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Risk of Vehicle Blind Spot towards Motorcyclist Safety in Malaysia: Assessment on Perceptions of Behaviour

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Abstract – *Motorization in Asian countries is growing fast, and the motorcycle is the dominating transport mode. The number of motorcycles per thousand people averaged over several major Asian cities is significantly higher than the average of the rest of the world. With the growing use of motorcycles, road injuries and fatalities are a growing concern in Malaysia and one of its major causes is vehicle blind spots. In this work, we conduct a survey to assess the perception of the behaviour of road users concerning the risk of blind spots towards motorcyclist safety in Malaysia. We asked 397 respondents to classify themselves into one of these driving roles – (1) motorists (those who drive vehicles other than motorcycles), (2) motorcyclists, and (3) dual-role (drives other vehicles and motorcycles). We provide the respondents with 21 questions classified into few categories of assessments including blind spot awareness, blind spot risks, perception of faults in road collisions and near-misses, motorists and motorcyclists' behaviours, perception towards motorists, motorcyclists, and technology used to improve road safety. We found that 98.2 % of respondents are aware of the existence of blind spots on the vehicle and a total of 43 % of respondents agree that they have driving difficulty due to blind spots. Moreover, 75 % of respondents suggest that blind spot is a major contributing factor to road collisions or near-misses, with 63 % of collisions experienced are side collisions. We found that more than 30 % of motorists and motorcyclists believe that motorists are not careful towards motorcyclists' safety. Moreover, 51 % of motorists perceive motorcyclists as not being careful towards their safety, but 40 % of motorcyclists stated otherwise. Dual-role drivers show that they are more cautious towards the safety of fellow motorcyclists than the motorists. More dual-role drivers than motorcyclists suggest that they practice good behaviours in relation to vehicle blind spots while riding a motorcycle.*

Keywords: Vehicle blind spot, motorcyclist safety, perception of behaviour, risk

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1.0 INTRODUCTION

While behind the wheel, a driver needs to pay attention to what other drivers are doing. However, it is not limited to those in front of the vehicle, because the driver must also observe the vehicle behind as well as to either side. Usually, a vehicle is equipped with two side-view mirrors and a rear-view mirror. In spite of that, the vehicle still suffers from blind spots, which is an area that a driver can't see easily from the driver's seat. This made it difficult for the driver to see what the other drivers are doing and often this becomes the root cause of road accidents.

The number of vehicles in Malaysia has increased tremendously because of economic growth and the growing demand for mobility. According to the Malaysia Automotive Association (MAA), the total number of registered vehicles on our roads is about 29 million units (Lee, 2017; Ahmad, 2019). More than 47 % of the total vehicles are motorcycle as it is the most affordable, convenient and preferable mode of transport (Lee, 2017; Motorcycles Data, 2019). In Malaysia, there are 13,826,693 registered motorcycles recorded up to February 2019. These numbers result in this vehicle becomes the second-highest used by the public after a car. As such, there is a growing concern on how safe Malaysian roads are for motorcyclists because the number of fatalities involving motorcycle riders and passengers accounts for more than 60 percent of the 6,742 accidental road death cases in 2018 (MOT, 2016; Malaysiakini, 2019). It is documented that there are 43,031 cases which is almost 62 % of the total. The reasons why this happens are multiple. They are caused by the motorcyclists themselves that speeding and not well maintained their motorcycle. Other than that, it is caused by the condition of the road which is uneven, has potholes and unclear signage. Additionally, blind spots that exist in the car, van and lorry when a driver changing lanes, open the door or stop at sudden also causes to the motorcycle fatal accidents.

Angular or side collision is a type of collision that has the highest number of motorcycle fatalities (Abdul Manan & Várhelyi, 2012). This is due to human behaviour which is the highest factor that contributes to the motorcycle crashes in Malaysia (Sultan et al., 2016; Hamzah et al., 2018), such as sudden change of lanes and direction and given less priority on the road for the motorcyclist, as depicted in Figure 1. Realizing the numbers of motorcycle accidents increase gradually year by year, a solution must be introduced to overcome it. Several enforcement ops and road safety campaigns are already taken by government authorities and non-governmental organizations to fulfil this goal (Mohamad, 2018). However, this study considers the need to use current technology as another method in solving this problem. Apparently, there are several researchers already put efforts to do this through the introduction of technology to combat vehicle blind spot issues (Abu Kassim et al., 2019).

