Jurnal Kejuruteraan SI 3(1) 2020: 83-88
https://doi.org/10.17576/jkukm-2020-si3(1)-13

Turn Signal Use among Motorcyclists in Klang Valley, Malaysia: A Case Study

Aqbal Hafeez Ariffin[a]*, Azhar Hamzah[a], Mohd Syazwan Solah[a], Noor Faradila Paiman[a], Muhamad Syukri Abdul Khalid[a], Noradrenalina Isah[a], Khairil Anwar Abu Kassim[a], Siti Zaharah Ishak[a], Hisashi Imanaga[b] & Hajime Ishida[c]

[a] *Malaysian Institute of Road Safety Research (MIROS), 43000 Kajang, Selangor D.E., Malaysia*
[b] *Japan Automobile Research Institute (JARI), Tsukuba, Ibaraki 305-0822, Japan*
[c] *Japan Automobile Manufacturers Association, Inc. (JAMA), Minato-ku, Tokyo 105-0012, Japan*

**Corresponding author: aqbal@miros.gov.my*

Received 02 December 2019, Received in revised form 26 May 2020
Accepted 20 June 2020, Available online 30 September 2020

ABSTRACT

Road crashes are serious concerns globally as they claim and cause more than 1.35 million fatalities and up to 50 million resulted injuries each year, respectively. Previous studies showed that the causes of road crashes are multifactorial, with human error contributed to approximately more than two-thirds of all road crashes, particularly in developing countries. One of the primary causes of vehicle crashes is failure to use turn signals by motorists. Although several studies have explored the use of turn signal among motorists in developed countries, limited studies have examined such risky behavior in developing countries, especially Malaysia. This paper aims to investigate the prevalence and characteristics of turn signal use among motorcyclists especially when changing lanes and turning at intersections, in Klang Valley, Malaysia. Video data of motorcycles in road traffic were recorded via instrumented research vehicle which made routine trips along selected driving routes in Klang Valley. The driving routes encompassed expressway, mixed with urban and interurban roads, as well as rural roads. The results reveal a significantly low overall percentage usage rate of turn signal among the observed motorcyclists at 41.1%. Furthermore, 60.9% of motorcyclists failed to signal when changing lanes, and 56.5% disregarded them while turning at intersections. The findings provide vital information to the authority to develop proper policy and propose measures to increase compliance of turn signal use among motorcycle motorcyclists such as more targeted enforcement, widespread road safety campaigns and mandated utilization of technology-based solutions.

Keywords: Motorcyclists; turn signal use; direction indicator; traffic safety; crash prevention; Malaysia

INTRODUCTION

ROAD CRASHES AND CAUSAL FACTORS

According to the recent data released by the World Health Organization (WHO) in 2018, about 1.35 million people are killed and up to 50 million injured each year as a result of road crashes worldwide. From the figure, more than 50% of road deaths are vulnerable road users, which include motorcyclists. The road safety situation in Southeast Asia (SEA) is also alarming, with the region recorded the second-highest rate of road death per 100,000 population (by WHO region definition) after Africa (WHO 2018). With a high proportion of motorcycles on roads, more than 43% of road deaths in the SEA region were those of motorcycle users.

In Malaysia, approximately more than 6,000 road deaths were registered yearly, with around 60% fatalities were of motorcyclists (Abdul Manan & Várhelyi 2012; RMP 2019). This situation is worrying as motorcycles accounted for nearly 45% (as in Jan-Feb 2019) of the total registered vehicles (RSD 2019). Among the main factors associated with motorcycle crashes are poor conspicuity and visibility due to their small size making them much harder to be detected by other road users (Radin Umar et al. 1995; Solah et al. 2013; Rahman et al. 2014; Micucci et al. 2019).

