenarios were arranged such that sequencing of the scenarios observed was counterbalanced in term of the time (day and period) of the observations. A Latin Square was designed to counterbalance the time of the observations. The scenarios were label as H1, H2, H3, H4, T1, T2, T3, and T4. The letter H or T represent the environment of the scenario – H for highway, T for town. The numbers – 1, 2, 3, and 4 – are simply assigned to the scenarios to differentiate the four scenarios in each type of the road environment being studied. The arrangement of the scenarios observed is shown in Figure 7 on the next page. In explanation, as can be seen in Figure 7, there are four slots for H1, and each of

them appear on the different day. In addition, two of the H1s are on the morning slots, and the other two H1s are on the evening slots.

| | | Monday | Tuesday | Wednesday | Thursday |
|---|---|---|---|---|---|
| Week 1 | Morning | H1 | T1 | H2 | T2 |
| | Evening | T4 | H3 | T3 | H4 |
| Week 2 | Morning | H4 | T4 | H3 | T3 |
| | Evening | T2 | H1 | T1 | H2 |
| Week 3 | Morning | H2 | T2 | H1 | T1 |
| | Evening | T3 | H4 | T4 | H3 |
| Week 4 | Morning | H3 | T3 | H4 | T4 |
| | Evening | T1 | H2 | T2 | H1 |

Figure 7 : Latin Square for Counterbalancing of the Scenarios to be observed

*Procedure*

The procedure for the study is categorized into three phases - pre-observation, during observation, and the post-observation.

Pre-observation: On a particular day of the study, a scenario was chosen to be observed based on the Latin Squared designed. At the chosen scenario's location duct tape was pasted to mark the launch zone of the scenario. This was to make sure that a study analyst will be able to analyze the data – to score the observation. After that, the video recorder system was set up. The tripod was stood on the flat surface for a quality video recording and the angle of the video was checked – to ensure that the launch zone and the target zone can be seen clearly in the LCD monitor of the video recorder. In addition, it was also to ensure that the recording cover the whole merging lane.

During Observation: Firstly, the scoring sheet was prepared. Then, the information of the scenario and observation – scenario name, time, and date – was filled in. After that, the observation was started and done based on the study design.

After Observation: The data was transferred into the video data storage, and was kept safely in the locked laboratory's cabinet for future use – analyzing phase.

*Research Questions, Variables, and Hypotheses*

There are two research questions to be answered. There are: (i) what is the motorcyclists head check behaviour during merging in traffic?, and (ii) is the motorcyclists head check behaviour better in one type of the road environment compared to another? The dependent variable is the head checks percentage - if a motorcyclist perform head check towards the target zone (the area in which the potential hazard may merge, e.g., the traffic from the toll both in the Gombak Toll scenario that travelling on the lane that a motorcyclist will merge) while in the launch zone (the area where it is crucial for a motorcyclist to do the head check, e.g., 3 seconds behind the merging point). The independent variable is the type of the road environment – highway (one type) and town (two types – with and without U-turn).The hypothesis testing for each question is as the following:

Question 1:

$H_0$ = the percentage of motorcyclists who performed the head check is equal to the percentage of motorcyclists who did not performed the head check.

$H_1$ = the percentage of motorcyclists who performed the head check is not equal to the percentage of motorcyclists who did not performed the head check.

Question 2:

$H_0$ = the percentage of motorcyclists who performed the head check is equal throughout the different types of the road environments.

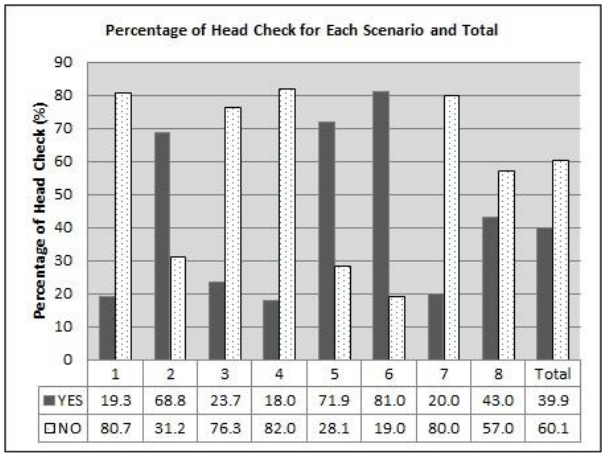
$H_1$ = the percentage of motorcyclists who performed the head check is not equal throughout the different types of the road environments.

