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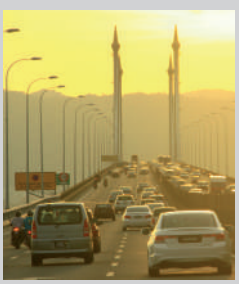

Research Report

Risk and Exposure of Motorcycle Activity in Selangor

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Ho Jen Sim
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MIROS
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Abstract

This report contains research findings of the risk and exposure of motorcycle activity in Selangor. Section 1.0 is an introduction on motorcycle accidents and highlights the main purpose of the study. Motorcycles appear to be the dominant transport mode in most developing countries. In Malaysia, motorcycles constitute 47% of the total vehicle population. At the same time, they consistently contribute around 60% of traffic fatalities. The current trend of research is mainly focused on two (2) areas: crash severity and crash risk. Exposures have also been found to play a significant role in motorcyclist traffic safety. This study is set to explore the relationship between exposure and risk for motorcycle crashes.

Section 2.0 provides an overview from past studies on the factors that contribute to the motorcycle crashes. Hurt (1981) concluded that approximately three-quarters of these motorcycle crashes involved collision with another vehicle, which is most usually a passenger automobile and intersections are the most likely place for motorcycle crashes, with the other vehicle violating the motorcycle right-of-way, and often violating traffic controls. Besides that, exposure measure is also an important factor. Forjouh and Zwi (1996) said that the differences in the prevalence of motorcycle riders, the amount of riding exposure, the purpose of riding a motorcycle, the type of motorcycle intervention programmes should account for the numbers and incidences of motorcycle crashes and injuries. Besides that, a review of risk factors and patterns of motorcycle injuries done by Lin and Kraus (2009) classified exposure measure in crash-event of time phase and under human influence. A longitudinal study of risk factors for motorcycle crashes among junior college students in Taiwan was done by Lin et al. found that past motorcycle crash history, number of riding days, average riding distance, risk-taking level, alcohol consumption, and traffic violations were all significantly associated with an increased risk of being involved in a crash. Conversely, increasing age, riding

experience, and automobile licensure were related to a decreased risk of crashing (Lin et al., 2003).

Section 3.0 covers the method used in this study. This study involved only motorcycle users and the sampling was limited to motorcyclists in Selangor. Questionnaire survey using face-to-face interview and self-completion survey have been chosen as method of data collection. First part of the questionnaire consists of respondents' travel profile such as number of trips made, distance and time travelled for daily, Saturday and Sunday routine. Second part of the questionnaire informs about respondents crash experience and the last part indicates the personal details of the respondents. The descriptive analyses were done to obtain the distributions and profiles of the data. The important variables have been analysed using Logistic Regression model to identify the significant attributes. Mann-Whitney and Kruskal-Wallis have been used to compare the travel pattern between demographic groups.

Section 4.0 reports on the findings of the study. Some interesting findings that can be highlighted are on the exposure measure. This study found that there are significance differences between demographic characteristics and exposure measure (i.e. distance and time travelled, number of trips). On weekdays, married people tend to travel quite far and spend more time on the road compared to single people. Age also plays an important role, as shown in the motorcycle study. Different age demographics travel different distances and time spend on the road differently. The older people gets, the farther they travel. Motorcyclists in urban and rural areas show a notable difference in their travel pattern. This study also revealed that motorcycle crashes always happen during trips to or from work. This study can conclude that only age, gender and income group made significant contribution to the prediction of motorcycle crashes.

1. Introduction

Motorcycles appear to be the dominant transport mode in most developing countries. In Malaysia, motorcycles constitute 47% of the total vehicle population. At the same time, they consistently contribute around 60% of traffic fatalities. Of the motorcyclists involved in fatal crashes, young motorcyclists aged between 16 and 25 were over-represented.

The risk of motorcyclists getting involved in a crash is similar to that of other means of transport, despite motorcycles being economical and popular. However, the severity of risk is much higher compared to others form of transport. Due to the high number of fatalities involving the young generation, many studies and intervention measures have been undertaken. The current trend of research is mainly focused on two areas: crash severity and crash risk. In crash severity studies, severity issues related to helmet usage, environmental and human-vehicle factors (Pai and Saleh, 2007; Savolainen and Mannering, 2007) were looked into while crash risk investigated the riders characteristics, exposure at signalised junctions, riding experience and etc (Sexton et al., 2004; Haque et al., 2008).

On the other hand, exposures have also been found to play a significant role in motorcyclist traffic safety. A study done in Taiwan has demonstrated that the risk of motorcyclists having a crash increases with exposure and falls with age and riding experience (Lin, Chang, Pai et al., 2003). Besides that, a study between exposure and crash risk has been proven to have a correlation, in which riders who rode relatively little had higher crash risk (per 100, 000 km travelled) than riders who rode more often (Harrison & Christie, 2004).

This study is set to investigate the validity of the notions from overseas findings that there is a relationship between exposure and risk factors that will lead motorcyclists to crash. Their travel needs and activity patterns will be established in this study. The

findings from this study are very useful as it provides some insight into effective motorcycle intervention measures.

1.1 Scope and Objectives of the Study

General objective:

i. To explore the relationship between exposure and risk for motorcycle crashes

Specific objectives:

i. To understand the different travel pattern among motorcyclists between urban and rural areas
ii. To identify the attributes of the exposure risk of motorcyclists
iii. To identify the underlying factors to motorcycle crashes
iv. To develop the risk exposure model

The outcomes of this study will provide recommendations to road transport related agencies in providing better services to their stakeholders. In addition, the findings would provide some recommendations for road safety authorities to better plan for motorcycle safety and interventions.

1.2 Limitation of the Study

The study was conducted only on motorcycle users in Selangor. The crash data in this study only involved those who had been involved in severe or minor crashes. This study cannot collect information from the fatal crash victims since the data needed is their exposure measured (distance and time travel, number of trip made) during the crash. Besides that, data collected is based on self-reporting of the respondents and the validity of the information given cannot be verified.

2. Literature Review

Many researches have been done in investigating the factors that contribute to motorcycle crashes. One of them was the study done by Harry Hurt on 1981. He had investigated the factors that contribute to the fatal motorcycle crashes. Hurt concluded that approximately three-quarters of these motorcycle crashes involved collision with another vehicle, which was most often a passenger automobile and intersections are the most likely place for motorcycle crashes to occur, with the other vehicle violating the motorcycle right-of-way, and often violating traffic controls. Besides crash and road configuration, the cause of death for a majority of victims is head injury. Experience from developed nations indicates that the use of seat belts is one of the most effective ways to reduce road crash fatalities. The use of safety helmet for motorcyclist is the single critical factor in reducing the severity of head injury; the safety helmet which complies with FMVSS 218 is a significantly effective injury countermeasure (Hurt et al., 1981).

Another study done in 1993 found that helmets are effective in reducing the severity of the worst head or neck injury (Andrew, 1993). Maimaris et al. (1994) used Multiple Logistic Regression analysis to investigate the probability of sustaining a head injury and his study found that only two (2) variables were significant; helmet use and involvement of a motor vehicle. Pang et al. (2000) studied the crash characteristics of injured motorcyclists in Malaysia and she found that fatal crashes were more likely to be associated with a larger engine capacity motorcycle, collision with a heavy vehicle, head on collision, and collision at a non-junction road. The comparison study on motorcycle traffic development between three developing countries was done by Hsu et al. (2003). In Taiwan, the frequency of motorcycle crashes on the road section in mid-stream section of a road is higher than at intersections while non-signalised intersections in Vietnam are one of the hazardous locations in Vietnam and head-on collisions between motorcycles often occurred there.