Previous studies showed that road crashes are caused by multiple factors that involve human error with the interactions of vehicle and roadway factors (Robertson 1992; Shankar & Mannering 1996; Hendricks WHO 2006; Mohanty & Gupta 2015). In many road crashes, human-related errors and deficiencies were the most frequently cited as the probable causal factors (Hurt et al. 1981; Petridou & Moustaki 2000; Green & Senders 2006; NHTSA 2008; Adanu & Jones 2017). Research also shown that majority of road crashes, especially in developing countries, were due to human error (TRL 1990; Gopalakrishnan 2012). Some examples of human errors and deficiencies that led directly to road crashes include inattention/distraction, driver's faults, and lack of skills. Ponziani (2012) in his study revealed neglecting the use of turn signals as one of the primary causes of vehicle crashes (estimated 2 million road deaths) and resulted in higher crash rates than distracted driving, for example, texting or using cell phones.

TURN SIGNAL, LEGISLATION AND USE RATE

Turn signal, or also known as "direction indicator" or "blinker," is one of the operational lighting and signaling devices required to be installed as a standard feature on a modern automotive vehicle. It is generally activated manually by the motorist or motorcyclist and functions by flashing to indicate that the vehicle is turning left or right or changing lanes towards one side. The indication alerts other motorists or riders of the vehicle's intention, thus providing time for them to make any necessary adjustments. At the same time, it increases conspicuity and safety, especially for motorcycles, which enable them to be seen by other motorists. This condition indirectly may reduce the risk of crash-related injury.

The use of proper turn signal to indicate lane change or turn is regulated by law in many countries worldwide. Nevertheless, the actual usage varies greatly amongst countries without compromising its purpose. In many states in the U.S., a signal is required whenever a driver is turning from a direct line or changing lanes (Fox Business 2012). Moreover, in some states, this turning movement must be made in a safe situation within a sufficient distance prior to the turn. For example, in Ohio and Texas, signaling must be continuously given 100 feet before turning to warn traffic (Ponziani 2012; Ohio Revised Code n.d.; Texas Public Law, n.d.).

Though usually a minor traffic violation, failure to signal would result in a penalty, which is varied by state in the U.S. and would raise vehicle insurance rates (Fox Business 2012; InsuranceNewsNet 2013). The use of turn signal when turning is also mandatory in Vietnam as required by the law (Nguyen-Phuoc et al. 2019). As for in Malaysia, a turning movement made must be indicated with a turn signal. This is in accordance with the Road Traffic Rules 1959 (LN 166/1959) (Laws of Malaysia 2008).

Although the device has become standard safety feature on all motor vehicles and despite signaling use being enforced by law in many countries, the use rate of turn signal among car drivers and motorcycle riders is still low based on a handful of studies. An observational study in Dayton, Ohio, US revealed 48% of drivers failed to signal when changing lanes and 25% disregarded them while at intersections (Ponziani 2012; Fox Business 2012). Nguyen-Phuoc et al. (2019) conducted cross-sectional roadside observation surveys to investigate the prevalence of turn signal use when turning at intersections among car drivers and motorcyclists in Danang, Vietnam. Based on the surveys, the overall prevalence of signal use among observed drivers and motorcyclists was around 44%. A study conducted in China investigated turn signal use when changing lanes (Zhang et al. 2006). The results revealed average turn signal use recorded was only 40% of the time. Another study involving more than 5,600 turning vehicles at a variety of intersections was carried out in British Columbia, Canada (Faw 2013). The overall signal use rate recorded was around 76% though the use rate occurrence varied widely with a range of 54-95%.

Several factors were identified to influence signal use rate and these include type of road, direction of turn, presence of forward vehicles, and behavior of other vehicles. However, studies revealed age and gender as insignificant predictors of whether a turn will be signaled. Faw (2013) in his study revealed an impressively high signal rate of around 95%, was observed among Canadian drivers turning left, which is a much more dangerous move as compared to those turning right. In addition, the study showed that drivers, either consciously or subconsciously, might be influenced by the driving behavior of other cars.

In a naturalistic study carried out in the U.S. on factors influencing turn signal, drivers were observed to behave better when there are more cars around (Sullivan et al. 2015). It was also revealed that drivers are 5 times more likely to signal on a major or minor surface road rather than on a local road based on the findings where less signaling were observed on low traffic volume roads.

