CORRELATION BETWEEN CRASH TEMPORAL-SPATIAL PATTERN AND CRASH INJURY TYPES AT EAST COAST EXPRESSWAY PHASE 2

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CORRELATION BETWEEN CRASH TEMPORAL-SPATIAL PATTERN AND CRASH INJURY TYPES AT EAST COAST EXPRESSWAY PHASE 2

NOR AZIRA BINTI RASEDI

Thesis submitted in fulfilment of the requirements

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This hard work is dedicated to my beloved family
and precious friends who love me and support me during my whole journey of
education at University Malaysia Pahang

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ABSTRACT

Road traffic crashes are the foremost causes of death and disability globally, with a top-heavy number occurring in developing countries. Crashes are currently ranked ninth globally amongst the leading causes of disability and the ranking is anticipated to rise to rank third by 2020. Over 1.2 million peoples die every year in the world's roads. The aim of this study is to get correlations of road traffic crashes related issues of East Coast Expressway Phase 2 in terms of time and space with crash type from 2013 to 2015. The necessary data for the study was collected from Traffic Branch, Royal Malaysian Police, Terengganu Contingent. Data Analysis was made by using Microsoft Excel 2010 and SPSS version 22. The results were presented in the form of line graphs, column graphs, pie charts and correlations. The result of the study revealed that, 1586 road traffic crashes have occurred in the highway within the study period. Hulu Terengganu categorized as black spot areas in this highway which number of severities recorded are large with 58% for fatal crashes, 33% for crashes with severe injuries and 32% for crashes with slight injuries. The time between 12 pm to 6 pm reveals as the largest proportion of all road traffic crashes scenes. Overall, correlations between crash temporal-spatial pattern and crash type showed weak correlations. In conclusion, it probably can be another reason that can caused of crashes at East Coast Expressway Phase 2. Human factors such as driving while sleepy, exceeding the gazetted speed limit, negligence and failure to comply with safety requirements were suspected to be one of the major causes contributing to this problem.

ABSTRAK

Kemalangan jalan raya ialah penyebab utama kematian dan kecacatan secara global, dengan mencatatkan satu angka besar yang berlaku dalam Negara-negara membangun. Kemalangan jalan raya kini disenaraikan di tempat ke Sembilan secara global yang merupakan punca utama kecacatan dan kedudan ini dijangka akan meningkat dan menempatkan ke tempat ketiga pada tahun 2020. Lebih daripada 1.2 juta orang meninggal setiap tahun di jalan raya di dunia ini. Tujuan kajian ini adalah untuk mendapatkan hubung kait kemalangan jalan raya dengan isu yang berkaitan dengan Lebuhraya Pantai Timur Fasa 2 dalam soal masa dan jarak dengan jenis kemalangan dari tahun 2013 hingga 2015. Data yang diperlukan untuk kajian ini diambil dari Cawangan Trafik, Polis Diraja Malaysia, Kontinjen Terengganu. Analisis data telah dibuat dengan menggunakan Microsoft Excel 2010 dan SPSS versi 22. Keputusan telah dibentangkan dalam bentuk graf garis, graf turus, carta dan hubungkait. Keputusan kajian mendedahkan bahawa, 1586 kemalangan jalan raya telah berlaku di lebuh raya ini di dalam tempoh kajian. Daerah Hulu Terengganu dikategorikan sebagai kawasan bintik hitam di dalam lebuh raya ini dengan angka keterukan kemalangan yang direkodkan adalah besar. Masa antara 12 tengahari hingga 6 petang mendedahkan bahawa waktu ini merupakan pecahan terbesar berlaku kemalangan yang mana waktu ini merupakan waktu trafik adalah sesak. Hubungkait antara corak ruang-masa kemalangan dengan jenis kemalangan menunujukkan hubung kait yang lemah. Sebagai kesimpulan, ia mungkin terdapat sebab lain yang boleh menyebabkan kemalangan jalan raya di Lebuhraya Pantai Timur Fasa 2. Faktor manusia seperti memandu dalam keadaan mengantuk, memandu melebihi had kelajuan yang diwartakan, kecuaian dan kegagalan untuk mematuhi keperluan keselamatan disyaki sebagai salah satu punca utama yang menyumbang kepada masalah ini.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

The East Coast Expressway Phase 2 (ECE2) is a newly built highway where it was opened to public to provide road network to east coast side of Peninsular Malaysia. The phase 2 of the East Coast Expressway connecting Jabur at the Pahang – Terengganu border and Gemuroh in Terengganu, with a total of 184 km in length. It will enable motorists to travel between Kuala Terengganu and Kemaman in 90 minutes, and between Kuala Terengganu and Kuala Lumpur in 4 hours. This East Coast Expressway phase 2 containing 10 interchanges, 10 toll plazas, 3 rest services, 2 lay-bys and 90 bridges.

The East Coast Expressway Phase 2 extends the expressway to Kuala Terengganu, serving as the alternative for both Federal Route 3 and Jerangau-Jabur Highway. The construction of the second phase of East Coast Expressway began in 2006. The section built by MTD Group was monitored by the Malaysian Highway Authority, while the remaining section was monitored by the Malaysian Public Works Department. The second phase of the East Coast Expressway was opened in stages. The sections from Telemong to Kuala Terengganu and Ajil-Bukit Besi were the earliest sections being opened to motorists on 22 August 2011, followed by Ajil-Telemong section on May 18 May 2012, Bukit Besi-Paka section on 25 January 2014, and Jabur-Cheneh section on 22 July 2014. On 31 January 2015, all sections of the Jabur-Kuala Terengganu of the East Coast Expressway has now opened to traffic.

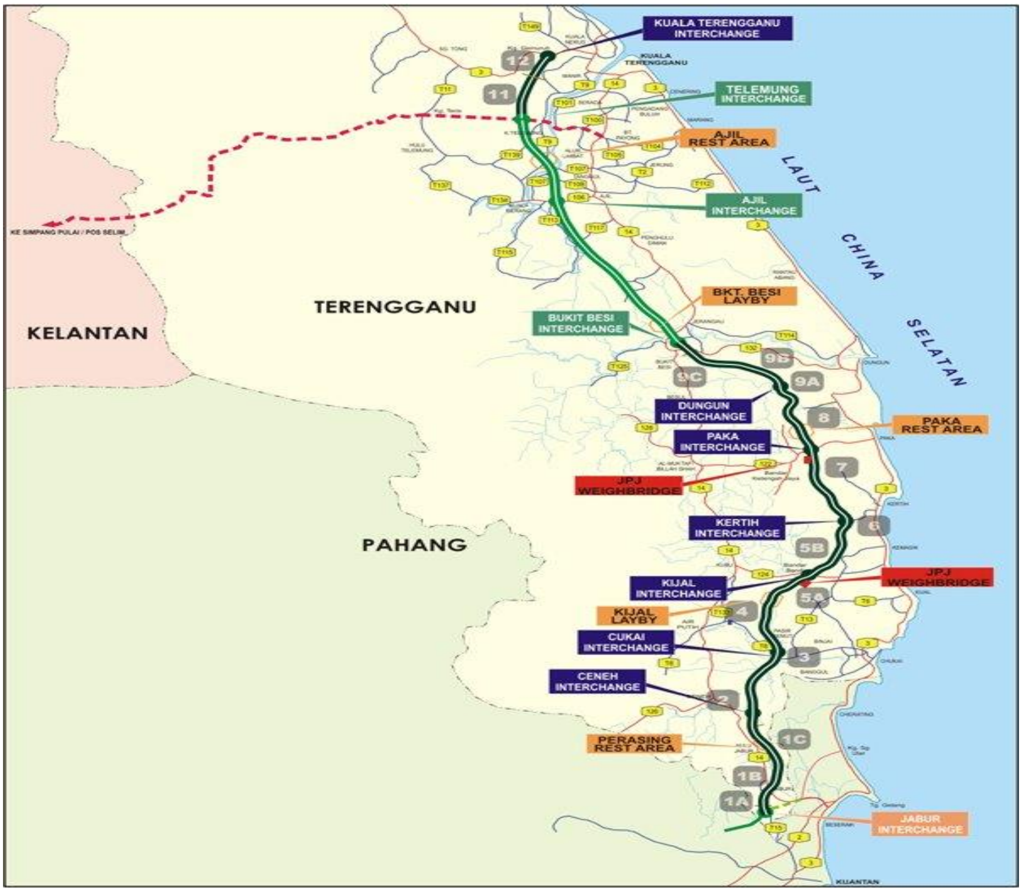


Figure 1.1 : Map of East Coast Expressway Phase 2

Since it was opened to traffic on 2011, there were many crashes have occurred along East Coast Expressway Phase 2. New Straits Times (2015) reported that, Deputy Works Minister, Datuk Rosnah Abdul Rashid Shirlin said that according to an analysis done between February and September 2015, 517 cases which is 78% of the crashes were caused by human factor, followed by 90 cases or 13% due to environment and the remaining occurred due to vehicle failure with 9%. East Coast Expressway Phase 2 was generally in good condition, but uneven surface was detected in several areas. This condition also may lead to road traffic crashes.

1.2 PROBLEM STATEMENT

The Malaysian Expressway System is a network of national controlled-access expressways in Malaysia that forms the primary backbone network of Malaysian national highways. The network begins with the North-South Expressway (NSE) and is being substantially developed. Malaysian Expressway are built by private companies under the supervision of the government highway authority, Malaysian Highway Authority. The Expressway network of Malaysia is considered the best controlled-access expressway network in Southeast Asia and also among the best network in Asia after China and Japan . They were 30 expressway in the country and the total length is 1821 kilometres and another 219.3 kilometres is under construction. The closed toll expressway system is similar to the Japanese Expressway System and Chinese Expressway System. All Malaysian toll expressway are controlled-access highway and managed in the Build-Operate-Transfer (BOT) system. There are expressway in West Malaysia and East Malaysia. One of the East Malaysia Expressway is East Coast Expressway.

East Coast Expressway is very useful to the users since it helped people to travel from one place to other place in short time compared to basic road. It is divided into two phase where Phase 1 is from Karak to Jabur, and Phase 2 extends from Jabur to Kuala Terengganu. The second phase of East Coast Expressway was opened in stages. The sections from Telemong to

Kuala Terengganu and Ajil to Bukit Besi were the earliest sections being opened to motorists on 22 August 2011. On 31 January 2015 all sections of the Jabur to Kuala Terengganu of the East Coast Expressway Phase 2 now opened to traffic. Although it is still newly opened, lots of crash cases have been recorded in this section of highway connecting Jabur to Kuala Terengganu.

Road traffic crash is defined by SafeCarGuide (2004) as any vehicle crash occurring on a public highway includes collisions between vehicles and animals, vehicles and pedestrians, or vehicles and fixed obstacles. It was reported that since East Coast Expressway Phase 2 opened on 2011, it has seen almost 2000 crashes and had claimed 85 lives, (New Straits Times, 2015). According to report by Bernama (2015), the Malaysian Highway Authority (LLM) finds that the majority of crashes that occur on the East Coast Expressway Phase 2 can be attributed to human error. LLM director-general, Datuk Ir Ismail Md Salleh said that 70% or 238 out of 339 crashes cases occurred on ECE 2 between February 1 and June 2 were due to human factors. Similar condition happened to road traffic crashes in East Coast Expressway Phase 2 where road traffic crashes are often found to follow spatial and temporal patterns as the factors that influence road crashes with space and time.

Road crashes depends on various mechanical, behavioural and environmental factors. These factors vary in space and time. Therefore, the incidence of road crashes and fatalities also vary at both spatial and temporal scales. Land use pattern, types of road network, local business and activity pattern influences the crashes risk in an area. Cutter (1993) reported that analysis of spatial distribution of road crashes is important in order to assess the impacts of influential factors. Besides that geography such as rural-urban differences, climate and topography often define the spatial pattern of road crashes . The road crashes often found to follow a pattern with the days of the week or the months of the year. Therefore, that road crashes incidence and road crashes risk changes continually with time and space. It is of vital importance to analyse road traffic crashes in both spatial and temporal scales in order to improve traffic security management. By considering temporal and spatial pattern, it also can be associate with type of road traffic crashes.

There are many variables in a road traffic crashes that will affect injury severity of the people involved. These include factors related to the casualty (age, gender, biomechanical tolerance, seat-belt wearing, etc.), factors related to the vehicle (size, shape, impact speed, effectiveness of absorbing impact energy, etc.), and also type of road traffic crashes (fatal crashes, crashes with severe injuries, crashes with slightly injuries, etc.). Considering crash type, in most countries there are three classes of crash type recorded by the police which is fatality, serious injury and slight injury. However there still have the ways to prevent or reduce the numbers of crash that may occur along East Coast Expressway Phase 2.

There were many approaches that can be used as a key to the factor of high number of crashes along East Coast Expressway Phase 2. There could be some safety aspects that have been overlooked or not anticipated. This study will analyse and review the number of road traffic crashes on the East Coast Expressway Phase 2 based on the statistic gathered from Traffic Branch, Royal Malaysian Police, Terengganu Contingent. The study aims to get the correlation between crash temporal-spatial pattern and crash injury typed at East Coast Expressway Phase 2. There is a particular focus on the correlation between time and space with crash type. By determine the correlation between this two variables , the result can lead us to the main period of time and specific location where the road traffic crashes frequently happened and improve the understanding of the causes and consequences of road traffic collisions, and thus aid the government in reducing road casualties. With the information obtained from result of this study, it may help to reduce the scope of area that contributes to high number of crashes recorded along this highway thus help to determine more specific solution to reduce the number of crashes.

1.3 OBJECTIVES

This study has three major objectives to be achieved. The objectives are :-

1. To determine types of crash injury along East Coast Expressway Phase 2.
2. To identify temporal-spatial pattern along East Coast Expressway Phase 2 based on crash data for East Coast Expressway Phase 2.
3. To identify the correlation between crash temporal-spatial pattern and crash injury types at East Coast Expressway Phase 2.

1.4 SCOPE OF STUDY

The areas of this study are:

1. The number of accidents was collected within the East Coast Expressway Phase 2 which comprises from Jabur to Gemuruh.
2. Data taken from Traffic Branch, Royal Malaysian Police, Terengganu Contingent only will be used.

1.5 SIGNIFICANCE OF STUDY

Since this study is about road crashes, the results from this research can be implemented as indicator for reducing number of road crashes by Polis Di Raja Malaysia (PDRM) and Jabatan Pengangkutan Jalan (JPJ). The road users also can be wary and may plan when is the right time to go through this expressway.

CHAPTER 2

LITERATURE REVIEW

2.1 ROAD TRAFFIC CRASHES IN MALAYSIA

The study by Mohamad Nizam (2015) has overviewed of current road safety situation in Malaysia. Road crashes is currently one of the major causes of death in Malaysia. The effort to ensure better road safety requires large allocation of resources which further signifies the importance of economic valuation in every possible area inflicted by road accident. The rapid growth in population, economic in development, industrialisation and motorisation is in link with the increase of road crashes encountered by the country. Since 1970's, Malaysia had experienced a remarkable growth in these sectors. In facts, there is an increase in Malaysian population from 10.4 million in 1974 to 26.1 million in 2005 at an average growth rate of about 2.1% per year.

Figure 2.1 below shows that the traffic accidents in Malaysia have been increasing at the average rate of 9.7% per annum over the last three decades. Compared to the earlier days, total number of road accidents had increased from 24,581 cases in 1974 to 328,264 cases in 2005, reaching more than 135% increase of accident cases over 30 years. The number of fatalities (death within 30 days after accident) also increased but at slower rate compared to total road accident from 2,303 in 1974 to 6,200 in 2005. However the upward trend of fatalities dropped in 1997 after Malaysia Government established a 5-year national road safety target to reduce road accident deaths by 30% by the year 2000. Furthermore, the total length of road had also increased from 11,161 km in 1974 to 71,814 km in 2005 to accommodate an increase in numbers of vehicles in Malaysia. This also led to an increase of ownership from 9.6 persons per vehicle in 1974 to 1.7 persons per vehicle in 2005. The total numbers of registered vehicles also increased from 1,090,279 to 15,026,660 vehicles in 2005.

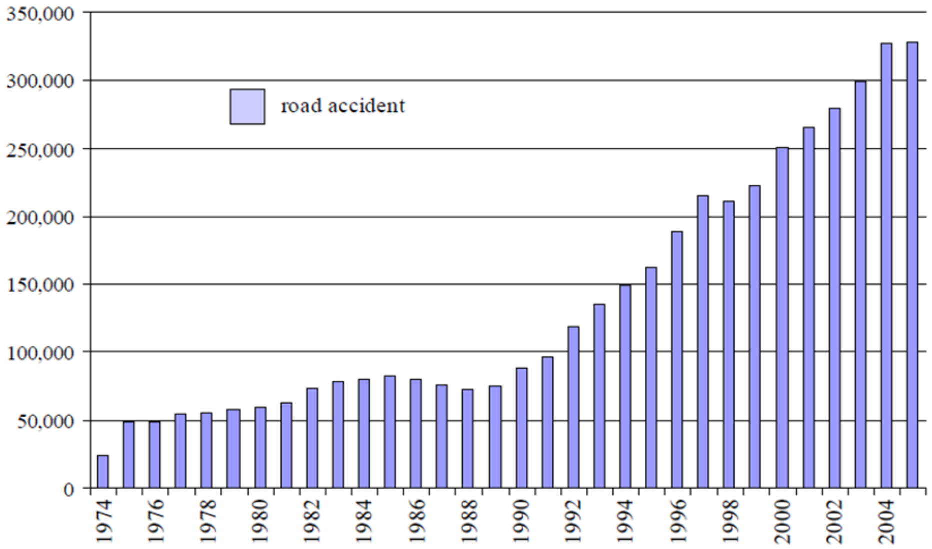


Figure 2.1: Statistics Road Accidents in Malaysia (2005)

Source: Royal Malaysian Police (PDRM)

Accidents statistical in 2001 to 2003 shows that estimated 46% to 49% fatal and serious accident occurred at State and Municipal roads (Shamsuddin Shahid et.al.,2015) . Cabinet Committee on Road Safety on 25 May 2004 have decided that road safety audit and road safety programmes to be implemented onto State Road and Municipal Road In order to accomplish the target. In 9th Malaysian Plan, allocation of about MYR 200 million was provided by the Government to improve the highest 5 hazardous locations along state and municipal roads. Malaysia has taken number of steps to increase road safety awareness. The Road Safety Education (RSE) Program was introduced in 2007 as a long term measure to reduce the high number of road accidents and deaths. It has been reported that awareness of road safety, understanding of the law, and recognition of road signs have been grown among people. In the present study, the recent trends (2008-2013) in road accidents, casualties and fatalities were assessed to understand the state-wise spatial distribution of the changes in accident and casualties in Malaysia. The recent trends in registered vehicles and registered accidents are show in Figure 2.1(a) and Figure 2.1(b) below. The number in the figure denotes change in percentage. The color shade indicates the significance of trend in a state. Significant changes are presented by deep shades in the figures.

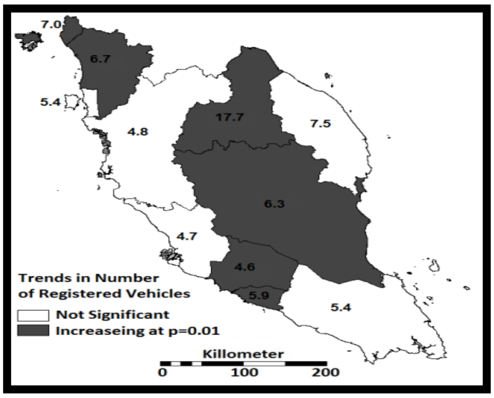


Figure 2.1(a) Trends in Number of Registered Vehicles

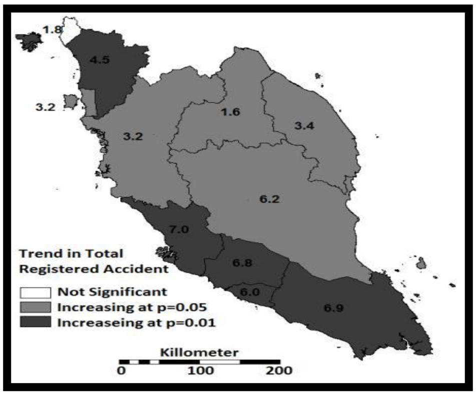


Figure 2.1(b) Trend in Total Registered Accident

Figure 2.1(b) shows that the number of registered accident has increased significantly in all states of peninsular Malaysia except Perlis. The increase is significant at 99% level of significance in the states of Selangor, Negeri Sembilan, Melaka, Johor and Kedah. On the other hand, it has increased significantly at 95% level of confidence in the states of Pahang, Perak, Kelantan and Terengganu. Maximum increase of registered road traffic accident was observed in Selangor (7%), followed by Johor (6.9%), Negeri Sembilan (6.8%), Pahang (6.2%) and Melaka (6.0%). Shamsuddin Shahid et al. (2015) state that, the spatial distribution of the trends in number of registered vehicles over the time period 2008-2013 shows that number of vehicles is significantly increase in Kelantan, Kedah, Perlis, Pahang, Melaka and Negeri Sembilan. It showed that number of registered vehicles is significantly increase in the states that have less number of vehicles. The increases were not significant in Selangor, Johor and Penang, which already have major share of total registered vehicles in Malaysia.

Though the number of registered road accident has increased in almost all states of peninsular Malaysia, number of casualties and fatalities has decreased in most of the states over the time period 2008-2013. It is shows that minor casualties has decreased significantly in Selangor, Negeri Sembilan, Melaka, Pahang, Terengganu, Pulau Pinang and Kedah. The maximum decrease was observed at a rate of 18% in Pulau Pinang and 15.8% in Melaka. The major casualties have decreased in most of the states of Peninsular Malaysia significantly. It is decreased at 99% level of significance in the states of Selangor and Pulau Pinang, which are among the most accident prone states of Malaysia. Maximum decrease of major casualties due to road accident over the time period 2008-2013 was found in Johor (17.4%) followed by Selangor (16.6%) and Pulau Pinang (13.4%).