Figure 1: Angular or side collision is most common among motorcyclist fatalities

Wu et al. (2012) propose a real-time embedded blind spot safety assistance system to detect the vehicle or motorcycle appearing in the blind spot area. In the system, an algorithm consists of several techniques namely automatic shadow threshold approach, bright object segmentation, edge feature method, lamp verification, spatial and temporal information tracking procedure is developed. The algorithm is proven works both in detections and false alarms at daytime and night-time conditions. In the meantime, Fernandez et al also design a real-time vision-based blind-spot warning system for motorcycle detection that can be used for daytime and night-time conditions (Fernández et al., 2013). They utilize a camera installed on the side mirror and two different detection methods are introduced for each condition. In the daytime, the optical flow features and Support Vector Machine-based (SVM) classification are used. Meanwhile, for night-time, the headlights detection method is utilized. They claimed this system able to warn a driver when a vehicle is presented at a blind area additionally, the position and type of vehicle can be known.

In terms of driving behaviour, it is known that driving behaviour has a strong correlation with the ability of the driver to assess risks and hazards. For example, a study showed that drivers with a higher ability to recognize hazards tend to reduce their driving speed during lane changes or overtaking motorcycles (Yoshida and Koyanagi, 2018), which led to a lower risk of accidents. It is therefore important to have a thorough investigation on Malaysian road users' perception of hazards and risks that pose an impact on motorcyclist safety, in order to accelerate further studies on solutions to this issue. Additionally, it is also important to note that the ability of road users to assess risks depends on their level of experience, for instance, motorcyclists with actual riding experience have a better capability of assessing hazards and dangerous situations (Rosenbloom et al., 2011). Hence, assessments must include this aspect as well.

Thus, in this paper, a survey was conducted among Malaysians in order to provide insights on how human behaviour is affected by the vehicle blind spots. The purpose of the survey is to assess perceptions of behaviour, particularly towards motorcyclist safety, with additional analysis to compare the results between groups with different driving category and experience. The rest of this paper is arranged as follows: Section 2 outlines the details of the survey conducted. Section 3 analyses and discusses the results obtained from the survey. Subsequently in Section 4, the paper is concluded.

2.0 SURVEY ON THE PERCEPTIONS OF BEHAVIOUR

We defined the respondents as three distinctive groups according to driver roles. Dual-role denotes that the respondent drive motorcycle and other vehicles equally. On the other hand, the motorist role denotes that the respondent only drives vehicles other than motorcycles while the motorcyclist role denotes that the respondent only drives the motorcycle. In this survey, we design the early questions to assess the awareness of the existence of vehicle blind spots among the respondents, as well as the difficulty in driving associated with these blind spots. Subsequently, the respondents give their feedback on their awareness of the existence of technology that can reduce the risk of the blind spot towards motorcyclist safety.

Next, we evaluate the number of collisions caused by blind spots, based on the respondents' own experience. Besides, the respondents give the type of collision they are involved in, as the type of collision can provide information on whether a blind spot is directly or indirectly causing the collision and the blind spot location. In terms of fault leading to the collision, we ask the respondents to choose, who they perceive as at fault in the accidents that

they experienced. Among the choice are either: (1) Motorcyclist; (2) Motorist; or (3) Both equally at fault. Overall, in total, there are 21 questions which are grouped into several types of assessments including blind spot awareness, blind spot risks, perception of faults in road collisions and near-misses, motorists and motorcyclists' behaviours, perception towards motorists, motorcyclists, and technology used to improve road safety. These questions are given in Table 1.

