EFFECT OF TRAFFIC VOLUME AND SHOULDER WIDTH TOWARDS CRASH CASES AT JALAN KUANTAN BYPASS

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ABSTRAK

Jalan Kuantan Bypass dikenali sebagai jalan yang mempunyai kadar kemalangan yang tinggi. Pembangunan yang pesat sepanjang jalan bersama dengan penubuhan banyak industri yang baru di kawasan telah dikaji sebagai faktor utama untuk isu ini. Kajian ini bertujuan untuk mengkaji kesan-kesan jumlah kenderaan dan lebar bahu jalan terhadap kes kemalangan yang terjadi di Jalan Kuantan Bypass. Kemalangan jalan raya boleh berlaku dalam beberapa sebab termasuk kecuaian pemandu, keadaan jalan, keadaan kenderaan, dan keadaan cuaca. Thesis ini memberi tumpuan kepada dua (2) kategori iaitu jenis kenderaan dan kelebaran bahu Jalan Kuantan Bypass. Semua data dikumpulkan di tapak pada hari minggu dan hari hujung minggu sepanjang 2.2km, jalan bermula daripada persimpangan isyarat berdekatan lampu isyarat persimpangan Wisma Belia sehingga lampu isyarat persimpangan Bukit Rangin. Hubungan antara komposisi kenderaan, kelebaran bahu jalan dan kes-kes kemalangan jalan raya menggunakan analisis regresi berganda. Model ini menjelaskan kemalangan dengan 61% (r-kuadrat=0.611) dan terbukti bahawa kenderaan berat dan lebar bahu secara statistik signifikan terhadap tahap kemalangan ($p = 0.0001$, $p < 0.001$). Hasil yang dijana dari kajian ini diharapkan dapat memberikan inspirasi kepada pihak berkuasa tempatan Kuantan untuk menghasilkan pelan yang betul untuk menyelesaikan gangguan kenderaan berat ke aliran lalu lintas di Jalan Kuantan Bypass.

ABSTRACT

Kuantan Bypass is known for having a very high vehicles crash rate from year to year. Rapid development along the roads together with establishments of many new industrial areas in the road surrounding area have been observed as the main factor for this issue. This study aims to investigate the effect of vehicles and shoulder width towards high number of crash cases along Jalan Kuantan Bypass. Crashes occur due to several reasons which include drivers' negligence, road conditions, vehicle conditions and weather conditions. This thesis will mainly focus on 2 categories of data namely, vehicles and shoulder width. All data were collected on site during weekdays and weekend along 2.2 km road starts from signalized intersection near Wisma Belia until signalized intersection at Bukit Rangin. Relationship between traffic volume, shoulder width and crash cases was generated using multiple regression analysis. The model shows that the multiple regression is explaining the severity of crash by 61% (r-squared = 0.611) and it is proven that vehicles and shoulder width is statistically significant to the severity of crash ($p = 0.0001$, $p < 0.001$). The outcomes generated from this study is hope to give an insight to the Kuantan local authority in producing proper plan to solve the interruption of heavy vehicles to traffic flow at Jalan Kuantan Bypass.

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LIST OF SYMBOLS

X_1	Independent Variable -Vehicles Classification (Car and Motorcycle)
X_2	Independent Variable- Shoulder width
X3	Independent Variable – Heavy vehicles
Y	Number of Crash
Bn	Regression coefficient of the nth independent variable

LIST OF ABBREVIATIONS

PDRM	Polis Diraja Malaysia
PWD	Public Work Department
MoT	Ministry of Transportation

CHAPTER 1

INTRODUCTION

1.1 Introduction

In 2004, the World Health Organization stated that the frequency of deaths from road crashes became the ninth causing the death in the world. The World Health Organization predicts that the frequency of death caused by bad crashes will be the fifth in 2030. The number of accidents reported may be underestimate. The actual number of accidents may be higher than the official statistics of crash. This is because not all of the crashes were reported to the police station.

The Malaysian government has been held responsible in looking after road safety in Malaysia. After Malaysia achieved independence in 1957, many bodies involved with road safety have been formed for example voluntary sector, government departments and private sector. A Cabinet Committee on Road Safety was set up in Malaysia and chaired by the Prime Minister to monitor and conduct research so that roads in Malaysia are better and more convenient to reduce traffic accidents.

Since the development of technology and economic growth, vehicle demand has also increased in Malaysia. As a results, crashes in Malaysia continue to rise and become serious due to the increase in vehicles on the road. In 2009, for example, the Malaysian government spent RM 9.3 billion as a result of traffic crashes(MIROS, 2016)(Abdelfatah, 2016).

Crashes usually come from a combination of four (4) elements namely drivers, roads, weather and vehicles. Crashes are often caused by drivers and are affected by vehicle conditions, roads or weather. Accidents can be reduced with changes in vehicle design, road geometry, surrounding road conditions, driver behaviour. If there are any factors that cause road crashes, it needs to change and improve the highway system.

To reduce road accidents, planning and research need to be carried out. Crash prediction models can be used to help in assessing the level of road safety during highway planning. Crash Prediction Model is used for the purpose of establishing Infrastructure Coefficient, as a result of obtaining a whole on road safety by using independent variables.

Road safety is becoming a big issue until now when the number of crashes is still huge despite the various programs that have been done. Table 1 shows statistical data on road crashes 2008 to 2015. The number of vehicles crashes and fatal shows an increment from year by year. While the number of serious and minor injury caused by vehicles crash decrease since 2008 until 2015.

Table 1.1 The general statistic in Malaysia of road crash

Year	**Crash**	**Fatal**	**Serious Injury**	**Minor Injury**
2008	373,071	6,527	8,868	16,879
2009	397,330	6,745	8,849	15,823
2010	414,421	6,872	7,781	13,616
2011	449,040	6,877	6,328	12,365
2012	462,423	6,917	5,868	11,654
2013	477,204	6,915	4,597	8,388
2014	476,204	6,674	4,432	8,598
2015	489,606	6,706	4,120	7,432

Source: Annual Transport Statistic 2008 to 2015.
(Ministry of Transport (MOT), 2017)

1.2 Background Study

Most people are unaware of how large a problem of unsafe traffic operation worldwide. The tragic consequence of vehicles crash puts unsafe traffic operations on a par with war or drug use, as an example of irresponsible social behaviour that must change. This lack of awareness and responsibility may be an important reason why more than 500,000 people are killed per year or about one life every minute and over 15 million suffer injuries as a result of road accidents every year worldwide(W. Organization, 2004).

Road crashes depend on various mechanical, behaviour and environment factors. These factors vary in space and time. Therefore, the incidence of road crashes and fatalities also vary at both spatial and temporal scales. From the previous accident analysis record, every year more than 1.17 million people die in road crashes around the world. It has been estimated that at least 6 million more will die and 60 million will be injured during the next 10 years in developing countries unless urgent action is taken(W.Organization, 2004).

The main cause of road crashes in Malaysia is because of the attitude and behaviour of people(Abdelfatah, 2016). Humans often drive using emotions when driving. According to reports from the Royal Malaysian Police, PDRM (2006), 90% of road crashes occurred due to humanity. The causes of road accidents are drivers who often disobey traffic safety laws, including driving under the influence of alcohol, illegal racing, driving in dangerous conditions, disturbing emotions, driving in tired conditions, and driving in high speed (NHTSA 2010). Speed is also one of the common causes of road accidents in Malaysia. Speeding is also based on road conditions, lighting, weather, and traffic areas. Although the Malaysian government has installed speed traps, it still cannot prevent Malaysian drivers to speed up and drive in dangerous conditions(Umar & Professot, 2005).

1.3 Problem Statement

Malaysia has achieved success in many fields including in economic activities. As a developing country, transportation and road network has become an important tool in building the nation as it connects different states in Malaysia. Therefore, there is a need for safe and modern road infrastructure to be used for all road users. A set of road law has been imposed by Road Safety Department and Malaysian Institute of Road Safety Research to ensure a systematic road system regulated for all types of road conditions and the ever increasing volume of traffic year to year.

Data from Royal Malaysia Police (PDRM) highlights that in average, 18 to 20 crashes happen daily on Malaysian roads. Their data further indicates that in 2014, 2,208 crash cases, from the total of 16,763, were rear collisions; and out of that, 1,289 cases contributed to fatalities and serious injuries of the victims. Most accidents happen due to driver negligence. However, the frequency of accidents, the severity of the crash can be capped with the proper use and control of the control device, besides, identifying the causes of the crashes.

Kuantan Bypass Road was chosen as study area because it is the main route between Kuantan town and Terengganu and it has become the main route of the lorry to/from industrial areas as well as buses to Kuantan Central Terminal. The purpose of this research is to study the effect of traffic volumes and shoulder width towards crash cases at Jalan Kuantan Bypass. According to Figure 1, road traffic crashes are increasing year by year steadily.

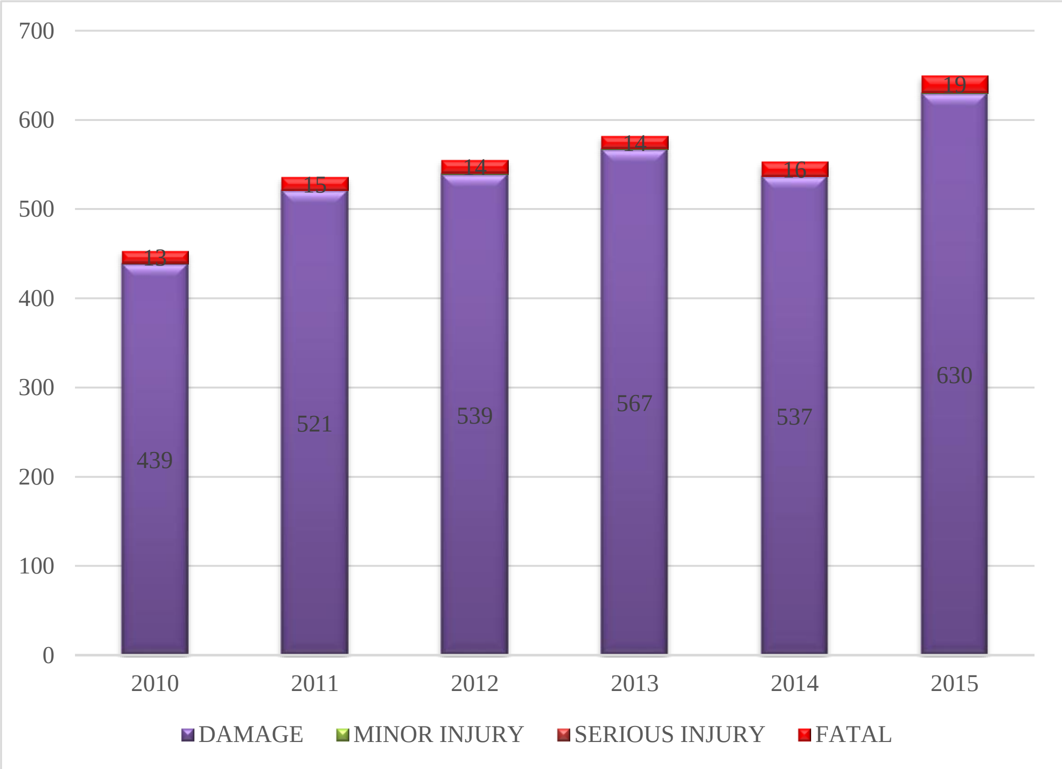

Figure 1.1 Statistic of crash at Jalan Kuantan Bypass. Source: Annual Transport Statistic 2008 to 2015.

(Ministry of Transport (MOT), 2017).

1.4 Objectives

There are three (2) objectives have been discussed and outlined in order to realize the purpose of this study:

- To study pattern of vehicles composition at Jalan Kuantan Bypass.

- To study and evaluate the effect of traffic volumes and shoulder width towards crash cases at Jalan Kuantan Bypass.

1.5 Scope of Study

The limitations of this study are listed below.

- The study area is focused in between main entrance road from signalized intersection of Wisma Belia until signalized intersection at Bukit Rangin at Jalan Kuantan Bypass.