A study done involving Heavy Goods Vehicle (HGV) and Motorcycle in Malaysia by Zaharah et al. (2004) found that the contributing factors to crash involving HGV and motorcycle were only road geometry, weather condition, lighting, location and type of area. Another study done by Radin Umar (2006) found that traffic speed, lane width, number of lanes, shoulder width and land use were found to be significant in explaining motorcycle crashes at triple-forked, major-minor priority junctions. Exclusive motorcycle lane turns out to be a good intervention in preventing fatal motorcycle crash. Tung (2007) studied the motorcycle crash patterns along the exclusive motorcycle lane in Malaysia and he found that road geometry of the crash location, the brightness condition during the crash and the roadside object involvement in the crashes were the significant factors.

Despite all the factors mentioned, exposure measure is also an important factor. Forjouh and Zwi (1996) said that the differences in the prevalence of motorcycle riders, the amount of riding exposure, the purpose of riding a motorcycle, type of motorcycle intervention programmes should account in the numbers and incidences of motorcycle crashes and injuries. Besides that, a review of risk factors and patterns of motorcycle injuries done by Lin and Kraus (2009) classified exposure measure in crash-event of time phase and under human influence. Figure 1 shows the risk factors for motorcyclist crash an injury using Haddon's Matrix and it was tabulated by Lin and Kraus.

	Human	Vehicle	Environment
Pre-event	Young age, male, low socioeconomic status, inexperience, crash history, no driving license, traffic violation history, high risk-taking behavior, alcohol and other drug use, motorcycle ownership, excessive and slow speeds, and rider's inconspicuity (e.g., without high-visibility clothing)	Motorcycle inconspicuity (e.g., without daytime headlight use)	Nighttime, poor light condition, poor road condition, summer period, rural area
Event	Large amount of riding distance and time, excessive speed, no safety devices (e.g., helmet wearing, leg protector, or airbag jacket)	Motorcycle make	Collision with a heavy object (e.g., moving car)
Post-event	Elderly person, pre-existing medical condition		Slow emergency response, poor rehabilitation programs

Figure 1 Risk factors for motorcycle crash injuries using Haddon's Matrix

They conclude that differences in the prevalence of motorcycle riders, the amount of riding exposure, the purpose of riding a motorcycle, type of motorcycle, and intervention programmes should account for large differences in the numbers and incidences of motorcycle crashes and injuries between developing and developed countries, even though more empirical evidence is required. Another study that aim to investigate the annual mileage, driving violation and crash involvement in relation to driver's sex, age and level education was done in Germany. The study concludes that in general, crash increased as annual mileage increased. This study also found out that; corrected for annual mileage; male and female drivers do not differ in crash involvement; younger drivers have the highest rate of crashes and level of education is not related to crash involvement (Lourens et al., 1999).

Another exposure study was done by Warren and Ron titled Exposure Study by Motorcycle Make and Type. The study aimed to determine the annual distance travelled by registered motorcycles in New South Wales by make and type then relate this to patterns of crash involvement and crash risk. This study found that the median exposure across the whole sample was estimated to be 3,576 km per annum (with a mean of 5,208 km per annum), based on the odometer readings provided by respondents. They also found that males rode about 30% more than females. Besides that, the study also found that crash rate was related to annual exposure, such that riders with low levels of annual exposure had substantially higher crash rates (per km) than those with higher levels of exposure. Riders with less than 1,000 km riding exposure per annum had a crash rate that was eight times that of the whole of the sample (Warren & Ron, 2003).

A longitudinal study of risk factors for motorcycle crashes among junior college students in Taiwan was done by Lin et al. found that past motorcycle crash history, number of riding days, average riding distance, risk-taking level, alcohol consumption, and traffic violations were all significantly associated with an increased risk of being involved in a crash. Conversely, increasing age, riding experience, and automobile licensure were related to a decreased risk of crashing (Lin et al., 2003).

3. Methodology

This study involved only motorcycle users and the sampling was limited to motorcyclists in Selangor. The sampling was determined based on the population of the area. A total of four districts were selected for the survey. The areas were chosen based on their regional characteristics. Kuala Selangor represents northern Selangor, Kajang represents southern Selangor while Shah Alam and Kuala Kubu Bharu represent western and eastern Selangor, respectively. This study aimed to understand the different travel pattern among motorcyclists between urban and rural areas. Thus, another site selection criterion also considered the area type. Two area type that being considered in this study were rural and urban. Shah Alam and Kajang are urban area in Selangor while Kuala Selangor and Kuala Kubu Bharu considered as rural area in Selangor. The surveys were conducted in shopping malls, supermarkets, post offices and at motorcycle parking lots.

Figure 2 shows the overall flow of this study. Questionnaire survey using face-to-face interview and self-completion survey have been chosen as the method of data collection. A copy of the questionnaire is in the Appendix section. The first part of the questionnaire consists of respondents' travel profile such as number of trips made, distance and time travelled for daily, Saturday and Sunday routine. The second part of the questionnaire informs about respondents crash experiences and the last part tells about personal details of the respondents. Initially this study planned to have a sample size of 400 respondents for each districts; a total of 1,600 samples, however only 1,526 people responded. The number of sample size is calculated based on the population of the area. Five important variables from the past studies have been identified to be tested in this study. The variables are socio-demographic, personal perception, time travel, distance travel and trip purpose. The studied variable aims to identify the attributes of the exposure risk of motorcyclist.

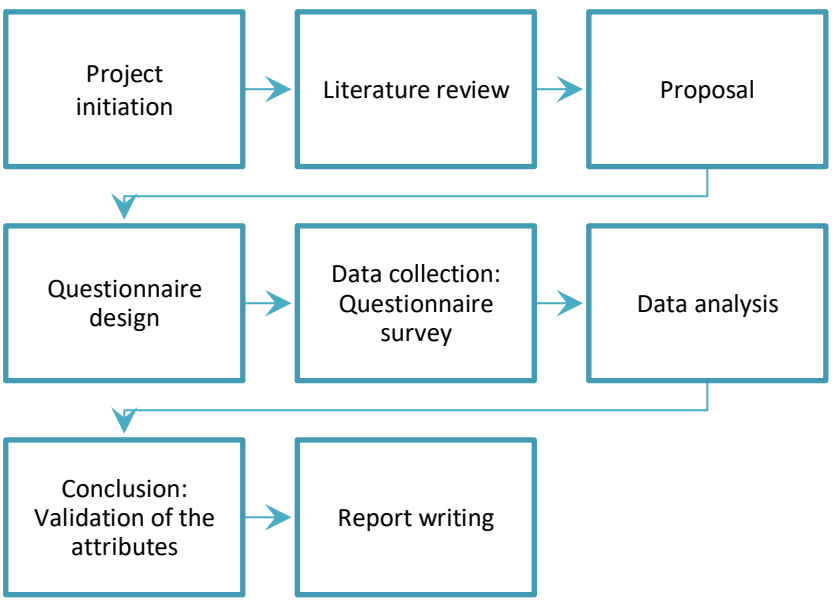

Figure 2 Methodology framework

The data collection activities were completed and the data were then gathered and analysed according to the objectives of the study. The descriptive analyses were done to obtain the distributions and profiles of the data. The important variables have been analysed using Logistic Regression model to identify the significant attributes. Logistic regression is widely used in identifying the contributing factors. A logistic regression model has been used to predict incident severity in a study done by Hrishikesh (2009). In a study done by Essam (2012), the logistic regression technique was also utilised to identify the different risk factor that may contribute to the type of serious collisions. Non-parametric analyses like Mann-Whitney and Kruskal-Wallis have been used to compare the travel pattern between demographic groups. IBM SPSS Statistics 20 and Microsoft Excel 2010 have been used to analyse the data collected.