Table 1: 21 questions asked in this survey

No.	Assessment	Questions
1	Blind spot awareness	Are you aware about the existence of blind spots in vehicle?
2		Are you aware that blind spots in vehicle can contribute to accidents?
4		Please choose the location of blind spot that you are aware of
5		Are you aware that several technologies are used in vehicles to reduce risk of road accidents due to blind spots?
6	Blind spot risks towards motorcyclist	I have experienced difficulty in driving due to blind spots
7		Have you ever experienced road accidents or near misses involving motorcyclist?
8		Did this accident or near miss happened due to motorists' blind spots?
9		What type of accidents or near misses have you involved in?
10	Perception of faults	For the following questions, choose one of the most significant accident or near-miss that you have experienced. What is your role during that time?
11		Who is at fault in that accident or near-miss?
12	Motorists behaviour	I check vehicle blind spots before turning
13		I check vehicle blind spots before changing lane
14		I pay attention to the nearby and approaching motorcyclists while overtaking
15		I pay attention to nearby motorcyclists at all time
16	Perception towards motorists	Do you agree that motorists in Malaysia are very careful towards motorcyclists' safety?
17	Motorcyclists behaviour	I pay attention to motorists' blind spots while overtaking them
18		I avoid riding in motorists' blind spots
19	Perception towards motorcyclists	Do you agree that motorcyclists in Malaysia are very careful towards their own safety?
20	Perception towards technology	Do you agree that the use of technologies can help reduce occurrence of road accidents?
21	Suggestion	Please give a suggestion on how to improve motorcyclists' safety in Malaysia

3.0 RESULTS AND DISCUSSION

The results obtained can be divided into four categories, namely: (1) blind spot awareness; (2) cause of collisions; (3) perception of driving behaviour; and (4) technology to improve motorcyclist's safety. In this survey, out of 397 respondents, 291 of them are males, 105 of them are females, and one respondent chose not to disclose the gender. The respondents' driving role and their driving experience are tabulated in Table 2. In terms of driving role, 163 of them assumes dual-role, 141 are a motorist, and 93 are a motorcyclist. Besides, based on the survey, 135 respondents have driving experience of more than 11 years, while 78 respondents have between 4 to 10 years of driving experience. Besides, 93 drivers have between 2 to 3 years of driving experience, and another 66 drivers have less than one year of driving experience. Thus, the majority of respondents come from a group of very experienced drivers where their response can give better insight into assessing the perception of behaviours among road users.

Further breakdown of respondents driving roles concerning gender is given in Figure 2. According to Figure 2, dual-role is dominated by male drivers with 63 male respondents assume dual-role as opposed to only four female respondents assume dual-role. On the other hand, 72 female respondents are a motorist, which is more than male respondent motorists who totalled up to 69. Male respondents dominate motorcyclists with 77 of them are motorcyclists, while only 15 female respondents are motorcyclists.

Table 2: The breakdown of respondents' driving roles

Driving Roles	Number of Respondents	Percentage of Respondents (%)
Motorcyclist	93	23
Motorist	141	36
Dual Role	163	41

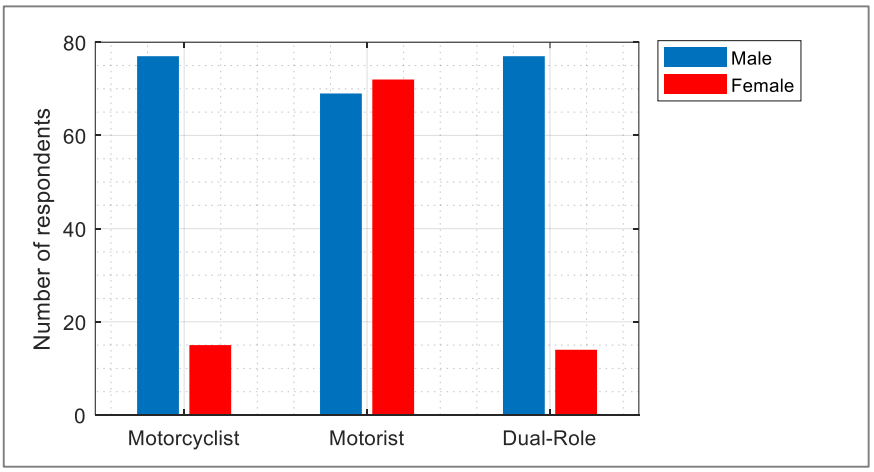

Figure 2: Breakdown of driver's role according to gender

3.1 Blind Spot Awareness

According to Table 3, 98.2 % of respondents are aware of the existence of blind spots on the vehicle, while only 1.8 % of respondents are not aware of. In terms of technology awareness, according to Table 3, 75.4 % of respondents are aware of the latest technology being used to reduce the risk of a blind spot, while 24.6 % of them are not aware. This highlights that most of the drivers are aware of the existence of blind spots, but most of them still struggle to cope with the difficulty in driving arise from these blind spots. Even though there are many technologies used to combat the risk of the blind spots which has been around for quite some time, still the majority of drivers are not aware of its existence. Besides, based on Figure 3, a total of 43 % of respondents agree that they have driving difficulty due to blind spots, while 17 % of respondents find that the blind spot did not cause difficulty in driving.