- The data collections are focused during Tuesday, Wednesday and Thursday for weekdays and Saturday for weekend.

- The data will be collect from 4.30pm until 7 pm.

1.6 Relevant of Study

This study aims to create awareness to all parties involved in producing a safer and reliable environment of users of the trunk route in specific and all road users. In our society, people will tend to put the blame on the drivers or road users when a traffic crash occurs, although in fact driver's carelessness might be caused by other factors that interrupt driver's attention.

Since the study is about road safety level, the result of this study can be implemented as indicator for reducing the vehicles crashes by The Road Transport Department Malaysia, abbreviated JPJ and The Royal Malaysia Police (PDRM). The data also may be useful to the Public Works Department (JKR) of the Ministry of Works Malaysia and the Local Authority to mitigate the problem in the road design and construction.

CHAPTER 2

LITERATURE REVIEW

2.1 Malaysian Road Crash Statistic

According to Global Health Observatory (2013), the percentage of total road crashes increases every year. Statistics from the Department of Statistics in 2005 showed a registered vehicle of 26,301,952 numbers in 2015, and the accident case recorded a total of 489,606 numbers of crash.

The main factors of the vehicles crash are due to human error, road conditions, vehicles and environmental conditions. Road accidents increase daily due to the increasing number of vehicles. This is becoming more serious during the festive seasons. The number of accidents during the festive seasons has increased by 10% (Mohd, 2017). In developed countries, it has been reported that 30% of deaths are due to vehicle speed(Mohammad, 2011). In mid-developed countries, speed has been considered a major factor in about half of the total number of crashes(World Heatlh Organization, 2004). Road conditions are also one of the factors that can potentially cause road accidents. Geometry, surface condition, road marking, street lighting and vision are factors that can affect driving vision. The relationship between the road and the environment is very complex with driving performance(Islam & Kanitpong, 2008)

Table 2.1 General Statistic of Vehicles Crash from 2000 to 2016

Year	Registered Vehicles	Population	Road Crashes	Road Deaths	Serious Injury	Slight Injury	Index Per 10,000 Vehicles	Index Per 100,000 Population	Index Per Billion VKT
2000	10,598,804	23,263,600	250,429	6,035	9,790	34,375	5.69	26.00	26.25
2001	11,302,545	23,795,300	265,175	5,849	8,680	35,944	5.17	25.10	23.93
2002	12,068,144	24,526,500	279,711	5,891	8,425	35,236	4.90	25.30	22.71
2003	12,819,248	25,048,300	298,653	6,286	9,040	37,415	4.90	25.10	22.77
2004	13,828,889	25,580,000	326,815	6,228	9,218	38,645	4.52	24.30	21.10
2005	15,026,660	26,130,000	328,264	6,200	9,395	31,417	4.18	23.70	19.58
2006	15,790,732	26,640,000	341,252	6,287	9,253	19,885	3.98	23.60	18.69
2007	16,813,943	27,170,000	363,319	6,282	9,273	18,444	3.74	23.10	17.60
2008	17,971,907	27,730,000	373,071	6,527	8,868	16,879	3.63	23.50	17.65
2009	19,016,782	28,310,000	397,330	6,745	8,849	15,823	3.55	23.80	17.27
2010	20,188,565	28,910,000	414,421	6,872	7,781	13,616	3.40	23.80	16.21
2011	21,401,269	29,000,000	449,040	6,877	6,328	12,365	3.21	23.70	14.68
2012	22,702,221	29,300,000	462,423	6,917	5,868	11,654	3.05	23.60	13.35
2013	23,819,256	29,947,600	477,204	6,915	4,597	8,388	2.90	23.10	12.19
2014	25,101,192	30,300,000	476,196	6,674	4,432	8,598	2.66	22.00	10.64
2015	26,301,952	31,190,000	489,606	6,706	4,120	7,432	2.55	21.50	9.60
2016	27,613,120	31,660,000	521,466	7,152	TBP	TBP	2.59	22.60	10.70 a

Sourc**e:** Annual Transport Statistic 2008 to 2015. (Ministry of Transport (MOT), 2017)

2.2 Road Crash Factor

Road safety features mean when there is no violation between road users(Viet Hung & Huyen, 2011). Traditionally, road safety is assessed using prior vehicles crash records and crashes are measured by the expected amount at the time given and the number of collisions (Nurul Ain, 2010). According Brown (1994), the records of offenses are important in safety analysis. So, some violations should be recorded before action is taken. Therefore, there is great interest in research related to road safety improvements (Gettman & Head, 2003). A research has studied the traffic conflicts and states that actual traffic conflict is much higher than reported crash statistics. (Brown, 1994, Hyden, 198, Sayed et al., 1994, Sayed and Zein, 1999, Svensson and Hyden, 2006).

According Nurul Ain (2010), traffic conflicts are similar processes with violations but no violations have occurred. It is an incident involving two or more vehicles moving towards another vehicles and causing a crash. Crash only can be avoided by one of the vehicles carrying out emergency maneuvering.

According to studies conducted in the investigation of the factors that could cause the violation, road environment, traffic characteristics and road demographic characteristics have been identified as mostly related to crash. Linkages between road crashes and existing traffic interventions are not clear due to the complex role of traffic interventions. There are many factors that cause road accidents in Malaysia. Accidents can occur for a variety of reasons. Accident factors are caused by:

i) Human factor

ii) Road and environment

iii) Vehicles factor

Most studies have shown that population and number of vehicles that have been registered have a very close relationship with the fatalities rate. This is evidenced by Zhao's review of road crashes in China (Zhao, 2009). The research concluded that the main factor in traffic deaths in China was due to road classification, driver experience and level of urban development along the way. Zhao also concluded that other factors include drunk driving, poor road conditions and heavy vehicles overload due to high toll rates. Population density in China also contributes to traffic death.

In addition, the study of Melchor et al. regarding the trend of deaths attributable to traffic in Spain from 1987 to 2011, focusing on the impact of gender and driver age. The mortality rate was reduced during the period of study, with the highest reduction in mortality rate in the 15-34 age group and the mortality rate among men was significantly higher than for women. In Japan, Jiang and Zhang (2014) have learned about the impact of traffic jams due to accidents. The result indicates that the discharge time does not intentionally have the greatest influence on driver behaviour, and information on accidental discharge must be provided as an interval.

2.3 Effect of road and environment factor

According to Polus (2006), poor infrastructure contributed significantly to accidents. This study also shows that it is possible to differentiate between lower emergency rate roads and higher accident rate roads by the way their overall infrastructure features. Well-built and operated highways reduce 44% crash, compared to highways with poor infrastructure, and these findings are at a 99% confidence level. As a result of this very important discovery, more focus is needed to upgrade the features of the road infrastructure.

K.W. Odgen (1997) also noted that paved road shoulders with significant statistically reduced frequency of emergency accidents and emergency accidents reduced by 41 percent, every one kilometer of vehicles (after correction for regression to min). It is equivalent to a decrease of 0.071 accident per million kilometers of vehicles.

According to Ranja B and Sudeshna M (2013), road characteristics affect the rate of road accidents. It explains that Annual Average Daily Traffic is the most important variable for multilane roads and lane paths. However, other factors also give different interests depending on the case. Looking closely at the normalized crash rate results on Annual Average Daily Traffic, it is concluded that the lane width factor and pavement state are the most important variables affecting the rate of accident for the two aisle case (Bhagyaiah & Shrinagesh, 2014). The importance of lane width seems to increase with a higher flow. On the other hand, the importance of pavement state factors seems to increase with lower flow due to higher speeds.

2.4 Vehicles factor

Vehicle defects can be categorized as human error as it is the driver's responsibility to ensure the condition of the vehicle is always safe before driving. Some of the vehicle's defects are like brake damage, left and right signalling lights do not work, third brake lights, headlights, rear lights and side mirrors. Drivers should ensure that vehicles are constantly inspected and in good condition to ensure the well-being of drivers, passengers and other road users. Additionally, the mistakes of some illegal drivers by installing unauthorized lights and large tires.

2.5 Road Geometry factor

Road safety is also influenced by road geometry. Geometry design has the potential to affect road traffic accidents in Thailand. The visibility, lane signs, road surface conditions, geometry, and facilities also contribute to road accidents.

In addition, Syu Yang et al. (2013) has been studying that the vehicles crash and economic costs due to road crashes are high in cities such as St. Petersburg. Louis Country and City St. Louis. Most of the crashes that occurred in the city were at the crossroads and change of route path. Road design and junction besides the traffic system, are the main factor that caused the number of vehicles crashes in the city.

2.6 Sight Distance

Sight distance is the distance the road can be seen by the driver. Sight distance is very important to ensure the driver can see clearly. For road safety, the engineer should provide adequate sight distance along the way so that the driver can control the tires and avoid the infringement of objects and other vehicles in advance. American Association of State Highway and Transportation Officials (AASHTO) have set acceptable limits for sight distance, pass and intersection based on rational analysis of safety requirements of 1-5.(Glennon, 2001.)

2.7 Vehicles Classification

In developed countries, road accidents are increasingly highly causing government intervention and authorities unfinished sentence. The tightened laws include speed limits, alcohol consumption advice, driving conditions and road design and use. Deaths in the United States declined by 27% in 1975 to 1988, but in the same period, Malaysia's death rose by 44%. Traffic deaths occur to drivers within the range of 15 to 44 years. The World Bank estimates that the cost of road traffic injury is 1% to 2% of Gross National Product (GNP) of developing countries, or twice the amount of development aid received worldwide by developing countries.

In addition, pedestrians, motorcyclists and cyclists are the weakest and most frequent road users in poor countries. The risk for motorcyclists, cyclists and pedestrians very high. For example, in Asia there are too many two or three wheeled vehicles. Figure 2.1 shows that the vehicles classification.

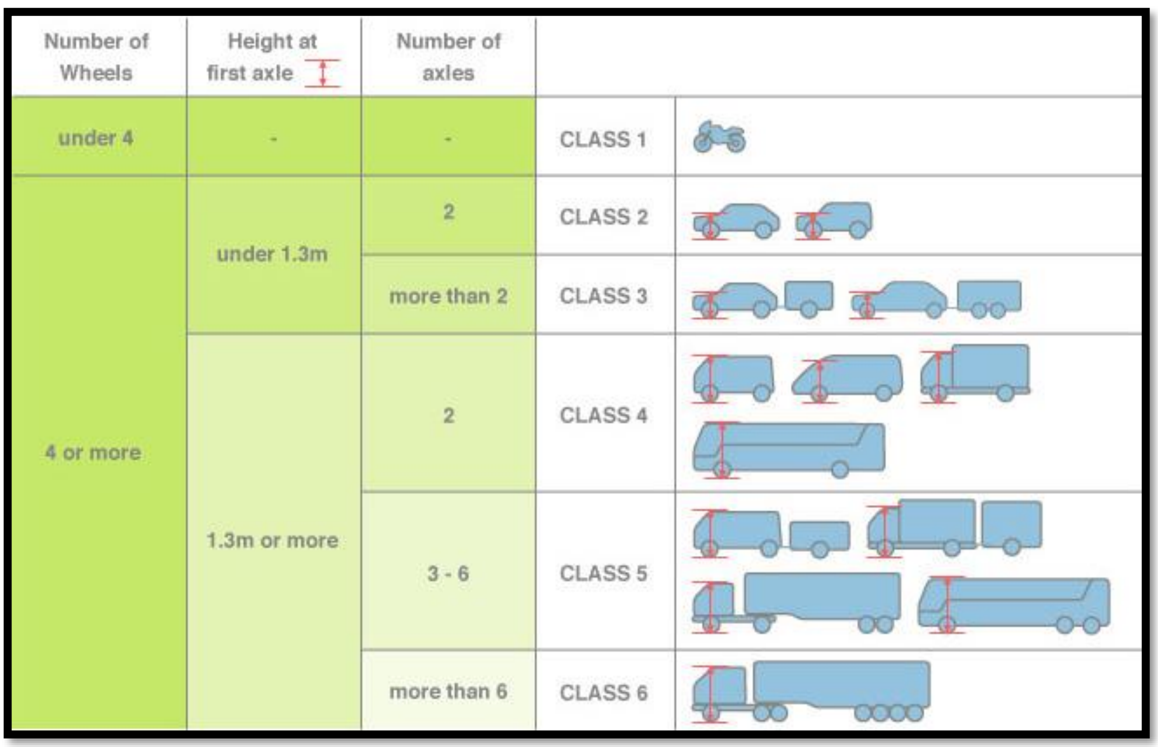

Figure 2.1 Vehicles classification

Table 2.2Statistic Fatalities in Malaysia according to Road Users for Jan – Dec 2016