MOTIVATION OF STUDY

Many local studies related to motorcycle safety had focused on crash rates and risks, riding behavior, traffic violation, licensing, personal protective equipment (PPE) performance and use, effectiveness of safety technology (e.g. airbag, antilock braking systems), conspicuity and visibility, and so on (e.g. Law et al. 2003; Abdul Manan & Várhelyi 2012; Solah et al. 2013; Hamzah et al. 2014; Rahman et al. 2014; Ariffin et al. 2016). Nonetheless, at present, it seems that limited studies have been carried out concerning turn signal use among motorcyclists in developing countries with high motorcycle volume, especially in Malaysia.

Previous related field study on local situation only investigated motorcyclists' turn signal use at different access points on straight primary road sections. In the study, motorcyclists were observed poor at using turning indicator with the recorded usage rates ranging from as low as 6% to 19% (Abdul Manan & Várhelyi 2015). Despite the frequency, however, a comprehensive study on characteristics of turn signal behaviors among motorcyclists is still inadequate. Thus, this study was conducted to investigate further and compare the prevalence and characteristics of turn signal use among motorcyclists that include turning at intersections and lane-changing movements.

METHODOLOGY

DATA COLLECTION

The data employed for this study was collected via a video recording method. Video data of motorcycles in mixed-traffic environment along selected driving routes were recorded via instrumented research vehicle (IRV) equipped with high definition cameras (Figure 1). The data collected is considered dynamic data in a naturalistic setting which is more or less similar to data collected as per the study conducted by Ponziani (2012). Throughout the data

collection, the observer was driving in a vehicle along the selected route. This method differs with other observational studies in which the observer was usually stationed on fixed or stationary location at any particular intersection during data collection.

The driving routes comprised public roadways, with a combination of expressway, urban and interurban roads, as well as rural roads. The routes passed through urban (city), suburban and rural areas with an abundant volume of motorcycles available for video records. Data collection for each route was carried out for five days (weekdays). The data were collected during peak and relax hours that include morning, afternoon, and evening time. Two routes were surveyed and selected for the study, with Kajang being selected as the starting point for both routes. Details of each route are as follow:

1. Route 1: Kajang – Cheras – Kuala Lumpur – Sungai Buloh
2. Route 2: Kajang – Cheras – Ampang – Hulu Kelang – Selayang

The IRV made four journeys (including return trips) per day for data collection with each journey took about two to three hours to complete depending on traffic and weather conditions.

DATA ANALYSIS

Video records were gathered and analyzed for the prevalence of turn signal use rate. Prior to that, a paper-based form consisting of chart was developed to assist in the recording of the information related to the prevalence and characteristics of motorcycle's turn signal use. All motorcycles observed making turn at intersections and changing lanes, whether signaling or not, were then recorded into the forms. In addition, other information relating to occupant demographic profile (gender, presence of pillions), type of motorcycle, road environment (type of carriageway, number of lanes, type of intersection, location), time of day and weather conditions were also recorded. So as to achieve utmost accuracy, observation was carried out without having the observed motorcyclists aware that they were being studied.

For this study, a "turn maneuver" is defined as a clear movement of a motorcycle making right or left turn at an intersection. Whereas, a "lane change" is defined as a motorcycle moving from one lane to another, crossing a white solid or dashed painted roadway line. However, any motorcycle observed weaving or lane splitting through traffic was not considered and opted for analysis. All data recorded in the forms were then transferred into the computer for further analysis.

FIGURE 1. Examples of video images captured by the IRV (left: changing lane movement; right: turning at intersection movement)