Table 3: The respondents' blind spot awareness and technology awareness

Types of Awareness	Aware	Unaware
Blind Spot Awareness	98.2 %	1.8 %
Technology Awareness	75.4 %	24.6 %

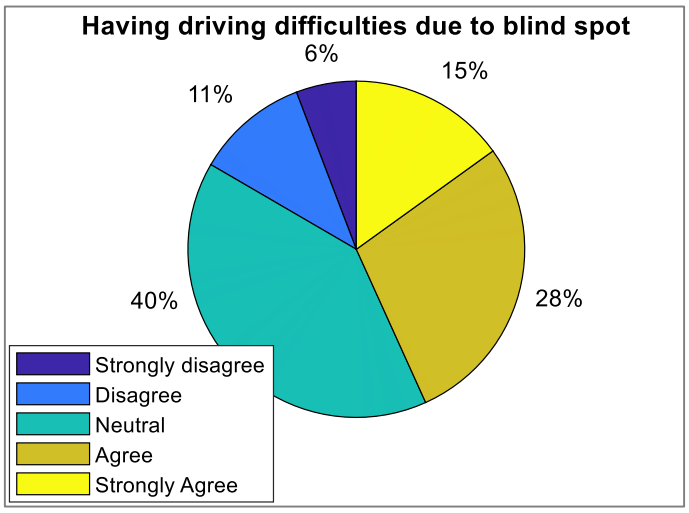

Figure 3: The respondents' opinion about having the difficulty of driving due to blind spot

While most of the respondents are aware of the existence of blind spot in vehicles, majority of respondents agree that blind spot causes difficulty in driving while 6 % of respondents strongly suggest that blind spot did not cause them any driving difficulties. This result points out that a practical solution is required to reduce the effect of the blind spot on driving difficulties in most respondents.

3.2 Perception on the Cause of Collisions

In this survey, 289 respondents have experienced or directly involved in road collisions or near-miss, while only a handful of 107 respondents have never involved in any collision or near-miss. Based on results illustrated in Figure 4, 75 % of these collisions and near-miss experienced by the respondents, according to them are caused by a blind spot, while only 25 % is not due to a blind spot. From these collisions, a significant 63 % are classified as a side or angular collision, while 27 % are classified as rear-ended collisions, and only 10 % are classified as head-on collisions, which is illustrated in Figure 5.