**RESULTS**

In total, there are 1091 motorcyclists were observed throughout the study period in the eight scenario locations – 54.8% was at the merging with highway road environment and 45.2% at the merging with town road environment. Among the observations at the town road environment, 47.7% was at the merging with U-turn and 52.3% without U-turn.

*Motorcyclists head check behaviour during merging in traffic*

The descriptive statistics are given in Figure 8 below. In overall, the percentage of the motorcyclists who performed the head check (39.9%, solid gray bar) is less than those who did not performed the head check (60.1%, dotted white bar).



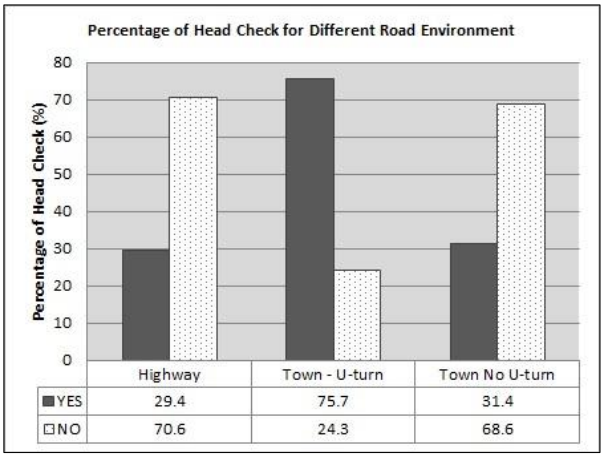

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Total |
|---|---|---|---|---|---|---|---|---|---|
| YES | 19.3 | 68.8 | 23.7 | 18.0 | 71.9 | 81.0 | 20.0 | 43.0 | 39.9 |
| NO | 80.7 | 31.2 | 76.3 | 82.0 | 28.1 | 19.0 | 80.0 | 57.0 | 60.1 |

Figure 8: Percentage of Head Check for each scenario location and in total

The data was analysed using chi-square goodness of fit test. The null hypothesis was rejected, $\chi^2(1) = 44.767$, $p \leq .0001$. More than half of motorcyclists did not perform head check during merging in traffic. Figure 8 also shows that, among the scenarios, three scenarios – one of the highway environment (scenario number 2) and two of U-turn town environment (scenario number 5 and 6) are not following the pattern of the null hypothesis.

*Differences of motorcyclists head check behavior during merging in traffic with different environment - highway and town (with and without u-turn situations)*

The descriptive statistics are given in Figure 9 below. In highway environment, the percentage of the motorcyclists who performed the head check (29.4%, solid gray bar) is less than those who did not performed the head check (70.6%, dotted white bar). More than two-thirds of motorcyclists did not perform head check during merging in traffic with highway environment. A similar pattern was observed in the town without U-turn environment. In town without U-turn environment, the percentage of the motorcyclists who performed the head check (31.4%, solid gray bar) is less than those who did not performed the head check (68.6%, dotted white bar). More than two-thirds of motorcyclists did not perform head check during merging in traffic with town without U-turn environment. However, in the town with U-turn environment, the opposite pattern was observed. In town with U-turn environment, the percentage of the motorcyclists who performed the head check (75.7%, solid gray bar) is higher than those who did not performed the head check (24.3%, dotted white bar). Only quarter of motorcyclists did not performed head check during merging in traffic.




| | Highway | Town - U-turn | Town No U-turn |
|---|---|---|---|
| YES | 29.4 | 75.7 | 31.4 |
| NO | 70.6 | 24.3 | 68.6 |

Figure 9: Percentage of Head Check for each type of road environment

The data was analysed using pearson chi-square goodness of fit and independent tests. These differences were significant, $\chi^2(2) = 161.062$, $p \leq .0001$. The SPSS output also given the effect size of the observation. From the output, Cramer's V value is 0.384 which means that this observation has a medium effect size (between 0.3-0.5).

