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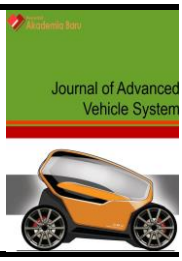

An Observational Study on Motorcycle Crossing Pattern at Three-Legged Signalised Junction in Malaysia

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ABSTRACT

Traffic signals are a common form of traffic control used by road authorities and local agencies all around the world to manage traffic movement at a junction. In 2012, 18.5% of all fatalities and injury collisions in Malaysia occurred at intersection. Many motorcycle fatalities occurred within intersections after a driver failed to see a motorcyclist. However, little is known about the behaviour of motorcyclists when they negotiate at intersection. This study was undertaken to analyse the behaviour of motorcyclist when crossing the three-legged signalised junction. Motorcycle path data were observed at three (3) signalised junction in peninsular Malaysia during peak and off-peak hour period. Motorcycle path in this study defined as to the path taken by the motorcycle when they start moving from one (1) leg to another leg of the junction This study grouped motorcycle path into turning and straight movement. Findings shows for turning movement 46.5% motorcycle executed a changing lane while for straight movement shows only 17.4% executed a changing lane to complete crossing maneuver. The disorderly movement by motorcycles creates traffic conflict at the junction and may lead to a crash. By following the actual path, motorcyclist may reduce the contact point with the other vehicles especially at intersection.

Keywords:
Motorcycle safety; motorcycle path;
three-legged junction

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1. Introduction

The increase in the population of motorcycle has also led to a decrease in the level of road safety throughout Malaysia. Motorcyclists are considered as vulnerable road users and they may suffer more severe injuries than other groups of road users due to the lack of protection at the scene of a crash. Crash rate involving motorcycles in Malaysia was accounted for almost half of the total road fatalities recorded yearly [6]. Other than that, developed countries like in Singapore also have a problem in motorcycle crashes. In Singapore, motorcycle crashes constitute about 36% of total road traffic crashes even though their share in the vehicle population is only about 18% of the total vehicle [5]. These evident that motorcycles are high-risk road users regardless of developing or developed countries and need serious attention.

While, traffic signals are a common form of traffic control used by road authorities and local agencies all around the world to manage traffic movement at a junction. They allow the shared use

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of road space by separating conflicting movements in time and allocating delay. They can also be used to enhance the mobility of some movements such as on along a major arterial. Traffic signals play a prominent role in achieving safer performance at junctions. Research has shown that, under the right circumstances, the installation of traffic signals will reduce the number and severity of crashes but inappropriately designed and/or located signals may give an adverse effect on traffic safety. Thus, the right placement, design, and operation are essential for the installation of a traffic signal.

Without a proper design and approach to increase the level of safety at intersection, it will cause a crash and fatalities as intersection collected vehicle from many area or road. In 2012, 18.5% of all fatalities and injury collisions in Malaysia occurred at signalised junctions [1]. A substantial portion (approximately 47%) of motorcycle crashes in Singapore also occur at junctions controlled by traffic. Singapore crash statistics also show that about 77% of fatal and 67% of injury crashes that occurred at signalised junctions involved motorcycles [5]. These statistics signify that motorcyclists are vulnerable at signalised junctions and it is worth of effort to identify significant factors that affect the occurrence of such crashes.

Signalised junction was influenced by the width of the carriageway and the variation in volume on the major road with respect to the traffic moving in the near and far side direction. Other factors affecting the motorists behaviour are speed and spacing between vehicles moving on the major road [2]. Junctions are areas with a high risk of traffic collisions, especially in urban areas where the road system is characterized by multiple junctions [9]. Signalised junction is a controlled device installed to control the traffic flow and conflict movement. However, large number of conflict point occur at signalised junction as shown in Figure. Note that many potential conflicts, including merging and crossing conflicts, can be managed (but not eliminated) at a signalised intersection by separating conflicts in time.:

i. Eight (8) merge and eight (8) diverge conflict points. Collisions associated with merging/diverging movements are rear-end and sideswipe collisions, occurring on a particular leg and involving another vehicle on the same leg.

ii. 16 crossing conflict points. Of these, 12 crossing movements are associated with left-turning vehicles. Collisions associated with this crossing movement occur when a vehicle attempting a left turn at a signal is struck by traffic passing through the junction on another approach. The remaining four crossing movements involve through movements on two (2) adjacent approaches. Angle collisions may occur as a result of this type of conflict.