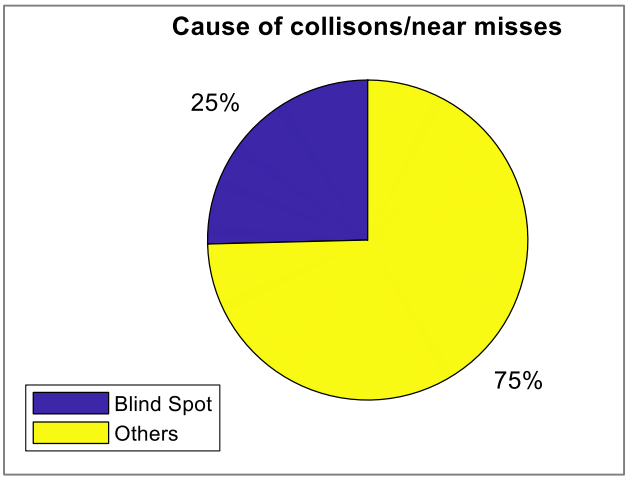

Figure 4: Cause of collisions/near-misses experienced by the respondents

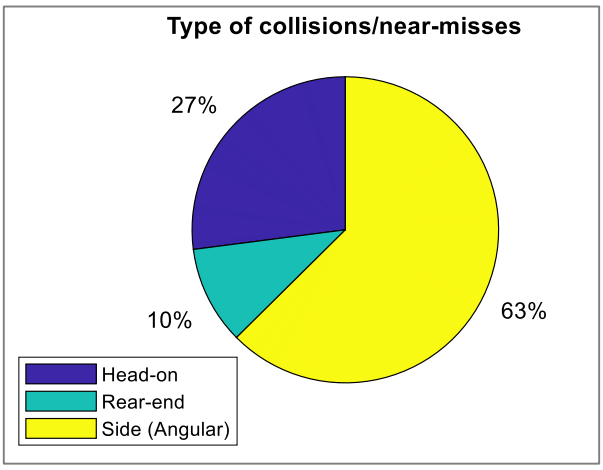

Figure 5: Type of collisions/near-misses experienced by the respondents

Furthermore, we asked the respondents to suggest which parties are faulty in the road collisions or near-misses that they have experienced, and their responses are illustrated in Figure 6. From the responses, 38 % of faults leading to collisions or near-misses come from Motorists while 22 % of faults come from Motorcyclists. The majority of fault leading to collisions or near-misses are from both parties, with accumulates to 40 % of total responses.

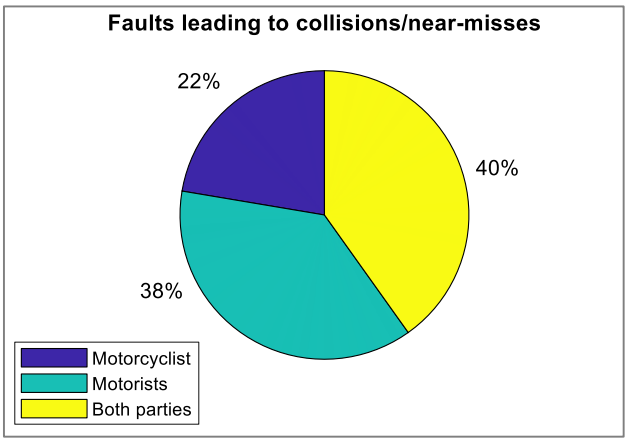

Figure 6: Percentage of faults leading to collisions/near-misses

Based on results presented, majority of respondents suggests that blind spot is a major contributing factor to road collisions or near-misses experienced by them, while side (angular) collisions are the most common type of collision. The majority of respondents also suggest that in collisions, both parties involved are in fault.

3.3 Perception on Driving Behaviour

We further analyse the response towards the faults leading to road collisions and near-misses to associate the perception of driving behaviour of motorcyclists from the opinion of motorists and vice versa. According to Figure 7, motorcyclists' responses show that the majority of faults in road collisions and near-misses that they experienced are due to motorists' fault with 70 faults, followed by motorcyclists with 46 faults and both parties with 42 faults. On the other hand, motorists' responses show that most faults come from motorcyclists with 28 faults, motorists with 20 faults and both parties with 11 faults. While according to dual-role drivers, most faults come from motorists with 42 faults, both parties with 29 faults and motorcyclists

with 28 faults. These results showed that besides having the majority of faults in collisions and near-misses with 132 faults in total, motorists are vastly perceived by both motorcyclist and dual-role drivers as the guilty party in road collisions and near-misses. On the contrary, the majority of motorists suggest motorcyclists as the guilty party in road collisions and near-misses. Dual-role drivers show that they do not tend to blame motorcyclists in road collisions and near-misses, as they suggest that motorists and both parties have more faults.

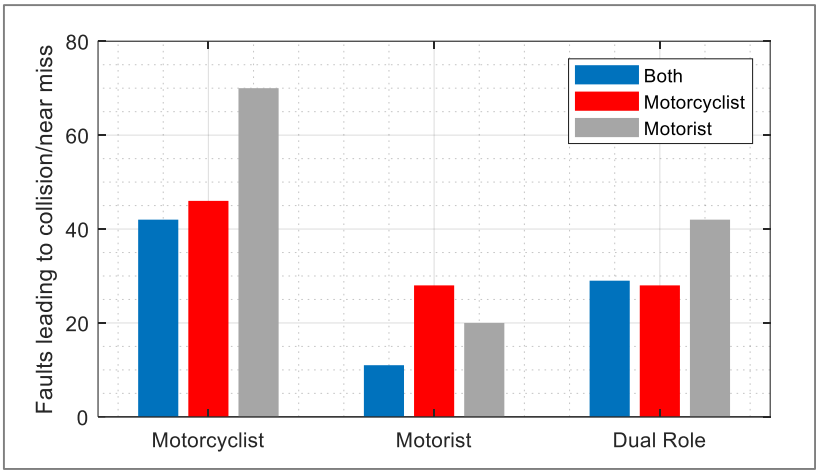

Figure 7: Number of faults leading to collisions/near-misses according to different driving roles