**DISCUSSION**

The first research question is to investigate the motorcyclists head check behavior during merging in traffic. The study found that the percentage of the motorcyclists who performed head check (39.9%) is less than those who did not performed head check (60.1%). This finding agreed with the expected result – rejecting the null hypothesis – where motorcyclists are expected to perform less head check towards the potential hazards during merging in traffic. This is because, with the current Malaysian riding education system, motorcyclists can be considered to have insufficient training (knowledge) or experience when it comes to safety procedure during merging in traffic[21]. In the program, head check procedure during merging in traffic is not specifically being exposed to the leaners rather than just generally mentioned as an awareness procedure during changing lane, overriding traffic, entering intersection, and before start riding the motorcycle[21]. In addition, as the failing to perform head check is not considers as a mandatory failed for the test[21], most of the motorcyclists are not aware of this crucial safety action during merging in traffic. Moreover, merging is also known as one of the risky locations for crashes with around 19,000 crashes (3.5%) were recorded in the 1999 study in the United States[26]. Most of the merging collisions also have been reported to occur when there are no traffic control (non-signalized)[27], in which matching the scenarios being studied under this study. With this finding, it is crucial for the riding program to be improved in general, more particularly, on the safe procedure during

merging in traffic as have been practice in other riding education system e.g. in California State[11].

The second research question is to investigate if motorcyclists head check behaviour during merging in traffic is better in one type of a road environment compare to another. The study found that: (i) at the highway road environment, the percentage of the motorcyclists who performed head check (29.4%) is less than those who did not performed head check (70.6%), (ii) at the town without U-turn road environment, the percentage of the motorcyclists who performed head check (31.4%) is less than those who did not performed head check (68.6%), and (iii) at the town with U-turn road environment, the finding is contrary to the previous two road environments, in which the percentage of the motorcyclists who performed head check (75.7%) is more than those who did not performed head check (24.3%). This findings agreed with the expected result – rejecting the null hypothesis – where motorcyclists are expected to perform differently depends on the road environment. Looking at these findings, the only difference among the road environments being studied is the occurrence of the U-turn. In general, when there is a U-turn, motorcyclists head check behavior could be similar or differ from the cases that have no U-turn. This is because, as a motorcyclist approaching the U-turn, he or she could notice if there are incoming traffics that may merge with him or her after the U-turn. Thus, this would affect his or her decision in performing the head check. In congested traffics – or at least there is a potential vehicle that may merge after the U-turn, motorcyclists are more likely to perform the head check before merging in traffic. One particular reason for this is that the riders and drivers are tend to give way to the incoming vehicles that he or she about to merge whenever there is a U-turn signage[10]. In contrast, if there are no incoming traffics, he or she may just skip this crucial procedure with an assumption that there is no vehicle going to be merged with him. However, this is not a safe behavior to be practiced. In addition, road users need to slow down whenever he or she taking a U-turn, thus, it will give more time for them to be more careful. Moreover, U-turn is also associated with a shorter merging lane in comparison to the road without U-turn. Shorter merging lane will result a sudden merging. Thus, this is maybe the cause for the motorcyclist to be more likely to perform head check. Another factor is that, as the length of a merging lane has an effect on the choice of speeding while in the merging lane, it also may affect the head check behavior.

Findings for both research questions above have met the expected hypotheses, however, there is one study mentioned that, 91% of merge collision occur on regular roads – i.e. town road environment – as opposed to interstate and exchange highway[27]. In our study, three is no different was found between the town and highway (i.e. exchange) road environment. This is perhaps because the traffic congestion and the length of the merging lane for both environments that being studied are not that much different. A different result may be shown if the study are comparing the town road environment to the interstate highway e.g. the PLUS highway.

Among the results found, there is one particular scenario – Scenario #2, Melati scenario, highway road environment – that was not agreed with the expected result. In this scenario, the percentage of the motorcyclists who performed head check (68.8%) is more than those who did not performed head check (31.2%). It was expected that, the reverse result should be found. Comparing to other highway scenarios, one possible cause for this difference is the length of the merging lane. In comparison, the length of the merging lane in Melati scenario is much shorter to other scenarios of highway road environment. Figure 10 and 11 illustrates the merging lane length (indicated by the double arrow) of the Melati and Auto City scenario respectively.

Figure 10: Double Arrow Indicate the Merging Lane Length of Melati Scenario

Figure 11: Double Arrow Indicate the Merging Lane Length of Auto City Scenario

Looking at this particular finding, there is potential effect of the length of the merging lane on head check behavior among motorcyclists. It seems like the percentage of performing head check will decrease proportionally to the length of the merging lane.

Motorcyclists from the shorter merging lane will have less margin error during the merging[28]. Besides, as the motorcyclists need to be extra precise when positioning himself in the safe gaps[28], it may result them more likely to perform the head check. However, this issue is an open question which only future research can answer.