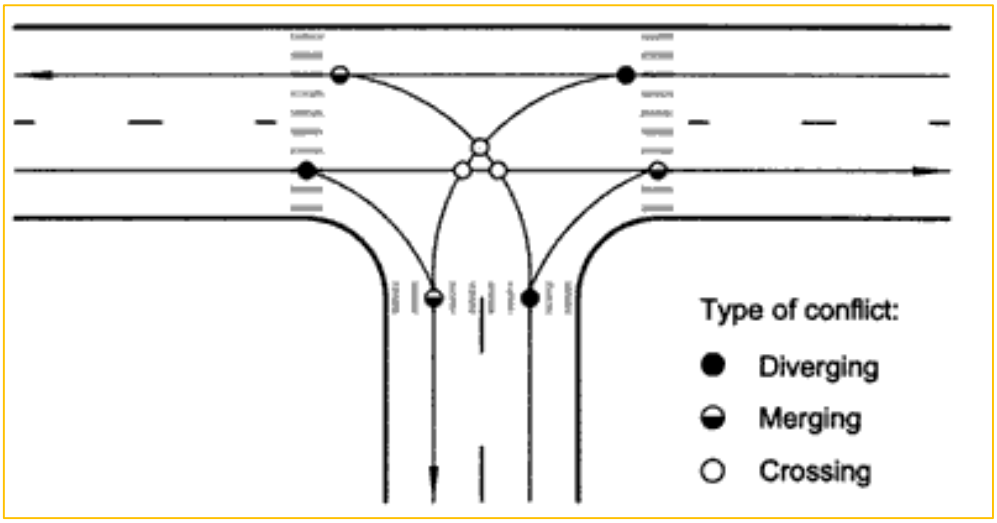

Fig.1. Traffic Conflict at three-legged Signalised Junction

Vehicle path usually executed by the driver based on their preferences to get a smooth path. In order to get a smooth path, the driver will execute the lane changing where it will lead to create a traffic conflict. To avoid collision, road users need to follow their path to reduce conflict point [3]. However, Mulyadi and Amelia [7] stated that motorcycle tends to do disorderly movement when approaching at signalised junctions. This disorderly movement will cause traffic conflict between motorcycle and other types vehicles. The basic difference in the movement of a car and that of a motorcycle relates to lane-based and non-lane-based movements, respectively. A car and other types four (4) wheel vehicles usually follow the lane-based movement and seldom changes lanes but a motorcycle frequently changes direction, especially under congested conditions [8]. Therefore, types of traffic movement have to be evaluated to determine the safe path of the vehicle.

2. Study Objective

Therefore, types of traffic movement have to be evaluated to determine the safe path of the vehicle.

3. Methodology

The data collection was carried out for two (2) hours during peak period and two (2) hours during off-peak period which is 7.00 am – 9.00 am and 10.00 am – 12.00 pm respectively. The selected junction was located in Selangor, Perak and Johor (the state with high road crash statistic). In this study, a video camera was utilised to observe the traffic at the signalised junction. The placement of the video camera during data collection is shown in Figure 2.