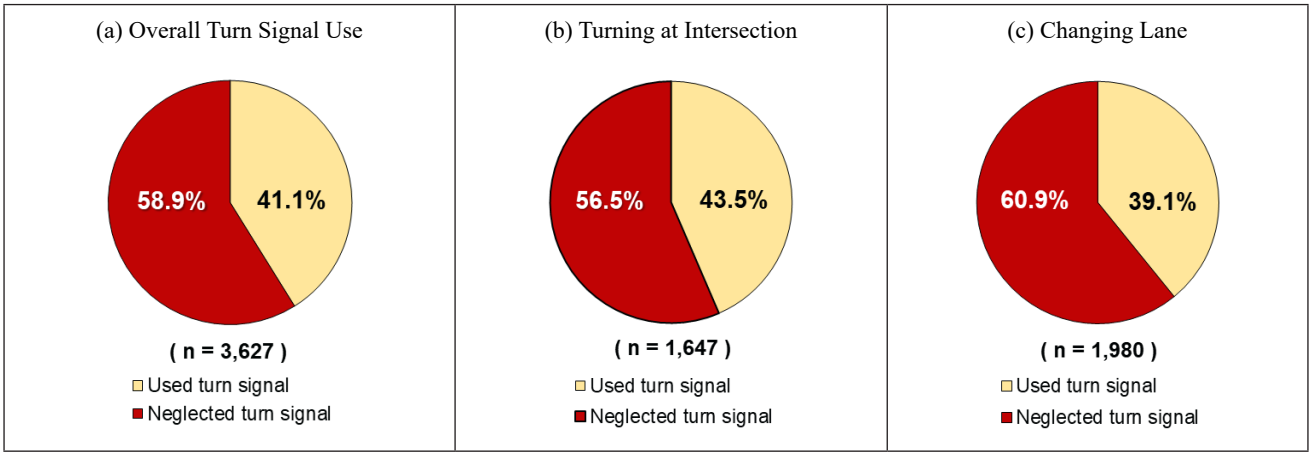

FIGURE 2. Prevalence of turn signal use rates: (a) overall; (b) turning at intersection; and (c) changing lane

TABLE 1. Turn signal use rates (%) among motorcyclists for turning at intersections and lane-changing movements

Variables	Turning at intersections			Changing lane		
	n_t	n'_t	Rate (%)	n_c	n'_c	Rate (%)
Overall	1,647	717	43.5	1,980	775	39.1
Gender						
Male	1,529	653	42.7	1,799	669	37.2
Female	118	69	58.5	186	99	53.2
Carrying pillion						
Yes	140	58	41.4	111	60	54.1
No	1,507	659	43.7	1,869	715	38.3
Turn direction						
Left	468	194	41.5	897	315	35.1
Right	1,179	523	44.4	1,011	391	38.7
Type of intersection						
Signalized	1,108	496	44.8	-	-	-
Unsignalized	539	221	41.0	-	-	-
Type of carriageway						
Single carriageway	569	219	38.5	1,858	733	39.5
Dual carriageways	1,078	498	46.2	122	42	34.4
Number of lanes						
2	821	347	42.3	687	276	40.2
3	517	230	44.5	1,026	396	38.6
4	309	140	45.3	267	103	38.6
Type of location						
Urban	966	460	47.6	1,282	535	41.7
Suburban/rural	681	257	37.7	698	240	34.4
Time of day						
Dawn/dusk	538	271	50.4	701	241	34.4
Daylight	641	235	36.7	625	186	29.8
Night	468	211	45.1	654	348	53.2
Weather condition						
Dry (fine)	1,623	705	43.4	1,878	751	40.0
Wet (raining)	24	12	50.0	102	24	23.5

Note:
n_t, n_c – total number of observed motorcyclists turning at intersections and changing lane, respectively.
n'_t, n'_c – total number of motorcyclists using turn signals.

RESULTS AND DISCUSSION

A total sample of 3,627 motorcyclists were observed executing turns and lane changes that met the study criteria. Furthermore, 1,980 (54.6%) and 1,647 (45.4%) motorcycles were observed changing lanes and turning at intersections, respectively. Of the total data points gathered, 1,492 (41.1%) motorcycles were observed using turn signal either during executing a turn or switching lane. For the observed lane changing motorcycles, 775 (39.1%) were observed executing turn signal use to indicate lane change while the remaining 1,205 motorcycles (60.9%) were observed otherwise. Of the 1,647 observed motorcycles making turn at intersections, 717 (43.5%) motorcyclists were observed signaling to indicate a turn and 930 (56.5%) were observed neglecting it. Figure 2 summarizes the prevalence of turn signal use rate. Table 1 provides and compares additional descriptive statistics of the sample related rates that are classified by a number of predetermined variables such as gender, location type and time of day.