TYPE OF VEHICLES/ MONTHS		TOTAL FATALITIES											
	JAN	FEB	MARC	APR	MAY	JUN	JUL	AUG	SEPT	OKT	NOV	DEC	TOTAL
MOTORCYCLE	390	366	369	391	394	393	401	403	371	343		664	4,485
CAR	114	136	113	116	134	151	138	104	125	137		221	1,489
PEDESTRIAN	45	54	47	35	34	45	41	32	46	44		88	511
LORRY	21	12	18	16	16	20	16	25	12	11		19	186
FOUR-WHEELED	8	20	11	11	10	17	15	13	10	6		21	142
OTHERS	15	2	24	10	7	7	19	9	2	8		19	122
BICYCLE	11	11	15	11	9	10	10	7	6	12		21	123
VAN	9	1	12	5	7	3	2	6	8	8		4	65
BUS	4	0	3	0	1	2	3	0	0	0		16	29
TOTAL	617	602	612	595	612	648	645	599	580	569		1,073	7,152

Source: Annual Transport Statistic 2008 to 2015. (Ministry of Transport (MOT), 2017)

Table 2.2 shows the statistic fatalities in Malaysia according to road users for January to December 2016. Statistics show that the number of injuries involving motorcycles is 4,485. The car is the second highest being involved in an accident in 2016 and pedestrian is the fourth highest cause of fatalities in Malaysia.

2.8 Heavy vehicles factor

Heavy vehicle transportation is growing rapidly in Malaysia's economic development. It has become very important for the industry. The rate of accident in Malaysia is also increasing every year. It is estimated that 600 people have been killed due to road accidents and 1000 deaths were motorists and motorcyclists killed due to violations with heavy vehicles (Huzaifah, M.M, 2010). In the suitability of the accident, it is one of the main reasons factors causing high severity in heavy vehicle accidents. Density and weight conditions cause heavy effects to other vehicles. In addition, heavy vehicles often move at lower speeds compared to other vehicles. Therefore, it can cause breakdown due to the difference in speed. In this type of accident configuration, tendencies play an important role especially in the event of a night accident.

The Malaysian Institute of Road Safety Research (MIROS) conducted a road crashes investigation in high profile cases revealed that the real end collision was the second highest type of crash with 28.4%. In the crash, the mortality rate shows an estimated tendency between daylight (51%) and night time (49%). However, at night, about 55.1% of crash occurred in areas without lights. This suggests that poor vision due to poor lighting may be the cause of major crashes for rear end crashes. A study in Australia has proven that night time is more likely to crash than daylight (Monash University, 2003). In the dark, ordinary heavy vehicles cannot be seen by other road users.

Therefore, one of the main elements of vehicle safety is a good sight in traffic. To increase the visibility of heavy vehicles, heavy vehicles and their trailers have to be equipped with perfect lighting signals. The purpose of this marker is to increase the visibility of heavy vehicles to other drivers, especially during dark and bad weather conditions. These signs reflect other users' lights and warn that their vehicles are approaching heavy vehicles. Red and white flags as heavy trailer carriers and at the same time help other road users measure their distance and approach (NHTSA, 2001).

2.9 Road Safety Analysis

According to Elvik (2004), has stated that road safety research can be seen as a fundamental lack of solid theoretical basis in areas where road accidents are very difficult to predict. This is because of high frequent of road crash. According to Fridstrom and Ingebrigtsen (1991), there is a regression-to-the-mean impact where accidents may be completely random and undetectable. On the other hand, Davis (2014) states that crash is an event that is not random and it is deterministic. Crash factors cannot be predicted. In Malaysia, the Malaysian Ministry of Works (MOW) constantly monitors road crash and ensures road safety is reduced and achieves its safety targets. Road is considered safe or will not be determined by the person using it. If the road is found to be dangerous, appropriate action should be taken immediately to avoid accidents. Government should work with engineers to overcome road defects. Even though roads are built according to standards, safety measures should be taken immediately if roads are in danger (Frank Navin, 1999). Improving road safety is one of the key drivers for transport policy. Identifying accident factors is very important in the process of enhancing effective security. Through this study, there are various factors that cause road accidents.

CHAPTER 3

METHODOLOGY

3.1 Introduction

As discussed in Chapter 2, there are various ways and methods to identify the road crash factors that occur in Bypass Kuantan. Some methods are used to achieve the objectives within the scope of work. Thus, an effective methodology must be carried out to ensure that the review process is smooth and orderly. The level is divided into five (5) stages. These stages include data collection, data interpretation, data analysis, research outcome and conclusion, and recommendation.

The main focus of this thesis is to identify the crash factor by using the model where the model corresponds to the data taken. There are two (2) variables to be used in this thesis, which are:

i) Traffic volumes

ii) Shoulder width

The study was expected to yield result and correlation of road crash for Jalan Kuantan Bypass. The distance of the study area is 2.2 km. Primary data was taken using the automatic counter (MetroCount) in the study area. Road inventory was also taken to investigate the factors of the crash. Considered as it is an effort to collect data and it will be used for this study. Secondary data is taken from the Police Traffic Department. Considered as it is an effort to collect data and it will be used for this study.

For the purpose of this study, the following stage research is used in order to collect data and report on findings and results, below is a flowchart that has been designed to be used as a guideline for this research.

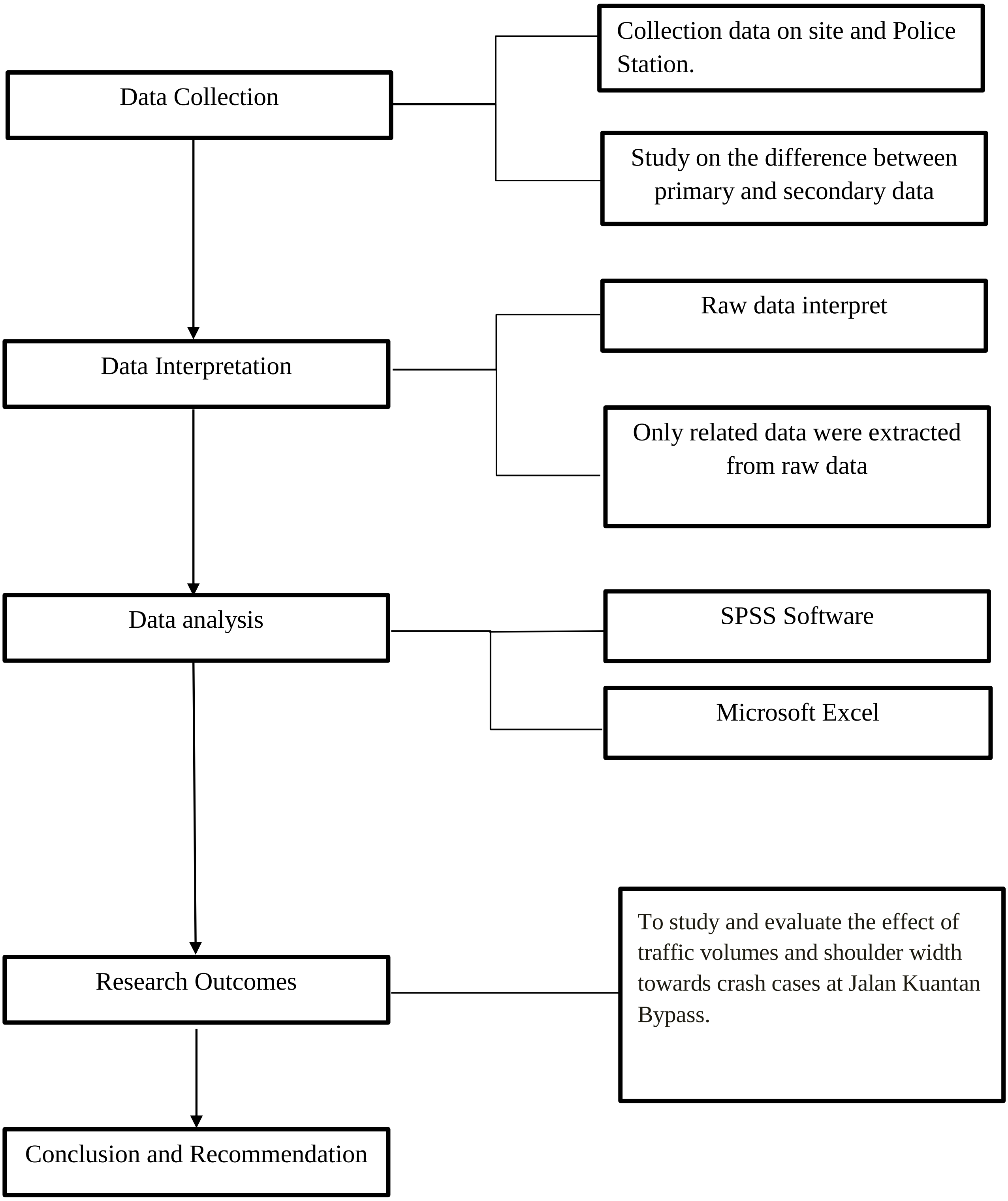

Figure 3.1 Research Flow

This study has been involved in two stages of data collection at Jalan Kuantan Bypass.

i) Primary collection data- Collection volume traffic by using MetroCount and manual counter and make road inventory throughout the study area to get shoulder width.

ii) Secondary collection data- Collecting vehicles crash data from the Royal Malaysia Police, Traffic Unit, Kuantan.

Using the manual and automatic (MetroCount) method to obtain traffic volumes at Jalan Kuantan Bypass. Then, analyze data using SPSS Software. Then, the model will be produced using Multiple Regression Analysis. Last, the conclusions and suggestions.

3.2 Study Area

Kuantan Bypass Road was chosen as study area because it is the main route between Kuantan town and Terengganu and it has become the main route of the lorry to/from industrial areas as well as buses to Kuantan Central Terminal. The purpose of this research is to evaluate the effect of traffic volumes and shoulder width towards crash cases at Jalan Kuantan Bypass.

Figure 3.2 Study area at Jalan Kuantan Bypass

Figure 3.3 Study area at Jalan Kuantan Bypass

Figure 3.4 The signalize intersection of Wisma Belia

Figure 3.4 The signalize intersection of Bukit Rangin

3.3 Road Inventory

The road inventory data are collected signalized intersection of Wisma Belia until signalized intersection at Bukit Rangin. The road segment data collected are the number of lanes, shoulder width, lane width, type of median, median length and lighting. The characteristics of the study area are:

1. Study area starts from the intersection of Wisma Belia until signalized intersection at Bukit Rangin. Distance study area is about 2.2 km.
2. The study area is divided into 55 sections.
3. The distance of each section is 40m.
4. Peak hour traffic volume is around 5 pm to 7 pm.

Table 3.1 shows the results of road inventory in the study area. From Table 3.1, the majority of the width of the travel way is 7.6 m except for the section having junction. Throughout the study area 2.2 m, there is a junction and a 280 m distance bridge. The study area has the same median width of 35 m, except on the bridge. Median type is raised type and it is grassy. Shoulder width differs in each section.