The trends in number of death due to road traffic accidents in Peninsular Malaysia revealed significant (95% level) decrease only in Perak over the time period 2008-2013. It indicates that in spite of number of initiatives taken to reduce fatalities due to road accident in Malaysia, number of deaths due to road traffic accident has not reduced significantly in almost any state of peninsular Malaysia. The states like Selangor where maximum number vehicles registered and maximum number of accident occurs, accidents were increase but the number of casualties was found to decrease over the time period 2008-2013. In Kelantan state, number of casualties per 10,000 vehicles is very high. The number of registered road traffic accident was found to increase, but number of casualties is found to decrease in Kelantan. It indicates that scenarios of casualties and deaths are different among developed and less developed states, but the trends in number of accident and casualties are similar in both cases. It means that government initiatives to reduce accident and casualties have similar effect in all the states.

2.2 ROAD TRAFFIC CRASHES IN EXPRESSWAY

Expressway is a highway which especially planned for high-speed traffic, usually having few if there are any intersections, limited points of access or exit, and a divider between lanes for traffic moving in opposite directions. Normally peoples prefer to use expressway because they want to save their time which obviously to avoid problems such as traffic jammed. Nevertheless, by using expressway also cannot exempt them by getting involved with road crashes.

In Malaysia, East Coast Expressway Phase 1 is a highway which was officially open to public on 1st August 2004. This highway is connecting West-Coast and East Coast of peninsular Malaysia beginning from Karak Highway and ended at Kuantan Interchange.

Table 2.1 below clearly showed that Kuantan districts is always on the top ranking on number of road accidents cases starting from year 2004 until year 2007 followed by Maran, Temerloh and lastly Bentong (Intan Suhana et.al, 2010). An ascending trends on numbers of road traffic accident where the numbers of accidents in this expressway always kept on increasing from year to year with the highest number of accidents is in year 2007 with 961 number of accident cases.

Table 2.1 : Numbers of road traffic accidents along East-Coast Expressway from 2004-2007

Districts	2004	2005	2006	2007	2008
Kuantan	93	237	281	350	961
Maran	77	233	276	283	869
Temerloh	95	196	215	207	713
Bentong	16	50	66	111	243
Total	281	716	838	951	2786

One of the largest expressway systems in the world is in China. Expressway safety problems have become serious concerns in China. Expressway deaths increased by 10.2 fold from 616 persons in 1995 to 6300 persons in 2010, and the average annual increase was 17.9% over the past 15 years, and the overall other road traffic deaths was -0.33%. China’s expressway mileage accounted for only 1.85% of highway mileage driven in 2010, but expressway deaths made up 13.54% of highway traffic deaths. The average annual crashes lethality rate for China’s expressway was 27.76% during the period 1995 to 2010, which was 1.33 times higher than the crashes lethality rate of highway traffic crashes (Jinbao Zhao & Wei Deng, 2012).

2.3 ROAD TRAFFIC CRASH INJURY TYPES

A report by World Report on Road Traffic Injury Prevention (2004), estimated that the costs of fatalities and injuries due to Road Traffic Accidents (RTAs) have a tremendous impact on societal well-being and socio-economic development. Road traffic accidents are among the leading causes of death and injury worldwide, causing an estimated 1.2 million deaths and 50 million injuries each year.

Despite the extent and severity of the crashes is different, it has a global scope in nature (Girmay Giday, 2014). Road traffic crashes is the prominent cause of death by injury in the world. According to UN (2011), above 1.2 million people die in the world's roads every year. In addition to this, about 65% of the total deaths in road crashes in world include pedestrians, 35% of these are children (UN 2011). In line with this report, WHO (2011) described that 145 people die at every hour of every day, someone is killed or utterly hurt in every six seconds of every minute, a million exceeding people lost their lives each year, one in five of whom is a child merely because of road traffic crashes. Likewise, WHO (2004) described an average of 3,242 persons were vanishing each day around the globe due to road traffic injuries.

In many countries, the police are obliged to go the scene of a crash where there is at least one injured person and on moving vehicle (motorized or not) involved. International Traffic Safety Data and Analysis Group (IRTAD) reported that, in all 23 countries, except Japan and the Czech Republic, the police are then responsible for collecting information on the number of casualties, assessing the severity of injuries, and the overall severity of the crash. In most countries, three levels of type of crash are recorded by police which is fatality, serious injury and slight injury

The Road Transport and Road Traffic Accident Statistics, Island of Mauritius (2007) has classified road traffic crashes into the following categories according to the types of the crashes:

a) Fatal accident – An accident resulting in the death of one or more persons. Prior to 2002, a fatal accident was defined as an accident where death occurred within 7 days. As from 2002, a fatal accident is defined as an accident where deaths occurred within 30 days.

b) Serious injury accident – An accident in which one or more persons are seriously injured.
c) Slight injury accident – An accident in which one or more persons are slightly injured.
d) Non-injury accident – An accident in which no one is killed or injured but which result is damage to the vehicle/s and/or other property only.

2.4 ROAD TRAFFIC CRASHES TEMPORAL-SPATIAL PATTERN

A fundamental per-condition for safe traffic is that the road users have sufficient information about road conditions, traffic characteristics and traffic regulations. The road layout and design should be improved. If it is not the case, traffic crashes will tend to increase.

2.4.1 TEMPORAL PATTERN IN MALAYSIA

Occurrences of road traffic crashes obviously vary with time. This variation occurs between hours in a day, days in a week, and months in a year closely following the variation of traffic volume. Even though night time driving is normally low, the rate and severity of the crashes is higher during the night time. According to Hobbs (1979), night time crashes rates are about 50% greater than day time crashes.

Road crash depends on various mechanical, behavioral and environmental factors. These factors vary in space and time. It is well recognized that number of crash within a year often follows some specific pattern. For example, more crash occurs during festival period, school holidays, and winter icing season. Knowledge on temporal pattern of crash can be help to plan necessary action to reduce accident.

Table 2.2 below show that maximum number of accident in Malaysia occurs during festival months. In all the years under study, maximum accident occurred in festival months in most of the states (Shamsuddin Shahid et al.,2015). In years 2008, maximum number of accidents occurred in October (month of Hari Raya Puasa) in all the states. In year 2009 and 2010, maximum accident occurred in September in most of the states as Hari Raya Puasa was in the month of September. Similarly, in years 2011-2013, maximum accident occurred in August in most of the states as Hari Raya Puasa was in the month of August. However, the table shows that the number of accident during festival months started to decrease or surplus by accident in other months in recent years in some states, particularly those are located in the west coast of Malaysia.

Table 2.2 : Peak accident months during 2008-2013 in different states of peninsular Malaysia

State	Year					
	2008	2009	2010	2011	2012	2013
Johor	Oct	Sep	May	Aug	May	Jul
Kedah	Oct	Sep	Sep	Aug	Aug	Aug
Kelantan	Oct	Sep	Sep	Aug	Aug	Aug
Melaka	Oct	Dec	Jun	Dec	Aug	Aug
Pahang	Oct	Sep	Sep	Aug	Aug	Aug
Perak	Oct	Sep	Sep	Aug	Aug	Aug
Perlis	Dec	Mar	May	Sep	May	Sep
Pulau Pinang	Oct	Aug	Nov	Aug	Jul	Jul
Selangor	Oct	Aug	Mar	Aug	Oct	Jul
Terengganu	Oct	Sep	Sep	Aug	Aug	Aug
N/Sembilan	Oct	Aug	Aug	Nov	Aug	Aug

No seasonal pattern in crash can be observed in recent years for the states like Selangor, Johor and Pulau Pinang as example. The table also shows that the month having the second highest accident in most of the states of peninsular Malaysia is May, which is the month of mid-year school holiday.

2.4.2 SPATIAL PATTERN IN MALAYSIA

Severe road traffic crashes are associated with those areas, where there is lack of information, overload of information and when is difficult to perceive as well as at intersections where traffic is not regulated and with complex geometry (design). Moreover, roads with heavy traffic volumes, with mix of local and through traffic, road users travelling at different speed levels and/or in different directions as well as in busy shopping streets where the high complexity makes it difficult to select sufficient information about the road and the traffic. Most road traffic crashes take place at junctions, on curves, at gaps in dual carriageways, at pedestrian crossings, private driveways and bus stops. Also crashes more likely occur at junctions than elsewhere and in urban areas (Hobbs, 1979).

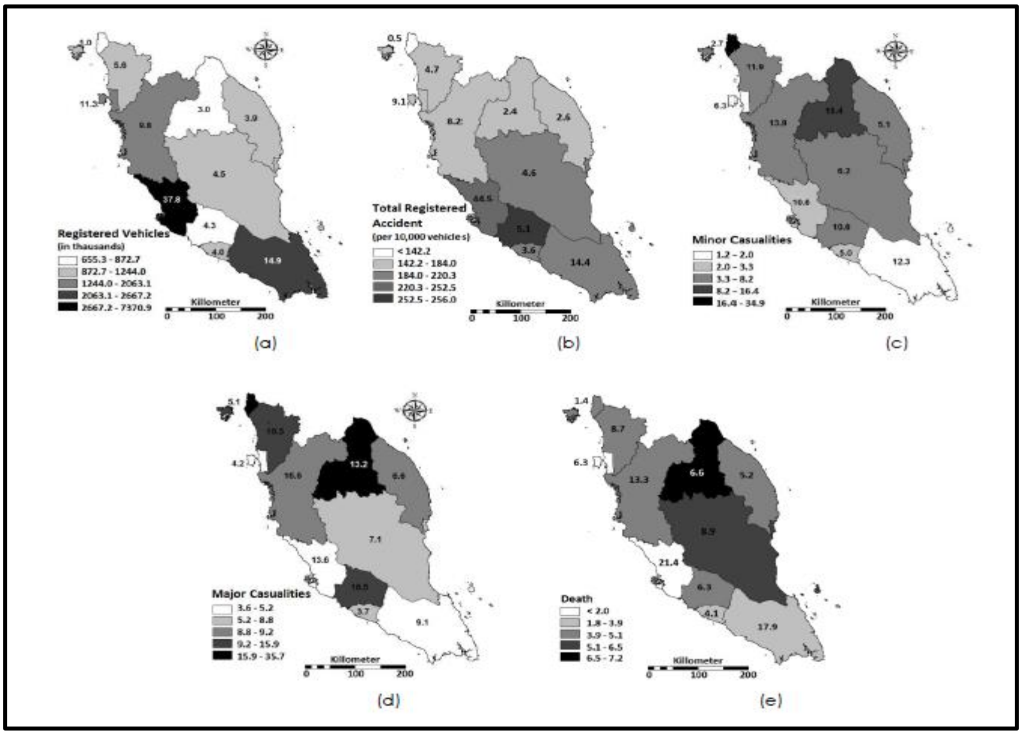


Figure 2.3 : (a) Registered road vehicles, (b) Total Registered Road Accident, (c) Minor casualties, (d) Major casualties, (e) Accident death in Peninsular Malaysia

The state-wise distribution of total number of registered vehicles, total number of registered accidents, major casualties, minor casualties, and deaths based on years 2008 to 2013 are presented in Figure 2.3 above, Shamsuddin Shahid et al (2015). The number of registered vehicles is give as legend and percentage of registered vehicles in Malaysia is given a level. Total number of registered vehicles in Kelantan in the range of 655.3 to 872.7 thousands. The level 3.0 means that 3% of total registered vehicles are registered in Kelantan. State-wise distribution of registered vehicles in Malaysia shows that more than one-third equals to 37.8% vehicles are registered in Selangor. Johor is in second in term of registered vehicles with 14.9%, which is followed by Penang with 11.3% and Perak 9.8%. Figure 2.3(b) shows state-wise distribution of percentage of accidents to total accidents in Malaysia follows the similar spatial pattern of registered vehicles. Maximum number of registered road accident occurs in Selangor with 44.5%. Johor is in second with 14.4% and followed by Penang with 9.1%. However, the spatial pattern of number of road accident per 10,000 registered vehicles in very much different from spatial pattern of registered vehicles.

2.5 ANALYSIS METHODS

Daniel Arkkelin (2014) stated that Statistical Package for the Social Sciences (SPSS) is a versatile package that allows many different types of analyses, data transformations and forms of output. In short, it will more than adequately serve our purposes. SPSS was chosen because of its popularity within both academic and business circles, making it the most widely used package of its type. One of the way to evaluate the relationship between continuous variables and such procedure involves the calculation of the Pearson correlation coefficient known as (*r*). The Pearson correlation coefficient (*r*) is used specifically to describe relationships when the variables to be correlated are continuous (measured on at least an interval scale). This procedure also assumes that the correlated variables are normally distributed, and that the relationship between the two variables approximates a linear one.

Study by Intan Suhana et al. (2010) aims to provide an analysis on road traffic accidents along major expressway in Malaysia. This research mainly focused on developing patterns of road traffic accidents along East Coast Expressway Phase 1 from year 2004 until year 2007 where the data had classified according to the four major districts which are Kuantan, Maran, Temerloh and Bentong. Determination of accident prone area is made to identify the stretches that have high ranking of accident cases. Unsuitable geometric designs that caused an uneven road surface were suspected to be one of the major causes contributing to accidents problem. This study were conducted mainly to make all road users realizes that the age of the roads doesn't reflects it's reliability in terms of safety since a newly built expressway can also creates a dangerous situation for the road users.

The main objective of the research by Girmay Giday, (2014) is to study road traffic crashes issues in Mekelle City in terms of time and space. This study was carried out to describe the characteristics of road traffic crashes, map places of frequent road traffic crashes, examine the trend of road traffic crashes , identify major causes of road traffic crashes, analyze the socio-economic impacts of road traffic crashes in terms of space and time and propose appropriate interventions which could help to reduce road traffic crashes in Mekelle City. This shows that the frequency and occurrence of road traffic crashes in Mekelle City exhibits variations because of the impact of various variables like age and driving experience of drivers, vehicle service year, vehicle category, road divide, road pavement, road moisture condition and weather conditions. Road traffic crashes are randomly distributed in the city in terms of time and space. The road traffic crashes black spots exhibit the highest frequency of road traffic crashes occurrences. The researcher believed that this study contributes much to those who need to understand the general characteristics of road traffic crashes in Mekelle City in terms of space and time and also inspire other stake holders to conduct further studies in the field. This study also tries to introduce the application of GIS in the spatial and spatio-temporal road traffic crashes assessment works.

An integrated road safety program was introduced for both prevent and reduce future traffic accidents to offset the upward trend in fatalities as well as to reduce injuries during and after accidents, Radin Umar (2005) strategies were categorized into exposure control, crash prevention, crash reduction, behaviour modification, injury control and post injury programs. Among the new initiatives were:

- The National Accident Database System
- The Five Stages Road Safety Auditing
- The National Blackspot Programs
- Road Safety Research and Evaluation
- Conspicuity Initiatives for Motorcycles
- National Targeted Road Safety Campaign
- Revision of the Road Transport Act (Revision 1999)
- Integrated Enforcement
- New Helmet Standard MS1-1996
- New Children's Motorcycle Helmet Initiative

Road safety research and scientifically driven initiatives have been recognized as the critical success factors of the safety investments in Malaysia. In addition, a new road safety department was recently set up to specifically plan, coordinate, implement and evaluate the safety interventions in the country.

2.6 SUMMARY

The rapid growth in population, economic in development, industrialisation and motorisation is in link with the increase of road crashes encountered by the country (Radin Umar, 2005). Shamsuddin Shahid et.al (2015) said that fatal and serious accident also occurred at State and Municipal roads. Current practice of road safety improvement only on federal road and with an earlier finding, there's new type of road need to be tackle as to improve road safety for all road users. Traffic collisions are the leading causes that can be preventable. Road crash depends on various mechanical, behavioral and environmental factors. These factors vary in space and time. It is well recognized that number of crash within a year often follows some specific pattern. Intan Suhana et.al (2010) has make all road users realizes that the age of the roads doesn't reflects it's reliability in terms of safety since a newly built expressway can also creates a dangerous situation for the road users. Knowledge on temporal pattern of crash can be help to plan necessary action to reduce accident. The setting of targets is a well established management strategy which, when applied to accident reductions, has proved very effective in other countries. It has contributed greatly to the overall objective by focusing the minds of road authorities on their individual quantifiable goal.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter will discuss about the methodology used from the start of this research until the completion. Methodology refers to the suitable method to conduct the research and establish an effective procedure in collecting all data related to the study problems. Methodology is needed to achieve the objective that has been set. Other than that, problems which arise can be answered based on the created methodology. The purpose of this study is to determine the main causes of crash within riskiest locations, time, day and month along East Coast Expressway Phase 2. As this primary data for this study, the data will carefully checked and any unsuitable data will be removed from datasets. In this chapter, things that should be given convergence were all elements which related to research design, method of study and location of study, respondent selection, data collection and data analysis.

3.2 RESEARCH FLOW CHART

The main purpose of this research is to identify correlation between crash temporal-spatial pattern and crash type at East Coast Expressway Phase 2. The research flow chart is an important part in this study. The process of study must be arranged so that the work process will be more systematic and orderly to achieve the objective of the study as shown in Figure 3.1.

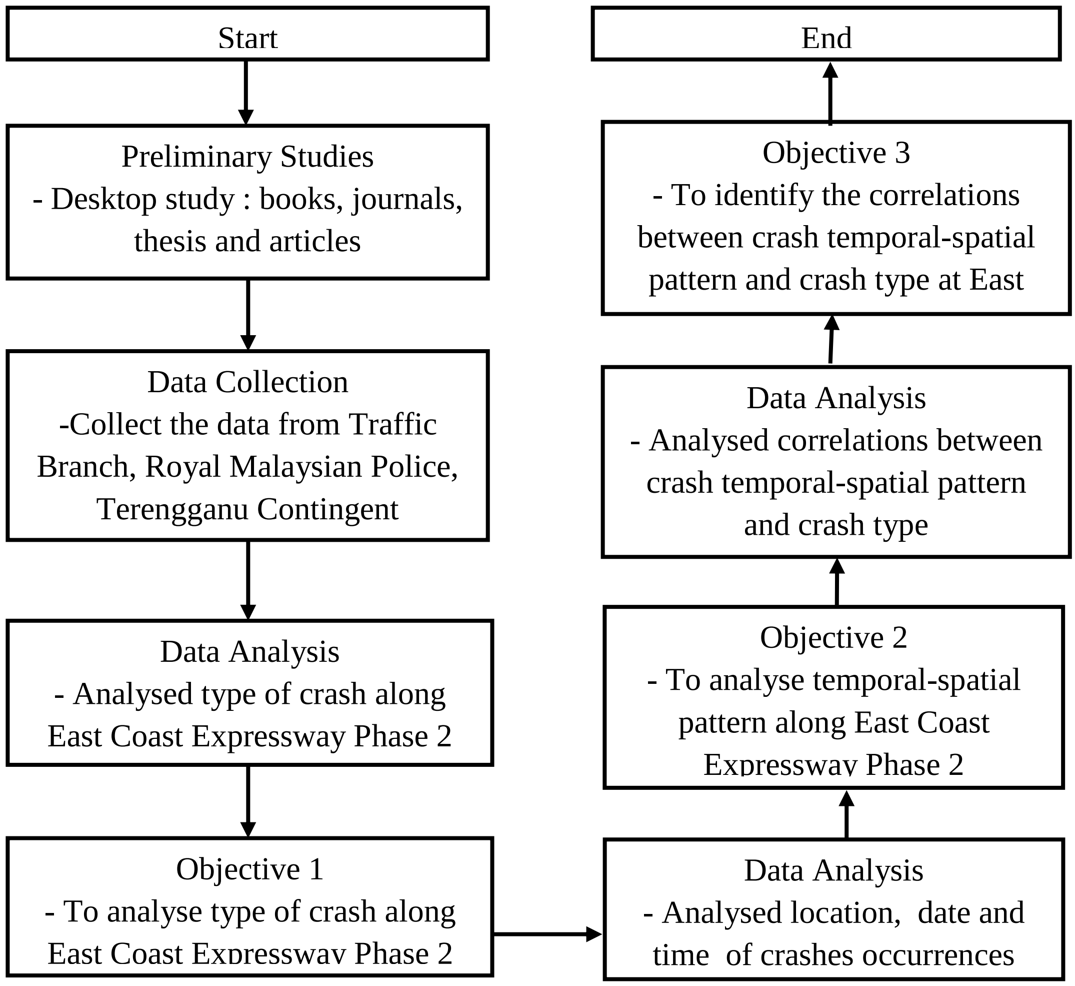


Figure 3.1 : Research Flow Chart

3.3 PRELIMINARY STUDIES

Preliminary studies is a first step to be done before any progress could be started. The preliminary studies is very important since it will give more information about the whole project. Books, Journals, thesis and articles were the sources that had been studied first to gain deep knowledge of the project. From those sources, information such as guideline, procedure and fact were collected.

3.4 RESEARCH AREA

The East Coast Expressway Phase 2 was selected as the research area for the study of road traffic accidents. The East Coast Expressway Phase 2 is newly built highway where it was first opened to public to provide road network to east coast side of Peninsular Malaysia on August 2011 and officially opened for all sections on 31 January 2015.