Based on the overall prevalence, signaling use rate by motorcyclists when making turn at intersection were observed higher as compared to when changing lane. However, this does not mean turning at intersection is riskier and requires more cautious action to execute than changing lane as indicated by the higher usage rate. Both maneuvering actions are risky and exposed to conflicts with other traffic flow, thus require the motorcyclist's full attention. This may be attributed to the motorcyclists having ample time to plan early when approaching the intersection to make turn as against lane change where many motorcyclists were observed executing it spontaneously.

Different turn signal use rate was observed in a field study by Ponziani (2012). He reported more vehicles were observed exercising signaling when executing a turn (74.6%) in contrast to when switching lane (51.7%). Nevertheless, generalization is inappropriate since the subjects being studied (include trucks, cars, buses, motorcycles, etc.) differ from this study that focused solely on motorcycles. Hence, further studies are needed to gain an understanding of motorcyclists' behavior in such situation.

From Table 1, female motorcyclists had greater proportion of turn signal use than male motorcyclists for both turning movements: 58.5% vs. 42.7% for turning at intersections and 53.2% vs. 37.2% for changing lane. This suggests higher compliance level among females than males

as observed in previous study (Nguyen-Phuoc et al. 2019). In term of carrying pillion, more motorcyclists who rode with pillions used turn signals when changing lane (54.1%). However, the prevalence was greater while riding alone for turning at intersections (43.7%). The prevalence of turn signal use for both turning movements were higher for right turn (44.4% and 38.7%) than left turn.

Higher turn signal use rates among motorcyclists were observed at signalized intersections (44.8%) compared with unsignalized intersections (41.0%). This is most likely associated with the presence of traffic lights. The impact of type of carriageway and number of lanes on turn signal use rate were different between turning at intersections and changing lane. The use of turn signals when executing a turn was generally found to increase with the increase in the number of lanes. Nonetheless, this was not the case for switching lane movement.

As expected, turn signal uses were significantly higher for both turning movements in roads within urban area compared to roads within suburban/rural location. This may be due to higher traffic volumes in the urban area which require the motorcyclists to activate turn signals to alert other road users of their intention of maneuvering turn movement. The result seems to be consistent with Sullivan et al. (2015) and Nguyen-Phuoc et al. (2019), but differs from the findings reported by Faw (2013).

Motorcyclists were more likely to activate turn signals during dawn/dusk and night as compared to daylight. A possible explanation is inadequate visibility due to low light conditions during these times, which might reduce motorcyclists' conspicuity, leading to higher activation of turn signal. The prevalence of turn signal use in wet weather condition was higher for turning at intersection (50.0%) but lower for changing lane (23.5%).

CONCLUSION AND RECOMMENDATIONS

Motorcyclists are constantly exposed to higher risk of injury and fatality on the road as compared to other road users. Previous studies showed that the risk of motorcyclists being involved in road crashes can be reduced by improving their safety and visibility. One of the ways to avoid road crashes is by using turn signals to communicate with other motorists or motorcycle riders of the intention to turn. Turn signal is the only predictor of where a vehicle wants to go either turning into an intersection or a parking lot, entering into or exiting from a roundabout, changing lanes on the roadway, or pulling out of roadside. Signaling is essential for safe driving and riding, and it is required to be used by law in many countries globally.

This study is the first attempt to investigate characteristics of motorcycle turn signal use in mixed-traffic environment on local situation, by utilizing naturalistic riding data recorded by an IRV. The study has given significant insights on the prevalence of motorcycle-signaling usage in Klang Valley where high motorcycle traffic volume dominating the national roads. The findings revealed the overall prevalence of turn signal use when turning at intersection and switching lane is significantly low with only 41.1% of the time. Based on the observed motorcyclists, turn signal use for maneuvering a turn at intersection and changing lane were found to be 43.5% and 39.1%, respectively. This indicated that more than half of the total observed motorcyclists neglected signaling throughout the study period which is a disturbing road safety problem for the nation. This alarming situation requires special attention and cannot be tolerated so as to reduce possible road deaths and associated injuries. The findings from the current study indicate that further research should be directed to exploring factors associated with turn signal activation, not only focusing on motorcyclists, but also on other motorists.