Table 3.1 Road Inventory Data

Section	Ditch (m)	Shoulder Width (m)	Travel Way (m)	Median (m)
1	1.35	5	7.6	3.5
2	1.35	5	7.6	3.5
3	1.35	5	7.6	3.5
4	1.35	5	7.6	3.5
5	1.35	4.5	7.6	3.5
6	2.7	4.5	7.6	3.5
7	2.7	0.5	8.8	3.5
8	2.7	0.5	10.8	3.5
9	0	0	7.6	3.5
10	1.9	0.5	10.2	3.5
11	1.9	0.5	10	3.5
12	0	0.5	9.8	3.5
13	0	4.5	7.6	3.5
14	0	4.5	7.6	3.5
15	0	4.5	7.6	3.5
16	0	4.5	7.6	3.5
17	0	4.5	7.6	3.5
18	0	4.5	7.6	3.5
19	0	4.5	7.6	3.5
20	0	4.5	7.6	3.5
21	0	4.5	7.6	3.5
22	0	5	7.6	3.5
23	0	5.5	7.6	3.5
24	0	5.5	7.6	3.5
25	0	5.5	7.6	3.5
26	0	4	7.6	3.5
27	0	4	7.6	3.5
28	0	3.2	7.6	3.5
29	0	3.2	7.6	3.5

30	0	3	7.6	3.5
31	0	3	7.6	3.5
32	0	3.2	7.6	3.5
33	0	3.2	7.6	3.5
34	0	1.5	7.6	3.5
35	0	1.5	7.6	3.5
36	0	1.5	7.6	3.5
37	0	1.5	7.6	3.5
38	0	1.5	7.6	3.5
39	0	1.5	7.6	3.5
40	0	1.5	7.6	0
41	0	5.5	7.6	0
42	0	5.5	7.6	0
43	0	5.1	7.6	0
44	0	5.1	7.6	0
45	0	5.1	7.6	0
46	0	5.1	7.6	0
47	0	5.1	7.6	3.5
48	0	5.1	7.6	3.5
49	0	5.1	7.6	3.5
50	0	5.1	7.6	3.5
51	0	5.1	7.6	3.5
52	0	5.1	7.6	3.5
53	0	5.1	7.6	3.5
54	0	5.1	7.6	3.5
55	0	5.1	7.6	3.5

Sources from Site Investigation at Jalan Kuantan Bypass

3.3.1 Road Inventory

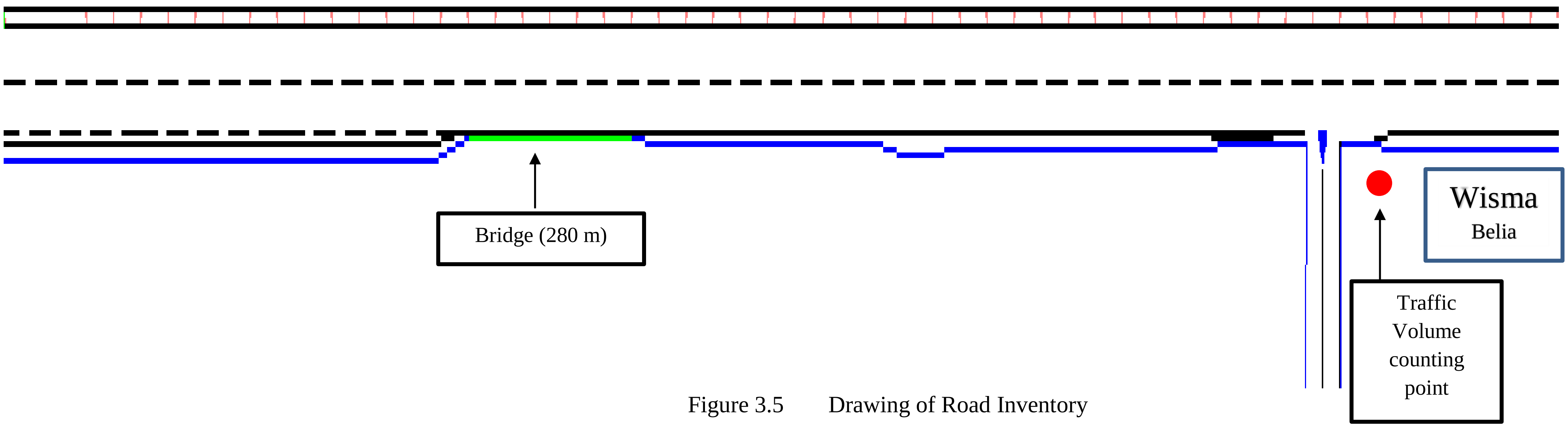

Figure 3.5 Drawing of Road Inventory

Drawing is drawn according to the actual distance of the study area of the site. The distance of study area is 2.2 km, starting from the signalized intersection of Wisma Belia to signalized intersection of Bukit Rangin. Length of the lane, lamp post, shoulder width, type of shoulder width, median width and type of median taken every 40 m distance. Throughout the study area, the median of the road was designed the raised and grassy. The lane width is also the same along the road except for the junction section of the road. there are only one (1) junction and a 280 m distance bridge. The distance between lamp post to another lamp post is 40m. Shoulder width has changed on each section of the road. Since then, shoulder width has been used as an independent variable in this study.

3.4 Data Collection

Field investigations involve site, area and route inspection. These includes traffic count and vehicle classification survey using two (2) methods, manual and automatic (MetroCount) counter. Preliminary analysis works to identify the possible causal factors of the vehicles crash as well as the countermeasures. The road inventory is conducted throughout the study area. Route area inspection are conducted to study the road characteristics, road width, lane width, median type, median width, shoulder width.

3.4.1 Primary Collection Data

For the secondary collection data, field investigation is conducted at Jalan Kuantan Bypass. Vehicles specifications survey and traffic count using two (2) methods, which are Automatic Counter (MetroCount) and Manual Counter. It was done at 4.30 pm to 5.00 pm. Based on observation, traffic conditions at 4.00 pm to 7.00 pm are very high for Jalan Kuantan Bypass and the road becomes very busy. Route and area inspection (road inventory) is run along the road from signalized intersection of Wisma Belia to signalized intersection of Bukit Rangin. Data collected include median width, lane width, shoulder width, the distance of the lamp post-lamp post and intersection.

3.4.2 Secondary Collection Data

Detailed crash data is available from traffic police. Data selection is done according to the needs of the research and analysis section. Firstly, Crash data at Jalan Kuantan Bypass is collected and data collection required reliable, reliable data and no uniform data required. (Naji & Djebarni, 1999).

The parties involved must be the traffic police officer in which traffic police officers should deal with all road related regulations and road accidents. Traffic crash data can be obtained from the Royal Malaysia Police Traffic Unit located in Kuantan.

There is a procedure used when obtaining primary data. This procedure is as follows:

i) Official letter from the Faculty of Civil Engineering (FKASA) is sent to the police headquarters in Kuantan.

ii) Make a phone call to the traffic police office to ensure the letter has arrived at the police headquarters and confirm the response from the traffic police office.

iii) When getting permission from traffic police, the process of collecting data is carried out.

3.4.2.1 Automatic Counter

Various equipment can be done by using automated arrangement. In this thesis only focus mainly on using MetroCount. MetroCount is used during field investigation to calculate the breakdown of the vehicle model and the amount of traffic on the road. Data is taken using MetroCount for 2 hours and 30 minutes starting at 4.30 pm to 7 pm. This is because the traffic situation at that time is very busy because it is the peak hour in Kuantan Bypass area. Traffic volume counting in the middle of the study area, between the signalized intersection of Wisma Belia road leading to the signalized intersection of Bukit Rangin. Traffic volume is taken using MetroCount for 1 week. The class breakdown of daily traffic is provided by the Daily Class Report. Each day is displayed with a daily total sum, and the sum and percentage for each vehicle class included in the Report profile. Figure 3.5 shows the traffic volume counting point using the MetroCount.

Figure 3.6 MetroCount installed on the road

3.4.2.2 Manual Counter

Traffic Data Collection and traffic volume are the requirements for planning traffic and management development. Manual Counter has been used in the second week of collection data. Vehicles are classified by the number of vehicles passing through a certain point. Traffic volume counting in the middle of the study area, between the signalized intersection of Wisma Belia road leading to the signalized intersection of Bukit Rangin. Manual Counter is conducted for two hours at 4.30pm to 7.00pm. It aims to determine vehicle classification through Jalan Kuantan Bypass. The device used in the counter manual is the Tally Counter. The tally counter is the electronic or mechanical device used to calculate the vehicles composition. It is very useful in calculating the vehicle at Bypass because the vehicle in the area is very busy and the vehicles are a fast-moving mode.

Figure 3.7 The location of traffic volume counting

Figure 3.8 Tally counter used to calculate the vehicles volumes

3.5 Data analysis

By SPSS Software, the data were analysed using multiple regression. This study uses three (3) Independent variables, so analysis is identified as Multiple Linear Regression. The independent variables are shoulder width and heavy vehicles. The dependent variable is data vehicles crash from PDRM.

The main purpose of multiple linear regression is to generate crash prediction model by using dependent and independent variables. As the results it will generate a form:

$$Y = ß0 + ß1X1 + ß2X2 + \ldots + ß\ n\ X\ n$$

Y means the numbers of crash

X means the independent variables

Bn mean the regression coefficient of the nth independent variable.

3.6 Summary

Jalan Kuantan Bypass was chosen as a research area as it is the main road connecting Kuantan City with Terengganu. As the main road to Kuantan City, Bypass Kuantan is among the locations that record high crash rates. Road safety assessment for the study area has also been discussed in this chapter. As main gateway to Kuantan, Jalan Kuantan Bypass must have the highest safety and reliability index. It would give the bad impression to tourist if this study area has bad crash record.

Chapter 3 has described data collection method and data analysis. Data collection is divided into two (2) categories:

i) Primary data collection- Traffic volume counting and road inventory

ii) Secondary data collection - Accident data from the police.

Radius study area starts from signalized intersection of Wisma Belia to signalized intersection of Bukit Rangin. Radius study area is 2.2 km and there are only one (1) junction and a 280 m distance bridge. There is no median on the bridge.

Data collected were analyzed by using SPSS software. Traffic volume is classified according to the type of vehicles. Vehicles volume and shoulder width are used as independent variables. Vehicle crashes are dependent variables.

The next chapter will discuss the results obtained from data analysis and some suggestions to address this problem.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

In Chapter 4, data is analysed as discussed in Chapter Methodology. The data from the primary and secondary collection are analysed. Analysed information is very useful to the Royal Malaysian Police and the Public Works Department (PWD) to reduce the number of road crashes especially during the festive seasons. Percentage of road crashes per day increases and is always in government observation. The vehicles crash data, traffic volumes and shoulder width were analysed using SPSS software. The analysed results will enable the authorities to avoid the causes of road accidents which are getting serious every day.

Due to field data collection, data vehicle volumes is taken using 2 methods which are automatic (MetroCount) counter and manual counter. The data were taken with 2 different methods to compare data and study the effectiveness of the method for use in the Jalan Kuantan Bypass area. Third analysis is data from road inventory. Road inventory is carried out to monitor whether shoulder width is the cause of frequent crashes in Jalan Kuantan Bypass. This decision is very important for the Public Works Department (PWD) to improve the safety of roads in Kuantan.

4.2 Crash Data

Figure 4.1, shows the severity of crashes from 2010 to 2015 by cars. The highest number of vehicles crash happened in 2015, recording 650 crashes. Second highest was 2013 involving 582 cases and the third highest is 2012 with 555 crashes, following with crashes in 2014 with 553 cases. The fifth highest of crash in 2011 with the number of crash recorded is 536 cases and the lowest number of vehicles crash in 2010 which recording 453 crashes.