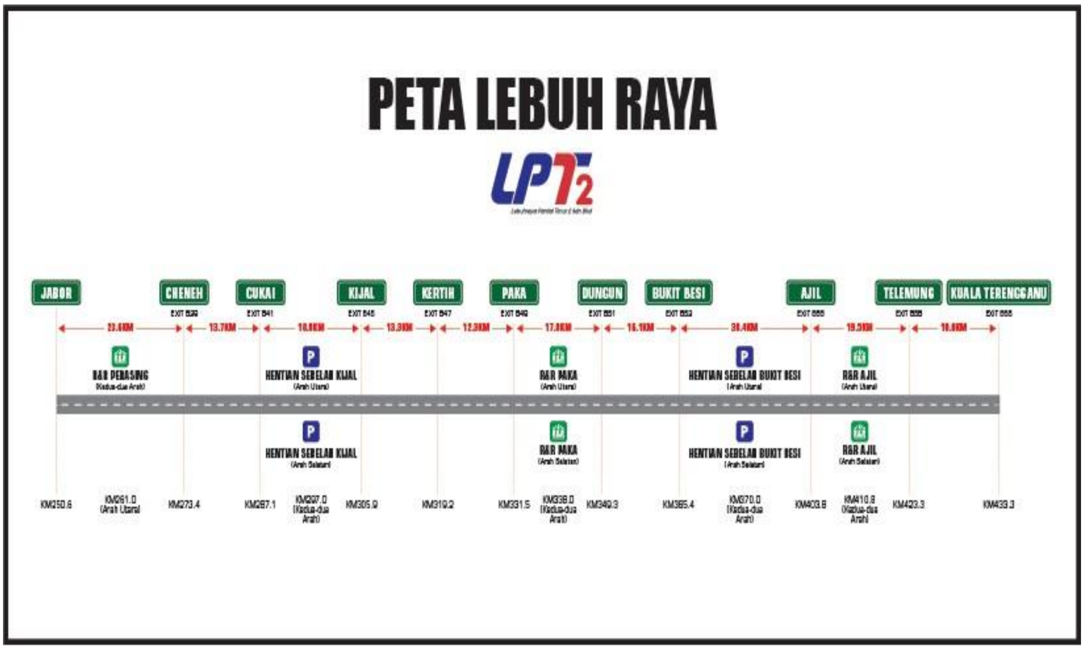


Figure 3.2: Map of East Coast Expressway Phase 2

The phase 2 of the East Coast Expressway connecting Jabur at the Pahang – Terengganu border and Gemuruh in Terengganu, which is as far as 184 km. Figure 3.2 above shows the map of East Coast Expressway Phase 2. This highway was built beginning from Jabur through Cheneh, Cukai, Kijal, Kertih, Paka, Dungun, Bukit Besi, Ajil, Telemong and ending to Kuala Terengganu. The highway adopts the close toll system. The section built by MTD Group was monitored by the Malaysian Highway Authority, while the remaining section was monitored by the Malaysian Public Works Department.

Technical fact of East Coast Expressway Phase 2 as below:

- Closed toll system operation
- Bridges – 90 units
- Rest and service area (R&R)- 3 units ; at Ajil, Paka and Perasing
- Layby - 2 units ; at Kijal and Bukit Besi
- JPJ weighbridge – 2 units
- 10 interchanges located at :

1. Cheneh Interchange
2. Cukai Interchange
3. Kijal Interchange
4. Kertih Interchange
5. Paka Interchange
6. Dungun Interchange
7. Bukit Besi Interchange
8. Ajil Interchange
9. Telemong Interchange
10. Kuala Terengganu Interchange

3.5 TYPE OF DATA

In order to execute this study and analysis, several data and information are required. There two types of data successfully been gathered to be used in this study. These data are:

1. Road traffic crashes records which include location, date and time of accidents along East Coast Expressway Phase 2 from year 2013 to year 2015.
2. Road traffic crashes records which include type of crash along East Coast Expressway Phase 2.

3.6 DATA COLLECTION AND TRANSCRIPTION

The data that stated above was obtained from Traffic Branch, Royal Malaysian Police, Terengganu Contingent. To get the data, an official letter was submitted to the Traffic Branch to request data needed for this study. After several follow up, the data needed was collected from Traffic Branch.

3.6.1 Primary Crash Data

To ease the process of organizing the data and building graph, the whole process of the analysis was done using Microsoft Excel 2010 (MS Excel) based on the tabulated data. The data used for this analysis was the road traffic crashes records along East Coast Expressway Phase 2 from 2013 to 2015 gathered from Traffic Branch.

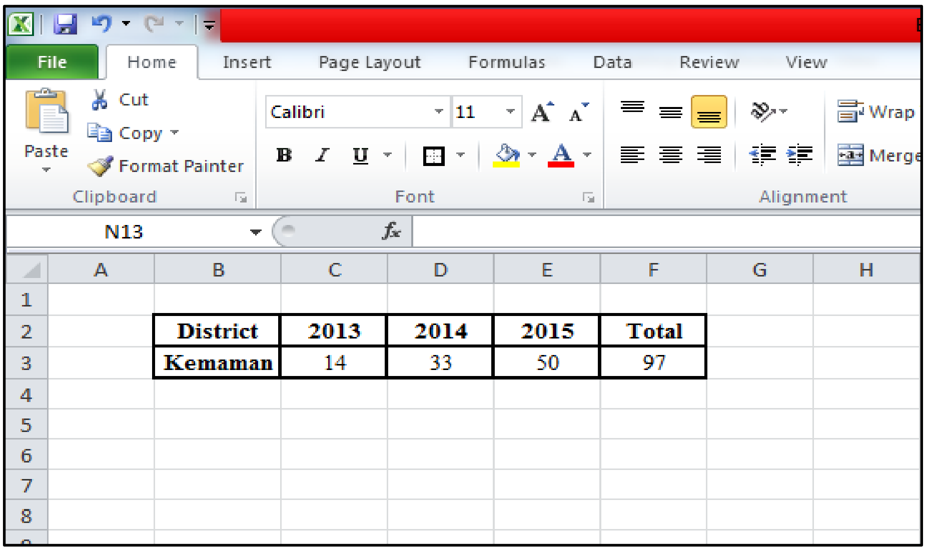


Figure 3.3 : Primary data of road traffic crashes based on district

The first analysis of road traffic crashes was based on Kemaman. The numbers of road traffic crashes for Kemaman from statistics was tabulated in a new table in MS Excel as shown in Figure 3.3 above. The number was filled into year of crashes which are 2013, 2014 and 2015 accordingly.

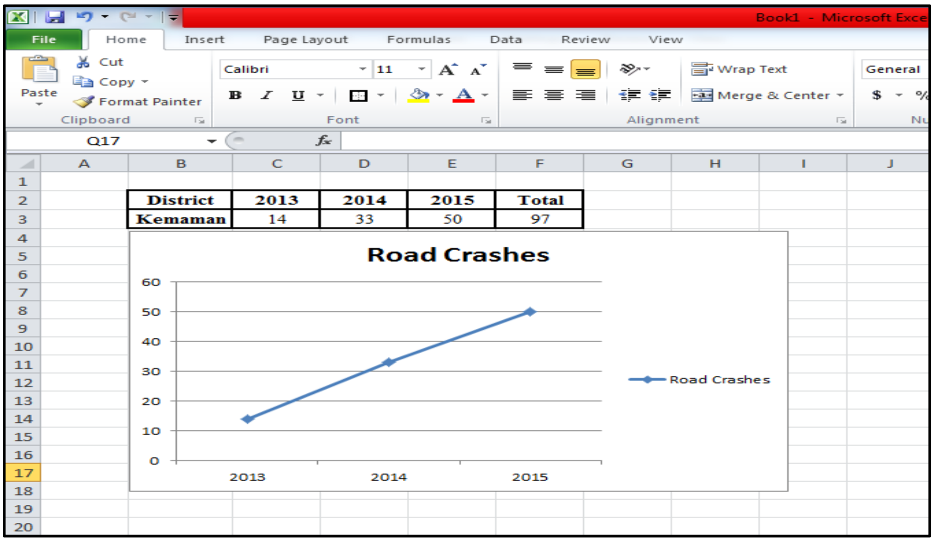
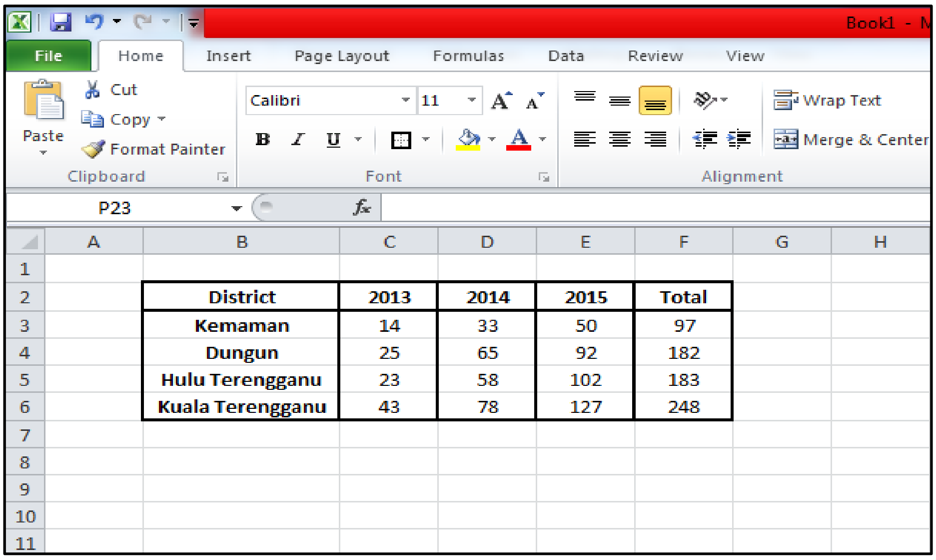


Figure 3.4 : Graph line based on tabulated data

After the table was tabulated, a graph line was built to show the numbers of road crashes in Kemaman district in visual form. The road traffic crashes pattern can be seen clearly thru this graph. The graph line was built in MS Excel by using *Chart*. In *Chart type*, *Line Chart* was selected and then proceeds with inserting of data. In *Chart Source Data*, the category of x-axis was filled with year 2013, 2014 and 2015 while the numbers of road traffic crashes were inserted for value of y-axis. By clicking *OK* button, the graph line was built automatically and the pattern of the graph was shown as in Figure 3.4 above. The same procedures were applied for the road traffic crashes in Dungun, Hulu Terengganu and Kuala Terengganu.



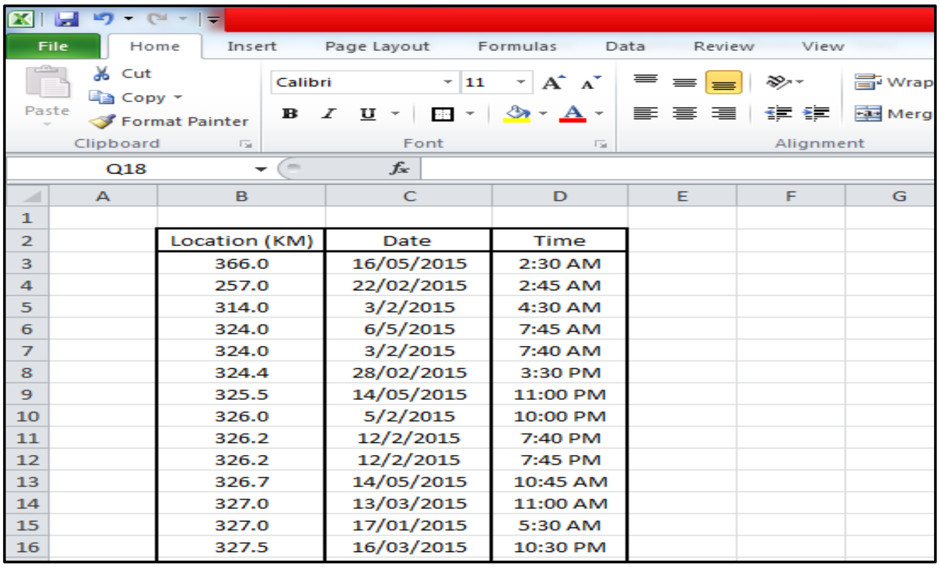
District	2013	2014	2015	Total
Kemaman	14	33	50	97
Dungun	25	65	92	182
Hulu Terengganu	23	58	102	183
Kuala Terengganu	43	78	127	248

Figure 3.5 : Tabulated data of road traffic crashes for all districts

For the step of analysis, the overall road traffic crashes statistic was re-organized based on years of crashes occurrences which are 2013, 2014 and 2015 and district which are Kemaman, Dungun, Hulu Terengganu and Kuala Terengganu as shown in Figure 3.5 above. The same method as previous was applied for building a graph line for this statistics. The comparison pattern of graph for overall road traffic crashes can be shown according to district and year of crashes occurrences.

3.6.2 Crash Temporal Pattern

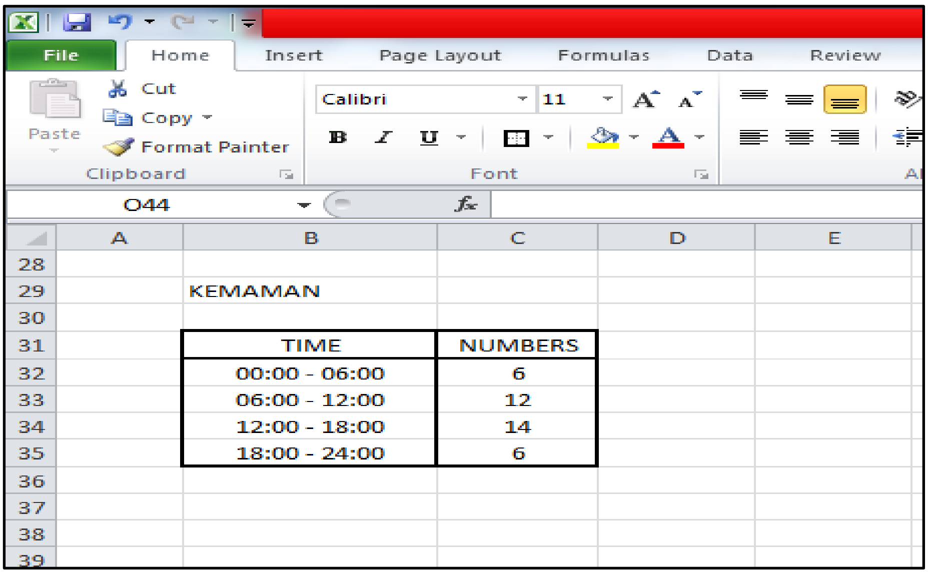
The statistics of road traffic crashes was created based on time of crashes occurrences. Firstly, all road traffic crashes record was copied into a new table in MS Excel where there were three columns represent three attribute; location, date and time of crashes occurrences as shown in Figure 3.6 below.



Location (KM)	Date	Time
366.0	16/05/2015	2:30 AM
257.0	22/02/2015	2:45 AM
314.0	3/2/2015	4:30 AM
324.0	6/5/2015	7:45 AM
324.0	3/2/2015	7:40 AM
324.4	28/02/2015	3:30 PM
325.5	14/05/2015	11:00 PM
326.0	5/2/2015	10:00 PM
326.2	12/2/2015	7:40 PM
326.2	12/2/2015	7:45 PM
326.7	14/05/2015	10:45 AM
327.0	13/03/2015	11:00 AM
327.0	17/01/2015	5:30 AM
327.5	16/03/2015	10:30 PM

Figure 3.6 : Raw data crashes within Kemaman district

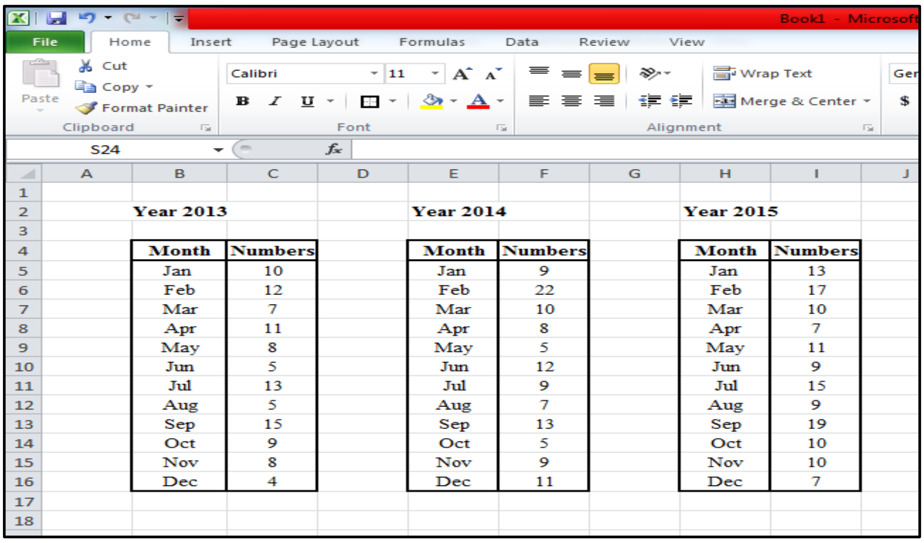
After all data were copied, the time of crashes was sorted in ascending order. This was done by select all time data from top to bottom, then followed by navigated to *Sort Ascending* located on the top toolbar panel. A new table that has time and numbers column was created after that. The attributes of times were started from 00:00 to 6:00, 6:00 to 12:00, 12:00 to 18:00 until 18:00 to 24:00 where each category has duration of six hours. The numbers of road traffic crashes were counted based on its crash time as shown in Figure 3.7 below. Bar graph was built based on the data and the method that used to create the graph was typically same as previous analysis.



TIME	NUMBERS
00:00 - 06:00	6
06:00 - 12:00	12
12:00 - 18:00	14
18:00 - 24:00	6

Figure 3.7 : Tabulated crashes data by time

Next step of analysis was based on month of crashes occurrences. Three new tables were created in MS Excel which represent year 2013, 2014 and 2015. Each table has categorized with month starting from January until December. After that, the number of crashes happening in that month has computed and recorded into the table as shown in Figure 3.8 below.



Year 2013

Month	Numbers
Jan	10
Feb	12
Mar	7
Apr	11
May	8
Jun	5
Jul	13
Aug	5
Sep	15
Oct	9
Nov	8
Dec	4

Year 2014

Month	Numbers
Jan	9
Feb	22
Mar	10
Apr	8
May	5
Jun	12
Jul	9
Aug	7
Sep	13
Oct	5
Nov	9
Dec	11

Year 2015

Month	Numbers
Jan	13
Feb	17
Mar	10
Apr	7
May	11
Jun	9
Jul	15
Aug	9
Sep	19
Oct	10
Nov	10
Dec	7

Figure 3.8 : Tabulated crashes data by month

After completed the table, a graph line was built where the method used was as previous. Then, the analysis was done by summed the number of crashes in each year followed by build a graph line to show pattern of the crashes from 2013 until 2015.

3.6.3 Crash Spatial Pattern

The statistics of road traffic crashes was created based on the location of the crashes occurrences. The location was arranged by ascending order.

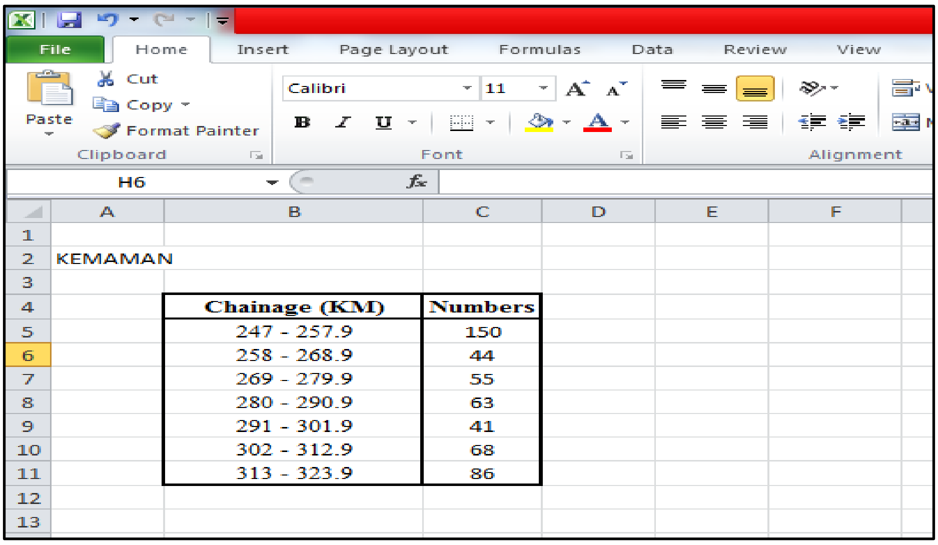
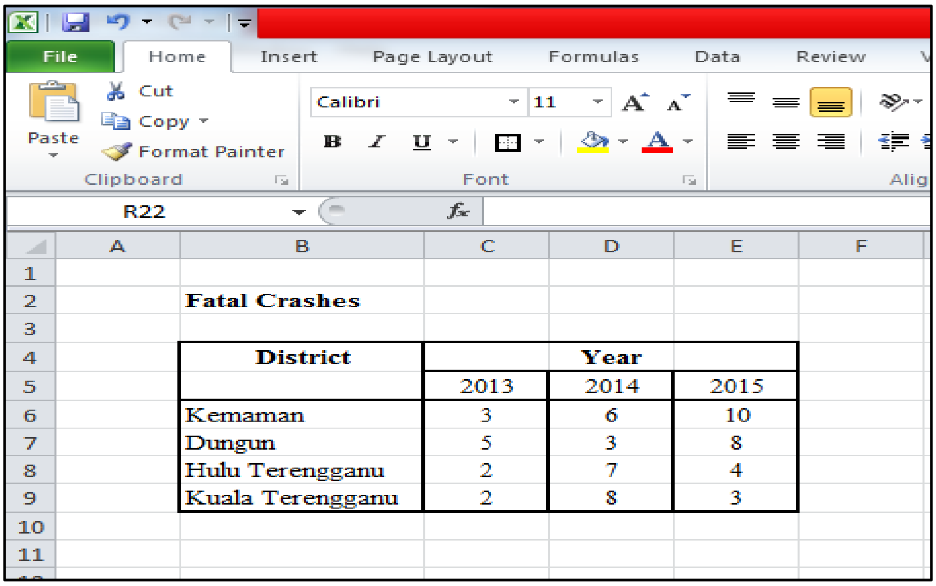


Figure 3.9 : Tabulated crashes data by location

This was done by select all location data from top to bottom, then followed by navigated to *Sort Ascending* located on the top toolbar panel. The location divided into sections by district following the length such as seven sections for Kemaman district. The numbers of road traffic crashes in each section were counted and recorded into the table as shown in Figure 3.9 above. Bar graph was built based on the data in the table by using as same as previous method.