4. Results and Discussions

This section discusses the results and findings of the study. This section is divided into four (4) subsections; sample population, motorcycle travel pattern, motorcycle crashes characteristic and risk exposure analysis.

4.1 Sample Population

Table 1 shows the number of sample size based on demographic criterion. The total number of respondents that is involved in this study was 1,526 and most of the respondents are male, as 60% of licence holders in Malaysia is male (JPJ, 2010). Half of the respondents are from rural area and another half are from urban area. 43% of respondent are aged between 18 – 25 years old while the least number of respondents are from the youngest and the oldest group with 6% each group. Percentage of age group 18 – 25 years old is larger compared to other age group, probably because of their availability during the survey and their willingness to answer the questionnaire. 80% of respondents had income less than RM2,000 and only 1.8% had income more than RM4,000. This proportion is not reflective of the national percentage household income and this may be due to the fact that people who earn more will use a better vehicle (i.e. car). In 2012, around 22.6% of Malaysian had household income below RM2,000 (Department of Statistics, 2012). The 443 respondents are unemployed because most of them are students and retiree.

Table 1 Sample population

Variables	N	Variables	N
Total	1526	**Marital status**	
Gender		**Single**	891
Male	1241	**Married**	635

Female	285	**Income**	
Age		**< RM2000**	1217
< 18 years	93	**RM2000 – RM4000**	282
18 – 25 years	659	**> RM4000**	27
26 – 35 years	371	**Employment**	
36 – 45 years	192	**Employed**	1083
46 – 55 years	117	**Not employed**	443
> 56 years	93	**Area type**	
Ethnic		**Urban**	707
Malay	1353	**Rural**	819
Chinese	31		
Indian	130		

4.2 Motorcycle Travel Pattern

Table 2, 3 and 4 shows the riding exposure by individual and household characteristics for Weekdays, Saturday and Sunday travel, respectively. Table 2 shows that during weekdays, the distance travelled, time travelled and numbers of trips were significantly different for all groups of age, marital status and area type. In general, the table shows that the distance travel is not so high but the time spent travelling is quite high. This is most likely due to the road congestion since most of the trips are made during peak hours (time people commuting to work) and the possibility of low speed travel because of the congestion. It is interesting to note that there are significant difference for distance and time travelled between male and female. On average, males ride 33.2 kilometer (km) with an average time of 48.1 minutes compared to females, who only ride 17.9 km with an average time of 26.8 minutes. Both group made a similar number of trips. This finding is similar to Scottish Household Survey: Travel Diary 2009 – 2011, which reported that men make longer trips than women. Another study done by Nurulhuda found that in terms of VKT, female drivers recorded 58.69 billion vehicle kilometers travelled, which was 40% lower as compared to their male counterparts (Nurulhuda, 2012).

When categorised according to age, the study shows a trend of the older age groups travelling farther compared to their younger peers. This result is similar to those achieved in the study done by Pauline et al. They found that with regard to trip distance, the results show that the average travel distance does not decrease as people get older (Pauline et el., 2011). However, respondents aged more than 56 years old travel around 20.81 km averagely. It is shorter compared to the 46 – 55 years old group. Chinese and Indian respondents spend almost the same period of time on the road; 37 minutes during their daily travel but covered slightly different distances. Travel patterns between ethnic groups are not significantly different. Commonly, one can say that all races travelled similar distances, spent approximately the same amount of time on the road and made similar number of trips. Employment group also shows that the working group travel far and spent more time travelling compared to the non-working group with an average difference of 19.7 km (distance) and 26.4 minutes (time).

Table 2 Riding exposure by individual and household characteristics-one day of weekday travel

	N	Mean distance travelled (km)	Mean trips	Mean time travelled (min)
Total	1526	30.35	2.14	44.12
Gender		a		a
Male	1241	33.22	2.14	48.10
Female	285	17.87	2.11	26.79
Age				
< 18 years	93	13.14	2.13	23.15
18 – 25 years	659	26.76	2.09	38.33
26 – 35 years	371	36.78	2.20	56.08
36 – 45 years	192	37.54	2.15	52.41
46 – 55 years	117	39.89	2.10	48.77
> 56 years	93	20.81	2.20	35.75
Ethnic				
Malay	1353	30.97	2.14	44.67
Chinese	31	18.50	2.19	37.45
Indian	130	25.86	2.14	37.73
Marital status				

Single	891	26.34	2.10	39.26
Married	635	35.99	2.19	50.94
Income				
< RM2000	1217	26.46	2.15	41.30
RM2000 – RM4000	282	45.05	2.09	55.33
> RM4000	27	52.49	2.04	54.37
Employment				
Employed	1083	36.08	2.15	51.79
Not employed	443	16.35	2.11	25.36
Area type				
Urban	707	35.99	2.17	53.36
Rural	819	25.49	2.11	36.14

a: Significantly different at the $p<0.05$

On Saturday, most of respondents made leisure trip and only the employment group showed a significant difference for all three exposure measures; distance, time travelled and number of trips made. People who stay in urban areas tend to travel far with an average distance of 31.8 km and travelled for an average of 46.4 minutes. Those between 26 – 35 years old spent significantly more distance and time on the road compared to other age groups on Saturday. On average this group has ridden 35.7 kilometers with average of 50 minutes on the road. The number of trips made on Saturday did not show much difference for all groups except for the income group. A significant difference can be noticed on the mean trips column on income group row.

Table 3 Riding exposure by individual and household characteristics – Saturday travel

	N	Mean distance travelled (km)	Mean trips	Mean time travelled (min)
Total	1526	26.92	1.59	38.26
Gender				
Male	1241	28.88	1.57	40.76
Female	285	18.41	1.66	27.38
Age				
< 18 years	93	16.08	1.55	24.95

18 – 25 years	659	25.56	1.56	35.92
26 – 35 years	371	35.65	1.71	50.01
36 – 45 years	192	23.53	1.54	35.93
46 – 55 years	117	28.01	1.44	36.21
> 56 years	93	18.48	1.67	28.91
Ethnic				
Malay	1353	27.58	1.59	38.93
Chinese	31	13.56	1.61	30.29
Indian	130	25.86	2.14	37.73
Marital status				
Single	891	26.34	2.10	39.26
Married	635	35.99	2.19	50.94
Income				
< RM2000	1217	26.46	2.15	41.30
RM2000 – RM4000	282	45.05	2.09	55.33
> RM4000	27	52.49	2.04	54.37
Employment				
Employed	1083	30.36	1.69	43.40
Not employed	443	18.53	1.34	25.69
Area type				
Urban	707	31.75	1.59	46.4
Rural	819	22.76	1.59	31.23

a: Significantly different at the $p<0.05$

On Sunday, the same pattern like on Saturday can be spotted. The employment group shows a significant difference for all three of exposure measure. However, on Sunday, urban and rural people travel quite the same distance and time compared on Saturday but a significant difference for number of trips made can be seen. On Sunday, the age group between 46 – 55 years old has ridden 26.5 km and almost 30 minutes on average.