Table 4.1 Seveiry of Vehicles Crash

YEAR	SEVERITY OF CRASH				TOTAL ACCIDENT
	FATAL	SERIOUS INJURY	MINOR INJURY	DAMAGE	
2010	13	1	0	439	453
2011	15	0	0	521	536
2012	14	1	1	539	555
2013	14	0	1	567	582
2014	16	0	0	537	553
2015	19	0	1	630	650

Sources : (Ministry of Transport (MOT), 2017)

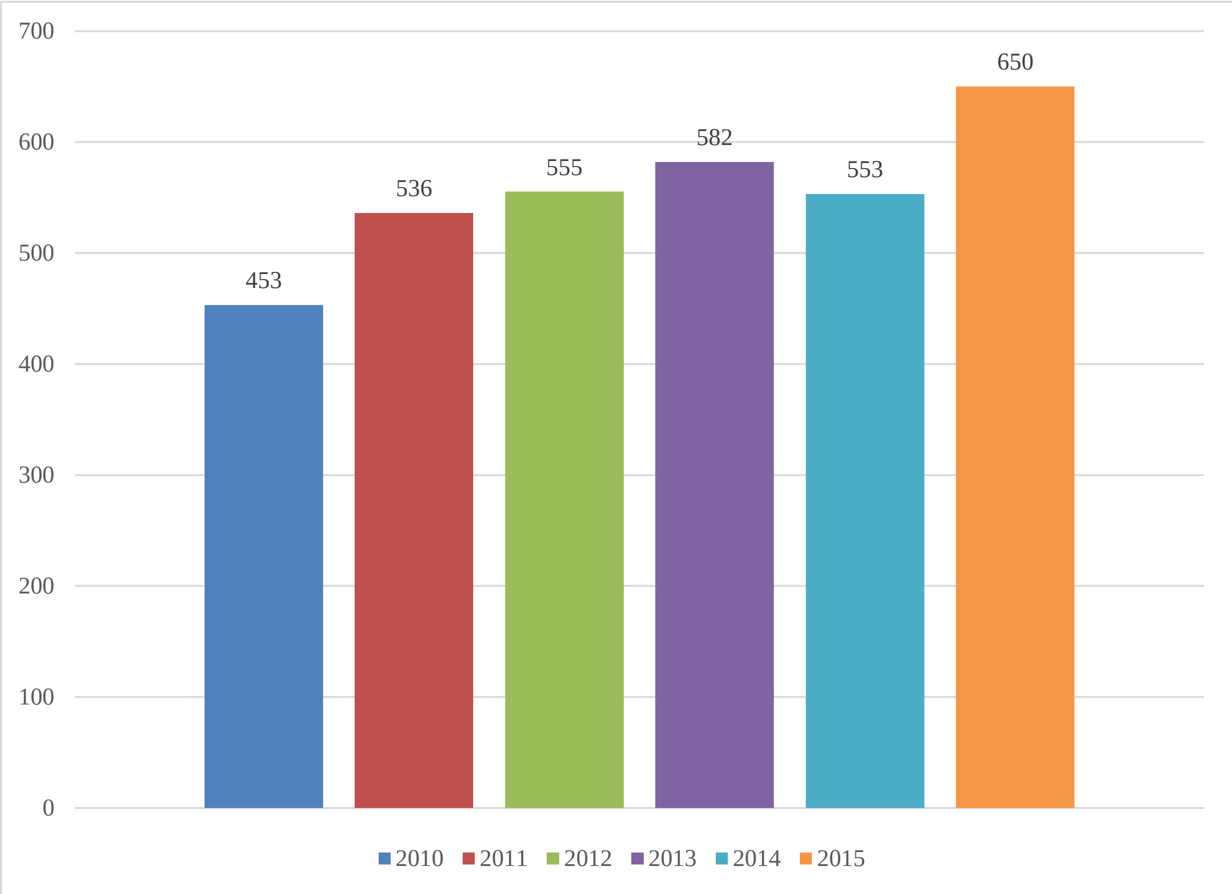

Figure 4.1 The statistic total of road crash at Kuantan Bypass from 2010-2015.

Sources : (Ministry of Transport (MOT), 2017)

Figure 4.1 shows that the crash trend from 2010 is increasing until 2013. Then, the number of crashes decreased in 2014 from 582 to 553. In 2015, the number of crash increases of 650 number of vehicles crash.

4.3 Vehicles Classification Data Collection

Vehicle classification data in Jalan Kuantan Bypass is collected from Malaysian transport report 2010-2015.Vehicles classification is classified into four categories, which motorcycles, cars, lorry mediums and large van and large lorry and buses. Vehicle factors, especially vehicle defects, are not investigated in this case. However, the trend of vehicles traveling through Jalan Kuantan Bypass are being investigated to analyse whether it is a factor for road crashes.

Table 4.3 The statistic total of road crash at Kuantan Bypass from 2010.

Time	**Class**					
	Motorcycle	**Car**	**Small Van/ Small Lorry**	**Medium lorry/ Large van**	**Large lorry/ Bus**	**Total Vehicles**
2010	699	700	227	139	81	1147
2011	721	2278	223	127	89	3438
2012	731	2425	318	144	74	3692
2013	800	2682	148	129	66	3825
2014	814	3016	309	110	52	3487
2015	644	2119	211	93	44	3111

Sources : Statistical Transportation Report(*Ministry of Transport (MOT), 2016*)

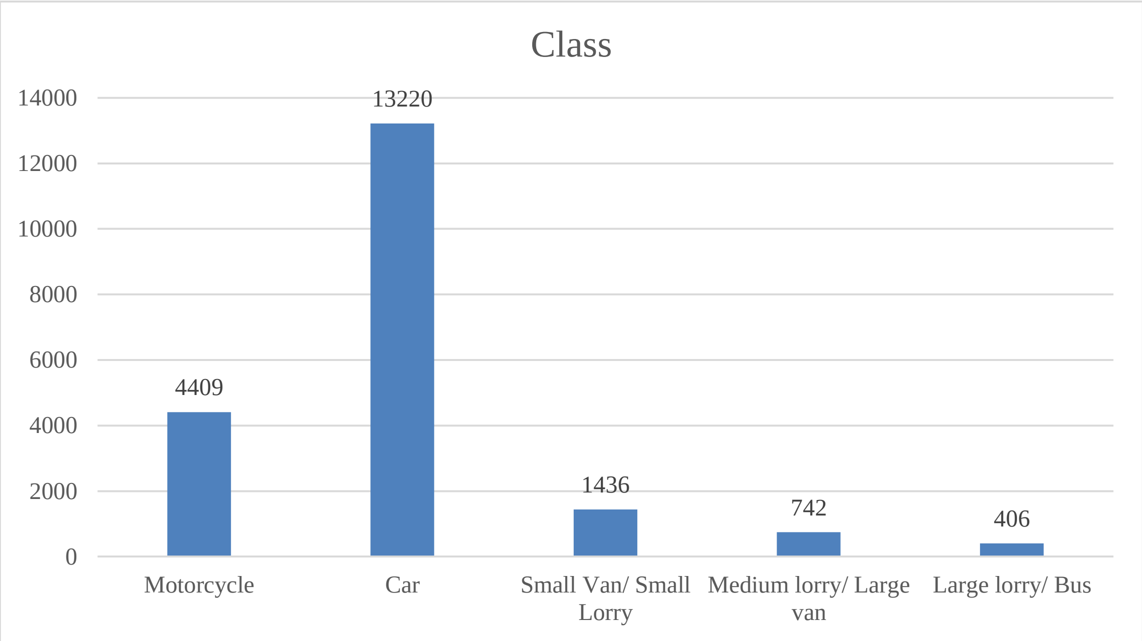

Figure 4.2 Total vehicles using Jalan Kuantan Bypass in 2010-2015

Table 4.2 and Figure 4.2 shows the trend of vehicles using Kuantan Bypass Road from 2010 to 2015. Vehicle volumes data is obtained from the Statistical Transportation Report from Ministry of Transport (MOT) in 2016. Observations and surveys have been made for 16 hours. The numbers of car and motorcycle are the highest in Jalan Kuantan Bypass. The number of cars and motorcycles recorded 13,220 and 4409.The number of vehicles on Jalan Kuantan Bypass is increasing in five (5) years. The number of heavy vehicles is also growing alongside new industrial area in Jalan Kuantan Bypass area.

4.4 Road Inventory Data

From Table 4.3 shows that the result of road inventory. Total distance from intersection of Wisma Belia to intersection of Bukit Rangin is 2.2km. Total distance of study area is divided into 55 sections, total length of each section is 40m. From the table 4.3, the majority of each section has a lane width of 7.6 m. There are several sections that have different lane widths because of junction. Since shoulder width have different size of width, so shoulder width is used as independent variables.

Table 4.4 Road Inventory Data at Jalan Kuantan Bypass

SECTION	DITCH	SHOULDER WIDTH	TRAVEL WAY	MEDIAN
1	1.35	5	7.6	3.5
2	1.35	5	7.6	3.5
3	1.35	5	7.6	3.5
4	1.35	5	7.6	3.5
5	1.35	4.5	7.6	3.5
6	2.7	4.5	7.6	3.5
7	2.7	0.5	8.8	3.5
8	2.7	0.5	10.8	3.5
9	0	0	7.6	3.5
10	1.9	0.5	10.2	3.5
11	1.9	0.5	10	3.5
12	0	0.5	9.8	3.5
13	0	4.5	7.6	3.5
14	0	4.5	7.6	3.5
15	0	4.5	7.6	3.5
16	0	4.5	7.6	3.5
17	0	4.5	7.6	3.5
18	0	4.5	7.6	3.5
19	0	4.5	7.6	3.5
20	0	4.5	7.6	3.5
21	0	4.5	7.6	3.5
22	0	5	7.6	3.5
23	0	5.5	7.6	3.5
24	0	5.5	7.6	3.5
25	0	5.5	7.6	3.5
26	0	4	7.6	3.5
27	0	4	7.6	3.5
28	0	3.2	7.6	3.5
29	0	3.2	7.6	3.5
30	0	3	7.6	3.5
31	0	3	7.6	3.5
32	0	3.2	7.6	3.5
33	0	3.2	7.6	3.5
34	0	1.5	7.6	3.5
35	0	1.5	7.6	3.5
36	0	1.5	7.6	3.5
37	0	1.5	7.6	3.5
38	0	1.5	7.6	3.5
39	0	1.5	7.6	3.5
40	0	1.5	7.6	3.5
41	0	5.5	7.6	3.5
42	0	5.5	7.6	3.5

43	0	5.1	7.6	3.5
44	0	5.1	7.6	3.5
45	0	5.1	7.6	3.5
46	0	5.1	7.6	3.5
47	0	5.1	7.6	3.5
48	0	5.1	7.6	3.5
49	0	5.1	7.6	3.5
50	0	5.1	7.6	3.5
51	0	5.1	7.6	3.5
52	0	5.1	7.6	3.5
53	0	5.1	7.6	3.5
54	0	5.1	7.6	3.5
55	0	5.1	7.6	3.5

4.5 Vehicles Classification Survey

The purpose of the vehicle classification survey conducted by using two (2) methods is to make comparison between MetroCount and Manual Counter. There are differences in data from the two (2) methods since there are unidentified (error) number of vehicles in the table. As a result of observation, it was found unidentified due to the traffic situation at Jalan Kuantan Bypass at 4.30pm 7.00pm very slow. So, it will happen when vehicles stop or two (2) vehicles move through the MetroCount tube simultaneously.

Vehicles classification survey was conducted to study the classification of vehicles at Jalan Kuantan Bypass. It was performed for eight (8) days using two (2) methods:

i) Four (4) days- Vehicles classification survey using Automatic Counter (MetroCount)

ii) Four (4) days – Vehicles classification survey using Manual Counter.

Table 4.2 Vehicles Classification Survey using MetroCount in 2018

Time	**Class**						
	Motorcycle	**Car**	**Small Van/ Small Lorry**	**Medium lorry/ Large van**	**Large lorry/ Bus**	**Unidentified**	**TOTAL**
Tuesday, March 06, 2018	710	3065	65	152	18	53	4063
Wednesday, March 07, 2018	658	3736	76	145	28	85	4728
Thursday, March 08, 2018	764	4012	78	178	29	19	5080
Saturday, March 10,2018	679	3665	71	157	22	63	4657

From table 4.2 is the vehicle classification data from MetroCount for four (4) days. From the data in the table, the number of cars is the highest among all types of vehicle modes. The second highest of vehicles is motorcycle and the third is the lorry and big van medium. The lowest is a large lorry and a bus. From four (4) day observations, showing the number of unidentified vehicles on Tuesday was the highest, recording a record of 85 vehicles because of the day, as traffic was very slow on that day as there was a night market on Tuesday.