3.6.4 Crash Injury Types

The numbers of road crashes from year 2013 until year 2015 keep analysed according to the type of crashes following district along East Coast Expressway Phase 2 by using MS Excel. Four new tables was built based on types of crashes where were classified into 4 classes which are fatal crashes, crashes with severe injuries, crashes with slight injuries and non-injuries accordingly.



Fatal Crashes

District	Year		
	2013	2014	2015
Kemaman	3	6	10
Dungun	5	3	8
Hulu Terengganu	2	7	4
Kuala Terengganu	2	8	3

Figure 3.10 : Tabulated crashes data by crash injury type

Each table created represent each type of crashes for year 2013, 2014 and 2015 following district respectively as shown in Figure 3.10 above. Bar graph was built based on the data in the table by using as same as previous method.

3.7 CORRELATION ANALYSIS BASED ON PRIMARY DATA

The process to get correlations between crash temporal-spatial pattern and crash type at East Coast Expressway Phase 2 was done by using Statistical Package for Social Science (SPSS) version 22.0. Correlation is a technique for investigating the relationship between two quantitative, continuous variables.

Pearson's correlation coefficient (r) is a measure of the strength of the association between the two variables. The type of correlation was using bivariate correlation to get the correlationship between crash temporal-spatial pattern and crash type variables.

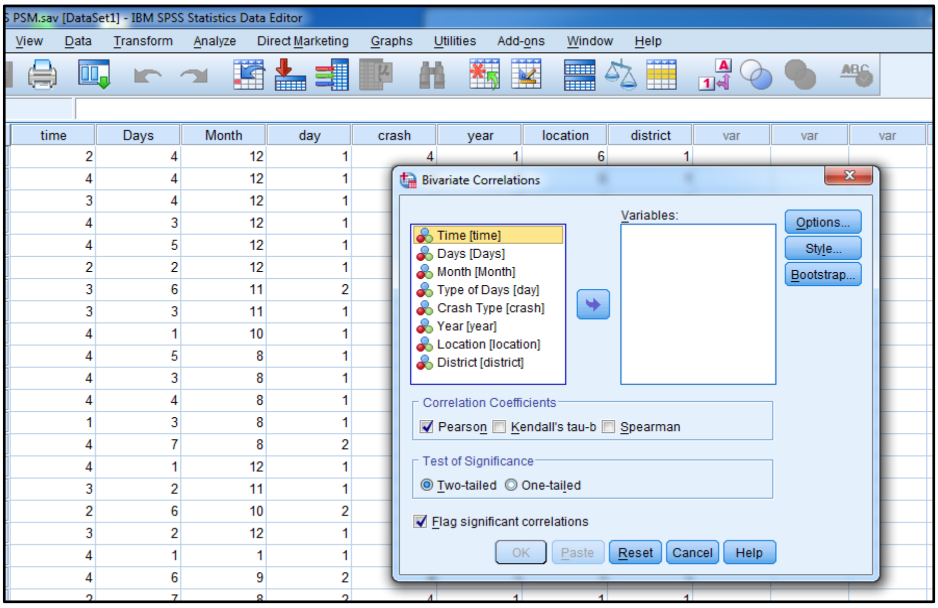


Figure 3.11 : Correlation Analysis Window

Previous research by Savolainen et al. (2010) has said that bivariate ordered probit model is a hierarchical system of two equations that can be used to model a simultaneous relationship, addressing possible issues of endogeneity such as that of safety-belt use and injury severity. The correlation analysis was done after descriptive analysis result was obtained. In the toolbox custom, the 'Correlate' item was clicked and 'Bivariate' option is chosen. A window appeared according to Figure 3.11 above. After clicked on the variables needed, the correlation box was generated after button 'OK' is clicked.

For the Test of Significance, the two-tailed test of significance was selected and the value can be found in the Correlations box. The two-tailed test defined if there is statistically significant correlation between the two variables. If the Sig (2-Tailed) value is greater than 0.05, it can be concluded that there is no statistically significant correlation between the two variables. That means, increases or decreases in one variable do not significantly relate to increases or decreases in the second variable. If the Sig (2-Tailed) value less than or equal to 0.05, it can be conclude that there is a statistically significant correlations between the two variables. That means, increases or decreases in one variable do significantly relate to increases or decreases in the second variable.

Meanwhile, the value nearing to 1 indicates the relationship between the variables was strongly correlated and if the value nearing 0, it is indicates that the correlation relationship is weak. If there is a '+' sign in front the value, it can be concluded as positive correlation where one variable decreases in value, the second variable also decreases in value. If the value nearing to -1, it is called negative correlation where one variable increases in value, the second variable decreases in value. Hence, the result for the correlation in this study is discussed whether those variables listed are really problematic and give effect to the crash or not.

3.8 SUMMARY

The planning method from the beginning until the end is important to ensure the study objectives to be the managed smoothly. It is needed at every steps of the process. In the absence of the methodology planning, time could be wasted and there are many unclear statements that could not be understood well enough. This study began with determination of study areas, road crash data collection, road crash temporal-spatial pattern analysis, crash type analysis and lastly correlation analysis of crash temporal-spatial pattern and crash type by using SPSS software. Thus from the analysis result that was obtained, the correlation between Crash temporal-spatial pattern and crash injury types at East Coast Expressway Phase 2 can be determined.

CHAPTER 4

RESULT AND ANALYSIS

4.1 INTRODUCTION

In this chapter, all result obtained from the road traffic crashes data from Traffic Branch, Royal Malaysian Police, Terengganu Contingent. All the data in this study were processed and analysed by using Microsoft Excel 2010 and Statistic Package for Social Science (SPSS) for Window Version 22.00. Methodology refers to the suitable method to conduct the research and establish an effective procedure in collecting all data related to the study problems. Methodology is needed to achieve the objective that has been set. Other than that, problems which arise can be answered based on the created methodology. The purpose of this study is to determine the correlations between crash temporal-spatial pattern and crash type at East Coast Expressway Phase 2. As this primary data for this study, the data will carefully checked and any unsuitable data will be removed from datasets. In this chapter, things that should be given convergence were all elements which related to research design, method of study and location of study, respondent selection, data collection and data analysis.

4.2 ROAD TRAFFIC CRASHES ALONG EAST COAST EXPRESSWAY PHASE 2 FROM 2013 TO 2015

Below was the result of analysis of road traffic crashes along East Coast Expressway Phase 2 from 2013 to 2015. The result contained crashes statistics from 2013 to 2015 within four districts which are Kemaman, Dungun, Hulu Terengganu and Kuala Terengganu.

4.2.1 Road Traffic Crashes in Kemaman District

The East Coast Expressway is started in Kemaman district where it is a connection from Jabur at the Pahang – Terengganu border. The length of the highway within Kemaman district was the longest compared to others district which is 77 kilometres, where it start at KM247 and end up at KM324.

Table 4.1 : Road traffic crashes in Kemaman district of East Coast Expressway Phase 2

YEAR	2013	2014	2015	Total
NUMBER	34	83	392	509

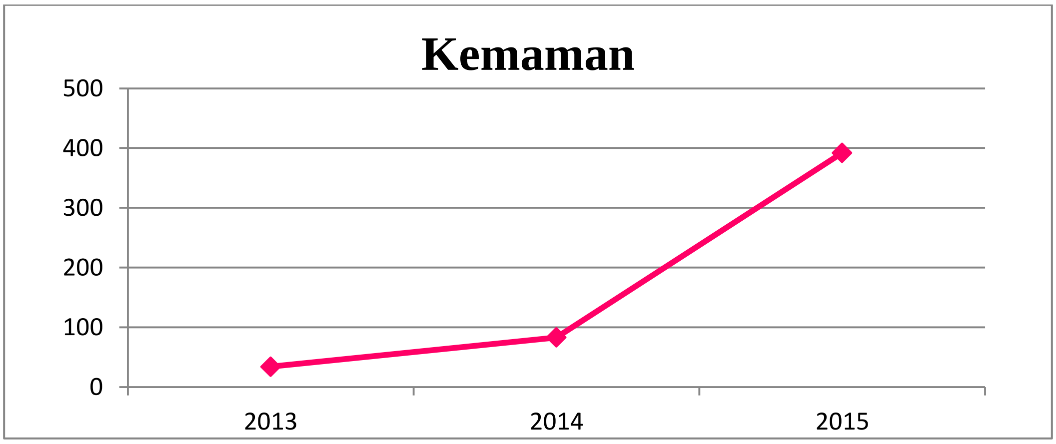


Figure 4.1 : Road traffic crashes in Kemaman district of East Coast Expressway Phase 2

Figure 4.1 above shows the numbers of road traffic crashes in Kemaman district of East Coast Expressway Phase 2 from 2013 to 2015. In 2013, there are 34 crashes were recorded. However, the kept increase by years with 83 on 2014, and extremely increased on 2015 with 392 cases were recorded. This rise could be related with the expansion of the total number of road users since on 2015 East Coast Expressway were officially opened to traffic. The total number of road traffic crashes in these three years within Kemaman district was 509 crashes.

4.2.2 Road Traffic Crashes in Dungun district

The East Coast Expressway also constructed in Dungun district where it begins from KM324 to KM378.4. This 54.4 kilometres length of highway connect from Kemaman district to Hulu Terengganu district.

Table 4.2 : Road traffic crashes in Dungun district of East Coast Expressway Phase 2

YEAR	2013	2014	2015	Total
NUMBER	37	164	150	351

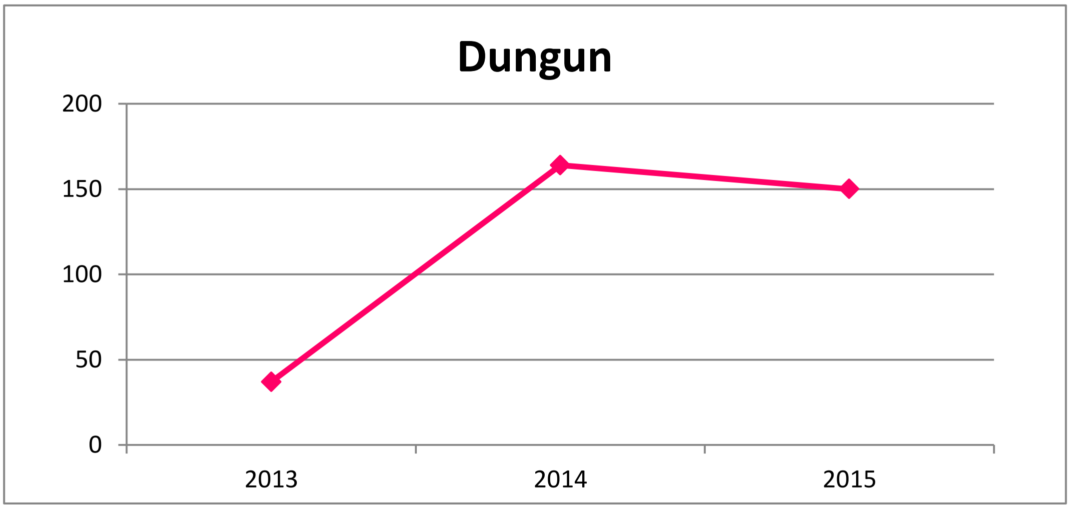


Figure 4.2 : Road traffic crashes in Dungun district of East Coast Expressway Phase 2

Figure 4.2 above is a graph of the road traffic crashes in Dungun district of East Coast Expressway from 2013 to 2015. From the graph, there are 37 crashes recorded on 2013, and then extremely increased in number of crashes on 2014 with 164 crashes. However, on 2015 number of crashes recorded were slightly decreased with 150 cases. The total number of crashes for this three years were 351, which is less than Kemaman district.

4.2.3 Road Traffic Crashes in Hulu Terengganu district

The East Coast Expressway Phase 2 also crosses Hulu Terengganu district where the boundary located start from KM378.4 to KM423. The length of the highway within Hulu Terengganu district is 44.6 kilometres.

Table 4.3 : Road traffic crashes in Hulu Terengganu district of East Coast Expressway Phase 2

YEAR	2013	2014	2015	Total
NUMBER	270	227	191	688

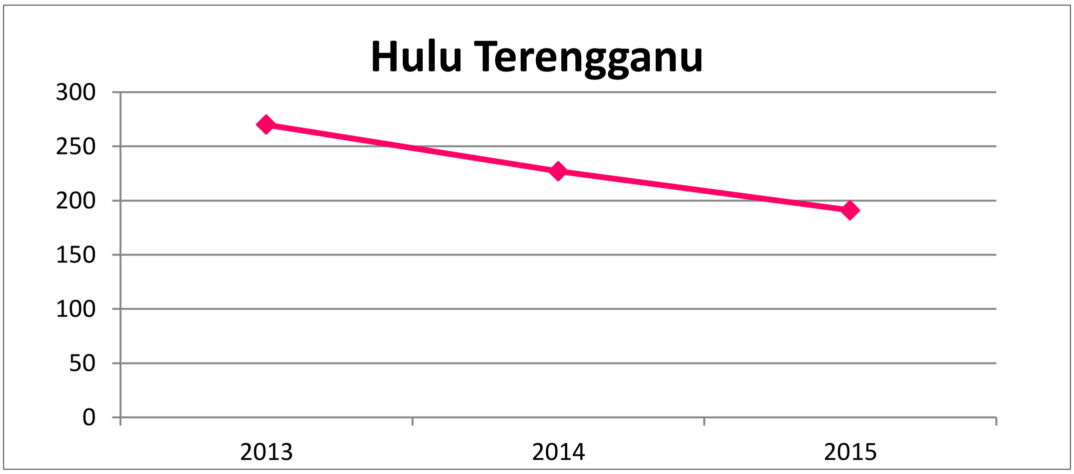


Figure 4.3 : Road traffic crashes in Hulu Terengganu district of East Coast Expressway Phase 2

Figure 4.3 above shows the number of road traffic crashes recorded in Hulu Terengganu district of East Coast Expressway Phase 2 from 2013 to 2015. From the graph above, it showed a different type of road crashes pattern compared with others district where at this district, the number of crashes recorded were decreased by years from 2013 until 2015. On 2014, there are 270 crashes and slightly decreased to 227 crashes on 2014. The number of crashes kept decreased on 2015 with 191 crashes were recorded in this district. The total numbers of crashes recorded in this three years at this district were 688 cases.

4.2.4 Road Traffic Crashes in Kuala Terengganu district

Kuala Terengganu is the fourth and last district where it located in the end of the East Coast Expressway Phase 2 that ended at Kuala Terengganu Interchange. The boundary of this district start from KM423 to KM438. This district is the smallest district compared to other three districts. It covers only 15 kilometres which is the shortest length of the highway in East Coast Expressway Phase 2 compared to other districts.

Table 4.4 : Road traffic crashes in Kuala Terengganu district of East Coast Expressway Phase 2

YEAR	2013	2014	2015	Total
NUMBER	6	14	18	38

Table 4.4 above represent the results for Figure 4.4 below which shows the number of road traffic crashes of East Coast Expressway Phase 2 within Kuala Terengganu district for year 2013 to 2015. Even the length of this district is the lowest, the number of road crashes in this district also kept increase following in Kemaman and Dungun districts. The number of road traffic crashes recorded on 2013 was the lowest compared to others year in it district itself and also others district with only 6 crashes recorded and kept increase on 2014 with 14 crashes. The number of road crashes on 2015 slightly increased with 18 cases recorded.

Total number of road crashes recorded in Kuala Terengganu district of East Coast Expressway Phase 2 was 38 cases which is the lowest number of crashes recorded compared to others district.

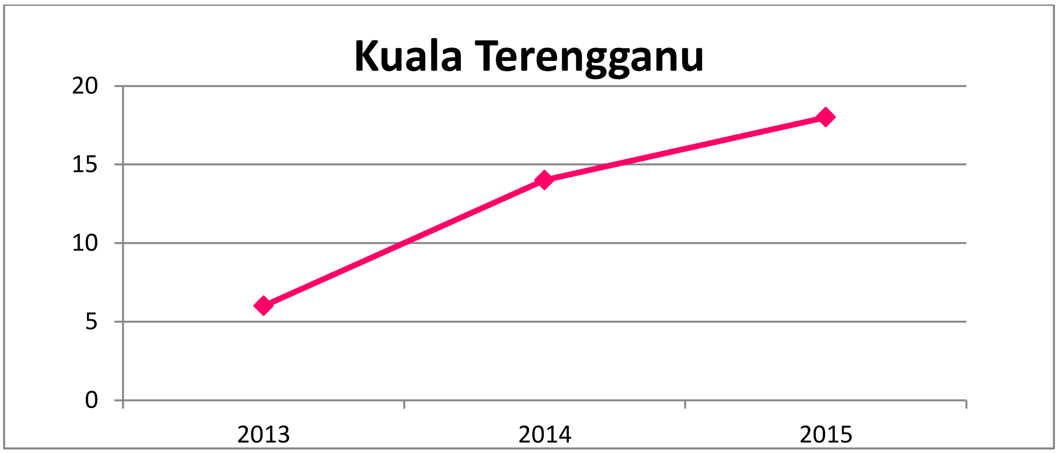


Figure 4.4 : Road traffic crashes in Kuala Terengganu district of East Coast Expressway Phase 2

4.2.5 Comparison Road Traffic Crashes between Districts

All four graphs previously were combined in one graph in order to compare the pattern of road traffic crashes between each districts and by year of crashes occurrences.

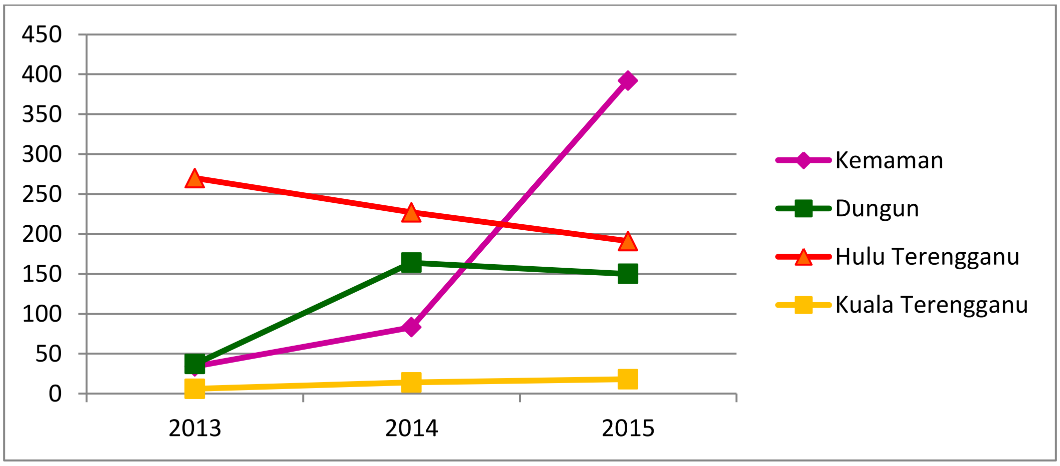


Figure 4.5 : Overall traffic crashes of East Coast Expressway Phase 2

Figure 4.5 above shows graph line of road traffic crashes for Kemaman, Dungun, Hulu Terengganu and Kuala Terengganu district. In year 2013 where it was third year since East Coast Expressway Phase 2 which opened by stages on 2011. Differ with three others district which recorded only slightly difference numbers of road crashes, Hulu Terengganu recorded a large numbers of crashes. In year 2014, the three district which is Kemaman, Dungun and Kuala Terengganu, the numbers of road traffic crashes were increased. However, for Hulu Terengganu district the number of road crashes recorded kept decrease until 2015. For Dungun district, it shows a slightly decrease number of crashes and Kemaman district recorded extremely high number of crashes on 2015. Only Kuala Terengganu district maintain lowest number of crashes from 2013 to 2015 with only slightly increase.

4.3 CRASH INJURY TYPE ALONG EAST COAST EXPRESSWAY PHASE 2 FROM 2013 TO 2015

Below was the result of analysis of road traffic crashes type along East Coast Expressway Phase 2 from 2013 to 2015. The result contained crashes statistics from 2013 to 2015 for each districts which are Kemaman, Dungun, Hulu Terengganu and Kuala Terengganu. The type of crashes were classified into 4 classes which are fatal crashes, crashes with severe injuries, crashes with slightly injuries and non-injuries.

4.3.1 Fatal Crashes Type

Road traffic crashes classified into fatal crashes category if the crashes resulting in the death of one or more persons. Prior to 2002, a fatal crashes was defined as an crashes where death occurred within 7 days. As from 2002, a fatal crashes is defined as an accident where deaths occurred within 30 days.

Table 4.5 : Fatal crashes type in all district of East Coast Expressway Phase 2

District	2013	2014	2015
Kemaman	0	0	10
Dungun	0	2	3
Hulu Terengganu	6	12	3
Kuala Terengganu	0	0	0

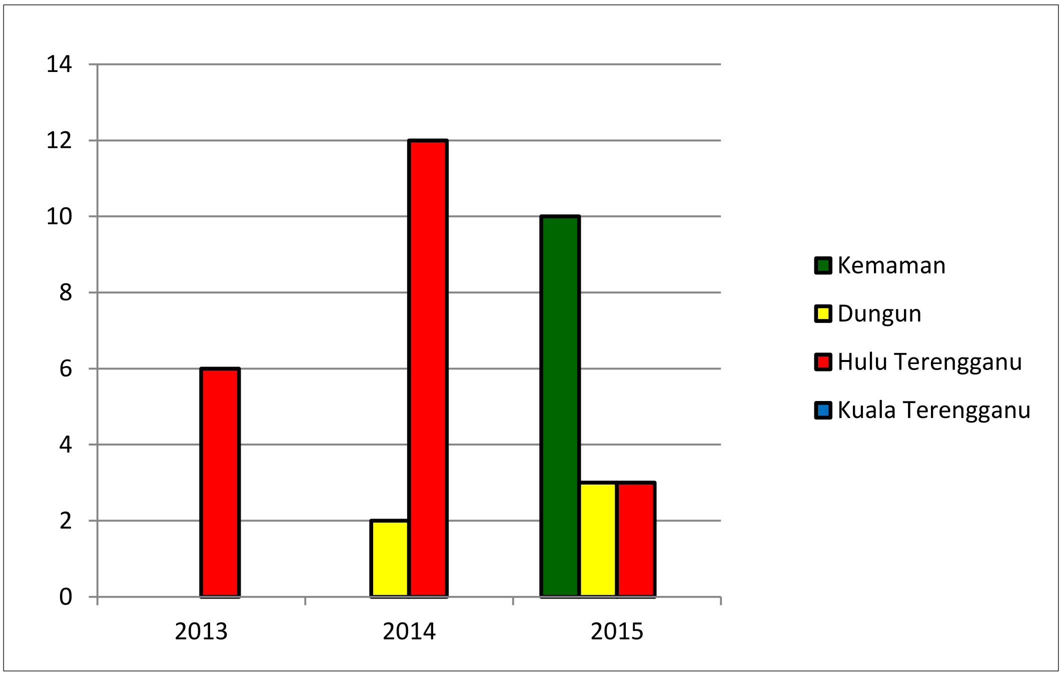


Figure 4.6 : Fatal crashes type in all district of East Coast Expressway Phase 2

Figure 4.6 above shows fatal crashes recorded in all district of East Coast Expressway Phase 2. Hulu Terengganu district recorded fatal crashes in all three years where the highest numbers recorded was on 2014. Differ with Kuala Terengganu district, where none of fatal crashes recorded in this district. Based on this graph, year 2013 can conclude as the lowest numbers of fatal crashes since cases recorded only in Hulu Terengganu district with small numbers of crashes.