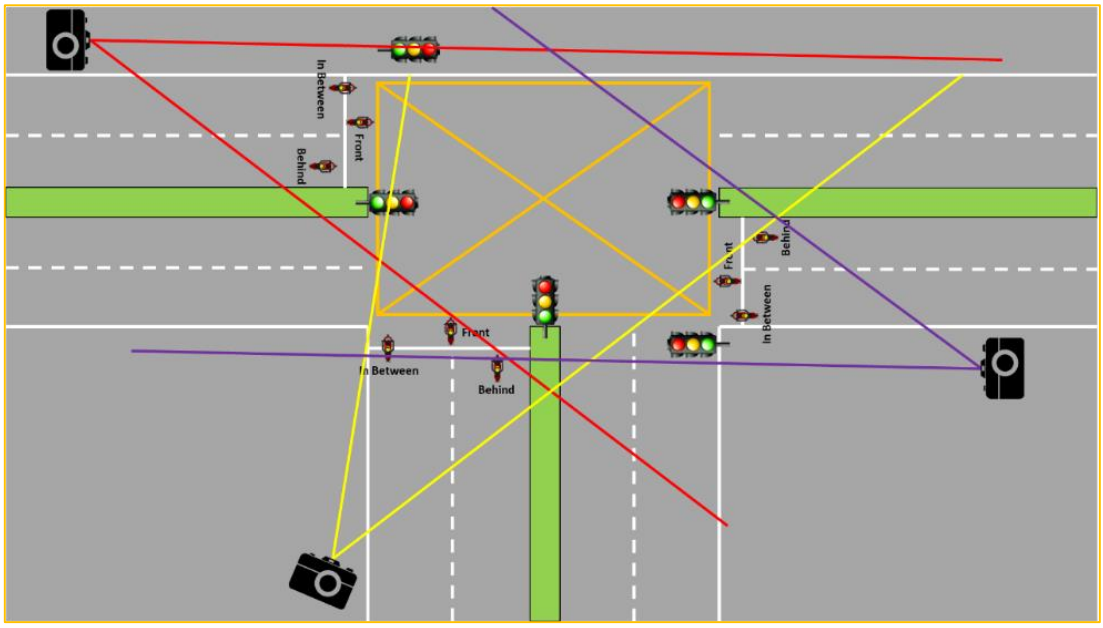

Fig.2. Visual of Video Camera Positioning During Data Collection

Vehicle movement path at the signalised junction should follow the lane-based rule to prevent conflicts between vehicles. During the movement from one (1) leg to another leg, vehicle on the left lane should go to the left lane and from right lane to the right lane of another leg respectively. In this study, the motorcycle was observed from their stopping position to their preferred lane on another junction leg. Ideally, a vehicle should move from one (1) leg to another leg in a straight path without changing lane or from the slow lane to slow lane or from the fast lane to fast lane. Figure 3 shows the possible motorcycle path for the straight direction which is from leg 2 to leg 3 and vice versa. While Figure 4 shows the possible path for turning movement which is from leg 3 to leg 1 and leg 1 to leg 2.