The findings provide important information to the authority to develop proper policy and propose measures to increase turn signal use among motorcyclists. This will indirectly increase their visibility and safety, thus prevent potential road crashes. Among the proposed measures include widespread road safety campaigns to educate motorcyclists and raise their awareness the importance of turn signal use, and strict and more targeted police surveillance and enforcement to increase compliance among them. In addition, innovative approaches are required to ensure continual improvement of regulatory compliance.

Correct use of turn signal is vital for avoiding road crashes. Since conventional turn signal only works manually, it is important to have an intelligent safety feature that can ensure motorists or motorcycle riders signal at all turns and assure appropriate auto deactivation after each turn or lane change. This can be realized through utilization of technology-based solutions via intelligent turn signals to rectify signaling neglect caused by human error and distraction. Though the technology is already at hand, some manufacturers have started to look into such system. It is just a matter of time before the system can be readily made available as standard fitment on all vehicles, particularly on motorcycles. So as to improve signaling use, the government push to regulate intelligent turn signal is required and therefore should not be delayed.

DECLARATION OF COMPETING INTEREST

None.

ACKNOWLEDGEMENT

This study used data extracted from MIROS-JAMA-JARI collaboration research project of motorcycle traffic analysis in Klang Valley (Research Grant: EN101107). The study has been carried out with the motivation from various individuals who have contributed either directly or indirectly, towards its completion and the development of this paper.

REFERENCES

Abdul Manan, M.M., & Várhelyi, A. 2012. Motorcycle fatalities in Malaysia. *IATSS Research* 36: 30-39.

Abdul Manan, M.M., & Várhelyi, A. 2015. Motorcyclists' road safety related behavior at access points on primary roads in Malaysia – A case study. *Safety Science* 77: 80-94.

Adanu, E.K., & Jones, S. 2017. Effects of human-centered factors on crash injury severities. *Journal of Advanced Transportation* 2017: 1-11. https://doi.org/10.1155/2017/1208170

Ariffin, A.H., Solah, M.S., Hamzah, A., Md Isa, M.H., Mohd Jawi, Z., Md Yusoff, N.I., & Hainin, M.R. 2016. Exploratory study on airbag suitability for low engine capacity motorcycles. *Jurnal Teknologi* 78(4): 65-69.

Clayton, M. & Myers, E. 2008. Increasing turn signal use by drivers exiting a university parking garage: A comparison of passive and mediated prompting. *Journal of Organizational Behavior Management* 27: 53-61.

Faw, H.W. 2013. To signal or not to signal: That should not be the question. *Accident Analysis and Prevention* 59: 374-381.

Fox Business 2012. Half of drivers don't use turn signals. https://www.foxbusiness.com/features/half-of-drivers-dont-use-turn-signals

Gopalakrishnan, S. 2012. A public health perspective of road traffic accidents. *Journal of Family Medicine and Primary Care*,1(2): 144-150. 10.4103/2249-4863.104987

Green, M., & Senders, J. 2006. Human error in road accidents. In P.S. Ranade (ed), Road safety management (pp. 57-70). Nagarjuna, Hills: Icfai University Press.

Hamzah, A., Ariffin, A.H., Solah, M.S., & Wong S.V. 2014. Estimating energy absorbing performance of motorcycle safety helmet. *Applied Mechanics and Materials* 663: 574-578.

Hurt, H.H., Jr., Ouellet, J.V., & Thom, D.R. 1981. Motorcycle accident cause factors and identification of countermeasures, Volume 1: Technical report. DOT HS-5-01160. Los Angeles, CA, US: Traffic Safety Center, University of Southern California.

InsuranceNewsNet 2013. Punish texters and spy on drunks, say most drivers in CarInsurance.com survey. https://insurancenewsnet.com/oarticle/Punish-Texters-and-Spy-on-Drunks-Say-Most-Drivers-in-CarInsurancecom-Survey-a-381295#.XR2gKOgzY2w

Law T.H., Lin, X., & Radin Umar R.S. 2003. Factors influencing red light runners among motorcyclists in Malaysia. *Journal of the Eastern Asia Society for Transportation Studies (EASTS)* 5: 2518-2525.