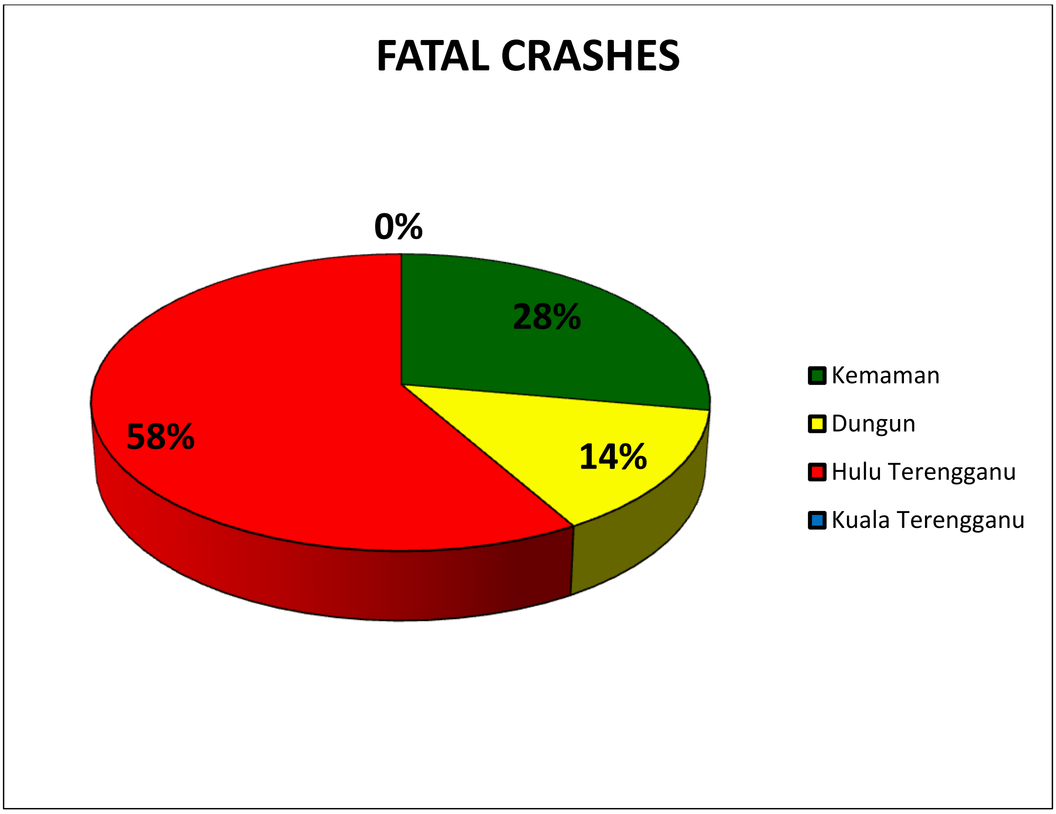


Figure 4.7 : Percentage of fatal crashes type in all district of East Coast Expressway Phase 2 from 2013 to 2015

Figure 4.7 above shows percentage of fatal crashes type in all district of East Coast Expressway Phase 2 from year 2013 to 2015. Hulu Terengganu district recorded the highest number of fatal crashes with 58%, following with Kemaman district with 28% and 14% for Dungun district. Fortunately, there is no fatal crashes cases recorded in Kuala Terengganu district.

4.3.2 Crashes with Severe Injuries Type

Road traffic crashes classified into crashes with severe injuries category if the crashes in which one or more persons are seriously injured.

Table 4.6 : Crashes with severe injuries type in all district of East Coast Expressway Phase 2

District	2013	2014	2015
Kemaman	1	1	4
Dungun	0	2	6
Hulu Terengganu	2	4	1
Kuala Terengganu	0	0	0

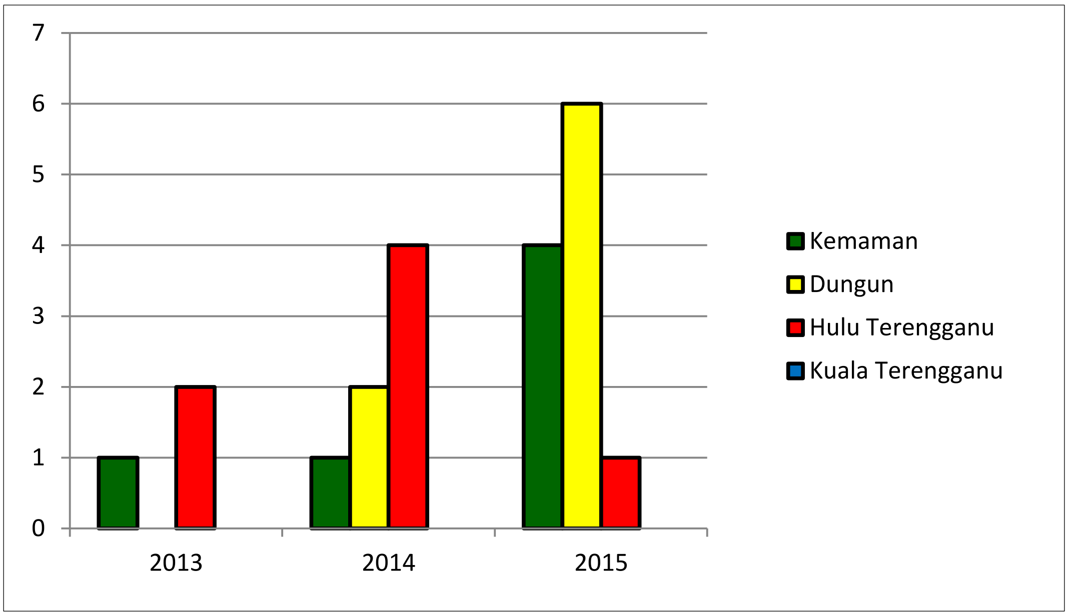


Figure 4.8 : Crashes with severe injuries type in all district of East Coast Expressway Phase 2

Figure 4.8 above shows crashes with severe injuries type in all district of East Coast Expressway Phase 2. For Kemaman and Hulu Terengganu districts, both recorded severe crashes in this three years where for Kemaman district it shared same numbers of crashes with severe injuries with 1 case on 2013 and 2014 and increased with 4 cases recorded on 2015. However, for Hulu Terengganu numbers of crashes with this type recorded 2 cases on 2013 and increased with 4 cases on 2014 before decreased to 1 case on 2015. Dungun district recorded the highest number of crashes with severe injuries on 2014 compared to others district in all three year. Only Kuala Terengganu district maintained with none crash cases recorded.

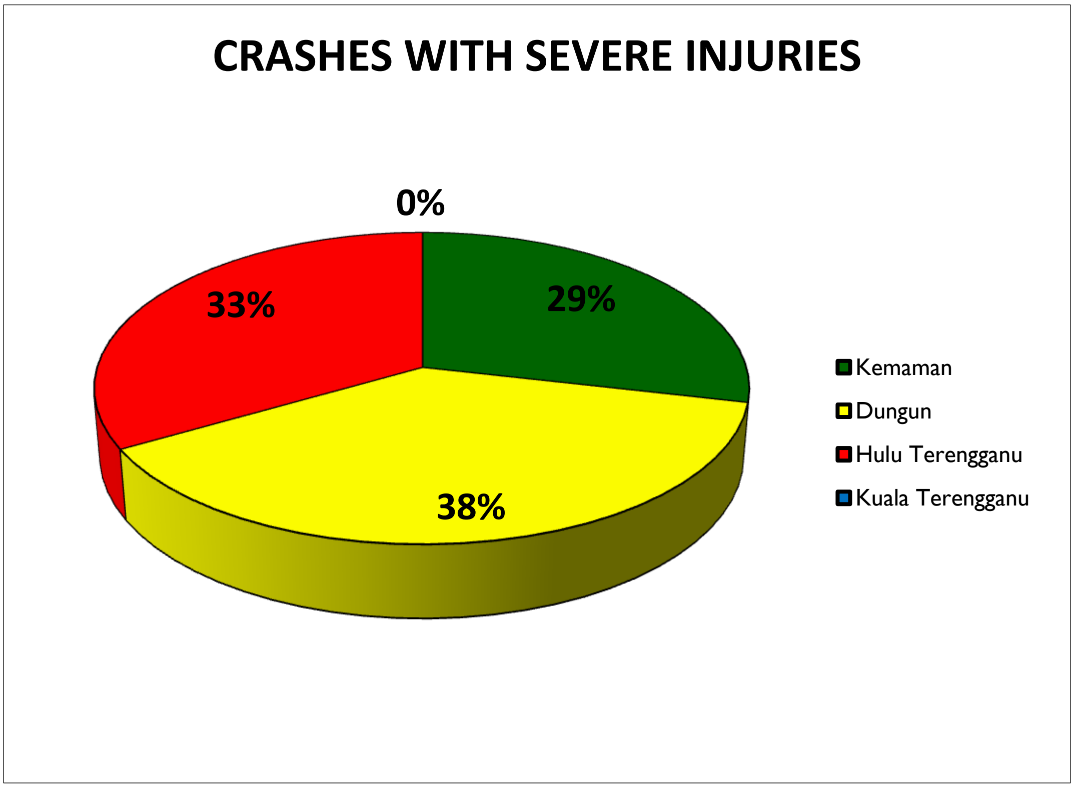


Figure 4.9 : Percentage of crashes with severe injuries type in all district of East Coast Expressway Phase 2 from 2013 to 2015

Figure 4.9 above shows percentage of crashes with severe injuries type in all district of East Coast Expressway for year 2013 to 2015. For crashes with severe injuries, Dungun district recorded the highest number of crashes with 38% which slightly difference with Hulu Terengganu district which percentage recorded was 33% and following by Kemaman district with 29%.

4.3.3 Crashes with Slight Injuries Type

Road traffic crashes classified into crashes with slightly injuries category if the crashes in which one or more persons are slight injured.

Table 4.7 : Crashes with slightly injuries type in all district of East Coast Expressway Phase 2

District	2013	2014	2015
Kemaman	0	0	2
Dungun	1	4	7
Hulu Terengganu	5	2	0
Kuala Terengganu	0	0	1

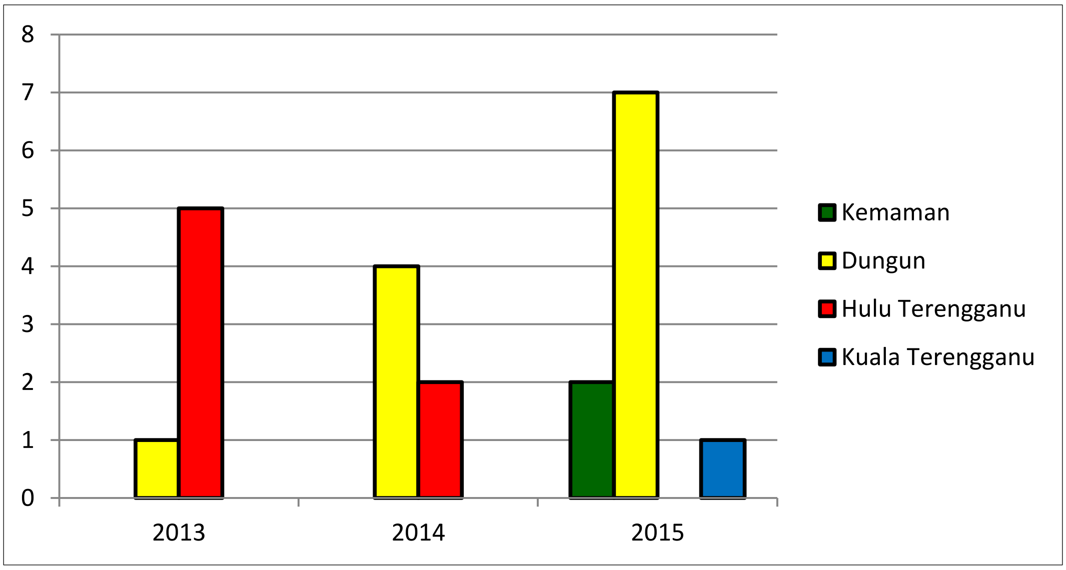


Figure 4.10 : Crashes with slightly injuries type in all district of East Coast Expressway Phase 2

Figure 4.10 shows crashes with slightly injuries type in all district of East Coast Expressway Phase 2.. For Dungun district, this crashes type recorded high number for all three years which kept increase where 1 case recorded in 2013, followed by 4 cases in 2014 and highest number recorded in 2015 with 7 cases. However, for Hulu Terengganu district recorded 5 cases in 2013 and decreased to 2 cases in 2014. For Kemaman and Kuala Terengganu districs both recorded in 2015 only. Differ with another two crash type previous, Kuala Terengganu recorded 1 case in 2015 and no cases with two year before.

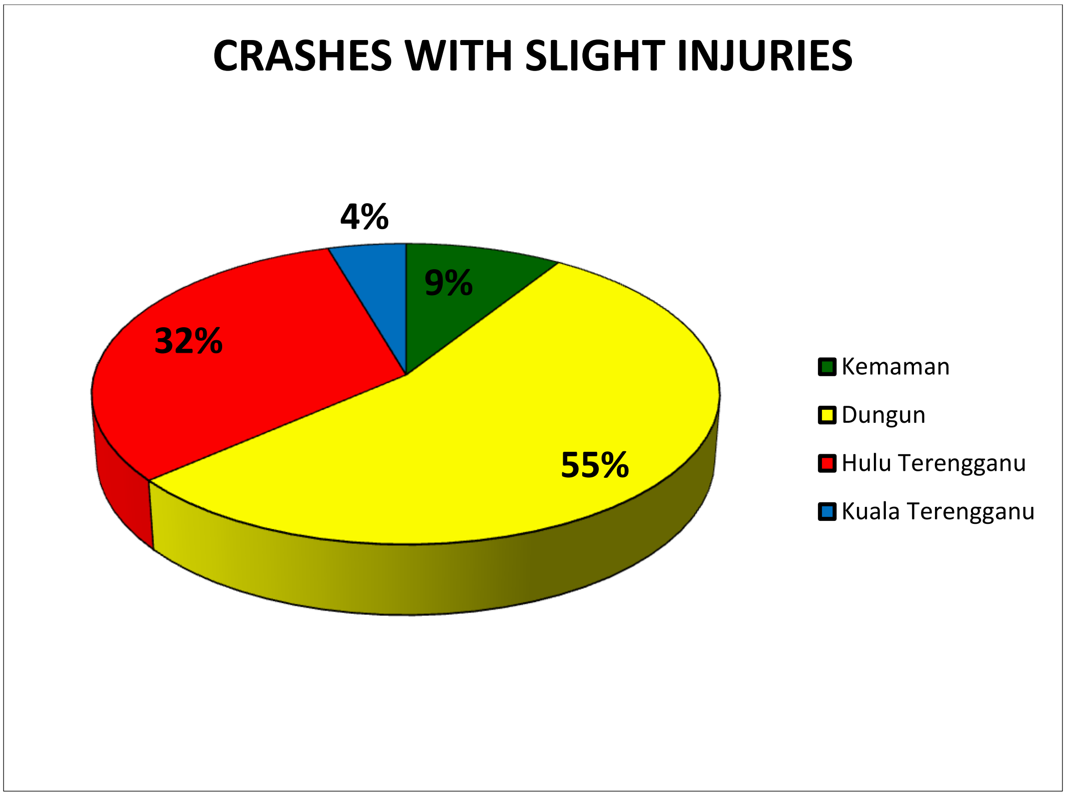


Figure 4.11 : Percentage of crashes with slightly injuries type in all district of East Coast Expressway Phase 2 from 2013 to 2015

Figure 4.11 above shows percentage of crashes with slightly injuries type in all district of East Coast Expressway Phase 2 from 2013 to 2015. Dungun district recorded the highest number of crashes with slightly injuries with 55%, followed by Hulu Terengganu district with 32%, and then Kemaman district with 9% and finally Kuala Terengganu district with 4%.

4.4 TEMPORAL-SPATIAL PATTERN ANALYSIS FOR ROAD TRAFFIC CRASHES AT EAST COAST EXPRESSWAY PHASE 2 FROM 2013 TO 2015

Below was the result of analysis for temporal-spatial pattern of road traffic crashes along East Coast Expressway Phase 2 from 2013 to 2015. The result contained crashes statistics from 2013 to 2015 within four districts which are

Kemaman, Dungun, Hulu Terengganu and Kuala Terengganu where location represent spatial category and temporal category represented by time, month and year.

4.4.1 Analysis of Crashes Occurrences Based on Location for Kemaman District

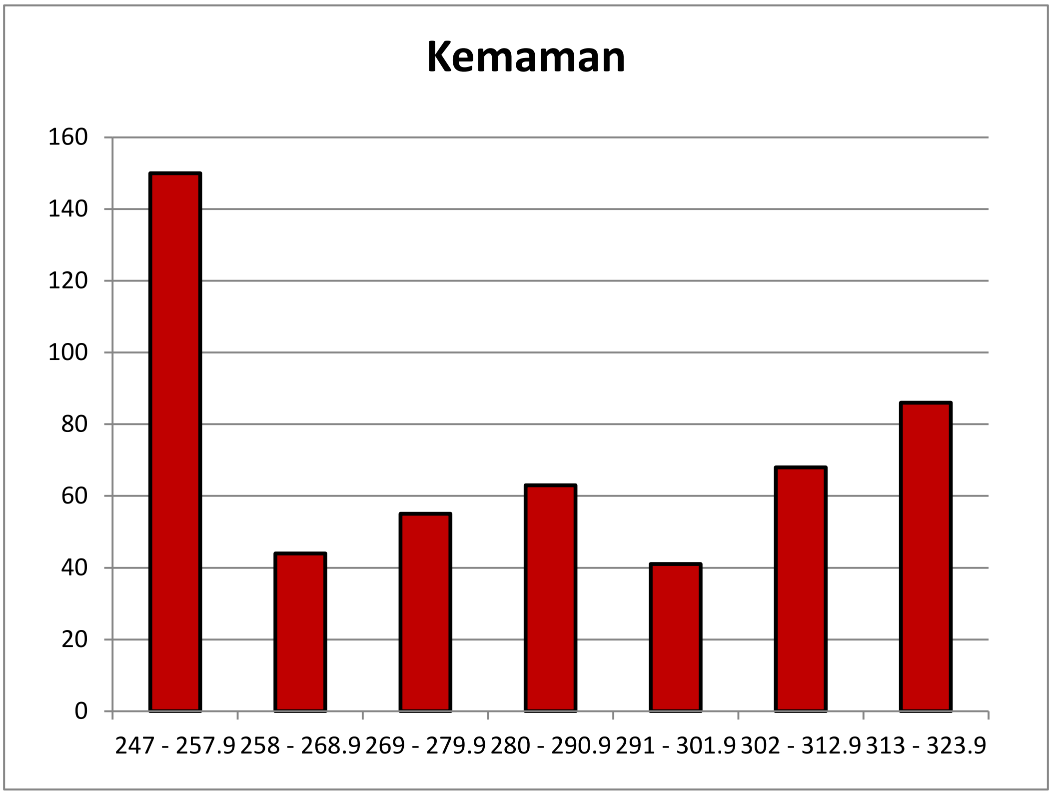


Figure 4.12 : Road traffic crashes based on location for Kemaman district

Figure 4.12 above shows road traffic crashes based on location for Kemaman district. Based on figure above, it shows that the highest number of road crashes recorded was in KM247.0 to KM257.9 with 150 crashes which equal to 30% compared to others section in Kemaman district. The lowest number of crashes recorded with 44 crashes happen in section KM291.0 to KM301.9. The average of number of road crashes happened in Kemaman district was about 72 crashes per each section.