Table 4.3 Vehicles volume using Manual Counter in 2018

Time	**Class**						
	Motorcycle	**Car**	**Small Van/ Small Lorry**	**Medium lorry/ Large van**	**Large lorry/ Bus**	**Unidentified**	**TOTAL**
Tuesday, March 13, 2018	864	4012	78	178	43	0	5175
Wednesday, March 14, 2018	1107	5286	97	213	55	0	6758
Thursday, March 15, 2018	1282	5658	118	267	74	0	7399
Saturday, March 17,2018	921	3994	86	112	46	0	5159

Table 4.3 shows the vehicle volumes data from Manual Counter for four (4) days. From the data in the table, the number of cars is the highest among all types of vehicle modes. The second highest of vehicles is the motorcycle and the third is the lorry and big van medium. The lowest is large lorry and a bus.

Based on the comparison between tables 4.2 and 4.3, there is a difference between calculation of vehicles using MetroCount and Manual Counter. In addition, the number of vehicles using the Manual Counter for four days is higher than the MetroCount result. So, the Manual Counter method is more relevant for the vehicle classification survey in Jalan Kuantan Bypass.

4.6 Analysis of Result

The Regression Model was formed using the SPSS Software (Statistical Package for Social Sciences). SPSS is used to research many fields of engineering, art, education and science. SPSS is considered as one of the most frequently used programs for researchers in many areas such as engineering, science, art, education, and psychology. In this study, dependent variable is vehicles crash data in 2010-2015. In contrast, the independent variables are shoulder width and the types of vehicles that use Jalan Kuantan Bypass from 2010 to 2015. As the results it will generate a form:

$$Y = ß0 + ß1X1 + ß2X2 + \dots + ß n X n \qquad \text{- Eqn (1)}$$

Y means the numbers of crash

X means the independent variables

Bn mean the regression coefficient of the nth independent variable.

Table 4.5 Variables used in Multiple Regression Model

Variable	**Definitions**
Independent variables	Shoulder width Vehicles data at Jalan Kuantan Bypass
Dependent variable	Vehicles crash data

Table 4.4 shows the variable used in multiple regression models. Independent variable is a variable that affects the dependent variable. In this thesis mainly focus on the effect of traffic volume and shoulder width. The dependent variable is one that will respond to the change of independent variables. The purpose of the thesis is to evaluate the effect of the traffic volume and shoulder width to vehicles crash, the dependent variable is vehicles crash.

4.6.1 Validation of Model

Model 1 is specially designed for cars and motorcycles as the number of cars and motorcycles is very high. Car and motorcycle data are separated from heavy vehicle data. There are two (2) variable used in Model 1:

i) Independent variable: The numbers of cars and motorcycles.

ii) Dependent variable: Crash.

From Table 4.5 shows that the coefficient between the crash and the number of cars and motorcycles (R2 = 0.5340). The multiple regression models explaining that the crash cases are influenced by the numbers of cars and motorcycles by 54%. The "R" column represents the value of R, the multiple correlation coefficients. The "R Square" column represents the R2 value (also called the coefficient of determination).

Table 4.6 Model Summary of The numbers of cars and motorcycles

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.731a	.534	.534	.259
a. Predictors: (Constant),The numbers of cars and motorcycles				

Source: SPSS Software

Variance Analysis (ANOVA) is a statistical method to test the difference between two (2) ways. Variance Analysis (ANOVA) consists of calculations that provide information on the degree of variability in the regression model and form the basis for an important test. The ANOVA calculation for multiple regression is almost the same as the calculation for easy linear regression, except that the degree of independence is adjusted to reflect the number of explanation variables included in the model. Table 4.6 shows ANOVA analysis output. The ANOVA test is f = 21841.162 which is at significance level of 0.000 (P-value = .000), P value is less than 0.005. This means that the regression equation is significant at the 95% confidence level in the degree of variability in the regression model.

Table 4.7 ANOVA Table of The numbers of the cars and motorcycles

ANOVA[a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	1467.167	1	1467.167	21841.162	.000[b]
	Residual	1280.546	19063	.067		
	Total	2747.713	19064			
a. Dependent Variable: Total crash						
b. Predictors: (Constant), The numbers of cars and motorcycles						

From the Table 4.7, The standard error is near to 0.000 and the crash prediction model for the numbers of the cars and motorcycles using the multiple regression analysis is presented in **Y= 1.137-0.522x$_1$.**

Y= The number of crash

X_1= The numbers of cars and motorcycles

Table 4.8 Coefficient Table of the numbers of Cars & Motorcycle

Coefficients[a]						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	Std. Error	Beta		
1	(Constant)	1.137	.007		167.764	.000
	The numbers of cars and motorcycles	-.522	.004	-.731	-147.788	.000
a. Dependent Variable: Total crash						

Source: SPSS Software

4.6.2 Validation of Model 2

Model 2 is designed for the numbers of the heavy vehicles. There are two (2) variable used in Model 2:

i) Independent variable: The numbers of heavy vehicles.

ii) Dependent variable: Crash.

From Table 4.8 shows that the coefficient between the crash and the number of heavy vehicles (R2 = 0.299). Model 2 explaining that the heavy vehicles influenced the number of crash cases at Jalan Kuantan Bypass by 30%.

Table 4.9 Model Summary of Heavy Vehicles

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.547[a]	.299	.299	.318
a. Predictors: (Constant), Heavy vehicles				

Variance Analysis (ANOVA) is a statistical method to test the difference between two (2) ways. Variance Analysis (ANOVA) consists of calculations that provide information on the degree of variability in the regression model and form the basis for an important test. The ANOVA calculation for multiple regression is almost the same as the calculation for easy linear regression, except that the degree of independence is adjusted to reflect the number of explanation variables included in the model. Table 4.9 shows ANOVA analysis output. The ANOVA test is f = 8132.300 which is at significance level of 0.000 (P-value = .000), P value is less than 0.005. This means that the regression equation is significant at the 95% confidence level in the degree of variability in the regression model.

Table 4.9 ANOVA Table of heavy vehicles

ANOVAa						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	821.658	1	821.658	8132.300	.000b
	Residual	1926.055	19063	.101		
	Total	2747.713	19064			
a. Dependent Variable: Vehicles crash						
b. Predictors: (Constant), Heavy vehicles						

From the Table 4.10, The standard error is near to 0.000 and the crash prediction model for the numbers of the heavy vehicles using the multiple regression analysis is presented in **$Y= 0.122+0.199x_1$**.

Y= The number of crash

X_1= The numbers of heavy vehicles

Table 4.10 Table of Coefficient of Heavy Vehicles

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.122	.002		51.563	.000
	Heavy vehicles	.199	.002	.547	90.179	.000
a. Dependent Variable: Total crash						

4.6.3 Validation of Model 3

Model 3 is designed for shoulder width as the number of shoulder width different for every section. There are two (2) variable used in Model 3:

i) Independent variable: Shoulder width

ii) Dependent variable: Crash.

From Table 4.11 shows that the coefficient between the crash and the shoulder width (R2 = 0.013). The multiple regression models explaining that the crash cases are influenced by the shoulder width.

Table 4.11 Model Summary of Shoulder Width

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.112[a]	.013	.013	.377
a. Predictors: (Constant), Shoulder Width				

From Table 4.12 shows the Variance Analysis (ANOVA), which is a statistical method to test the difference between two (2) ways. Variance Analysis (ANOVA) consists of calculations that provide information on the degree of variability in the regression model and form the basis for an important test. The ANOVA calculation for multiple regression is almost the same as the calculation for easy linear regression, except that the degree of independence is adjusted to reflect the number of explanation variables included in the model. The ANOVA test is f = 242.594 which is at significance level of 0.000 (P-value = .000), P value is less than 0.005. This means that the regression equation is significant at the 95% confidence level in the degree of variability in the regression model.

Table 4.12 ANOVA Table of Shoulder Width

ANOVAa						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	34.528	1	34.528	242.594	.000b
	Residual	2713.185	19063	.142		
	Total	2747.713	19064			
a. Dependent Variable: Total crash						
b. Predictors: (Constant), Shoulder Width						

From the Table 4.13, The standard error is 0.003 and 0.009 which are near to 0.000 and the crash prediction model for the numbers of the heavy vehicles using the multiple regression analysis is presented in $\mathbf{Y= 0.172+0.133x_1}$.

Y= The number of crash

X_1= Shoulder width

Table 4.13 Coefficient Table of Shoulder Width

Coefficients[a]						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.172	.003		63.021	.000
	Shoulder Width	.133	.009	.112	15.575	.000
a. Dependent Variable: Total crash						

4.6.4 Validation of Model 4

Model 4 is designed of combination of all the independent variables. There are four (4) variable used in Model 4:

iii) Independent variable: The number of cars and motorcycles, the number of heavy vehicles and shoulder width

iv) Dependent variable: Crash.

The statistical results show in the table. significant F and significant t for each variable. In addition, the coefficients show a correlation between dependent variables and variables (R2 = 0.611). The "R" column represents the value of R, the multiple correlation coefficients. The "R Square" column represents the R^2 value (also called the coefficient of determination).

Table 4.10 Model Summary the Number of Car & Motorcycle, Heavy Vehicles and Shoulder Width

Model Summary				
Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.782[a]	.611	.611	.237
a. Predictors: (Constant), Heavy vehicles, Shoulder Width, Number of cars and motorcycles				

The ANOVA calculation for multiple regression is almost the same as the calculation for easy linear regression, except that the degree of independence is adjusted to reflect the number of explanation variables included in the model. The ANOVA test is f = 9991.722 which is at significance level of 0.000 (P-value = .000), P value is less than 0.005. This means that the regression equation is significant at the 95% confidence level in the degree of variability in the regression model.

Table 4.11 ANOVA Table The Numbers of Cars and Motorcycles Shoulder Width, Heavy Vehicles

ANOVA[a]						
Model		**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
1	Regression	1679.641	3	559.880	9991.722	.000[b]
	Residual	1068.072	19061	.056		
	Total	2747.713	19064			
a. Dependent Variable: Total crash						
b. Predictors: (Constant), Heavy vehicles, Shoulder Width and the Number of Cars and Motorcycles						

From the Table 4.16, The standard error is 0.003 and 0.009 which are near to 0.000. The selected regression model should have a maximum variation of 3 to 4 to have easy projection and application, and to get lower costs. Also, the selected regression model should have a strong R^2 stress coefficient. The determination coefficient R^2, calculates the fact that the goodness of regression line lines increases with the ratio of the number of variations depicted by the regression line. R^2 ranges from zero when no variation is explained by the regression line to unity when all variations are explained by the line. It is symbolized as a squad to capture the fact that it is always negative. R^2 square squares, the determination coefficient is called coefficient of correlation (r or R). Values can range from -1 to 1. In the case of linear regression, the R sign is the same as the regression line slope. When R is near 1, there is a high positive correlation between x and y. when R almost -1, there is a high negative correlation. If R is about zero, then there is no relationship between x and y (Mohammad, 2011)

The crash prediction model for the numbers of the heavy vehicles using the multiple regression analysis is presented in **$Y = 0.949 - 0.436x_1 + 0.007x_2 + 0.110x_3$.**

Y = The number of crash

X_1= The number of cars and motorcycles

X_2= Shoulder Width

X_3= Heavy Vehicles

Table 4.12 Coefficient Table The Numbers of Cars and Motorcycles ,Shoulder Width, Heavy Vehicles

Coefficients [a]						
Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
	(Constant)	.949	.007		137.309	.000
	The numbers of cars and motorcycles	-.436	.004	-.609	-123.716	.000
	Shoulder Width	.007	.005	.006	1.373	.170
	Heavy vehicles	.110	.002	.302	60.474	.000
a. Dependent Variable: Total crash						

4.7 Summary

The research was conducted to assess road safety at 2.2km of Bypass Kuantan. The end of result of this study to reduce the rate of accident occurring on the Jalan Kuantan Bypass. In addition, the end of this study is expected to help the road users and the Royal Malaysian Police in overcoming the problem of crashes. There are many studies on the roads that have been done reducing the rate of road accidents in Jalan Kuantan Bypass. The main objective of this study is to Evaluate the effect of vehicles and shoulder width towards of crash cases at Jalan Kuantan Bypass, which starts from intersection of Wisma Belia to intersection of Bukit Rangin. In addition, safety level assessments are essential for Jalan Kuantan Bypass. For shoulder width, the number of samples taken in this study is 55 sections.