Laws of Malaysia. 2008. Road traffic rules 1959 (LN 166/1959) - As at 15 September 2008. Ampang, Selangor: The Malaysian Current Law Journal (CLJ Law).

Micucci, A., Mantecchini, L., & Sangermano, M. 2019. Analysis of the relationship between turning signal detection and motorcycle driver's characteristics on urban roads; A case study. *Sensors (Basel)* 19(8), 1802: 1-15. *doi: 10.3390/s19081802*

Mohanty, M., & Gupta, A. 2015. Factors affecting road crash modeling. *Journal of Transport Literature* 9(2): 15-19. *doi: 10.1590/2238-1031.jtl.v9n2a3*

Nguyen-Phuoc, D.Q., Tran, A.T.T., De Gruyter, C., Kim, I., & Su, D.N. 2019. Turn signal use when making a turn at intersections among car drivers and motorcyclists – A case study of Da Nang, Vietnam. *Accident Analysis and Prevention* 128: 25-31.

Ohio Revised Code. n.d. 4511.39 Turn and stop signals. *http://codes.ohio.gov/orc/4511.39*

Petridou, E., & Moustaki, M. 2000. Human factors in the causation of road traffic crashes. *European Journal of Epidemiology* 16: 819-826.

Ponziani, R. 2012. Turn signal usage rate results: A comprehensive field study of 12,000 observed turning vehicles. SAE Technical Paper 2012-01-0261. https://doi.org/10.4271/2012-01-0261

Radin Umar, R.S., Mackay, G.M., & Hills, B.L. 1995. Preliminary analysis of motorcycle accidents: Short-term impacts of the running headlights campaign and regulation in Malaysia. *Journal of Traffic Medicine* 23: 17-28.

Rahman, M.K., Solah, M.S., Hamzah, A., Paiman, N.F., Siam, M.F., Ariffin, A.H., Mohamed, N., & Wong S.V. 2014. Visual masking of motorcycle turn signals by amber position lamps. *Australian Journal of Basic and Applied Sciences (AJBAS)* 8(14) Special 2014: 1-6.

Robertson, L.S. 1992. Injury epidemiology. US: Oxford University Press.

RMP. 2019. Statistical report of road accidents Malaysia 2018. Bukit Aman, Kuala Lumpur: Traffic Branch, Royal Malaysian Police (RMP).

RSD. 2019. Road safety statistics book (updated 17 May 2019). Putrajaya: Road Safety Department Malaysia (RSD).

Shankar, V., & Mannering, F. 1996. An exploratory multinomial logit analysis of single-vehicle motorcycle accident severity. *Journal of Safety Research* 27(3): 183-194.

Solah, M.S., Hamzah, A., Ariffin, A.H., Rahman, M.K., & Mohamed, N. 2013. Prevalence study of motorcycle lightings and conspicuity. SAEM 2013-015. In *Proceedings of the Southeast Asia Safer Mobility Symposium 2013*, 64-67.

Sullivan, J.M., Bao, S., Goudy, R. & Konet, H. 2015. Characteristics of turn signal use at intersections in baseline naturalistic driving. *Accident Analysis and Prevention* 74: 1-7.

Texas Public Law. n.d. Texas statutes, Texas transportation code, Sec. 545.104, Signaling turns; Use of turn signals. *https://texas.public.law/statutes/tex._transp._code_section_545.104*

TRL 1990. Road safety in developing countries. Crowthorne: Transport and Research Laboratories.

WHO. 2006. Unit 2: Risk factors for road traffic injuries. In D. Mohan et al. (eds), Road traffic injury prevention training manual (pp. 21-40). Geneva: World Health Organization (WHO).

WHO. 2018. Global status report on road safety 2018. Geneva: World Health Organization (WHO).

Zhang, W., Huang, Y., Roetting, M., Wang, Y. & Wei, H. 2006. Driver's views and behaviors about safety in China – What do they NOT know about driving? *Accident Analysis and Prevention* 38: 22-27.