4.4.2 Analysis of Crashes Occurrences Based on Location for Dungun District

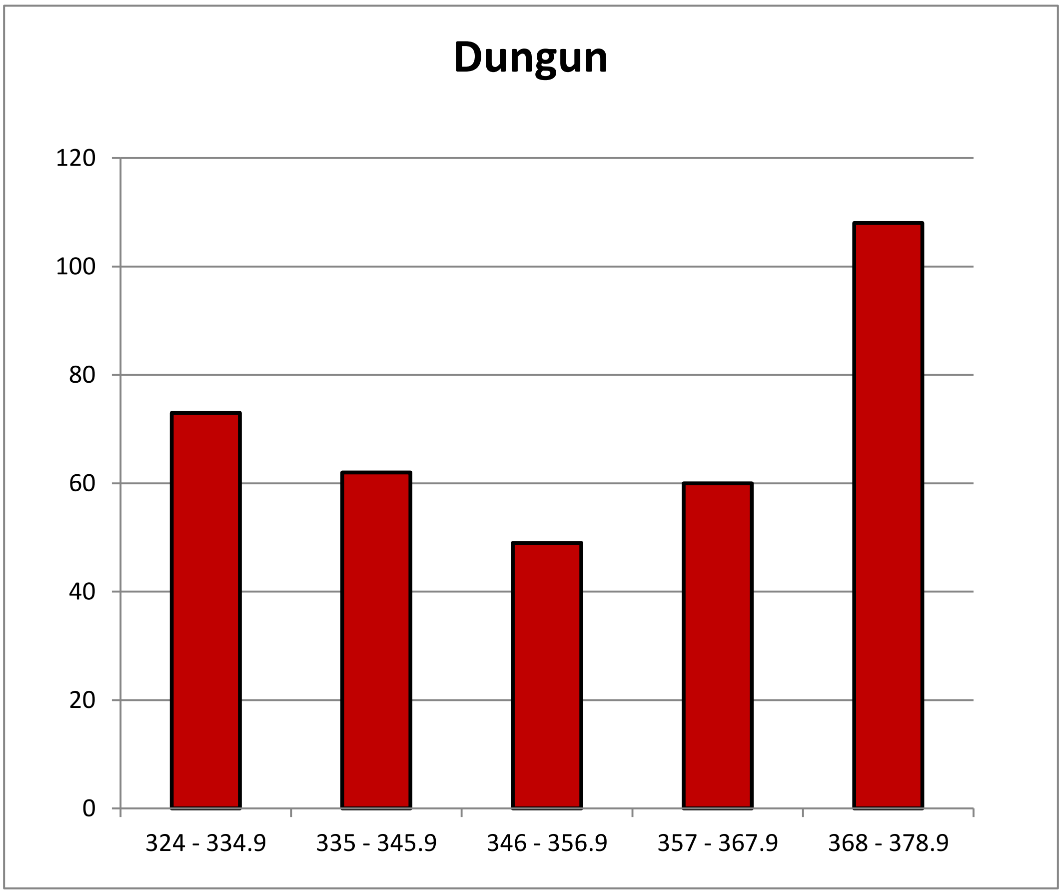


Figure 4.13 : Road traffic crashes based on location for Dungun district

Figure 4.13 above shows road traffic crashes based on location for Dungun district. Based on five sections divided, KM368.0 to KM378.9 recorded the highest number of road traffic crashes in Dungun district with 199 crashes which almost reach 200 cases in this section. However, for four others sections number of road traffic crsahes recorded was slightly different between each others with lowest number recorded was 49 crashes happen in section KM346.0 to KM356.9. The average of number of road crashes happened in Dungun district was about 70 crashes per each section.

4.4.3 Analysis of Crashes Occurrences Based on Location for Hulu Terengganu District

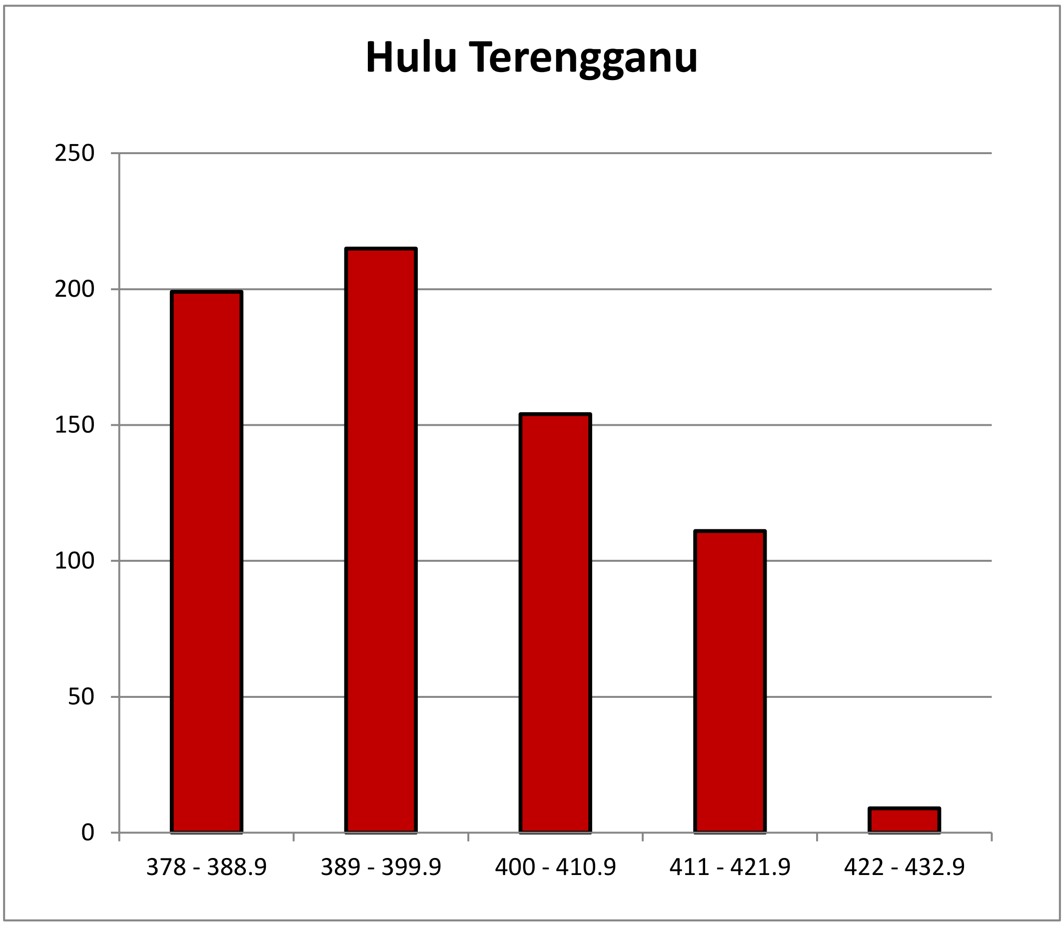


Figure 4.14 : Road traffic crashes based on location for Hulu Terengganu district

Figure 4.14 above shows road traffic crashes based on location for Hulu Terengganu district. Hulu Terengganu district with 44.6 kilometres were divided into 5 sections, with almost all section recorded high number of crashes. The highest number of crashes was happen in section KM389.0 to KM399.9 with 215 crashes. However, different with section KM422.0 to KM432.9 recorded lowest number with only 9 crashes. The average of number of road crashes happened in Hulu Terengganu district was about 137 crashes per each section.

4.4.4 Analysis of Crashes Occurrences Based on Location for Kuala Terengganu District

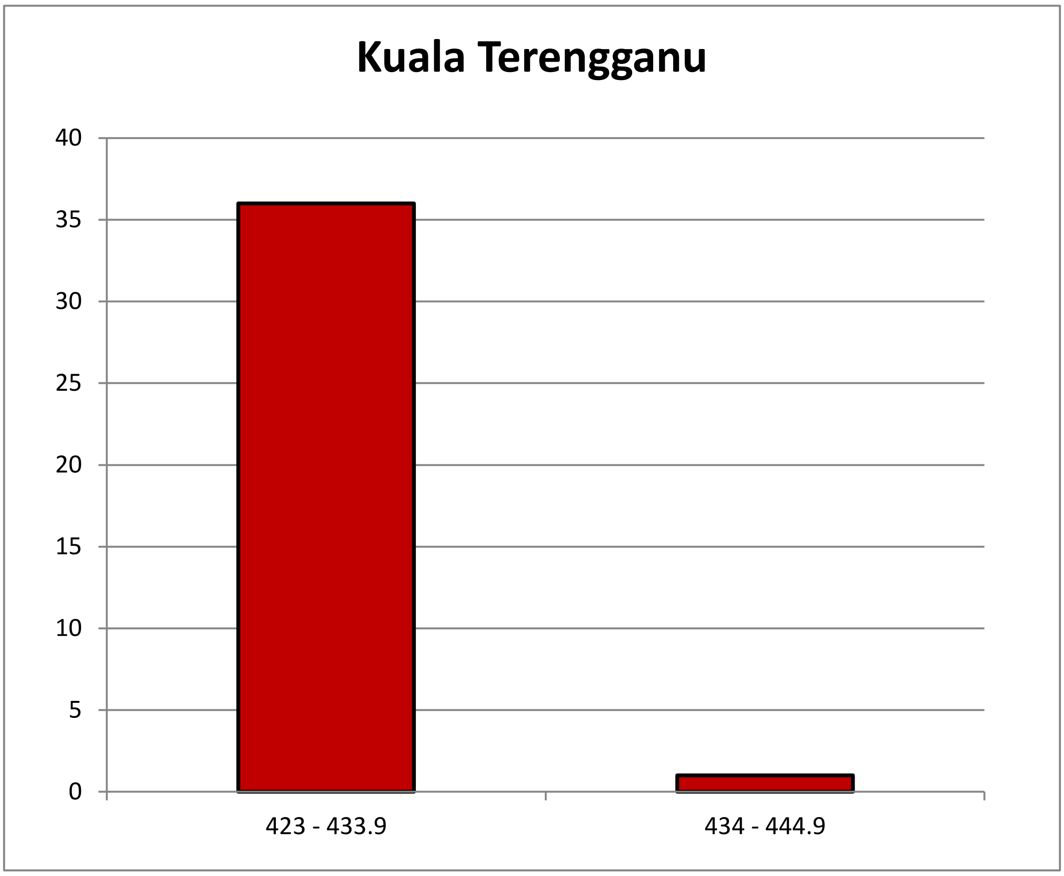


Figure 4.15 : Road traffic crashes based on location for Kuala Terengganu district

Figure 4.15 above shows road traffic crashes based on location for Kuala Terengganu district. Since Kuala Terengganu district cover short length only, the section of location divided into 2 sections only. A big difference can be seen in this both sections where in section KM423.0 to KM433.9, high number of crashes happened with 36 crashes recorded. However, only small number of crashes recorded in section KM434.0 to KM444.9 with 1 case only.

4.4.5 Analysis of Crashes Occurrences Based on Time for Kemaman District

Table 4.8 : Road traffic crashes based on time for Kemaman district

TIME	NUMBERS
00:00 - 06:00	106
06:00 - 12:00	102
12:00 - 18:00	152
18:00 - 24:00	149

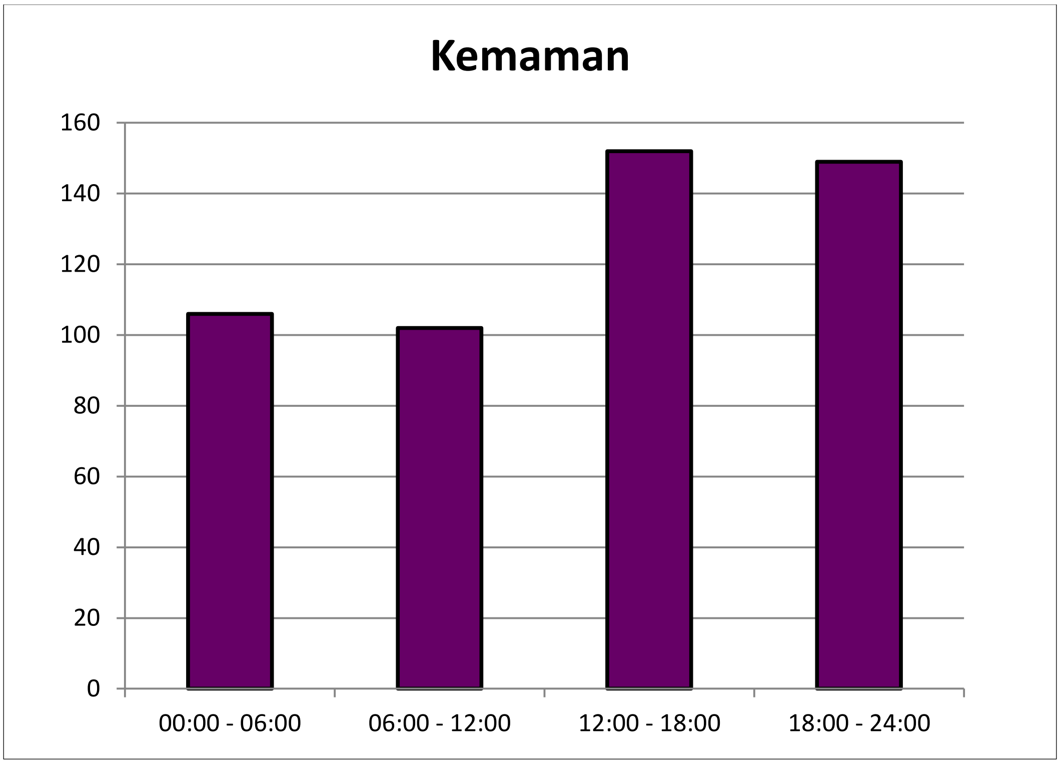


Figure 4.16 : Road traffic crashes based on time for Kemaman district

Figure 4.16 shows road traffic crashes based on time for Kemaman district. From figure above, the time of crashes frequently happened in this area was in between 12:00 to 18:00 where it was in peak hour. There were 152 crashes happened in that time where traffic volume was high. The lowest number of crashes was recorded in the morning which is between 6:00 to 12:00 with 102 crashes.

4.4.6 Analysis of Crashes Occurrences Based on Time for Dungun District

Table 4.9 : Road traffic crashes based on time for Dungun district

TIME	NUMBERS
00:00 - 06:00	51
06:00 - 12:00	80
12:00 - 18:00	112
18:00 - 24:00	108

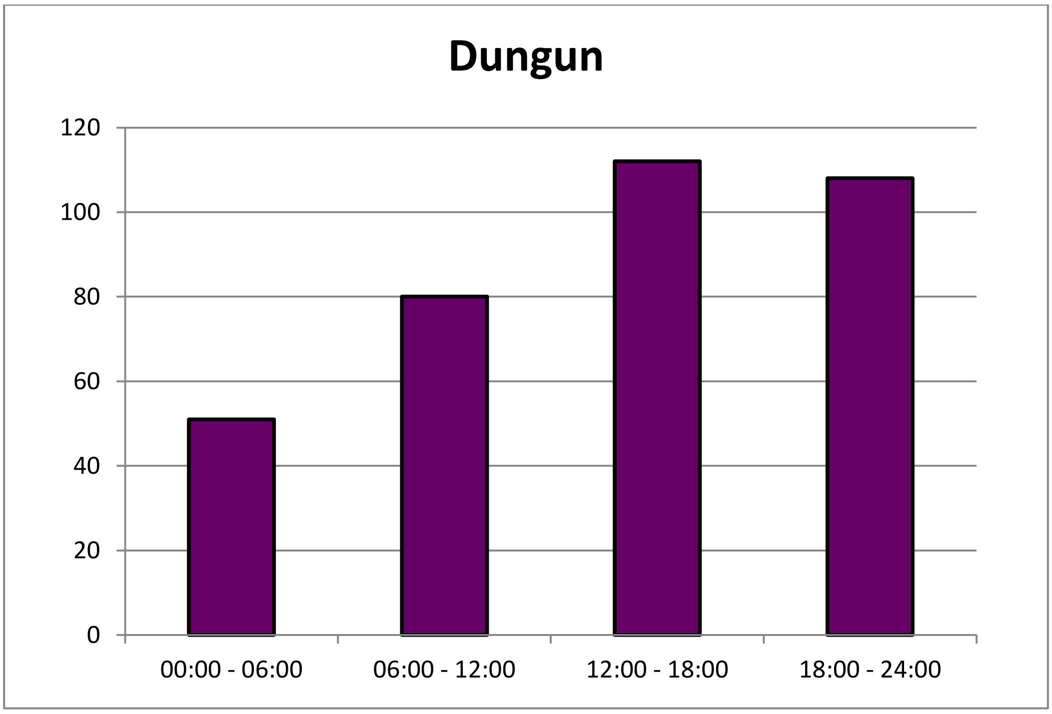


Figure 4.17 : Road traffic crashes based on time for Dungun district

Figure 4.17 above shows road traffic crashes based on time for Dungun district. Same pattern recorded with Kemaman district where the highest numbers of crashes happened in between 12:00 to 18:00 with 112 crashes where on that time traffic volume was high. The lowest number of crashes recorded in between 00:00 to 06:00 with 51 crashes which is in midnight where small volume of traffic on the highway during this tim

4.4.7 Analysis of Crashes Occurrences Based on Time for Hulu Terengganu District

Table 4.10 : Road traffic crashes based on time for Hulu Terengganu district

TIME	NUMBERS
00:00 - 06:00	124
06:00 - 12:00	127
12:00 - 18:00	291
18:00 - 24:00	146

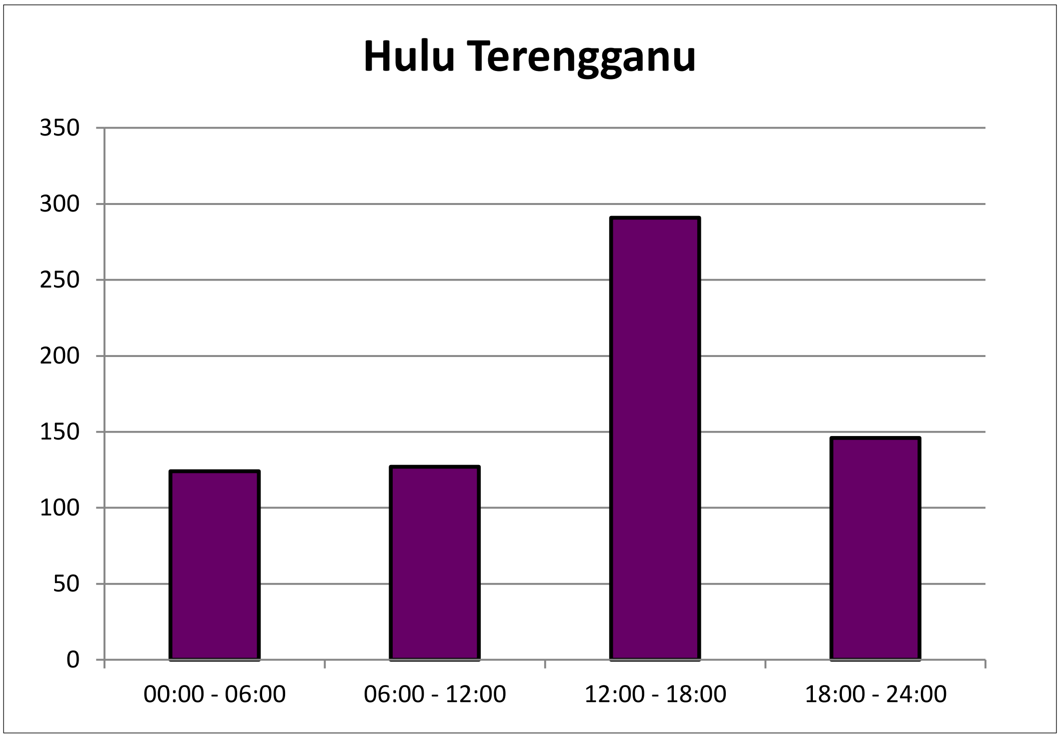


Figure 4.18 : Road traffic crashes based on time for Hulu Terengganu district

Figure 4.18 above shows road traffic crashes based on time for Hulu Terengganu district. Road crashes in this district also recorded highest number in between 12:00 to 18:00 with 291 crashes. The lowest number of road crashes happened in between 00:00 to 06:00 with 124 crashes which not much difference with time in between 06:00 to 12:00 which happened 127 crashes in this time.

4.4.8 Analysis of Crashes Occurrences Based on Time for Kuala Terengganu District

Table 4.11 : Road traffic crashes based on time for Kuala Terengganu district

TIME	NUMBERS
00:00 - 06:00	6
06:00 - 12:00	12
12:00 - 18:00	14
18:00 - 24:00	6

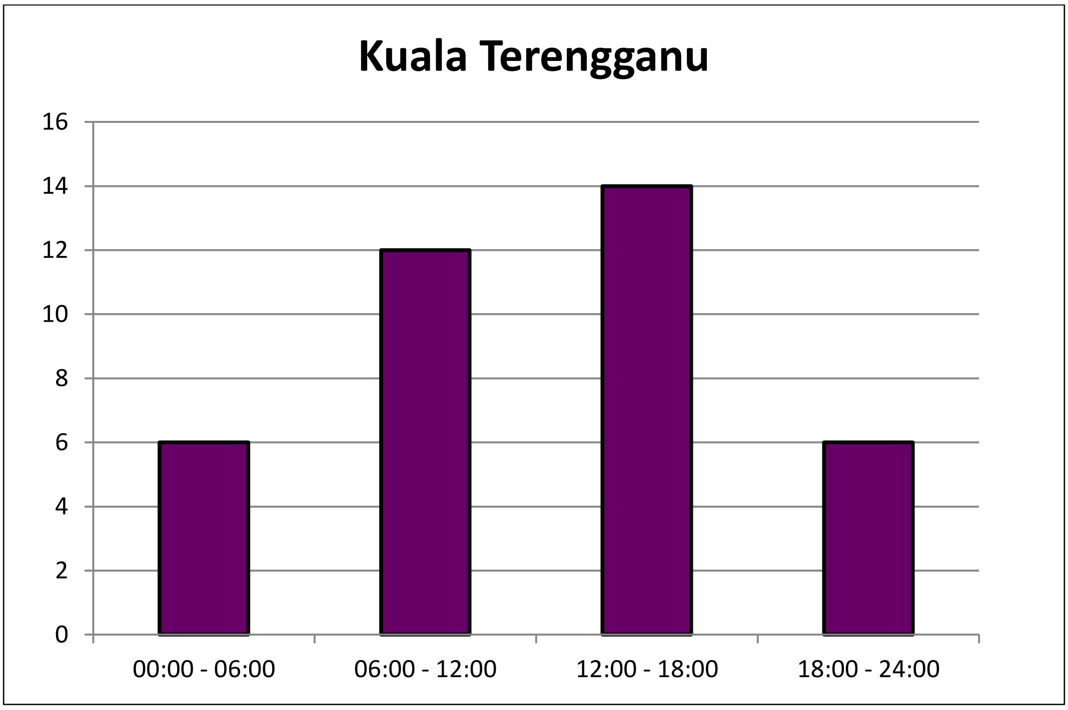


Figure 4.19 : Road traffic crashes based on time for Kuala Terengganu district

Figure 4.19 above shows road traffic crashes based on time for Kuala Terengganu district. Same pattern goes to this district where it shows that road crashes recorded high numbers in between 12:00 to 18:00 with 14 crashes. However, the lowest number shared same number of crashes in two section of time which is between 00:00 to 06:00 and 18:00 to 24:00 with 6 crashes.