To investigate the practices of good driving behaviours according to those three driving roles, respondents are asked to give their agreement on their own practices while driving, such as checking vehicle blind spots before turning, pay attention to motorcyclists and so on. Figure 8 shows the results from this question according to different driving roles. Based on Figure 8, more than 80 % of motorists agree that they check vehicle blind spots before turning and changing lane as well as pay attention to motorcyclists while overtaking. Less than 80 % of motorists agree that they pay attention to nearby motorcyclists during driving. Besides, there is a higher percentage of dual-role drivers than motorists who agree that they check blind spots and pay attention towards motorcyclists, which may indicate that dual-role driver is more cautious towards the safety of fellow motorcyclists than the motorists.

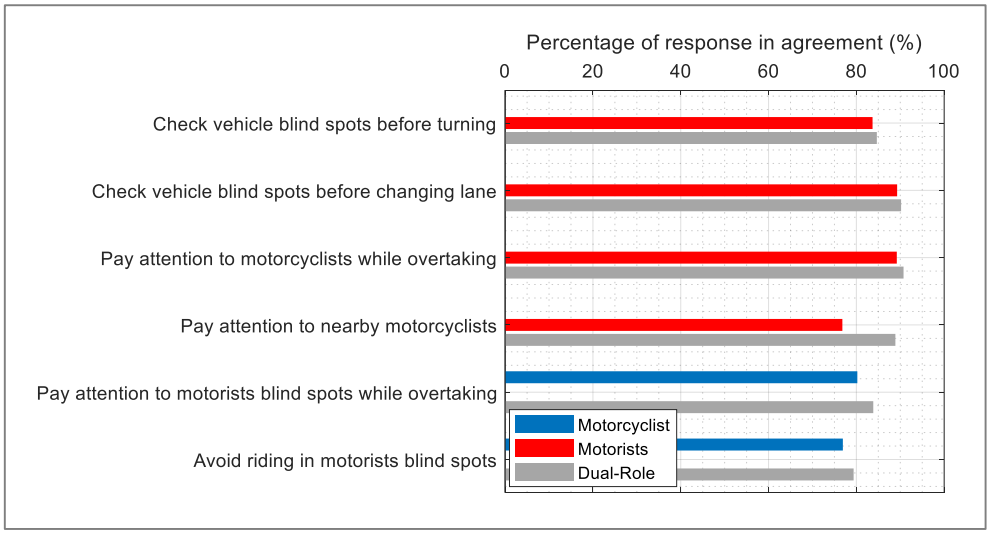

Figure 8: Percentage of responses in agreement with respondents' own practices of several good driving behaviours, according to different driving roles

Also referring to Figure 8, higher percentage of dual-role drivers as compared to motorcyclists who agree that they pay attention to motorists' blind spots while overtaking and avoid riding in motorists' blind spots. This may also show that dual-role drivers understand the driving risks and difficulties faced by motorists due to the blind spots. Another important takeaway from this result is there is between 10 to 20 percent of road users who is either take a natural stand or disagree that they practice these good driving behaviours, which is quite worrying.

Furthermore, the survey asked the respondents to give their perception towards the motorists' carefulness towards motorcyclists as given in Figure 9, and motorcyclists' carefulness towards their own safety as given in Figure 10. According to Figure 9, 29 % of motorcyclists at least agree that motorists are careful towards motorcyclist's safety while 32 % of motorcyclists at least disagree with the statement. Also showing a similar trend, 34 % of motorists agree with the statement while 30 % of motorists disagree. Based on Figure 10, more than 40 % of motorcyclists and more than 30 % of dual-role drivers at least agree that motorcyclists are careful towards their own safety. However, only 20 % of motorists at least agree that motorcyclists are careful towards their own safety. A high percentage of motorists (51 %) disagree with the statement while 24 % of motorists and 37 % of dual-role drivers disagree. These results show that a large percentage of motorists (30 %) and motorcyclists (32 %) still perceive motorists as not careful towards motorcyclists' safety. On the other hand, the majority of motorists perceive motorcyclists as not being careful towards their own safety, while the majority of motorcyclists stated otherwise.