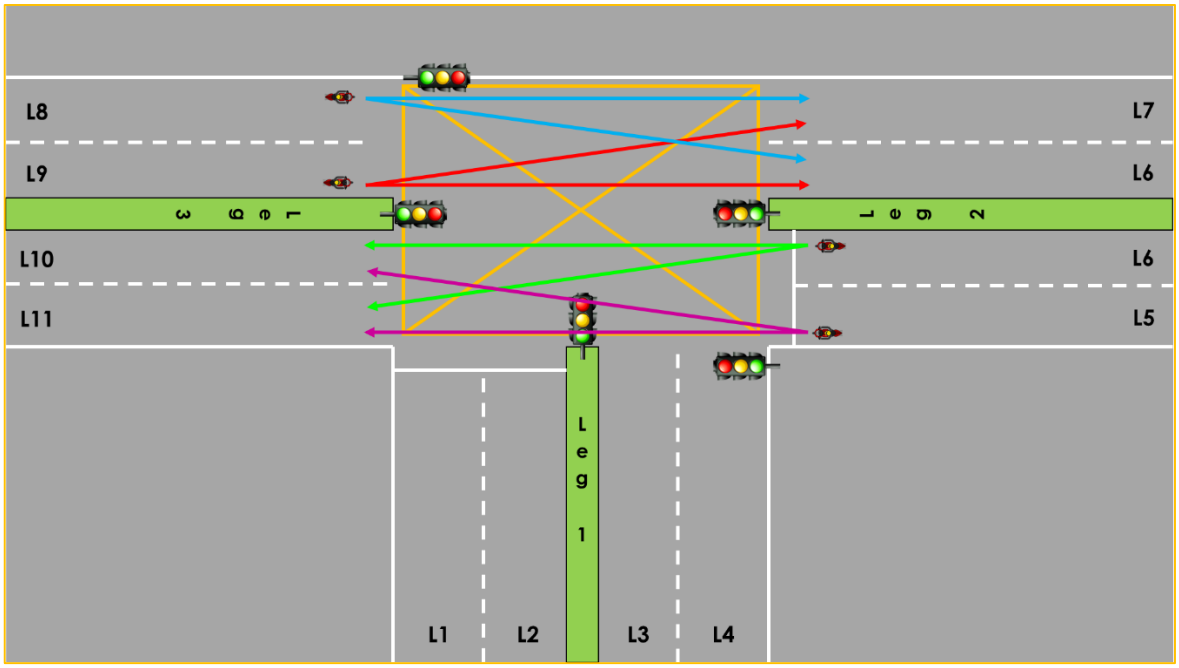

Fig.3. Observing Motorcycle Path for Straight Path at Three-legged Signalised Junction

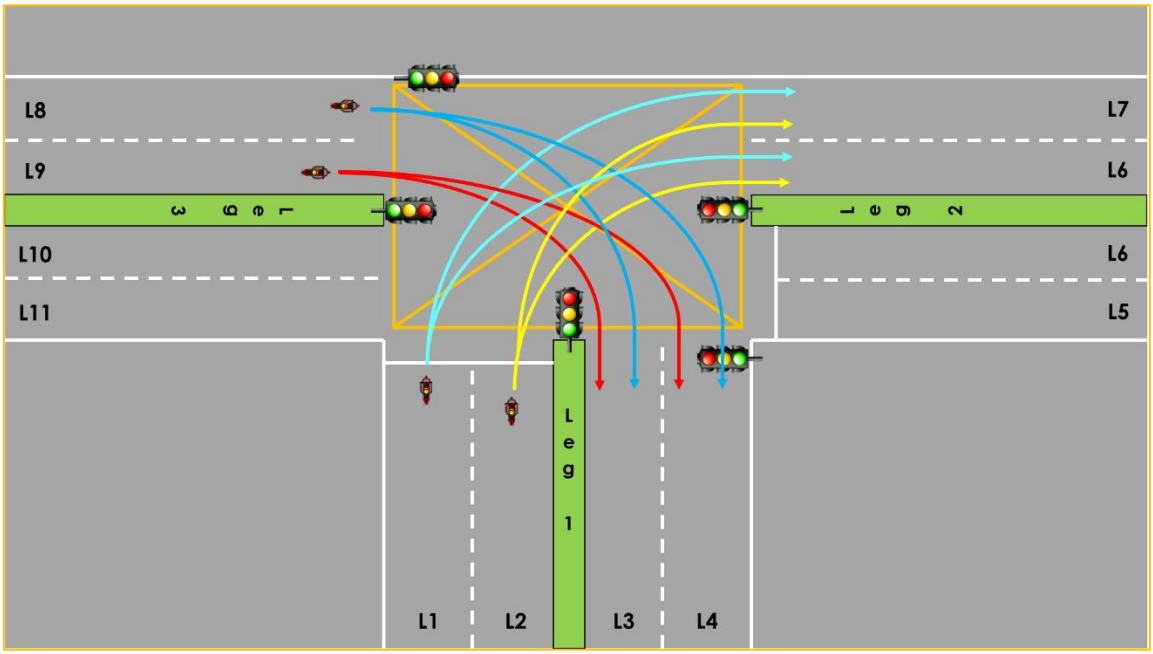

Fig.4. Observing Motorcycle Path for Turning Path at Three-legged Signalised Junction