4.4.9 Comparison Road Traffic Crashes Based on Time Between Districts

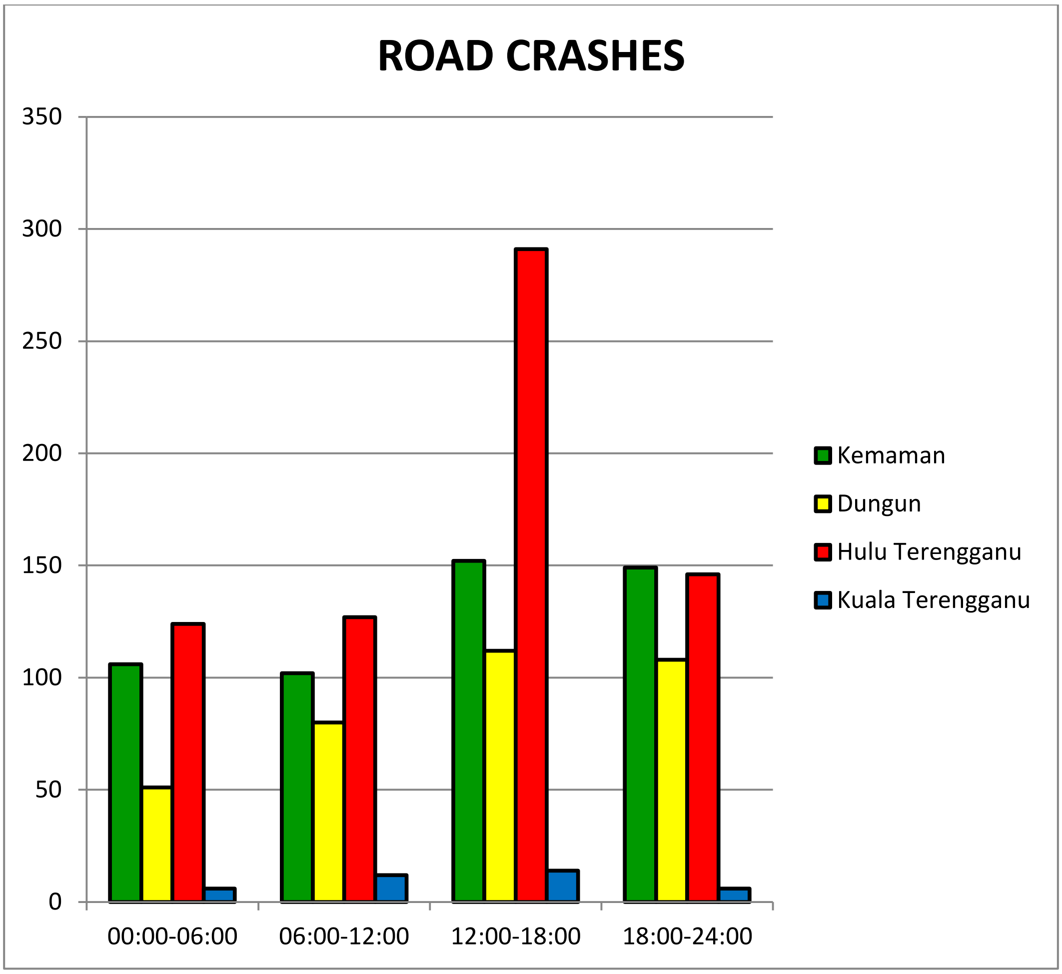


Figure 4.20 : Overall Road Traffic Crashes of East Coast Expressway Phase 2 based on time by district

Figure 4.20 above shows overall road traffic crashes of East Coast Expressway Phase 2 based on time by district. Based on 4 sections of time divided, road crashes overall recorded highest number in between 12:00 to 18:00 where Hulu Terengganu district recorded the highest number of crashes compared to others district at this time where the traffic volume was high which is peak hour. Following by time in between 18:00 to 24:00 which recorded second highest rate of road crashes. For time between 00:00 to 06:00 and 06:00 to 12:00, road crashes happened more or less difference.

4.4.10 Analysis of Crashes Occurrences Based on Month for Kemaman District

Table 4.12 : Road traffic crashes based on month for Kemaman district

Month	Numbers
January	47
February	67
March	107
April	68
May	87
June	66
July	47
August	69
September	64
October	61
November	79
December	96

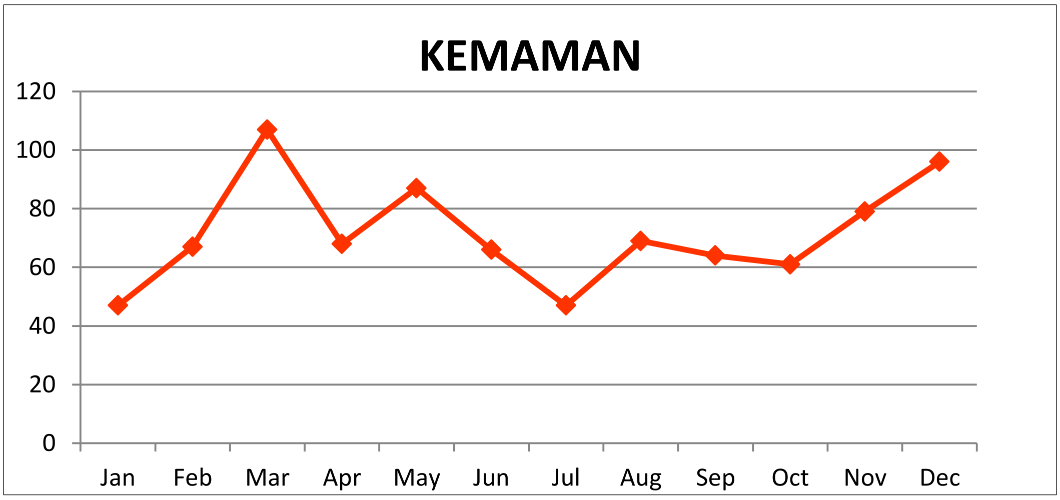


Figure 4.21 : Road traffic crashes based on month for Kemaman district from 2013 to 2015

Figure 4.21 above shows road traffic crashes based on month for Kemaman district from 2013 to 2015. The highest number of road crashes recorded for this district was frequently happened in March with 107 crashes. Number of road traffic crashes recorded in December also high where it recorded

96 crashes. This records probably affected by the holiday or festive season during this time where road users most of the time using highway to go back to hometown or travel. However, the lowest number of crashes recorded in two month which is in January and July where both month recorded 47 crashes.

4.4.11 Analysis of Crashes Occurrences Based on Month for Dungun District

Table 4.13 : Road traffic crashes based on month for Dungun district

Month	Numbers
January	15
February	25
March	18
April	13
May	29
June	12
July	3
August	7
September	9
October	3
November	8
December	8

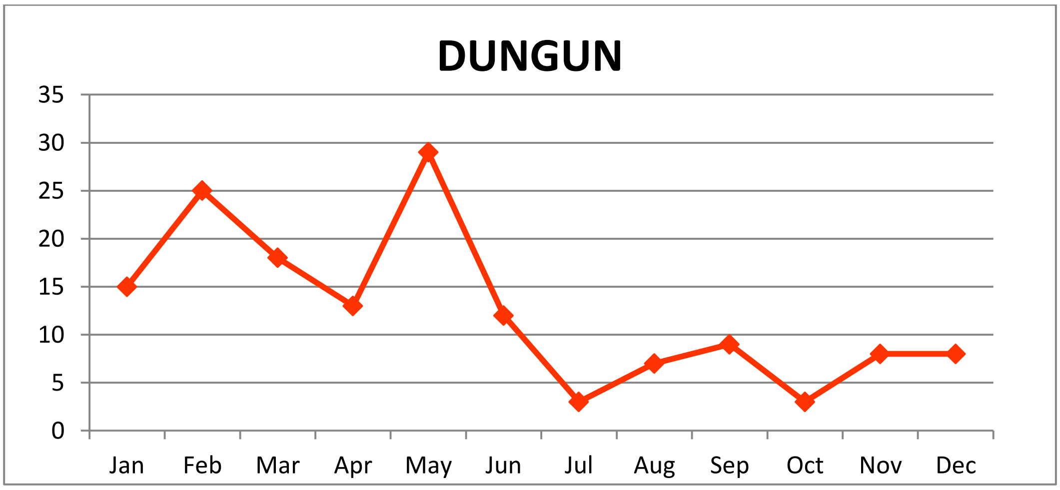


Figure 4.22 : Road traffic crashes based on month for Dungun district from 2013 to 2015

Figure 4.22 above shows road traffic crashes based on month for Dungun district from 2013 to 2015. The highest number of road crashes recorded in May with 29 crashes. Starting from July, the number of crashes recorded were slightly up and down each months until December, which final record for this district for this three years were maintained with 8 crashes in November and December. The lowest number of crashes recorded were happen in July and October where both month shared same number of crashes with 3 crashes.

4.4.12 Analysis of Crashes Occurrences Based on Month for Hulu Terengganu District

Table 4.14 : Road traffic crashes based on month for Hulu Terengganu district

Month	Numbers
January	68
February	53
March	31
April	47
May	48
June	57
July	50
August	70
September	53
October	57
November	66
December	88

Table 4.14 above represent the result obtained in Figure 4.23 below which shows road traffic crashes based on month for Hulu Terengganu district from 2013 to 2015. In January, number of road crashes can be categorized as high number since it is early in the year. However in February, it kept decrease until March which is the lowest number of crashes recorded in this month with 31 crashes. The number of crashes start to increase in April until June and start to up and down until reached the highest number of crashes in December with 88 crashes.

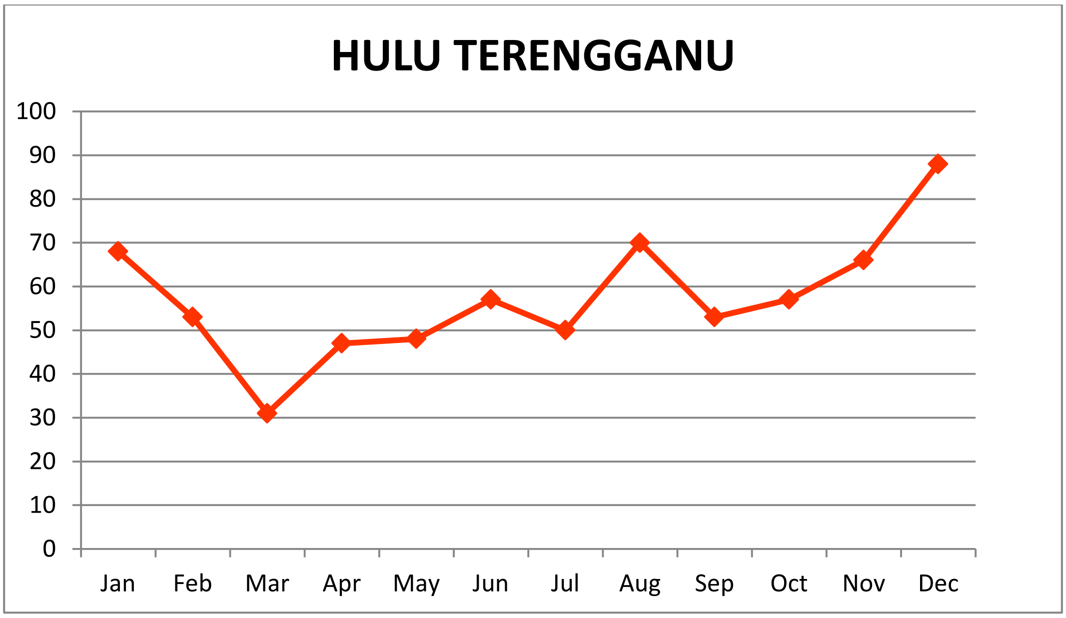


Figure 4.23 : Road traffic crashes based on month for Hulu Terengganu district from 2013 to 2015

4.4.13 Analysis of Crashes Occurrences Based on Month for Kuala Terengganu District

Table 4.15 : Road traffic crashes based on month for Kuala Terengganu district

Month	Numbers
January	3
February	1
March	0
April	0
May	2
June	6
July	5
August	0
September	4
October	3
November	6
December	7

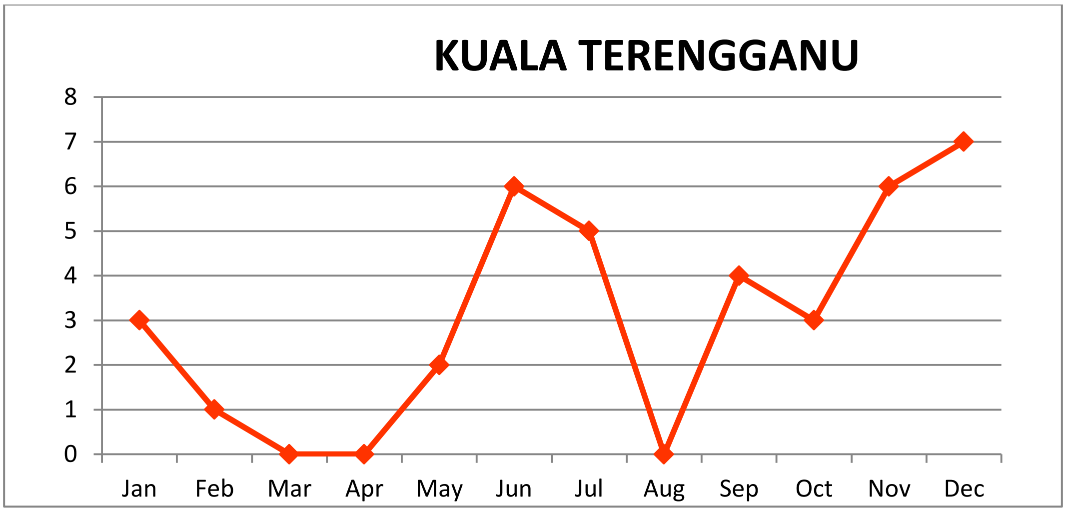


Figure 4.24 : Road traffic crashes based on month for Kuala Terengganu district from 2013 to 2015

Figure 4.24 above shows road traffic crashes based on month for Kuala Terengganu district from 2013 to 2015. Fortunately, Kuala Terengganu district only recorded small number of crashes since the length of this district in East Coast Expressway was the shortest which mean less chances for crashes to happen in this area. The highest number of crashes recorded was in December with 7 crashes and the lowest number recorded was 1 crash only in February. However, in March, April and August there no any crashes recorded for these three months.

4.4.14 Comparison Road Traffic Crashes Based on Month Between Years

Figure 4.25 below shows overall road traffic crashes of East Coast Expressway Phase 2 based on month by year. On 2013 and 2014, the highest number of crashes happened was in December. Differ with crashes happened 2015, where the highest number recorded was in May. The lowest number of crashes happened on 2013 and 2015 was in July. However, on 2014 the lowest number of crashes recorded was in March. Comparing to all month for these three years, 2014 recorded the highest number where happened in December with 113 crashes.

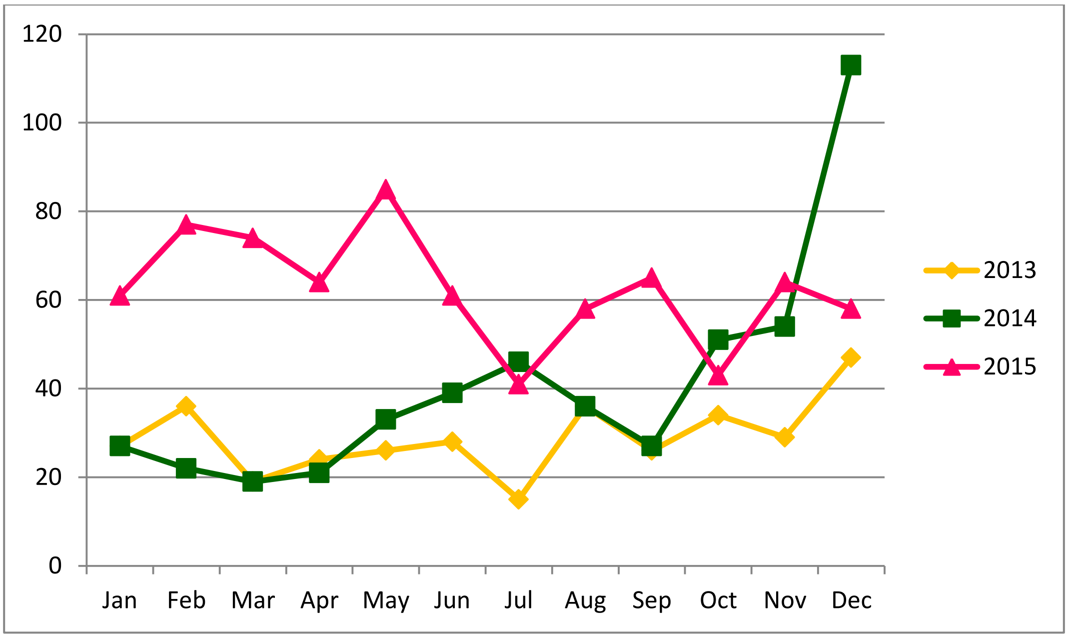


Figure 4.25 : Overall Road Traffic Crashes of East Coast Expressway Phase 2 based on month by year

4.4.15 Analysis Based on Year of Crashes Occurrences

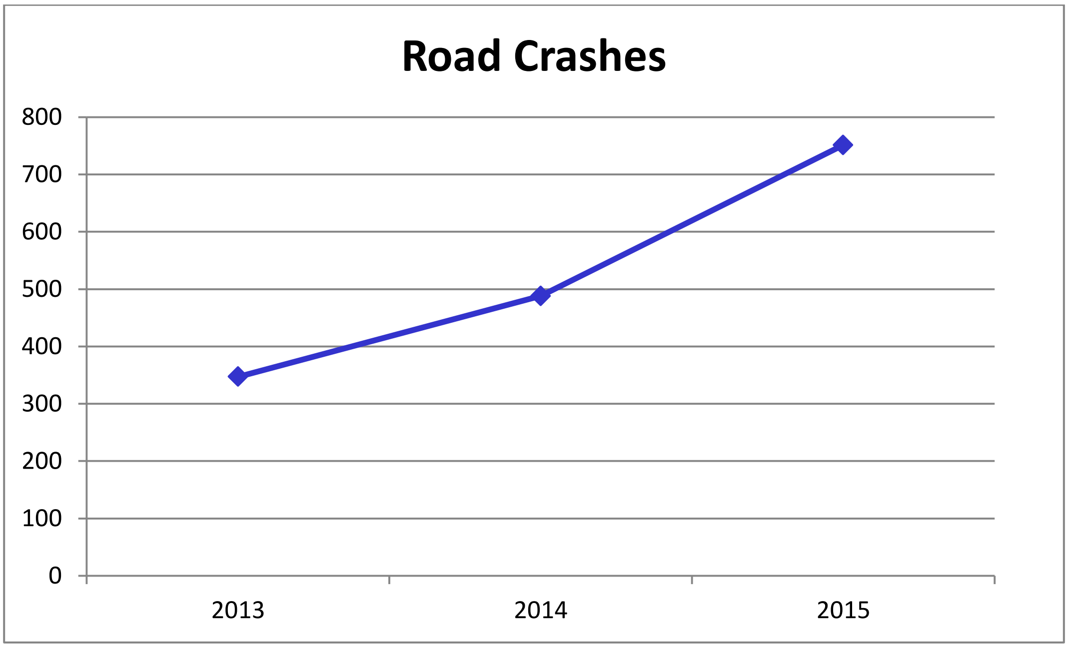


Figure 4.26 : Road traffic crashes based on year

Figure 4.26 above shows road traffic crashes based on year. Based on the graph above, the number of crashes recorded kept increase each year from 2013 to 2015 with number recorded 347 crashes on 2013, 488 crashes on 2014 until reached 751 crashes on 2015. This rise can be related with the increased number of vehicles using this highway which contributed to heavy volume of traffic in East Coast Expressway Phase 2 where at the same time increase the chances for crashes to happen. This pattern shows that an increased number of road traffic crashes within East Coast Expressway Phase 2 could be expected on 2016.

4.5 CORRELATION BETWEEN CRASH TEMPORAL-SPATIAL PATTERN AND CRASH INJURY TYPES FOR ROAD TRAFFIC CRASHES AT EAST COAST EXPRESSWAY PHASE 2 FROM 2013 TO 2015

Below was the result of correlation between crash temporal-spatial pattern and crash injury types for road traffic crashes at East Coast Expressway Phase 2 from 2013 to 2015. The result contained crashes statistics from 2013 to 2015 within four districts which are Kemaman, Dungun, Hulu Terengganu and Kuala Terengganu. In this case, spatial was represent for location and district, while temporal represent time, days, type of days, month and year.

4.5.1 Correlation Between Location and Crash Injury Type

Table 4.16 below shows correlation between location and crash injury types for road traffic crashes from 2013 to 2015. The R-value obtained was -0.15 which categorized in negative weak correlation, where when the location was increase, crash injury type was decrease. That means, there no enough evidence to correlate these both variables. It is supported by P-value with 0.547 which are greater than 0.05, meaning that there is no statistically significant for these both variables.

Table 4.16 : Correlation between location and crash injury type

		Location	Crash Injury Type
Location	Pearson Correlation	1	-.015
	Sig. (2-tailed)		.547
	N	1586	1586
Crash Injury Type	Pearson Correlation	-.015	1
	Sig. (2-tailed)	.547	
	N	1586	1586

4.5.2 Correlation Between District and Crash Injury Type

Table 4.17 below shows correlations between district and crash injury type for road traffic crashes from 2013 to 2015. Same goes to this both variables as previous where the R-value obtained was -0.09 which categorized in negative weak correlation, where when the district was increase, crash injury type showed decrease in value. That means, there no enough evidence to correlate these both variables. Here also supported by P-value with value obtained was 0.708 which are greater than 0.05, meaning that there is no statistically significant for these both variables.