Table 4 Riding exposure by individual and household characteristics – Sunday travel

	N	Mean distance travelled (km)	Mean trips	Mean time travelled (min)
Total	1526	19.60	1.11	25.39
Gender				
Male	1241	20.21	1.09	26.16
Female	285	16.93	1.20	22.04
Age				
< 18 years	93	10.94	0.92	15.55
18 – 25 years	659	18.13	1.10	24.07
26 – 35 years	371	23.00	1.16	28.24
36 – 45 years	192	22.73	1.12	29.77
46 – 55 years	117	26.53	1.09	29.99
> 56 years	93	10.13	1.12	18.60
Ethnic				
Malay	1353	19.69	1.09	25.05
Chinese	31	14.20	1.42	28.55
Indian	130	19.81	1.18	27.18
Marital status				
Single	891	18.44	1.11	24.64
Married	635	21.22	1.11	26.44
Income				
< RM2000	1217	17.54	1.12	23.91
RM2000 – RM4000	282	26.91	1.09	31.00
> RM4000	27	35.96	0.93	33.33
Employment				
Employed	1083	22.18	1.20	28.68
Not employed	443	13.30	0.88	17.35
Area type				
Urban	707	21.85	1.00	27.43
Rural	819	17.65	1.20	23.63

a : Significantly different at the $p<0.05$

Comparison between days; weekdays, Saturday and Sunday for the three exposure measures are shown in Table 5. The Kruskal Wallis significant values show that all the three exposure measures; trips number, distance and time travelled, are significantly different (sig.value= 0.00 < 0.05).

Table 5 Comparison between days for exposure measure

Day		Distance travelled (km)	Trips number	Time travelled (min)
Weekday	**Mean**	30.35	2.14	44.12
	Median	18.40	2.08	29.29
Saturday	**Mean**	26.92	1.59	38.26
	Median	10.97	1.70	20.84
Sunday	**Mean**	19.60	1.11	25.39
	Median	2.66	1.17	9.36
Kruskal Wallis Sig. value		0.00[a]	0.00[a]	0.00[a]

a: Significantly different at the p<0.05

4.3 Motorcycle Crash Characteristics

This section will explore the exposure characteristics of motorcycle crashes. Out of 1,526 people surveyed, 345 respondents (23%) had experienced a motorcycle crash within a year as shown in Figure 3. Respondents then being ask to self-report the incident characteristics.

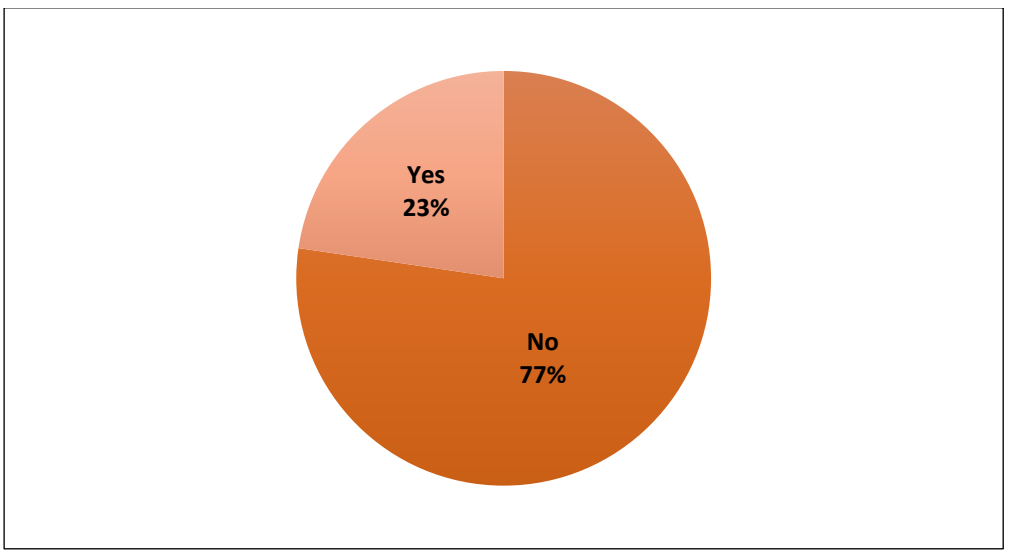

Figure 3 Percentage of samples who had a crash within a year

Figure 4 shows the severity type of the crashes. From the chart, 57% out of 351 respondents had a minor injury and 17% had serious injury during the crash.

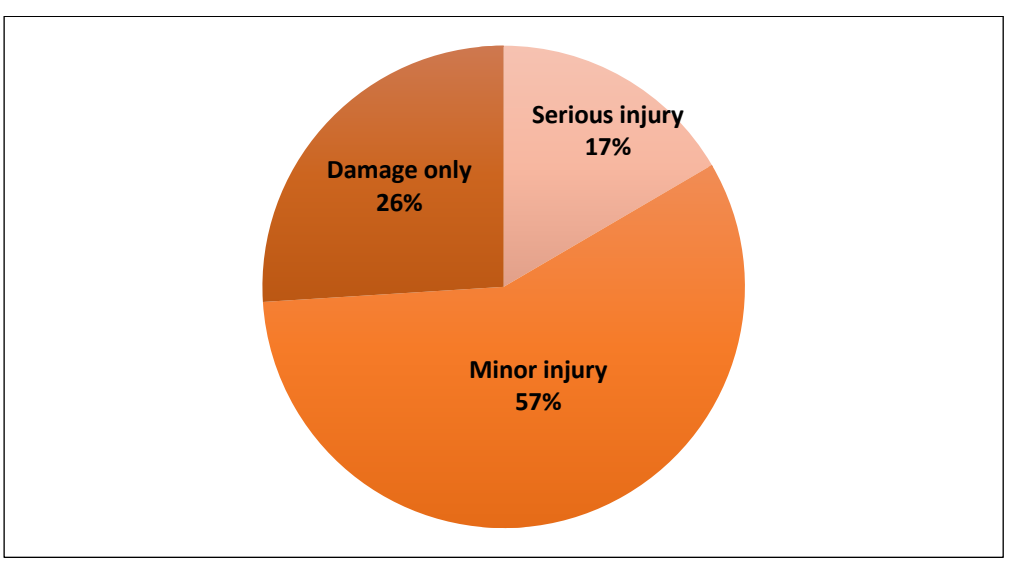

Figure 4 Crash severity type

Figure 5 shows the travel purpose that they made before the crash happen. 37.8% of them commute to work and around 15% of them crash during their leisure trips.

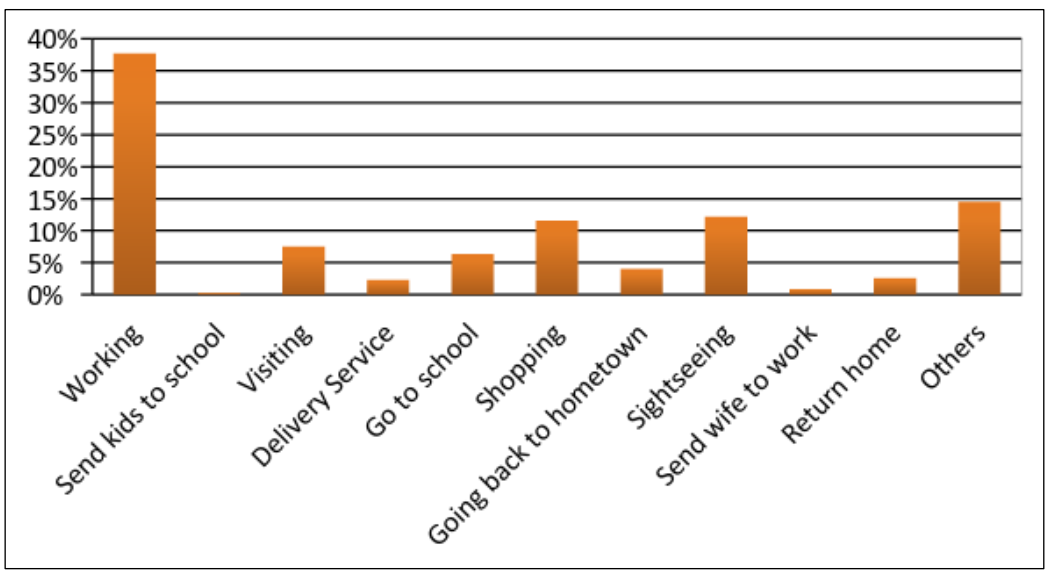

Figure 5 Crash travel purpose

The bar chart on Figure 6 shows the timing of the crashes. 34% reported that they had a crash in the evening while 23% of crashes happened in the morning and night. Only 3% had crashed during the wee hours (12.00 am – 7.00 am).

