ROAD ACCIDENT STUDY BY USING GIS APPLICATION ALONG FT 2 KUANTAN – MARAN (KM 1 – KM 57)

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ABSTRACT

Road accidents are one of the major contributors of human deaths in Malaysia. In the year 2005, 326,850 accidents were recorded, resulting in an average 17 deaths from road accident every single day. Many highway and traffic agencies have been using Geographic Information System GIS for analyzing accident data. Identification of problematic locations is one of the most important aspects in accidents studies. The GIS based application combines the information collection capabilities with the visualization. Federal Route 2 from Kuantan to Maran experienced 5605 road accidents between the years 2006 and 2010, killing 122 peoples and injuring 466 peoples. The purpose of this study is to establish road accident database by using GIS which give a quick access for obtaining information based on accident statistic in FT 2 Kuantan – Maran (KM 1 – KM 57) and to perform prioritization and diagnosis of the blackspot locations along the road and developed of countermeasure of selected blackspot. It was revealed that ArcGIS 9 has proven to be very useful when identifying such zones. The accident statistic from PDRM used as the source for information needed in the database development. The location of the accident was obtained on digitize map. By indication on it, the user can perform queries on particular characteristic to get the accident information.

ABSTRAK

Kemalangan jalanraya adalah penyumbang terbesar kepada jumlah kematian di Malaysia. Pada tahun 2005, sebanyak 326, 850 kes kemalangan direkodkan dan hasil daripada itu, sebanyak 17 kes kematian di jalanraya direkodkan setiap hari. Kebanyakkan agensi lebuhraya dan trafik telah menggunakan Perisian Sistem Maklumat Geografi (GIS) untuk menganalisis rekod kemalangan. Mengenalpasti lokasi kemalangan yang bermasalah adalah salah satu daripada perkara penting dalam kajian kemalangan. Jalanraya Persekutuan 2 dari Kuantan hingga Maran merekodkan 5,605 kes kemalangan antara tahun 2006 hingga 2010 dengan 122 kes kematian dan 466 kes kecederaan. Tujuan kajian ini dilakukan adalah untuk menubuhkan satu bentuk pangkalan data kemalangan jalanraya dengan menggunakan GIS dimana ia mencepatkan perolehan maklumat berkaitan kemalangan jalanraya di FT 2 Kuantan – Maran (KM 1 – KM 57) dan mengenalpasti keutamaan kawasan hitam kemalangan dan langkah mengatasinya di sepanjang jalan yang terpilih. ArcGIS 9 telah membuktikan perisian ini sangat berguna dalam mengenalpasti kawasan hitam. Statistik kemalangan jalanraya diambil daripada PDRM sebagai sumber yang diperlukan dalam memhasilkan pangkalan data. Lokasi kemalangan jalanraya diperolehi daripada peta digital dan hasil daripada itu, pengguna perisian ini boleh menggunakan sistem pertanyaan yang berkaitan untuk mendapatkan maklumat kemalangan.

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CHAPTER 1

PREFACE

1.1 Introduction

In Asia record, almost 400,000 people are killed on the road accident annually and more than four million injured. According to the World Health Organization (WHO), almost one million people are killed, three million are strictly paralyzed for life and thirty million are injured in road accidents each year. In 1990, death by road accidents remained 9th in ranking and in year 2020, it has been divined that traffic accidents will be the third leading cause of death worldwide.

Highways and transportation engineers very rely on geographic information system (GIS). Previously, the common paper maps have used for centuries. Large numbers of paper maps with highways features data marked on them which our predecessors have serious disadvantages and hidden elements. The term GIS is now invariability and fix used to describe computerized systems. It can be viewed in any desired combination and at any scale which comprise a digital map background and layers of additional information.

Nowadays, many highway agencies have been using GIS software for analyzing accident data. Identification of problem area is one of the most important aspects of road accident studies. Using the system, the user can consolidate accident and roadway data, well-matched the accident data and locations, analyze the data using fixed part, sliding and spot analysis, count the frequency and rate of accidents, make a variable selection for stratification to obtain mean and standard deviation of accident rates and regularities and sort the sections based on selected criteria.