Each section is divided into 40 m in length for each section. All data were collected on site during weekdays and weekend along 2.2 km road starts from signalized intersection near Wisma Belia until signalized intersection at Bukit Rangin. Number of crashes in the study area from 2006 to 2016 for reliable in terms of crash.

All crashes data obtained from the Royal Malaysian Police is then analyzed using SPSS Software. Statistical method used the Multiple Regression Model Method. The main purpose of multiple linear regression is to generate accident prediction model by using dependent and independent variables.

Vehicle classifications and shoulder width from MetroCount is analyzed. Data from manual methods were included in the SPSS software datasheet and statistical analysis used to determine the connection of each crashes in the study area.

The results of this study found that the area of study was often the case. This is because the area of study is very busy with vehicles as it is the main route to enter Kuantan City from Terengganu and it is also an industrial area. Furthermore, it is a growing area with the population.

To generate the crash prediction model using the SPSS, the data dependent and independent variables are need to be collected. The appropriate variable need to be selected as it will affect the results. This study uses three (3) Independent variables, so analysis is identified as Multiple Linear Regression. The independent variables are vehicles classification (car and motorcycle), heavy vehicles and shoulder width. The dependent variable is data vehicles crash from PDRM.

CHAPTER 5

CONCLUSION

5.1 Conclusion

As the conclusion, all the objectives of the study are successfully achieved. First objective is to study the vehicles composition that caused accident. Bypass Kuantan Road is one of the main roads connecting Terengganu with Kuantan City. In addition, the main bus station in Kuantan, Kuantan Central Terminal is located at Bypass Kuantan and is an industrial area. So, it's not surprising that there are many vehicles that use Bypass Kuantan. From 2-wheeled vehicles to large vehicles.

The second objective is about to study the relationship between the shoulder width and the number of traffic crashes. Typically, pavement management requires road inventory to be created and tied to an Asset Location Referencing System (ALRS). Road inventory includes road location using both coordinate and linear referencing systems, road width, road length and pavement type. Road accidents can occur in any situation. Therefore, shoulder width was conducted to evaluate whether the characteristics of the road in Kuantan Bypass the cause of the vehicles crash at Jalan Kuantan Bypass.

The next objective is to study the relationship between traffic volumes and the traffic crashes. The heavy vehicle transportation continues to grow in Malaysia in line with Malaysia's growth. The rate of crash among heavy vehicles increases and causes serious injuries and death. 6000 people are killed each year due to road accidents. Approximately 1000 of these fatalities are car occupants and motorcyclists, killed in collision involving rigid and articulated type's trucks (Huzaifah, M.M, 2010).

The model 1 shows that the crash cases by the number of the cars and motorcycles by 53 % (r-squared= 0.531) and it is proven that shoulder width is statistically significant towards crash cases. The model 2 shows that the multiple regression model explaining that the heavy vehicles influenced the vehicles crash by 30% (r-square =0.299). The model 3 shows that the shoulder width has contributed the vehicles crash by 1.3% (r-squared = 0.013), and the model 4 which are combination of the numbers of cars, motorcycles, heavy vehicles and shoulder width proved that the crash cases have contributed to the vehicles crashes at Jalan Kuantan Bypass by 61% (r-squared =0.611) and it is proven that vehicles and shoulder width is statically significant to the severity of crash ($p = 0.0001$, $p < 0.001$).

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APPENDIX A
RESULT OF METROCOUNT

MetroCount Traffic Executive
Daily Classes

DailyClass-53 -- English (ENU)

Datasets:

Site:	**[KUANTAN BYPASS DAY 2] MetroCount Factory Test Setup**
Attribute:	PEAK HOUR
Direction:	2 - East bound, A trigger first. **Lane:** 2
Survey Duration:	16:53 Wednesday, March 07, 2018 => 12:06 Thursday, March 08, 2018,
Zone:	
File:	KUANTAN BYPASS DAY 2 0 2018-03-08 1206.EC2 (Plus)
Identifier:	MJ97BVC7 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm:	Factory default axle (v4.06)
Data type:	Axle sensors - Paired (Class/Speed/Count)

Site:	**[KUANTAN BYPASS DAY 4] MetroCount Factory Test Setup**
Attribute:	PEAK HOUR
Direction:	2 - East bound, A trigger first. **Lane:** 2
Survey Duration:	17:09 Thursday, March 08, 2018 => 15:43 Saturday, March 10, 2018,
Zone:	
File:	KUANTAN BYPASS DAY 4 0 2018-03-10 1544.EC2 (Plus)
Identifier:	MJ97BVC7 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm:	Factory default axle (v4.06)
Data type:	Axle sensors - Paired (Class/Speed/Count)

Site:	**[KUANTAN BYPASS DAY 5] MetroCount Factory Test Setup**
Attribute:	PEAK HOUR
Direction:	2 - East bound, A trigger first. **Lane:** 2
Survey Duration:	16:28 Saturday, March 10, 2018 => 16:16 Friday, March 23, 2018,
Zone:	
File:	KUANTAN BYPASS DAY 5 0 2018-03-23 1616.EC2 (Plus)
Identifier:	MJ97BVC7 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm:	Factory default axle (v4.06)
Data type:	Axle sensors - Paired (Class/Speed/Count)

Daily Classes

DailyClass-53
Site: KUANTAN BYPASS DAY 2.2.0E KUANTAN BYPASS DAY 4.2.0E KUANTAN BYPASS DAY 5.2.0E
Description: **Multiple sites - See Header sheet for site descriptions.**
Filter time: **17:00 Wednesday, March 07, 2018 => 21:00 Sunday, March 11, 2018**
Scheme: Vehicle classification (Scheme F3)
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12 13) Dir(NESW) Sp(6,99) Headway(>0) Span(0 - 328.084)

Monday, March 05, 2018

	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
Mon*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Tue*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Wed*	534	4310	86	3	4	34	90	13	21	21	2	0	137	5255
(%)	10.2	82.0	1.6	0.1	0.1	0.6	1.7	0.2	0.4	0.4	0.0	0.0	2.6	
Thu	503	4097	91	7	12	49	98	13	14	14	0	0	75	4973
(%)	10.1	82.4	1.8	0.1	0.2	1.0	2.0	0.3	0.3	0.3	0.0	0.0	1.5	
Fri	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Sat	511	4526	124	31	18	24	51	2	14	25	0	0	29	5355
(%)	9.5	84.5	2.3	0.6	0.3	0.4	1.0	0.0	0.3	0.5	0.0	0.0	0.5	
Sun*	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Average daily volume

Entire week

	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
	338	2874	71	12	10	24	49	5	9	13	0	0	34	3442
(%)	9.8	83.5	2.1	0.3	0.3	0.7	1.4	0.1	0.3	0.4	0.0	0.0	1.0	

Weekdays

	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
	251	2048	45	3	6	24	49	6	7	7	0	0	37	2486
(%)	10.1	82.4	1.8	0.1	0.2	1.0	2.0	0.2	0.3	0.3	0.0	0.0	1.5	

Weekend

```
          511   4526    124     31     18     24     51      2     14     25      0      0
29     5355
(%)       9.5   84.5    2.3    0.6    0.3    0.4    1.0    0.0    0.3    0.5    0.0    0.0
0.5
```

Vehicle Flow

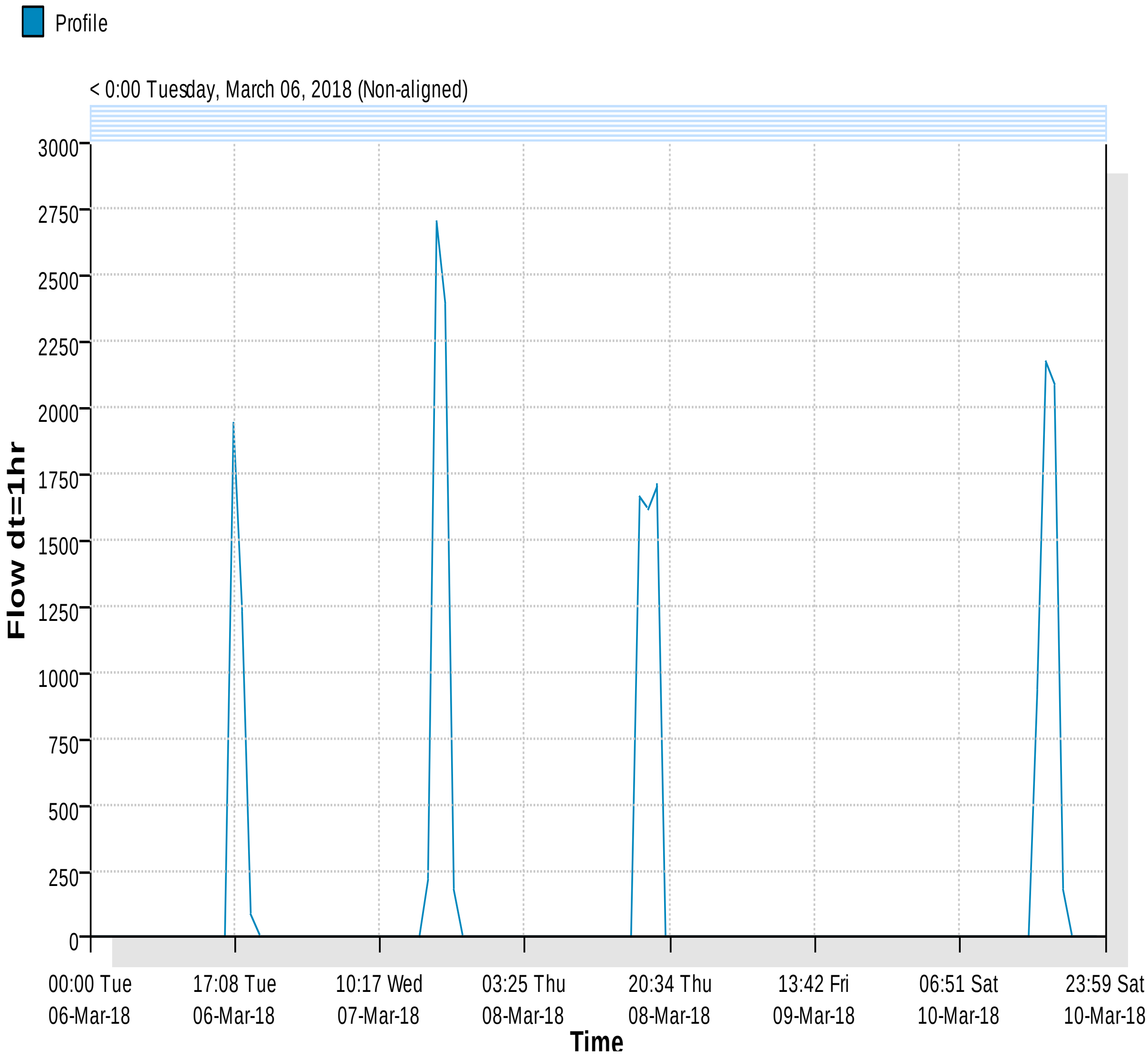
VehicleFlow-55 (Non metric) **Site:**KUANTAN BYPASS.2.0E KUANTAN BYPASS DAY 2.2.0E KUANTAN BYPASS DAY 4.2.0E KUANTAN BYP

Description: Multiple sites - See Header sheet for site descriptions.