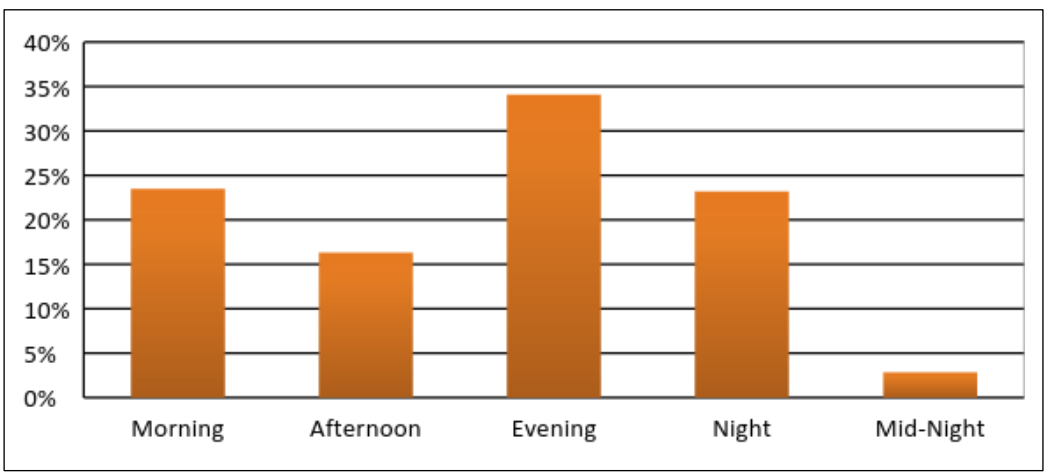

Figure 6 Time of trash

The pie chart in Figure 7 shows the weather condition during the crashes. 80% of the crashes happen during a clear day while only 20% crash happen during rainfall.

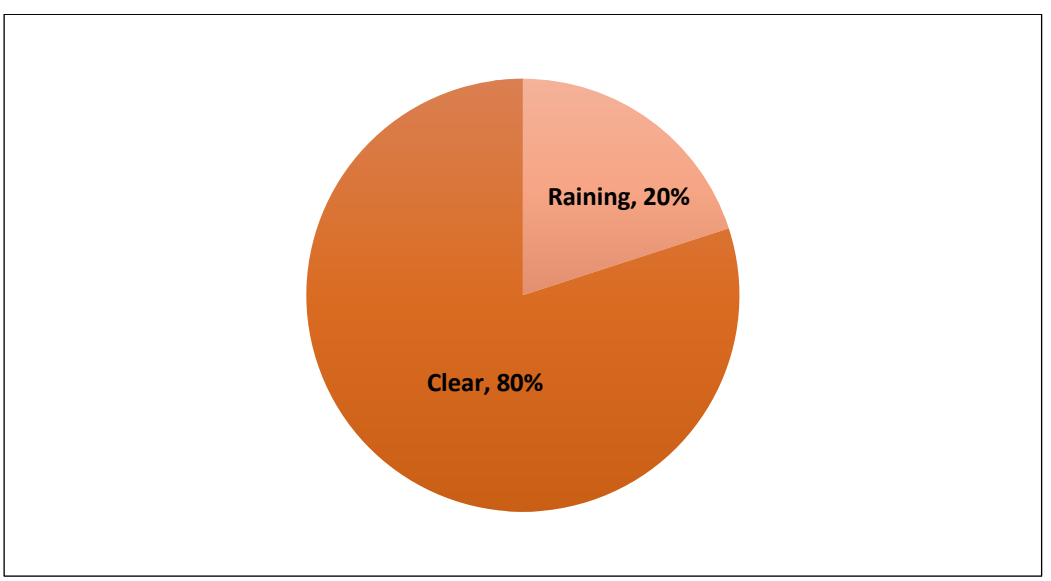

Figure 7 Weather during the crash happen

Figure 8 shows the day of the crashes. 70% of the crashes happen during weekdays while only 30% of crashes happened during weekend.

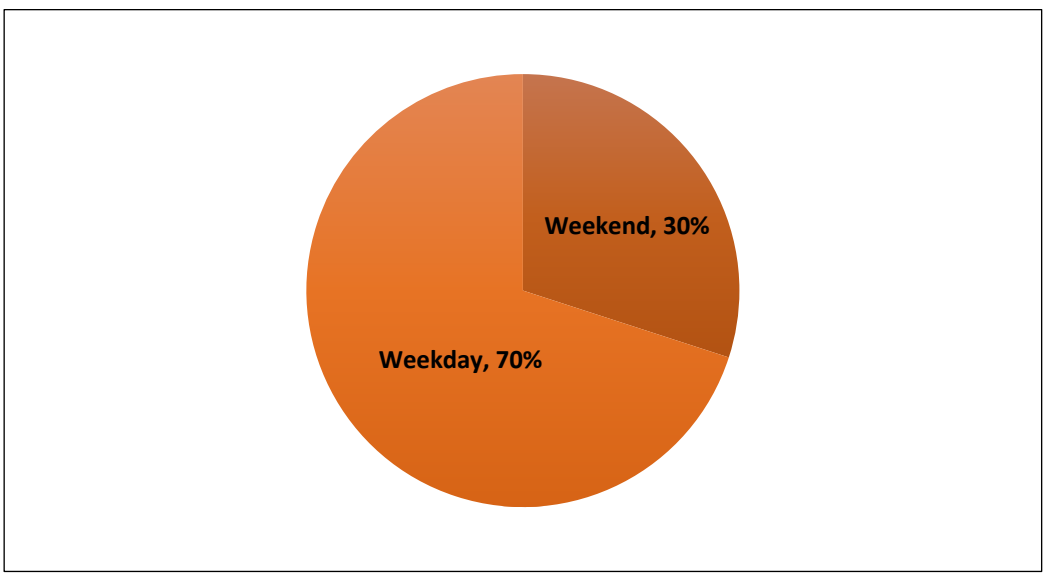

Figure 8 Day of crash happen

Figure 9 shows the collision type and Figure 10 shows who is at fault during the crashes. 43% reported that they being hit by other vehicle and 21% admit that they collided into another vehicle; 82% reported that they are not at fault during the crashes. The Royal Malaysian Police report state that around 75% of crash victims are not at fault (PDRM, 2012). The statistics is quite similar compared with the results of this study.