3.4 Technology to Improve Motorcyclist's Safety

The respondents further give their opinion on whether technology in a vehicle can help reduce the number of road accidents. As shown in Figure 11, the majority of respondents (89 %) agree that technology can help reduce road accidents while only 1 % of respondent disagrees. The respondents further gave their suggestions towards improving motorcyclists' safety. By arranging their suggestions into different classes, most suggestions given by respondents as shown in Figure 12 is on introducing affordable technology, while the second-highest number of suggestions urge the road user to improve their behaviour and attitude. Subsequently, respondents also suggest to (arrange in order of the number of responses) making safety practices as a habit, improving road and infrastructure, more education and training, stricter law enforcement, and more awareness campaign.

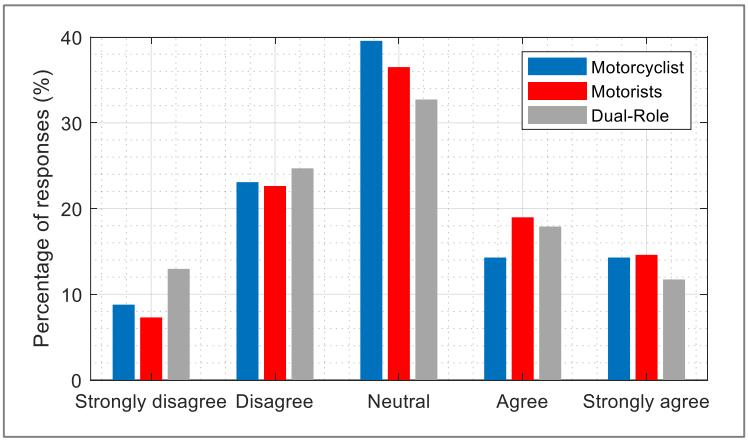

Figure 9: Perception of motorists' carefulness towards motorcyclists, whose responses are grouped according to driving roles

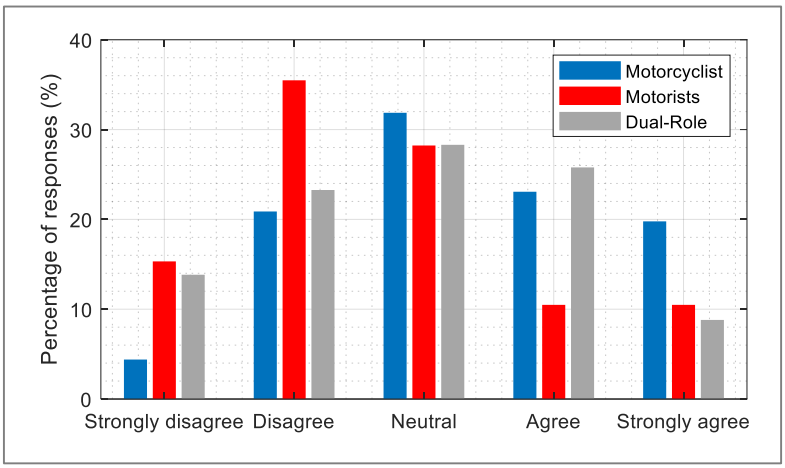

Figure 10: Perception of motorcyclists' carefulness towards their own safety, whose responses are grouped according to driving roles