4. Results and Discussion

This study observes the motorcycle path during peak and off-peak hour manually on site. The analysis also differentiates the direction of traffic turning (from Leg 1 to Leg 2 and Leg 3 to Leg 1) or straight (Leg 2 to Leg 3 and Leg 3 to Leg 2) as shown in Figure 5 and Fig 6 respectively. The observation for motorcyclist from the Leg 1 to Leg 3 is not carried out because one (1) of the locations allowing authorised left turn on red. To synchronize the data, this movement was not evaluated in this section.

4.1. Turning Direction

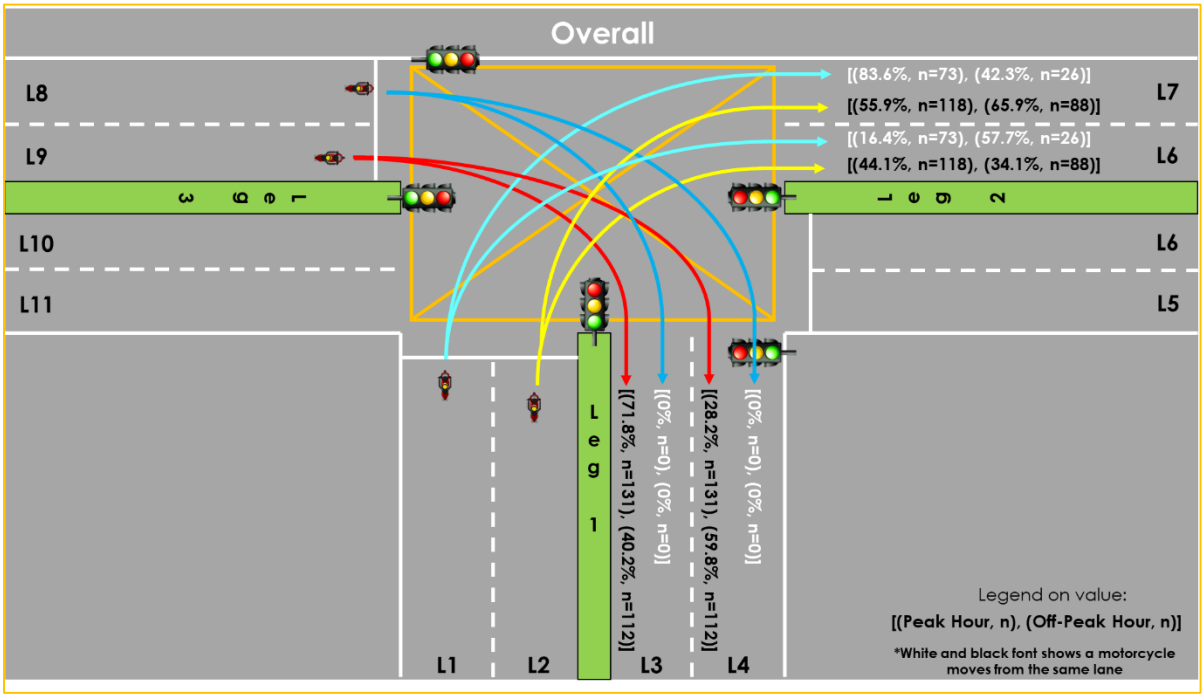

Fig.5. Motorcycle Path for Turning Movement

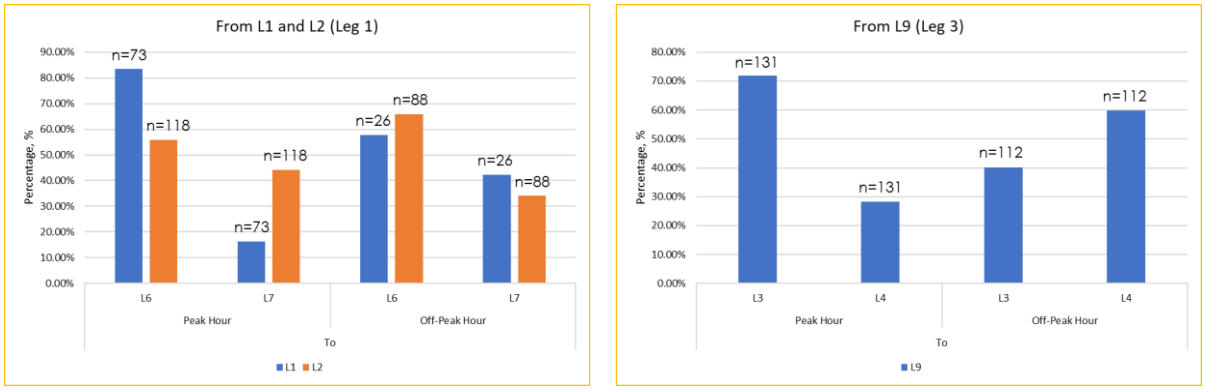

Fig.6. Bar Chart Perspective on Motorcycle Path for Turning Movement

For traffic direction from Leg 1 to Leg 2, during peak hour, majority of motorcycle from L1 will arrive on the L7 with 83.6% (n=73) and only 16.4% (n=73) arrived on the L6. On the other hand, 55.9% (n=118) of motorcycle from L2 arrived on the L7 and 44.1% (n=118) arrived on L6. The motorcycle that chooses path L1-L6 and L2-L7 were changing lane during crossing the intersection. Overall, most motorcycle chooses to arrive on the L7 which is slow lane when turning into Leg 2 (major road).

During the off-peak hour, the percentage of motorcycle choose path L1-L7 and L1-L6 is almost the same with 42.3% (n=26) and 57.7% (n=26) respectively. However, for the motorcycle from L2, 65.9% (n=88) arrived on L7 and 34.1% (n=88) arrived on L6. The off-peak hour trends also show that most motorcycles from L2 chosen to arrive on L7 (slow lane). Overall, for turning traffic from Leg 1 (minor road) to Leg 2 (major road), a high percentage of motorcycles took the path from L2 (67.5%, n=306) was observed during peak hour and off-peak hour.