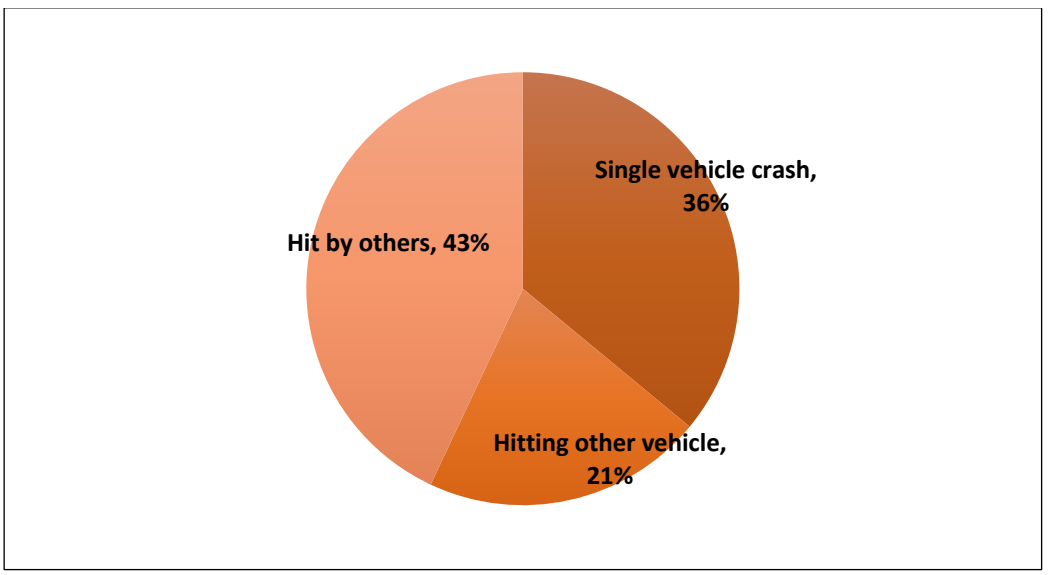

Figure 9 Collision type

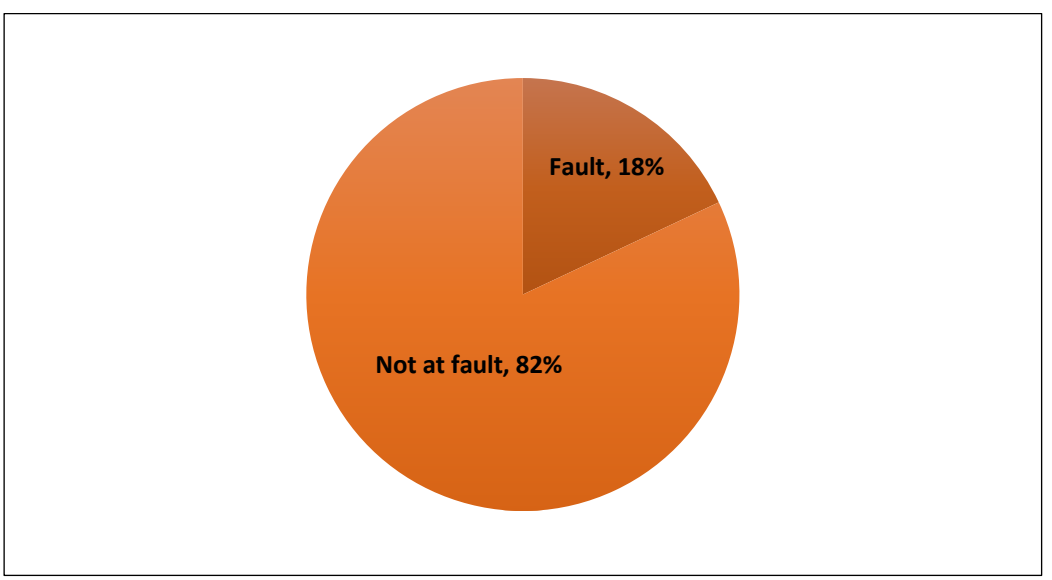

Figure 10 Who is at fault

4.4 Risk Exposure Analysis

Table 6 shows the comparison between group that had a crash and the group that did not. The result can be seen in table below. All the three (3) factors are significantly different since the sig.value=0.00 < 0.05. These result highlights that the group that had crashed has an average 9.3 years of riding experience, while the group that did not have a crash has average around 13.2 years. The licence year's column shows the group that had a crash has been a licence holder for an average of 6.8 years, whereas the group that did not have a crash has an average of 10.1 years. Other studies have also found that age is one of the influencing factors of motorcycle crashes. The average age of group that had a crash is around 25.5 years old while the group that did not have a crash has an average age of 31.4 years old.

Table 6 Exposure measure comparison for age, riding and license years

Crash		Riding experience	License years	Age
No	**Mean**	13.2	10.1	31.4
	Median	10	6	27
Yes	**Mean**	9.3	6.8	25.5
	Median	7	3	22
Mann-Whitney Sig. Value		0.00 [a]	0.00 [a]	0.00[a]

a: Significantly different at the p<0.05

Table 7 shows the underlying factors of motorcycle users having a crash. Based on table below, only age and gender significant at α=0.05* while income significant at α=0.10**. Other exposure measures do not show any significant value to the model (distance and time travelled, number of trips and years of rides motorcycle) and did not affect the motorcycle crashes for this study.

Based on the significant variable mentioned in the table above, a multiple logistic regression between the probabilities of having motorcycle crash and not having motorcycle crash can be expressed as:

Let $K = P\ (y = 1|x_i)$,

$Log\ (K)$ = -21.205 - 0.041 Age + 0.510 Gender $_{(male)}$ +
0.023 Income $_{(<RM2000)}$ - 0. 415 $Income$ $_{(RM2000 - RM4000)}$

The interpretation of the model will be explained by the odds ratio value for each of the significant variable.

Table 7 Underlying factors of motorcycle user crashing

Variables	β	P-Value	Odds ratio	95% CI	
				Lower	Upper
Constant	-21.205	0.999			
Age	-0.041	0.002*	0.961	0.936	0.986
Gender – Male	0.510	0.011*	1.617	1.118	2.341
Race		0.541			
Race – Malay	19.968	0.999	472079993.788	0.000	0.000
Race – Chinese	19.138	0.999	218382835.167	0.000	0.000
Race – Indian	19.722	0.999	379822725.321	0.000	0.000
Marital status – Single	0.256	0.243	1.274	.849	1.910
Income		0.080**			
Income – <RM2000	0.023	0.919	1.056	.372	2.998
Income – RM2000 RM4000	-0.415	0.445	0.661	0.228	1.913
Employment – Employed	0.178	0.320	1.172	0.857	1.601
Area type – Urban	0.171	0.210	1.186	0.908	1.549
Riding experience	-0.003	0.809	0.997	0.974	1.021
Years hold license	0.007	0.493	1.007	0.986	1.029
Distance daily	0.001	0.800	1.001	0.993	1.009
Time daily	0.001	0.868	1.001	0.994	1.008
No. of trips daily	0.129	0.394	1.138	0.845	1.532
Distance on Saturday	0.003	0.476	1.003	0.994	1.012
Time on Saturday	-0.003	0.480	0.997	0.989	1.005
No. of trips on Saturday	0.050	0.579	1.051	0.882	1.252
Distance on Sunday	-0.001	0.868	0.999	0.989	1.010

Time on Sunday	0.002	0.733	1.002	0.991	1.012
No. of trips on Sunday	0.003	0.969	1.003	0.855	1.177

Beside the regression coefficients, the odds ratio is important in explaining the significant variables. Odds ratio is a measure of association of the risk factor for motorcycle crash. The value is obtained by taking exponential of each coefficient value of the independent variables. From the fourth column of Table 8, the odds ratio of age is 0.961 which indicates that the odds of older motorcyclists are less than the odds of younger motorcyclists in having a motorcycle crash. So it can be said that younger motorcyclists have a higher risk of a crashing compared to those who are older. Between genders, the study can say that the odds of motorcyclists having a crash increased by 61.7% if the rider is male compared to women riders. For income group, the odd ratio for those who had income below RM2,000 is 1.056. It means that the odds of a motorcyclist having a crash increased by 5.6% for those who had income below RM2,000 compared to those who had income more than RM4,000. The odds ratio value for those who had income between RM2,000 and RM4,000 is smaller than 1 which indicates that the reference category is more influential. The odds ratio is 0.661, take reciprocal it turn into 1.513. It means that the odds of a motorcyclist having a crash increased by 51.3% for those who had income more than RM4,000 compared to those who had income between RM2,000 and RM4,000.