Filter time: 17:00 Tuesday, March 06, 2018 => 20:00 Saturday, March 10, 2018

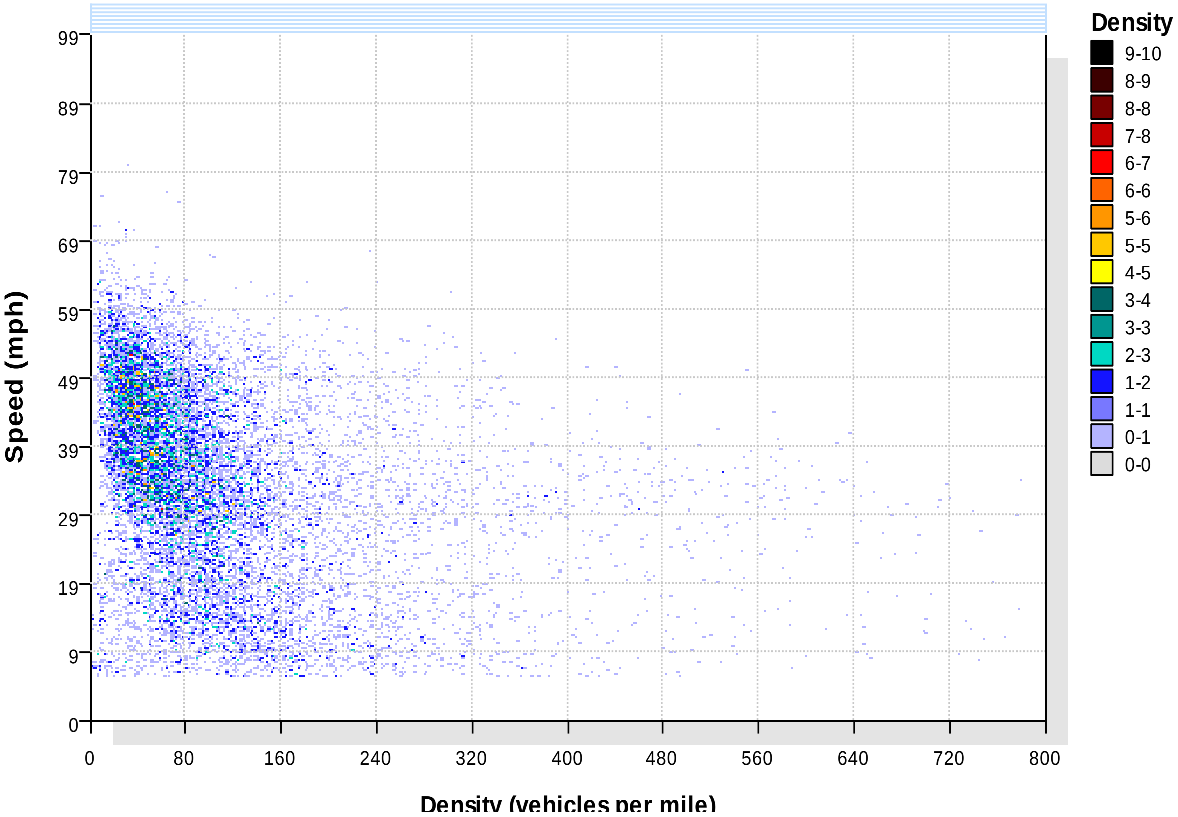
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12 13) Dir(NESW) Sp(6,99) Headway(>0) Span(0 - 328.084)

Scheme: Vehicle classification (Scheme F3)



Density vs Speed

DenSpeed-54 (Non metric) **Site:**KUANTAN BYPASS.2.0E KUANTAN BYPASS DAY 2.2.0E KUANTAN BYPASS DAY 4.2.0E KUANTAN BYPAS
Description: Multiple sites - See Header sheet for site descriptions.
Filter time: 17:00 Tuesday, March 06, 2018 => 21:00 Saturday, March 10, 2018
Filter: Cls(1 2 3 4 5 6 7 8 9 10 11 12 13) Dir(NESW) Sp(6,99) Headway(>0) Span(0 - 328.084)
Scheme: Vehicle classification (Scheme F3)



MetroCount Traffic Executive
Vehicle Counts

VehicleCount-56 -- English (ENU)

Datasets:

Site:	**[KUANTAN BYPASS] MetroCount Factory Test Setup**
Attribute:	PEAK HOUR
Direction:	2 - East bound, A trigger first. **Lane:** 2
Survey Duration:	16:53 Tuesday, March 06, 2018 => 22:41 Tuesday, March 06, 2018,
Zone:	
File:	KUANTAN BYPASS 0 2018-03-06 2241.EC2 (Plus)
Identifier:	MJ97BVC7 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm:	Factory default axle (v4.06)
Data type:	Axle sensors - Paired (Class/Speed/Count)

Site:	**[KUANTAN BYPASS DAY 2] MetroCount Factory Test Setup**
Attribute:	PEAK HOUR
Direction:	2 - East bound, A trigger first. **Lane:** 2
Survey Duration:	16:53 Wednesday, March 07, 2018 => 12:06 Thursday, March 08, 2018,
Zone:	
File:	KUANTAN BYPASS DAY 2 0 2018-03-08 1206.EC2 (Plus)
Identifier:	MJ97BVC7 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm:	Factory default axle (v4.06)
Data type:	Axle sensors - Paired (Class/Speed/Count)

Site:	**[KUANTAN BYPASS DAY 4] MetroCount Factory Test Setup**
Attribute:	PEAK HOUR
Direction:	2 - East bound, A trigger first. **Lane:** 2
Survey Duration:	17:09 Thursday, March 08, 2018 => 15:43 Saturday, March 10, 2018,
Zone:	
File:	KUANTAN BYPASS DAY 4 0 2018-03-10 1544.EC2 (Plus)
Identifier:	MJ97BVC7 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm:	Factory default axle (v4.06)
Data type:	Axle sensors - Paired (Class/Speed/Count)

Site:	**[KUANTAN BYPASS DAY 5] MetroCount Factory Test Setup**
Attribute:	PEAK HOUR
Direction:	2 - East bound, A trigger first. **Lane:** 2
Survey Duration:	16:28 Saturday, March 10, 2018 => 16:16 Friday, March 23, 2018,
Zone:	
File:	KUANTAN BYPASS DAY 5 0 2018-03-23 1616.EC2 (Plus)
Identifier:	MJ97BVC7 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm:	Factory default axle (v4.06)
Data type:	Axle sensors - Paired (Class/Speed/Count)

Profile:

Filter time:	**17:00 Tuesday, March 06, 2018 => 20:00 Saturday, March 10, 2018**
(4.125)	
Included classes:	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13
Speed range:	6 - 99 mph.
Direction:	North, East, South, West (bound), P = East
Separation:	Headway > 0 sec, Span 0 - 328.084 ft
Name:	Default Profile
Scheme:	Vehicle classification (Scheme F3)
Units:	Non metric (ft, mi, ft/s, mph, lb, ton)
In profile:	Vehicles = 19035 / 20581 (92.49%)

*** Tuesday, March 06, 2018 - Total=3230 (Incomplete) , 15 minute drops**

0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1932	1218	80	0	0	0	0	
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	640	298	80	0	0	0	0	0
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	479	352	0	0	0	0	0	0
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	440	297	0	0	0	0	0	0
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	373	271	0	0	0	0	0	0

*** Wednesday, March 07, 2018 - Total=5477, 15 minute drops**

0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	222	2696	2385	174	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	686	676	174	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	671	635	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	700	537	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	222	639	537	0	0	0	0	0	0

AM Peak 0000 - 0100 (0), AM PHF=1.00 PM Peak 1700 - 1800 (2696), PM PHF=0.96

*** Thursday, March 08, 2018 - Total=4973, 15 minute drops**

0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1659	1614	1700	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	250	169	561	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	769	376	532	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	357	477	452	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	283	592	155	0	0	0	0	0

AM Peak 0000 - 0100 (0), AM PHF=1.00 PM Peak 1830 - 1930 (2162), PM PHF=0.91

*** Friday, March 09, 2018 - Total=0, 15 minute drops**

0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

AM Peak 0000 - 0100 (0), AM PHF=1.00 PM Peak 1200 - 1300 (0), PM PHF=1.00

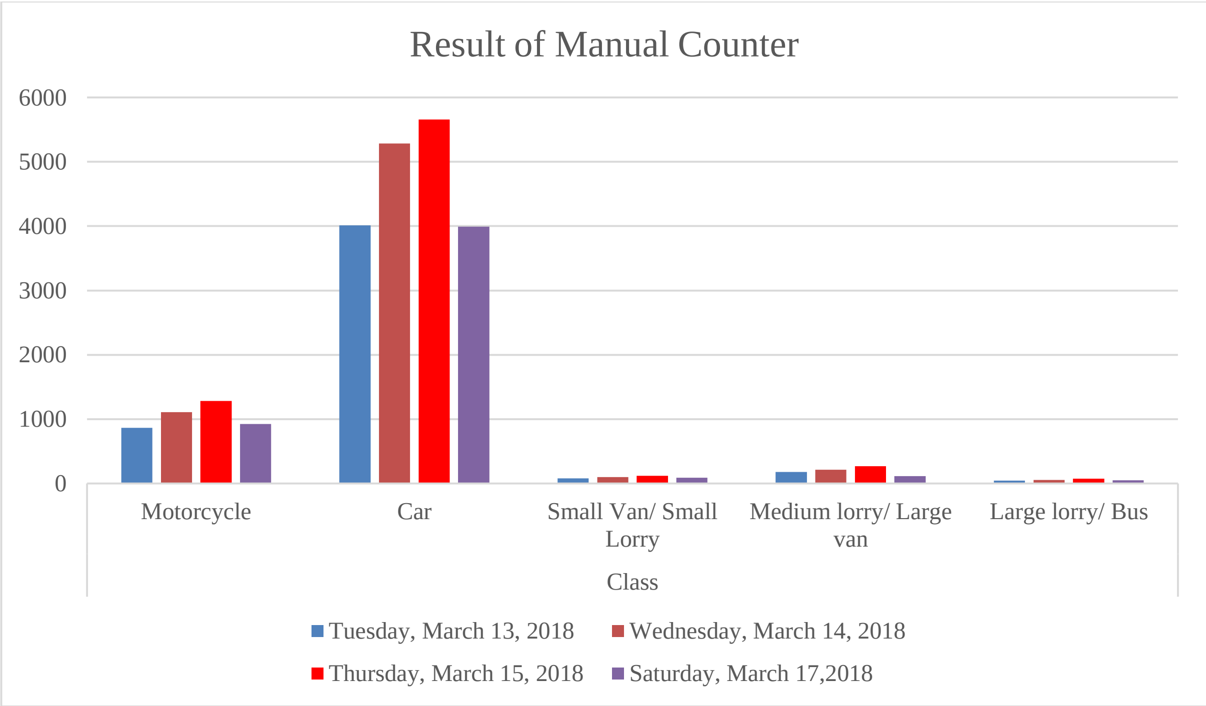
*** Saturday, March 10, 2018 - Total=5355 (Incomplete) , 15 minute drops**

0000	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	932	2169	2078	176	–	–	–	–	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	556	497	176	–	–	–	–	–
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45	550	564	0	–	–	–	–	–
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	473	548	550	0	–	–	–	–	–
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	414	515	467	0	–	–	–	–	–

AM Peak 0000 - 0100 (0), AM PHF=1.00

APPENDIX B
RESULT OF MANUAL COUNTER

Time	Class						
	Motorcycle	**Car**	**Small Van/ Small Lorry**	**Medium lorry/ Large van**	**Large lorry/ Bus**	**Unidentified**	**TOTAL**
Tuesday, March 13, 2018	864	4012	78	178	43	0	5175
Wednesday, March 14, 2018	1107	5286	97	213	55	0	6758
Thursday, March 15, 2018	1282	5658	118	267	74	0	7399
Saturday, March 17,2018	921	3994	86	112	46	0	5159



APPENDIX C
RESULT OF ROAD INVENTORY