Table 4.17 : Correlation between district and crash injury types

		District	**Crash Injury Type**
District	Pearson Correlation	1	-.009
	Sig. (2-tailed)		.708
	N	1586	1586
Crash Injury Type	Pearson Correlation	-.009	1
	Sig. (2-tailed)	.708	
	N	1586	1586

4.5.3 Correlation Between Time and Crash Injury Type

Table 4.18 below shows correlations between time and crash injury type for road traffic crashes from 2013 to 2015. Based on total crashes with 1586 crashes correlate between time and crash injury type, the R-value obtained was 0.029 where different with previous result where it showed positive weak correlations. That means, when the time value increased, crash injury type value also increased. In this case, it also supported by P-value with 0.252 which is greater than 0.05. Same as previous, large P-value means that there is no statistically significant for this both variables.

Table 4.18 : Correlation between time and crash injury type

		Time	Crash Injury Type
Time	Pearson Correlation	1	.029
	Sig. (2-tailed)		.252
	N	1586	1586
Crash Injury Type	Pearson Correlation	.029	1
	Sig. (2-tailed)	.252	
	N	1586	1586

4.5.4 Correlation Between Day and Crash Injury Type

Table 4.19 below shows correlations between days and crash injury type for road traffic crashes from 2013 to 2015. The correlations between this two variables which is between days and crash injury type, the R-value obtained was 0.011 where it showed same case with previous result which is positive weak correlations. That means, when the time value increased, crash injury type value also increased. In this case, it also supported by P-value with 0.675 which is greater than 0.05.

Table 4.19 : Correlation between days and crash injury type

		Days	Crash InjuryType
Days	Pearson Correlation	1	.011
	Sig. (2-tailed)		.675
	N	1586	1586
Crash Injury Type	Pearson Correlation	.011	1
	Sig. (2-tailed)	.675	
	N	1586	1586

4.5.5 Correlation Between Type of Days and Crash Injury Type

Table 4.20 below shows correlations between type of crash injury type for road traffic crashes from 2013 to 2015, where type of days represent for weekdays or weekend. In this case, correlationship between this two variables give the results for R-value with 0.009 and P-value was 0.709. Both values showed that there is no correlation between this variables and there is no statistically significant for type of days and crash injury type.

Table 4.20 : Correlation between type of days and crash injury type

		Type of Days	Crash Injury Type
Type of Days	Pearson Correlation	1	.009
	Sig. (2-tailed)		.709
	N	1586	1586
Crash Injury Type	Pearson Correlation	.009	1
	Sig. (2-tailed)	.709	
	N	1586	1586

4.5.6 Correlation Between Month and Crash Injury Type

Table 4.21 below shows the results for correlations between month and crash injury type for road traffic crashes from 2013 to 2015. Same pattern of results obtained where it shows positive weak correlations. The R-value and P-value both resulting 0.032 and 0.208 respectively. Both values also showed that there is no correlation between this variables and there is no statistically significant for type of days and crash injury type which means there is no enough evidence to correlate this two variables.

Table 4.21 : Correlation between month and crash injury type

		Month	**Crash Injury Type**
Month	Pearson Correlation	1	.032
	Sig. (2-tailed)		.208
	N	1586	1586
Crash Injury Type	Pearson Correlation	.032	1
	Sig. (2-tailed)	.208	
	N	1586	1586

4.5.7 Correlation Between Year and Crash Injury Type

Table 4.22 below shows correlations between year and crash injury type for road traffic crashes from 2013 to 2015. Table above shows that R-value obtained negative weak correlations with the values was -0.11. In this case also supported by P-value where the data obtained was 0.611 greater than 0.05 which means there is no statistically significant for year and crash injury type respectively.

Table 4.22 : Correlations between year and crash type

		Year	Crash Injury Type
Year	Pearson Correlation	1	-.011
	Sig. (2-tailed)		.661
	N	1586	1586
Crash Injury Type	Pearson Correlation	-.011	1
	Sig. (2-tailed)	.661	
	N	1586	1586

4.6 SUMMARY

This research conducted by doing the analysis from the data received for road traffic crashes at East Coast Expressway Phase 2 from 2013 to 2015. It is clearly seen that number of road traffic crashes kept increased each year from 2013 to 2015 with total of number crashes recorded are 5186 crashes. Each district recorded different kind of pattern for number of road traffic crashes recorded. Based on analysis for number of road traffic crashes according to crash injury type, Hulu Terengganu district recorded big number of road traffic crashes for each type of crash. It is then following by Dungun district that recorded large number for each crash injury type. For road traffic crashes based on location analysis, it showed that road traffic crashes frequently happened which is the highest number of road traffic crashes recorded was in first or last section for each districts which is in section between KM247 to KM257.9 in Kemaman district, KM368 to KM378.9 in Dungun district, KM389 to KM399.9 in Hulu Terengganu district and finally in Kuala Terengganu district in between KM423 to KM433.9. Road traffic crashes analysis by the time occurrences showed that road traffic crashes frequently happened in daytime which is in between 12:00 to 18:00. Each district recorded highest number of crashes happened in between this 6 hours during daytime. Meanwhile, analysis for road traffic crashes based on month showed that highest number of road traffic crashes happened on December in 2013 and 2014 and also on May in 2015. On the other hand, correlations between the variables which is crash temporal-spatial pattern and crash type showed the same correlations for overall which is weak correlations are obtained.

CHAPTER 5

DISCUSSION

5.1 INTRODUCTION

This chapter will discuss the correlationship between crash temporal-spatial pattern and crash type at East Coast Expressway Phase 2. In this chapter, the result of the previous analysis will be discussed and summarized . All the relevant information obtained from the analysis that connects to the objectives of the study will be stated in this chapter.

5.2 ROAD TRAFFIC CRASHES ALONG EAST COAST EXPRESSWAY PHASE 2 FROM 2013 TO 2015

From the analysis, it revealed that number of road traffic crashes increased each year from 2013 to 2015 with 347 crashes in 2013 and followed by 488 until reached to 751 crashes in 2014 and 2015 respectively which total up with 1586 crashes for these three years. The number of road traffic crashes recorded kept increase as the number of road users also kept increase which affected by the opening of sections in East Coast Expressway Phase 2 since this highway opened by stages and only officially opened to traffic on January 2015.

The pattern for number of road traffic crashes recorded showed that each district did not have specific crashes pattern where not all districts kept increase by year. It is proved when Hulu Terengganu district decrease in number of road traffic crashes from 2013 to 2014 which is from 270 and turned to 191 crashes. This matter is because the road users and governments had took precautions and attentions when they want to use this area of highway since its already recorded a large number of road traffic crashes on 2013 which is when the East Coast Expressway not yet officially opened for traffic. The number of road traffic crashes in this district probably can be keep reduce to small of number if the road users will keep beware for their health and safety.

Differ with number of road traffic crashes recorded in Kuala Terengganu and Dungun district where in Kuala Terengganu district, number of road traffic crashes recorded kept slightly increase each year from 2013 to 2015. However, for Dungun district number of road traffic crashes increased in 2014 with 164 crashes before decreased in 2015 with 150 crashes recorded.

On the other hand, number of road traffic crashes in Kemaman district kept increase each year from 2013 to 2015. With number of road traffic crashes recorded as lower as 34 crashes in 2013 until reached the highest number of road traffic crashes compared to number of road traffic crashes recorded in others district in all three years with 392 crashes which showed extremely increase compared to previous year in 2014 with number of crashes recorded was 83 crashes. Compared to others district, Kemaman district cover longest length in East Coast Expressway Phase 2 which cause to big number of vehicles that enter and exit in this highway. Based on road traffic crashes pattern showed in this district, since number of crashes on 2013 and 2014 were small in number, it seems like road users did not beware and ignored safety factor where they preferred to drive in high speed or over the limit.

5.3 CRASH TYPE ALONG EAST COAST EXPRESSWAY PHASE 2 FROM 2013 TO 2015

Fatal crashes type in all district of East Coast Expressway Phase 2 that showed in Figure 4.5 gives the result that Hulu Terengganu has recorded highest number of fatal crashes, where the number of fatal crashes recorded in every year in this district. The percentage of fatal crashes from 2013 to 2015 obtained in Figure 4.7 proved that fatal crashes frequently happened in Hulu Terengganu with 58% which more than half of fatal crashes recorded compared to others district for this three years.

Referring on Figure 4.9, Dungun district recorded the highest number of crashes with severe injuries following with Hulu Terengganu and Kemaman district district with 38%, 33% and 29% respectively. A big number of crashes with severe injuries recorded in 2015 contributed to the highest number of crashes with severe injuries in Dungun district. However, for number of crashes with severe injuries recorded in Kemaman and Hulu Terengganu district were small in numbers even the crashes recorded every year from 2013 to 2015.

Same pattern can be seen for crashes with slightly injuries where Dungun district recorded highest number of crashes, which contributed from crashes recorded in every year from 2013 to 2015 with 55%, showing more than half of crashes with slightly injuries that recorded in this three years for this Dungun district. Then, following with Hulu Terengganu district with number of crashes with slightly injuries recorded were 32% where it only recorded in first two years which is in 2013 and 2014. In this crashes with slightly injuries cases only number of crashes recorded in Kemaman district with small of numbers which is 4% only.

Based on results obtained for this three type of crash recorded in four districts from 2013 to 2015, it can be conclude that Hulu Terengganu are categorized as the black spot in East Coast Expressway Phase 2 since it recorded a large number of crashes in all three types of crash. This can be proved from the perspective of Rokytova (2000), which stated that black spots are defined as locations that are generally classified after an assessment of the level of risk and the likelihood of a crash occurring at a location. Not only crash rates, but unsafe locations can be ranked according to their severity (Elvic, Runee et al. 2005). In addition, Lisa, David et al. (2005) stated that black spot areas are sites that have had more than fatal crash, sites with multiple crashes within a mile from one another.

5.4 TEMPORAL-SPATIAL PATTERN ANALYSIS FOR ROAD TRAFFIC CRASHES AT EAST COAST EXPRESSWAY PHASE 2 FROM 2013 TO 2015

The results from data analysis showed the frequency and occurrence of road traffic crashes in East Coast Expressway Phase 2. Road traffic crashes are randomly distributed in the East Coast Expressway Phase 2 in terms of time and space.

5.4.1 Crashes Occurrences Based on Location

Referring road traffic crashes in Kemaman district in Figure 4.12, the highest numbers of road traffic crashes spots as well as the largest frequency of road traffic crashes incidents were recorded in between KM247 to KM257.9. It showed that, road traffic crashes frequently happened in the first section of Kemaman district, which is the focus area in this district where at the same time, this section become crowded with road users where they start to enter in this district area.

Same pattern goes to others district where the highest number of road traffic crashes recorded in the first and last section for Dungun and Kuala Terengganu districts, where in Dungun district the highest number of crashes happened in last section of this district in between KM368 to KM378.9. For Kuala Terengganu district, the highest number of road traffic crashes recorded also in first section where it is in between KM423 to KM433.9. The higher density of roads, larger volume of vehicle and population movements and extensive business activities makes these sections to take lion share of the spatial distribution of road traffic crashes spots of the East Coast Expressway Phase 2 from 2013 to 2015.

These section that recorded the highest and largest number of road traffic crashes can be defined as black spots area in each districts. This is proved by Elvic, Runee et al. (2005) stated that crash black spot on a National Highway in Norway is defined as any place with a maximum length of 100 meters, where at least four injury crashes have been testified to the police in four year period

5.4.2 Crashes Occurrences Based on Time

Referring on Figure 4.20 which is showed the overall road traffic crashes of East Coast Expressway Phase 2, the time between 12 pm to 6 pm reveals the largest proportion (35.9%) of all road traffic crashes scenes in East Coast Expressway Phase 2 between years 2013 to 2014 where by the time the traffic was congested which road people used this highway to move at the same times each day. Ironically, the time between 12 am to 6 am contributes only 18% of road traffic crashes records. In nearly similar context, Segni (2007) have discussed that the time between 3 pm to 6 pm contributes for the majority of road traffic crashes occurrences in the roads found between Addis Ababa and Shashemene. This means, driving or travelling on the roads of East Coast Expressway Phase 2 between 12 pm to 6 pm is two more precarious for being engaged in road traffic crashes than driving or travelling between 12 am to 6 am. This result is different from Bahir Dar City. Addis (2003) which stated that about 51% road traffic crashes in Bahir Dar City are commonly exhibit during the day time as opposed to 49% in the night time. The difference in the temporal occurrence of road traffic crashes between day and night times in East Coast Expressway Phase 2 also disproves the idea stated by Hoobs (1979) that night time crashes rates are about 50% greater than daytime crashes.

5.4.3 Crashes Occurrences Based on Month

Based on Figure 4.25 that showed the overall road traffic crashes of East Coast Expressway based on month by year, like the variation in the distribution of road traffic crashes within the 24 hours of a day, there is disparity of road traffic crashes frequencies between months of a year. Comparatively, May and December are the months of highest road traffic crashes panorama in East Coast Expressway from 2013 to 2015 where they contribute 47 and 113 crashes on 2013 and 2014 respectively in December and 85 crashes in May on 2015. This could be mainly due to school holiday where people mostly used this highway during this time to travel and return to their hometown.

5.4.4 Crashes Occurrences Based on Year

Road traffic crashes based on year showed in Figure 4.26 revealed that road traffic crashes in East Coast Expressway Phase 2 was increased by year where the of road traffic crashes recorded as low as 347 crashes in 2013 until reached 751 crashes in 2015 with total road traffic crashes for this three years was 1586 crashes. This rise can be related with the increased number of registered vehicles thus increased the volume of traffic in East Coast Expressway Phase 2.

5.5 CORRELATION BETWEEN CRASH TEMPORAL-SPATIAL PATTERN AND CRASH INJURY TYPES FOR ROAD TRAFFIC CRASHES AT EAST COAST EXPRESSWAY PHASE 2 FROM 2013 TO 2015

The results from data analysis for correlationship between crash temporal-spatial pattern and crash type for road traffic crashes at East Coast Expressway Phase 2 from 2013 to 2015 that has been obtained has clearly shown that there is weak correlations between this two variables.

Spatial pattern that represented by location and district, both correlations result showed negative weak correlations with R-value obtained was -0.015 and -0.009 respectively. Where when this both spatial pattern increased in value, crash type was decrease in value. This correlations result also support by P-value with 0.547 and 0.708 respectively where this value are greater than 0.05. This is mean that there is no statistically significant between crashs spatial pattern and crash type.

On the other hand, temporal pattern that represented by time, days, type of days, month and year also showed weak correlations which is positive and negative result. All temporal pattern result showed positive weak correlations except for year variable where the result obtained was negative weak correlations. The result obtained for this variables were 0.029 for time variable, 0.011 for days variable, 0.009 for type of days variable, 0.032 for month variable and finally -0.011 for year variable. All R-value obtained was less than 0.1. These mean that there is no enough evidence to correlate crash temporal pattern and crash type. Same goes to P-value where all result obtained were greater than 0.05 which means there is no statistically significant between these two variables.

Since all correlations between temporal-spatial pattern and crash type showed weak correlations, which means there no enough evidence to correlate for this two variables. It probably can be another reason that can caused of crashes at East Coast Expressway Phase 2. Deputy Works Minister, Datuk Rosnah Abdul Rashid Shirlin said according to an analysis done, out of the total, 484 cases or 73% involved damages to vehicles and higway assets, 19% involved light injuries, serious injuries 6% while the remaining 2% were fatal crashes. Most of the crashes or 66% of these occurred during good weather (New Straits Time, 2015). On other hand, New Straits Time (2015) also has reported that Works Minister, Datuk Seri Fadillah Yusof said that it was found that fatal crashes mostly occurred on straight roads and where the surface of the highway was good and not bumpy. Human factors such as driving while sleepy, exceeding the gazetted speed limit, negligence and failure to comply with safety requirements were suspected to be one of the major causes contributing to this problem.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

6.1 INTRODUCTION

This chapter will summarize the data analysis that has derived from Chapter 4. Problem encountered during this study also described one by one, this providing recommendations for this study.

6.2 CONCLUSION

Based on crash type results, it can be concluded that Hulu Terengganu are the black spot area in East Coast Expressway Phase 2 since it recorded a large number of road traffic crashes in all three types of crash especially for fatal crashes type where the highest number of fatal crashes recorded for these three years are Hulu Terengganu district. Based on this analysis, objective one are achieved where to analyse crash type along East Coast Expressway Phase 2.

In this study, objective two is to identify temporal-spatial pattern along East Coast Expressway Phase 2 based on crash data for East Coast Expressway Phase 2. This objective has achieved where the results of road traffic crashes based on location, time, month and year are obtained. Road traffic crashes frequently happened by the time between 12 pm to 6 pm. Meanwhile for month occurrences, it showed that highest number of road traffic crashes recorded in May and December.

Finally is the correlations between crash temporal-spatial pattern and crash type at East Coast Expressway Phase 2 that stated in objective 3 are achieved when the results for this two variables showed weak correlations for location and district that represent for spatial pattern, and temporal pattern represent by time, days, type of days, month and year. Overall correlations result showed there is no enough evidence to correlate for this two variables.

6.3 RECOMMENDATIONS

For future research in this field, here are a few suggestions for the improvement of this study in the future.

i. The study about correlations between crash temporal-spatial pattern and crash type are suggested to correlate according to year and make comparison between years.

ii. The study could be done for other section of East Coast Expressway Phase 2 and with additional data from 2015 to shows an updated pattern of road traffic crashes.

iii. Further research could be done such as study of blackspot area of East Coast Expressway Phase 2. This can be done by selecting the stretches that have highest number of road traffic crashes as the blackspot area and study that area in term of road geometry and surface condition.

6.4 LIMITATION OF THE STUDY

When the study was conducted, it was realized that there is a limitation of the study of crashes data of East Coast Expressway Phase 2. It was recognized that the location of crashes happened in some report have not stated there by the police officer. To overcome this problem, a condition has been made in order to ease the analysis. The data with no location recorded eliminated and not use in the analysis based on location from this study.

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APPENDICES

Location * Crash Injury Type Crosstabulation

		Crash Injury Type				Total
		Fatal Crashes	Crashes With Severe Injuries	Crashes With Slightly Injuries	Non Injuries	
Location	KM247-KM257.9	0	2	0	149	151
	KM258-KM268.9	2	0	0	43	45
	KM269-KM279.9	6	1	0	48	55
	KM280-KM290.9	1	0	2	61	64
	KM291-KM301.9	0	1	0	39	40
	KM302-KM312.9	0	1	0	67	68
	KM313-KM323.9	2	0	0	85	87
	KM324-KM334.9	1	2	3	61	67
	KM335-KM345.9	3	2	3	61	69
	KM346-KM356.9	1	0	2	48	51
	KM357-KM367.9	0	2	4	71	77
	KM368-KM378.9	1	2	1	83	87
	KM378-KM388.9	2	2	3	189	196
	KM389-KM399.9	6	2	2	207	217
	KM400-KM410.9	2	2	1	150	155
	KM411-KM423.0	8	1	1	109	119
	KM423-KM433.9	0	0	2	35	37
	KM434-KM444.9	0	0	0	1	1
Total		35	20	24	1507	1586

District * Crash Injury Type Crosstabulation

		Crash Injury Type				Total
		Fatal Crashes	Crashes With Severe Injuries	Crashes With Slightly Injuries	Non Injuries	
District	Kemaman	11	5	2	491	509
	Dungun	6	8	13	324	351
	Hulu Terengganu	18	7	7	656	688
	Kuala Terengganu	0	0	2	36	38
Total		35	20	24	1507	1586

Time * Crash Injury Type Crosstabulation

		Crash Injury Type				Total
		Fatal Crashes	Crashes With Severe Injuries	Crashes With Slightly Injuries	Non Injuries	
Time	00:00-06:00	5	5	3	279	292
	06:00-12:00	10	3	10	288	311
	12:00-18:00	16	6	9	545	576
	18:00-24:00	4	6	2	395	407
Total		35	20	24	1507	1586

Days * Crash Injury Type Crosstabulation

		Crash Injury Type				Total
		Fatal Crashes	Crashes With Severe Injuries	Crashes With Slightly Injuries	Non Injuries	
Days	Monday	8	3	1	218	230
	Tuesday	5	2	3	174	184
	Wednesday	3	1	4	194	202
	Thursday	4	4	4	226	238
	Friday	4	4	5	195	208
	Saturday	3	3	3	247	256
	Sunday	8	3	4	253	268
Total		35	20	24	1507	1586

Type of Days * Crash Injury Type Crosstabulation

		Crash Injury Type				Total
		Fatal Crashes	Crashes With Severe Injuries	Crashes With Slightly Injuries	Non Injuries	
Type of Days	Weekdays	24	14	17	1010	1065
	Weekend	11	6	7	497	521
Total		35	20	24	1507	1586

Month * Crash Injury Type Crosstabulation

		Crash Injury Type				Total
		Fatal Crashes	Crashes With Severe Injuries	Crashes With Slightly Injuries	Non Injuries	
Month	January	3	1	2	109	115
	February	3	2	1	129	135
	March	4	3	1	103	111
	April	2	0	3	104	109
	May	2	3	5	134	144
	June	4	1	1	122	128
	July	3	0	1	99	103
	August	3	2	3	122	130
	September	3	1	1	113	118
	October	6	4	3	115	128
	November	0	3	0	144	147
	December	2	0	3	213	218
Total		35	20	24	1507	1586

Year * Crash Type Crosstabulation

		Crash Type				Total
		Fatal Crashes	Crashes With Severe Injuries	Crashes With Slightly Injuries	Non Injuries	
Year	2013	6	3	6	332	347
	2014	13	7	6	462	488
	2015	16	10	12	713	751
Total		35	20	24	1507	1586