Table 8 shows the underlying factors of crash injuries. Based on table below, only age, marital status, collision type and time for recovery significant at α=0.05*. Other factors like distance and time travelled, weather, time of crash and days did not affect the injury model. The crash injury model can be written as follows:
Let $S = P\ (y = 1|x_i)$,

$Log\ (S)$ = 44.426 - 0.045 Age - 1.232 Marital Status $_{(single)}$ +
0.929 Collision Type $_{(Hit\ by\ others)}$ + 0. 647 $Collision\ Type\ _{(Hitting\ other\ vehicle)}$ + 0.077 Recovery Time

The odds ratio value for injury model can be seen on the fourth column of Table 8. The odds ratio of age is 0.956 which indicates that the odds of an older motorcyclist is less than the odds of a younger motorcyclist in having a crash injury. So it can be said that younger motorcyclists have a higher chance of suffering a crash injury compared to those who are older. This age indication is similar with the crash model. Marital status odds ratio value is 3.425 (after taking the reciprocal). It indicates that motorcyclists who are married are 3 times more likely to be injured during a crash compared to those who are single. Odds ratio for collision type; hit by other vehicle is equal to 2.533 which indicates that motorcyclist who were hit by other vehicles are almost 3 times more likely to be injured compared to those who had crashed by themselves. The odds of a motorcyclist getting injured during a crash increased by 91% for those who hit other vehicles compared to those who had crash by themselves. On the other hand, the odds ratio value for recovery time is equal 1.081. It means that the odds of a motorcyclist having a crash injury increase by 8.1% with each additional day of recovery time.

Table 8 Underlying factors of crash injury

Variables	β	P-Value	Odds ratio	95% CI	
				Lower	Upper
Constant	44.426	0.999			
Age	-0.045	0.041*	0.956	0.916	0.998
Gender – Male	0.638	0.153	1.892	0.789	4.540
Race		0.133			
Race – Malay	-2.178	0.044	0.113	0.014	0.947
Race – Chinese	17.324	0.999	33409472.887	0.000	
Marital status – single	-1.232	0.026*	0.292	0.098	0.866
Income		0.646			
Income – <RM2000	-20.208	0.999	0.000	0.000	
Income – RM2000 – RM4000	-19.653	0.999	0.000	0.000	
Employment – Employed	-0.125	0.732	0.882	0.432	1.802
Distance travel	0.030	0.286	1.030	0.975	1.088
Time travel	-0.011	0.662	0.989	0.942	1.039
Time crash happen		0.101			
Time crash happen – Morning	-20.457	0.999	0.000	0.000	0.000

Time crash happen – Afternoon	-20.875	0.999	0.000	0.000	0.000
Time crash happen – Evening	-21.553	0.999	0.000	0.000	0.000
Time crash happen – Night	-20.770	0.999	0.000	0.000	0.000
Weather – Clear	0.363	0.369	1.438	0.651	3.178
Days – Weekdays	-0.213	0.546	0.808	0.405	1.614
Collision type		0.045*			
Collision type – Hit by others	0.929	0.016	2.533	1.189	5.397
Collision type – Hitting another vehicle	0.647	0.122	1.910	0.841	4.337
Fault – at fault	0.204	0.630	1.226	0.535	2.808
Time for recovery	0.077	0.001*	1.081	1.031	1.133

5. Conclusion and Recommendations

This study aims to explore the relationship between exposure and risk for motorcycle crashes and to understand the different travel pattern among motorcyclists. The study findings are very useful as it provide some insight into effective motorcycle intervention measure. Knowing motorcyclists' travel pattern will help Road Safety Authorities in planning and provide facilities to avoid motorcycle crashes.

This study found that there are significance differences between demographic characteristics and exposure measure (i.e. distance and time travelled, number of trips). During weekdays, married people tend to travel quite far and spend more time on the roads compared to single people. Age also plays an important role in the motorcycle study. Different age groups travel different distances and spend varying periods of time on the road. The older people get, the farther they travel. Motorcyclists in urban and rural areas show a notable difference in their travel pattern. This study can conclude that there is not much different between travel pattern on Saturday or Sunday. This may be due to the fact that both days are weekend and people usually do leisure trips.

This study revealed that motorcycle crashes always happens during trips to or from work, and usually resulting in minor injury. Crashes always happen in the evening; this correlates to the finding that crashes tend to happen during trips from work. Usually, motorcyclists get into a crash during clear (sunny) weather and during weekdays. Even though the weather is clear, the hot and sunny can lead to fatigue. In parallel, crash always happen during weekday since more trips are made on weekdays compared to weekends. Almost half of the crash victims claimed that they were hit by other vehicles and more than half claim that they were not at fault.

The logistic regression model aims to identify the contributing factor to motorcycle crashes. The important exposure measure variables were included and not even one variable show a significant effect on the model for this study. This result is limited to this

scope of study only and further in-depth study need to be done, such as including the fatal crash experience or using a different method of data collection; for example, a focus group discussion can increase the precision of the data reported. This study can conclude that only age, gender and income group made significant contribution to the prediction of crash. The second model was developed to identify the factors that contribute to the crash injury. Age, marital status, collision type and recovery time were significant contributor to crash injury. Time for recovery shows a very significant effect since it has positive relationship between injury and recovery time. If the recovery takes longer, it is usually an indicator that the injury is bad.

There are several limitations to the generalisability of these findings. The responses for this study were individual self-reports of crash criteria, which can be criticised for underestimating or overestimating the validity of the information. To improve this study, a focus group study is suggested.

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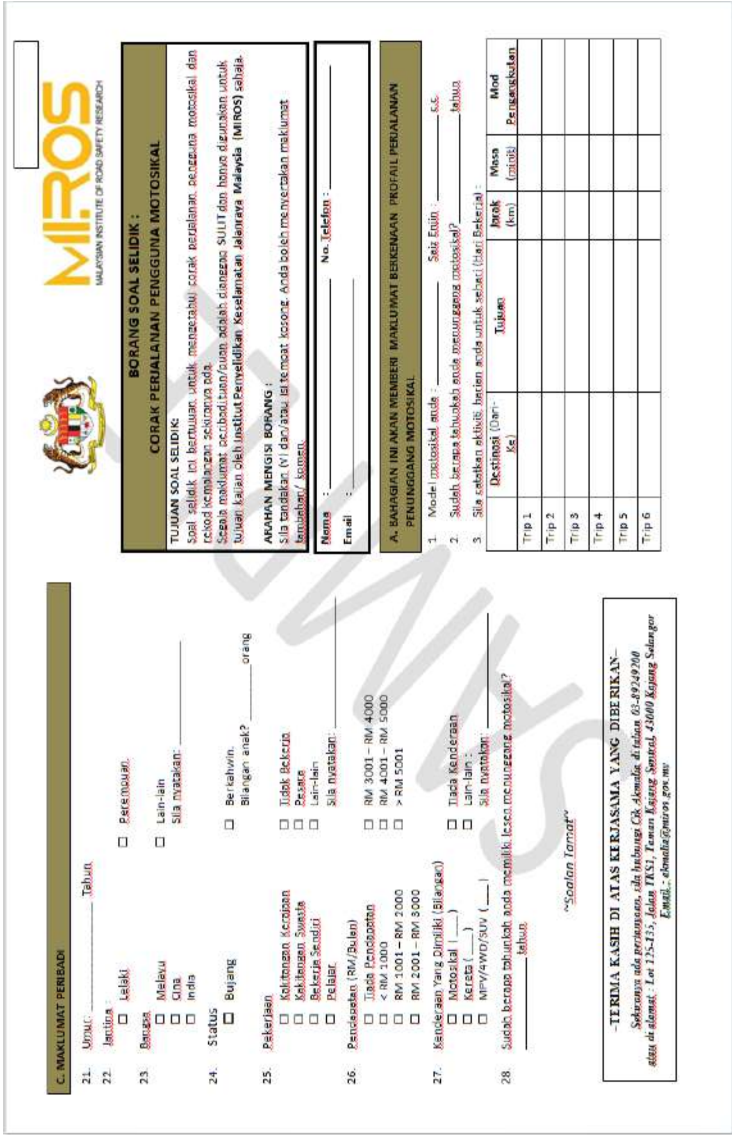
Appendix