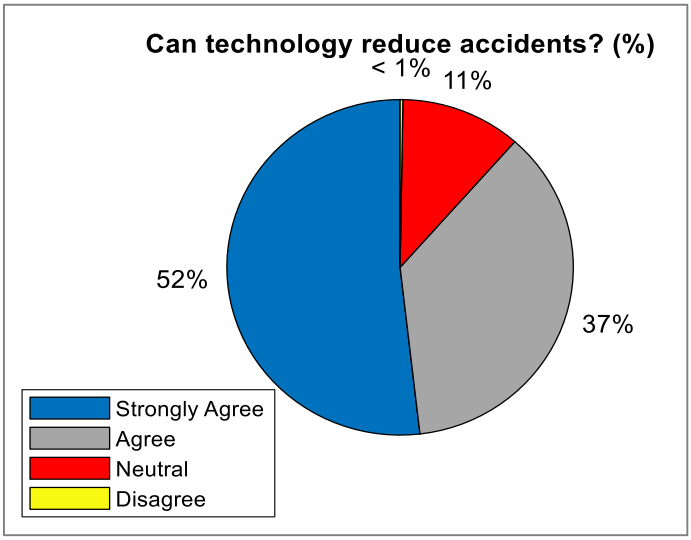

Figure 11: Perception of whether technology can reduce the number of accidents

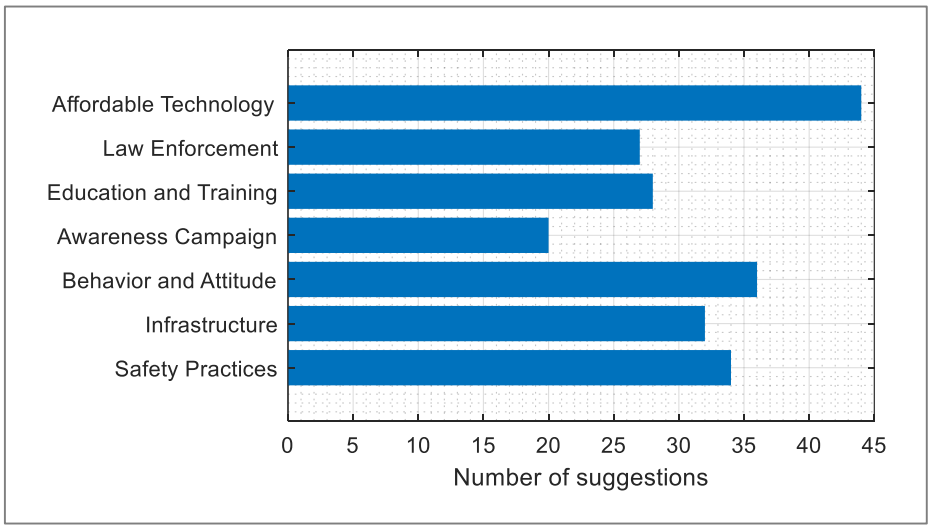

Figure 12: Suggestions from respondents to improve motorcyclists' safety

4.0 CONCLUSION

In this paper, we present results and analysis of a survey we carried out specifically to assess the behaviour of road users in relation to the risk of blind spots towards motorcyclist safety in Malaysia. We asked 397 respondents to classify themselves into one of these driving roles – (1) motorists (those who drive vehicles other than motorcycles), (2) motorcyclists, and (3) dual-role (drives other vehicles and motorcycles). Then, they are asked to answer 21 related questions classified into few categories of assessments including blind spot awareness, blind spot risks, perception of faults in road collisions and near-misses, motorists and motorcyclists' behaviours, perception towards motorists, motorcyclists, and technology used to improve road safety. Based on the results discussed in this paper, we found that 98.2 % of respondents are aware of the existence of blind spots on the vehicle, while only 1.8 % of respondents are not. A total of 43 % of respondents agree that they have driving difficulty due to blind spots, while 17 % of respondents find that the blind spot did not cause difficulty in driving. Moreover, majority of respondents suggest that blind spot is a major contributing factor to road collisions or near-misses experienced by them, with side (angular) collisions are the most common type of collision (63 %). The majority of respondents also suggest that in collisions, both parties involved are at fault.

Furthermore, motorists have the majority of faults in collisions and near-misses (132 faults) and are vastly perceived by both motorcyclists and dual-role drivers as the guilty party in road collisions and near-misses. Dual-role drivers show that they do not tend to blame motorcyclists in road collisions and near-misses, as they suggest that motorists and both parties have more faults. Dual-role drivers also show that they are more cautious towards the safety of fellow motorcyclists than the motorists. More dual-role drivers than motorcyclists suggest that they practice good behaviours while riding a motorcycle. We found that a large percentage of motorists and motorcyclists still perceive motorists as not careful towards motorcyclists' safety. On the other hand, the majority of motorists (51 %) perceive the motorcyclists as not being careful towards their own safety, but the majority of motorcyclists (40 %) stated otherwise. Finally, most suggestions given by respondents to improve motorcyclists' safety is by introducing affordable technology to be used in vehicles or motorcycles.

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