Furthermore, for traffic direction from Leg 3 (major road) to Leg 1 (minor road), during peak hour, majority of motorcycle from L9 arrived on L3 with 71.8% (n=131) and only 28.2% (n=131) arrived on L4. On contrast, during the off-peak hour, the percentage of motorcycle arrived on L4 is 19.6% higher than the percentage of motorcycle arrived on the L3. From the observation, none of the motorcycles was chosen L8 to turn into Leg 1 whether during peak and off-peak hour. This is because L8 usually designated for straight direction and L9 for turning movement. The turning movement from Leg 3 (major road) to Leg 1 (minor road) usually under lower speed and lower number of vehicles that caused lesser interaction between vehicle. Also, as the starting point to turn is only from one (1) point which is L9, it can be concluded that the movement from L9 to L3 and L4 is safe for motorcyclist.

It is also interesting to highlight that the path selection for a motorcycle from the major road to the minor road is different from minor road to major road. From the major road (Leg 3), it was observed that most of the motorcycle arrived to the L3 of minor road (Leg 1) which is to the fast lane. It is vice versa with minor road (Leg 1) to major road (Leg 2) where it was found that most of the motorcyclist arrived on the L7, which is the slow lane. This circumstance might be occurred due to different speed limit between major and minor road. Minor road usually has a lower speed limit than the major road because minor road at three-legged signalised junction usually connecting residence area and commercial area. At this area, both lanes have a slower speed which caused motorcycle preferred to choose both lane as destination (L3 and L4). While at major road, on the left lane (L7) usually have a lower speed compared to right lane. It caused majority motorcyclist choose to stay on left lane when arriving to major road. It can be concluded that, this pattern occurred due to behaviour of the motorcyclist that tend to stay at the slower speed lane of the leg that involved turning movement.