MIROS
MALAYSIAN INSTITUTE OF ROAD SAFETY RESEARCH

BORANG SOAL SELIDIK :
CORAK PERJALANAN PENGGUNA MOTOSIKAL

TUJUAN SOAL SELIDIK:
Soal selidik ini bertujuan untuk mengetahui corak perjalanan pengguna motosikal dan rekod kemalangan sekiranya ada.
Segala maklumat peribadi tuan/puan adalah dianggap SULIT dan hanya digunakan untuk tujuan kajian oleh Institut Penyelidikan Keselamatan Jalanraya **Malaysia (MIROS)** sahaja.

ARAHAN MENGISI BORANG :
Sila tandakan (√) dan/atau isi tempat kosong. Anda boleh menyertakan maklumat tambahan/ komen.

Nama : ______________ **No. Telefon** : ______________
Email : ______________

A. BAHAGIAN INI AKAN MEMBERI MAKLUMAT BERKENAAN PROFAIL PERJALANAN PENUNGGANG MOTOSIKAL

1. Model motosikal anda : ______________ Saiz Enjin : ______________ c.c.
2. Sudah berapa tahunkah anda menunggang motosikal? ______________ tahun
3. Sila catatkan aktiviti harian anda untuk sehari (Hari Bekerja) :

	Destinasi (Dari-Ke)	Tujuan	Jarak (km)	Masa (minit)	Mod Pengangkutan
Trip 1					
Trip 2					
Trip 3					
Trip 4					
Trip 5					
Trip 6					

C. MAKLUMAT PERIBADI

21. Umur: ______________ Tahun
22. Jantina :
    - ☐ Lelaki
    - ☐ Perempuan
23. Bangsa
    - ☐ Melayu
    - ☐ Cina
    - ☐ India
    - ☐ Lain-lain Sila nyatakan: ______________
24. Status
    - ☐ Bujang
    - ☐ Berkahwin. Bilangan anak? ________ orang
25. Pekerjaan
    - ☐ Kakitangan Kerajaan
    - ☐ Kakitangan Swasta
    - ☐ Bekerja Sendiri
    - ☐ Pelajar
    - ☐ Tidak Bekerja
    - ☐ Pesara
    - ☐ Lain-lain Sila nyatakan: ______________
26. Pendapatan (RM/Bulan)
    - ☐ Tiada Pendapatan
    - ☐ < RM 1000
    - ☐ RM 1001 – RM 2000
    - ☐ RM 2001 – RM 3000
    - ☐ RM 3001 – RM 4000
    - ☐ RM 4001 – RM 5000
    - ☐ > RM 5001
27. Kenderaan Yang Dimiliki (Bilangan)
    - ☐ Motosikal (___)
    - ☐ Kereta (___)
    - ☐ MPV/4WD/SUV (___)
    - ☐ Tiada Kenderaan
    - ☐ Lain-lain : Sila nyatakan: ______________
28. Sudah berapa tahunkah anda memiliki lesen menunggang motosikal? ______________ tahun

~Soalan Tamat~

–TERIMA KASIH DI ATAS KERJASAMA YANG DIBERIKAN–
Sekiranya ada pertanyaan, sila hubungi Cik Akmalia di talian 03-89249200 atau di alamat : Lot 125-135, Jalan TKS1, Taman Kajang Sentral, 43000 Kajang Selangor Email : akmalia@miros.gov.my

4. Sila catatkan aktiviti hari Sabtu anda untuk sehari :

	Destinasi (Dari-Ke)	Tujuan	Jarak (km)	Masa (minit)	Mod Pengangkutan
Trip 1					
Trip 2					
Trip 3					
Trip 4					
Trip 5					
Trip 6					

5. Sila catatkan aktiviti hari Ahad anda untuk sehari :

	Destinasi (Dari-Ke)	Tujuan	Jarak (km)	Masa (minit)	Mod Pengangkutan
Trip 1					
Trip 2					
Trip 3					
Trip 4					
Trip 5					
Trip 6					

6. Mengapakah anda memilih motosikal sebagai mod pengangkutan utama anda?

____

7. Adakah anda pernah melakukan kesalahan jalan raya walaupun tidak dikenakan saman? (Contoh: Melanggar lampu merah, Menggunakan jalan kecemasan)

Tidak Pernah — Jarang-Jarang — Kadang-Kadang — Selalu

8. Adakah anda akan menggunakan kenderaan lain pada hari hujan?

☐ Ya ☐ Tidak

B. BAHAGIAN INI AKAN MEMBERIKAN MAKLUMAT BERKENAAN PENGALAMAN ANDA TERLIBAT DALAM KEMALANGAN JALAN RAYA

9. Adakah anda pernah mengalami kemalangan motosikal dalam setahun lepas?
   ☐ Ya ☐ Tidak (Jika TIDAK sila ke **Bahagian** C)

10. Berapa kali anda pernah terlibat dalam kemalangan motosikal? __________ kali

REKOD KEMALANGAN INI ADALAH KEMALANGAN YANG TERBARU.

11. Tahap Kecederaan?
    ☐ Cedera dan masuk wad ☐ Tidak cedera tapi kenderaan rosak
    ☐ Cedera dan mendapatkan rawatan luar

12. Asalan dan destinasi anda semasa anda kemalangan motosikal?
    Dari : __________ ke __________
    Contoh : Dari *rumah (Cheras)* ke *tempat kerja (Kajang)*

13. Anggaran jarak perjalanan anda dari asalan ke destinasi : __________ km

14. Anggaran masa perjalanan anda dari asalan ke destinasi : __________ minit

15. Tujuan perjalanan anda semasa anda kemalangan motosikal?
    ☐ Pergi dan balik kerja ☐ Pergi sekolah
    ☐ Hantar anak ke sekolah ☐ Membeli barang/Membeli-belah
    ☐ Menziarahi rakan/saudara ☐ Balik kampong
    ☐ Perkhidmatan Penghantaran (Barang/Surat/Makanan) ☐ Bersiar-siar
    ☐ Lain-lain (Sila Nyatakan) __________

16. Masa kejadian :
    ☐ Pagi (7pg-12tgh hari) ☐ Petang (2ptg-7mlm)
    ☐ Tengah Hari (12 tgh hari-2ptg) ☐ Malam (7mlm-12tgh mlm)
    ☐ Tengah Malam (12tgh mlm-7pg)

17. Cuaca pada masa itu?
    ☐ Cerah ☐ Hujan

18. Hari semasa kemalangan berlaku? I / S / R / K / J/ S / A

19. Semasa kemalangan berlaku, adakah anda?
    i. ☐ Dilanggar dengan kenderaan __________ ☐ Melanggar dengan kenderaan __________
    ii. ☐ Bersalah ☐ Tidak Bersalah

20. Berapa lamakah anda mengambil masa untuk sembuh dan kembali bekerja?
    __________ hari

Research Report

Risk and Exposure of Motorcycle Activity in Selangor

Designed by: MIROS

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