*Limitation and Recommendation*

From the SPPS output, Cramer's V value is 0.384 which means that this study has a medium effect size (between 0.3-0.5). The reason of finding this output is because, during designing the study, the scenarios were categorized into two types of road environments – four scenarios for each type. However, during the data analysis phase, the data were categorized into three types, in which the town scenarios were divided into two types – with and without U-turn, with two scenarios each. Thus, the scenarios numbers are not evenly observed between those three categories. To have a small effect size, it is recommended that the number of scenarios is same among the categories that being analyzed.

In this study, only the highway and town environment scenarios were being studied. The other two well-known types of scenario environment – residential and rural – were not included. Thus, future study that involves these types of road environments is needed. This type of study also can be conducted with different methods such as: (i) a field study – having a participant riding in the real environment, (ii) riding simulator study – in the laboratory, and (iii) and computer simulation study. Therefore, this study should be conducted with different methods, and the findings can be compared. Lastly, in this study, whenever a motorcyclist performs the head check, we are unsure if he or she detecs the hazard or at least turning his or her head to the exact location of the potential hazards. Thus, the more sophisticated equipment such as the eye-tracker – the equipment to detect the eye movement – would give a better insight on the study. This is because; the eye-tracker is able to give the exact area that the participant is looking at. Therefore, the score obtain in this type of study would be more precise. In addition, the eye-tracker also could analyze the data in more details such as to investigate the frequency of the head check and the gaze period. Therefore, it is recommended for the study to be done using the more valuable equipment.

## CONCLUSION

As a conclusion, in general, motorcyclists are less likely to perform head check during merging in traffic. Specifically, there is no difference on the motorcyclists head check behavior between the town and highway road environment, in which, motorcyclist are less likely to perform head check during merging in both road types. However, when there is a U-turn involve in the scenarios, the contrary results was found, where motorcyclists are more likely to perform head check during merging in traffic that involved a U-turn. The result from this research will provide additional information about Malaysian motorcyclist behavior in general and, more particularly, behavior on the head check during merging in traffic. The findings shall recommend for an improvement to the current Malaysia riding/driving education system and road users awareness program in which may decrease the road crashes. Lastly, the finding from this study also could lead the other similar research studies in deeper approaches.

## 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

1. Association for Safety International Road Travel (2014). Annual Global Road Crash Statistics. Retrieved 5 5, 2014, from http:// www.asirt.org/initiatives/informing-road-users/road-safety-facts/road-crash statistics. aspx

2. World Health Organization (2014). Global Health Observatory. Retrieved 5 5, 2014, from http://www.who.int/gho/road_safety /mortality/traffic_deaths_distribution/en/X

3. Pang Toh Yen, Radin Umar RS, Azhar Abdul Aziz, Harwant Singh, Shahrom Abdul Wahid, Abdul Halim b. Haji Mansor, Zahari Noor & Mohd Shafie bin Othman (1999). Fatal Injuries in Malaysian Motorcyclist. Road Safety Research Centre, Faculty of Engineering, University Putra Malaysia.

4. Rohayu Sarani, Azzuhana Roslan, & Noriah Saniran (2011). Accident Database System and Analysis Unit. Malaysian Institute of Road Safety Research.

5. Oxley, Ravi, Yuen, & Hashim (2013). Fatal Motorcycle Collisions in Malaysia, 2007–2011. 16th International Conference Road Safety on Four Continents, 15–17 May 2013, Beijing, China.

6. Yusof Ghani (2013). Community-based Programme: a Potential Policy for Road Safety and Injury Prevention in Malaysia, The Newsletter of the Road Traffic Injuries

Research Network (RTIRN), October–December 2013, pp 9–10.

7. Noor Faradila Paiman, Mohd Syazwan Solah,Aqbal Hafeez Ariffin, Mohd Hafzi Md Isa, Mohd Khairudin Rahman, Zulhaidi Mohd Jawi, Azhar Hamzah, Kharil Anwar Abu Kassim & Norlen Mohamed (2013). Prevalence of Multiple Pillion Riders on the Route to School, International Conference of Ergonomic, KL, September 2013 – 2–4 September 2013.

8. Rabihah, I, Azli, A.Z., Abdullah, S. & Nurulhana, B. (2013). Enforcement and Helmet Use Compliance: An Observation in Selected Areas in Selangor, 4th International Conference for Road Safety, 4–6 March 2013, Sydney, Australia.