4.2. Straight Direction

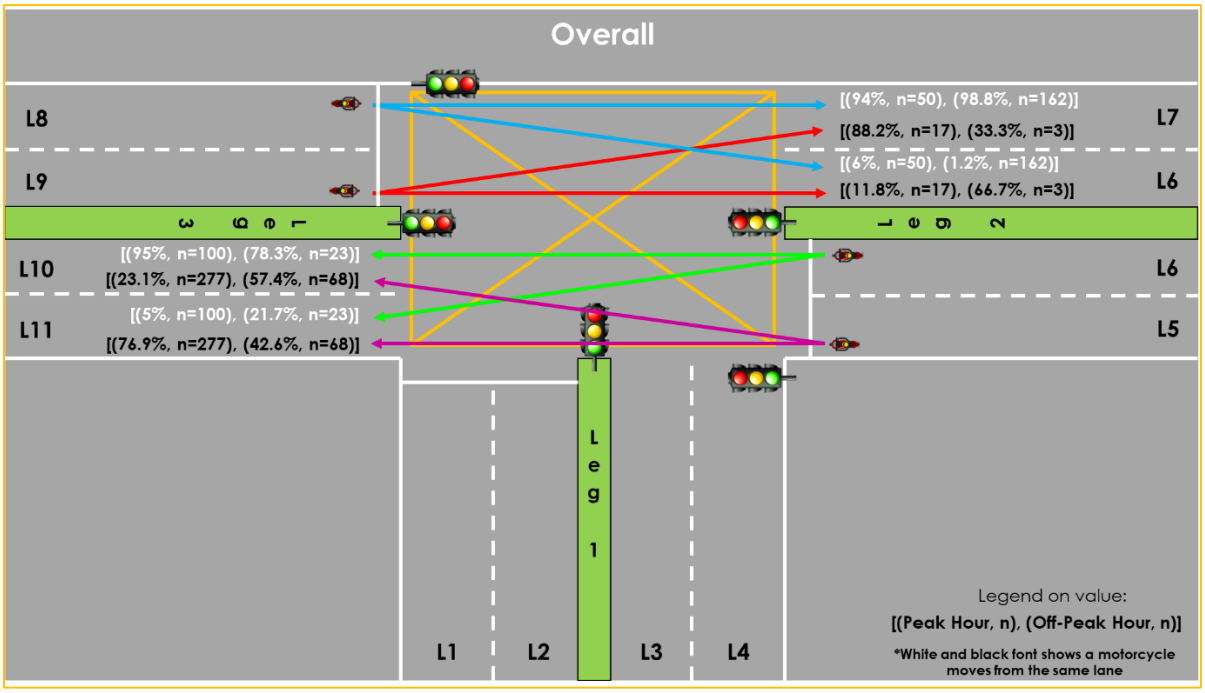

Fig.7. Motorcycle Path for Straight Movement

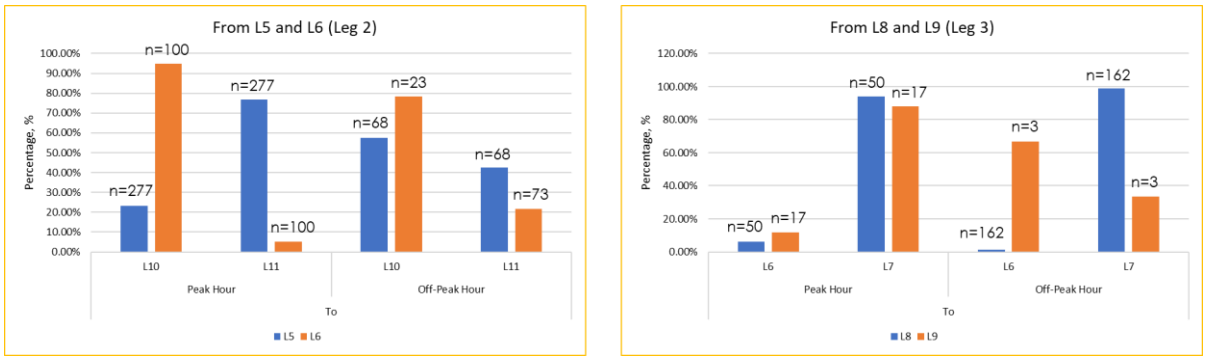

Fig.8. Bar Chart Perspective on Motorcycle Path for Straight Movement

For the straight movement from Leg 2 (major road) to Leg 3 (major road), the majority of the motorcycle choose L5 to go to the Leg 3 with 73.7% (n=468). During peak hour, 76.9% (n=277) of the motorcycles from L5 going straight to L11 and 23.1% (n=277) changing lane to L10 during crossing the junction. While for the motorcycle from L6, almost all of the motorcycle going straight to L10 with 95% (n=100) and only 5% (n=100) changing lane into L11. It shows that during peak hour, motorcycles tend to follow the lane continuity and not changing lane while crossing the junction on the green phase.

During the off-peak hour, for the motorcycle from L5, the percentage of the motorcycle arrive on L10 and L11 are equally the same with 57.4% (n=68) and 42.6% (n=68) respectively. While for the motorcycle from L6, the majority of the motorcycles choose to arrive on L10 with 78.3% (n=23) and this trend is similar to during peak hour. The findings show that changing lane behaviour is more prominent during the off-peak hour. It is occurred due to behaviour of the motorcyclist that tend to fill in the available gaps which much more exists during off-peak hour because of the lower number of traffic volume compared to peak hour.

For the straight movement from Leg 3 (major road) to Leg 2 (major road), there is a small number of motorcycles that chose L9 to go straight whether during peak and off-peak hour. This is because L9 usually designated for turning movement into Leg 1. During peak hour and off-peak hour, almost all motorcyclist follows the lane continuity by going straight from L8 to L7 with 94% (n=50) and 98.8% (n=162) respectively. The other 6% (n=50) and 1.2% (n=162) during peak and off-peak hour respectively do lane changing to L6 while crossing the junction. On the other hand, during peak hour, majority (88.2%, n=17) of motorcycles on the L9 change lane while crossing and arrived on the L7. Even though L9 usually designated for turning movement, some of the motorcyclist also tend to stay on that lane to moves straight. During an off-peak hour, the number of motorcycles that use the L9 is too small i.e. 3 motorcycles and not included in this study. Therefore, it shows that majority of the motorcyclist using the L8 for a straight movement from Leg 3 (major road) to Leg 2 (major road) by moves straight to the slow lane of the adjacent leg without changing lane. However, even the motorcyclist stays on the L9, the motorcyclist tends to changing lane to slow lane of the adjacent leg. It shows that slow lane is a preferred lane for motorcyclist when moving from Leg 3 (major road) to Leg 2 (major road).

5. Conclusions

Motorcycle path observed in this study referred to the path taken by the motorcycle when they start moving from one (1) leg to another leg of the junction. For the turning movement, most of the motorcycles tend to choose the slow lane on the arrival leg. While for the straight movement, the motorcycles have a propensity to choose faster lane regardless of staying on the same lane or do lane changing. The movement from one (1) leg to another leg should be executed without a changing lane to ensure the safety of vehicle movement at three-legged signalised junction always at the highest level. This is because, the disorderly movement by motorcycles may create traffic conflict at the junction and may lead to a crash.

Acknowledgements

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