9. S. Kulanthayan, R S Radin Umar, H Ahmad Hariza, M T Mohd Nasir, S Harwant (2000). Compliance of Proper Safety Helmet Usage in Motorcyclist. Road Safety Research Centre, Faculty of Engineering, University Putra Malaysia.

10. Department of Transport and Main Roads Queensland (2012). Queensland Motorcycle Riders' Guide. Queensland Government.

11. Department of Motor Vehicles California (2014). California Driving Handbook. Retrieved 5 5, 2014, from https://www.dmv.ca.gov/portal/dmv/detail/pubs/hdbk/driver_handbook_toc

12. Pradhan, A., Pollatsek, A., Knodler, M., & Fisher, D.L. (2009). Can younger driver be trained to scan for information which will reduce risk roadway traffic scenarios that are hard to identify as hazardous? Ergonomics, 657-673.

13. Fisher, D. L., Pradhan, A. K., & Knodler, M. A. (2007). Empirical evaluation of hazard anticipation behaviors in the field and on a driving simulator using an ey tracker. Proceeding of the 86th Transportation Research Board Annual Meeting, CD-ROM . Washigton D.C.: TRB, NAtional Research Council.

14. Fisher, D. L., Thomas, D., Pradhan, A., Pollatsek, A., Blomberg, R., & Reagan, I. (2009). Development and evaluation of a PC-based attention maintenance training program. Washington D.C.: National Traffic Safety Administration.

15. Pollatsek, A., Vlakveld, W., Kappe, B., Pradhan, A. K., & Fisher, D.L. (2011). Driving Simulator as Training and Evaluation Tools: Novice Drivers. In D.L. Fisher, M. Rizzo, J. Caird, & J.D. Lee, Handook of Driving Simulator for Engineering, Medicine and Psychology (pp. 30.1-30.18). Bota Raton, Florida: Taylor & Francis Group.

16. Anuj Kumar Pradhan (2009). Risk Awareness and Perception and the Novice Driver: Development and Evaluation of Training Interventions and Their Influence on Tactical and Strategic Visual Search Behavior. University of Massachusetts, Amherst.

17. Chan, E., Pradhan, A. K., Pollatsek, A., Knodler, M. A., & Fisher, D. L. (2010). Are driving simulators effective tools for evaluating novice drivers' hazard anticipation, speed management, and attention maintenance skills? Transportation Research Part F, 13, 343-353.

18. Vlakveld, W., Romoser, M. R., Mehranian, H., Diete, F., & Fisher, D. L. (2011). Does the experience of crashes and near crashes in a simulator-based training program enhance novice driver's visual search for latent hazards? Transportation Research Record, 153-160.

19. 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.

20. Hamid, M., Samuel, S., Borowsky, A., & Fisher, D.L. (2014). Evaluation of Effect of Total Awake Time on Driving Performance Skills - Hazard Anticipation and Hazard Mitigation: A Simulator Study. Transportation Research Board 93rd Annual Meeting, Washington DC.

21. Jabatan Pengangkutan Jalan Malaysia (2015). Buku Panduan Memandu. Retrieve 5 5, 2015 at ttp://www.jpj.gov.my/documents/10157/2d8a1e2d-b2a2-4669-a498-efdc09cb35bf

22. Medicine Net (2014). Definition of Naturalistic study, retrieved from http://www.Medterms.com/script/main/art.asp?articlekey =30957 Motorcycle Safety Foundation (2007). Rider Handbook. Motorcycle Safety Foundation.

23. About.com Psychology (2014). What Is Naturalistic Observation? http://psychology.about.com/od/nindex/g/naturalistic.htm

24. National Speed Limit (Malaysia). (2014, 06 4). Default Speed Limit. Retrieved from Wikipedia:http://en.wikipedia.org/wiki/National_Speed_Limits_%28Malaysia%29

25. Directorate – General for Energy and Transport (2004). Driver Training and Traffic Safety Education

26. NHTSA (2014). http://www.nhtsa.gov/DOT/NHTSA/NRD/Multimedia/PDFs/Crash%20Avoidance/2003/DOTHS809571.pdf.

27. Stephen K. Young, Carol A. Eberhard, Philip J. Moffa. (1995). Development of Performance Specifications for Collision Avoidance Systems for Lane Change, Merging and Backing Task 2 Interim Reports: Functional Goals Establishment. National Highway Traffic Safety Administration.

28. Zhong, J. and Chee, D (2009) Road Safety Thematic Audit High Speed Merging Facilities. Parsons Brinckerhoff Australia Pty Limited.