Conventional accident analysis normally has not been successful in reducing the incident of traffic related accidents. There is need for improvement information on the circumstances of collisions, especially with respect to location in order to produce the result with a general picture of the data. More explicit location data could help provide facts to guide programs including rule enforcement, learning, maintenance, vehicle inspection, emergency medical services, and engineering to improve streets and highways.

A prototype Geographic Information System (GIS) was developed to analyse road accident for the purpose of reducing the number of accidents. Using the system, the user can determine the highest accident location, obtain the accident location's ranking, visualize the road accident and location details, input and retrieve the accident database, execute statistical analysis on the selected road accident location and so on within a short period. The system is able to perform several types of analysis which is operating to display the accident data and visualize a particular area. There is function which is able to display the overall of the accident cases in general along the road.

1.2 Problem Statement

Federal Route (FT 2) Kuantan – Maran where travelled by an estimated 35,000 to 40,000 people each day. The vehicles travelled in this road have been increasing dramatically every year. Since then, traffic accident has become more common. Most of these accidents flow from the mistake and carelessness on the part of the drivers. However, the probability of circumstance, and its severity, can often be reduced by the utilization of proper traffic control devices, and good roadway design features. The success or failure of such manages devices and design specifications depend extensively upon the analysis of traffic accident recorded at specific locations. It has been identified that the most effective means towards accident decrease lies in a systematic and scientific approach based of use of correct and reliable traffic accident data. But the quality and quantity of important data for the analysis are not always sufficient such as lack of high accident location and accident location's ranking database, no visualize the road accident and location information, lack of input and retrieve the accident database and unperformed statistical analysis on the preferred accident location and so on within a short period.

1.3 Objective

This study was conducted to achieve several objectives. The objectives of this study are:

1. To establish road accident database by using GIS which give a quick access for obtaining information based on accident statistic in Federal Route (FT 2) Kuantan – Maran (KM 1 – KM 57).
2. Prioritization and diagnosis the blackspot locations along the road and developed of countermeasure of selected blackspot.

1.4 Scope

The scope of this study to create a database with relationships between tabular attributes and spatial features, this system used ArcGIS software as spatial data storage and this system also was used for developing the user-interface and analysis tools. By visual analysis the system capable to produce figures or maps, this can be used to visually assess the problem.

The location of this study is along Federal Route (FT 2) Kuantan – Maran (KM 1 – KM 57), Kuantan District, Pahang Darul Makmur. The purpose of this study is to carry out an accident investigation and propose improvements for Federal Route 2 especially selected blackspot area. The road accident trend and blackspot ranking were established at Federal Route (FT 2) Kuantan – Maran. This study is limited to the reticulation system in this area only.

1.5 Expected Result

The result will be expected that the GIS system can access the road accident and the problem can be analyzed. The blackspot area can be defined and the problem for selected blackspot area can be diagnosis and recommendation can be provided.

1.6 Study Area

Study area was along FT 2 Kuantan – Maran (KM 1 to KM 57), Pahang Darul Makmur which is from junction KM 1 Telok Sisek Traffic Light to the KM 57 Kuantan – Maran. The length of the road is 57 kilometres shows in Figure 1.1.

Figure 1.1: Location of FT 2 Kuantan – Maran (KM 1 – KM 57)

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter presented a review of the literature on two criteria related to traffic engineering. There are road accident study and the used of GIS application in road accident. The main topic discussed in this chapter is the used of GIS in analysis of road accident in Malaysia. In addition, the factors of road accidents also discussed in this chapter based on the previous research studies in certain area.

Generally, Geographical Information System (GIS) was a software program combined with a database that allows the manipulation, analysis and printing or plotting of data with geospatial locations. According to Chang (2008), the important part of this system was database which GIS was a combination of tools for explore, visualize, query edit, and analyze any geographical locations information based on the database. By the capability of this software, it can be relate to road accident analysis.

2.2 Road Accident

Road accidents are common and the injuries suffered by those involved can differ greatly from minor whiplash to fatal injuries (Thompsons solicitors, 2007). Accidents happen as a result of combination of several factors and are often not caused by a single factor. According to the World Health Organization's (WHO's), road traffic injuries are defined as "fatal or non-fatal injuries incurred as a result of a road traffic crash" and road traffic crash is defined as "collision or incident that may or may not lead to injury, occur on a public road and involving at least one moving vehicle" (World Health Organization, 2007b). Road traffic accidents and injuries is a public health problem worldwide. In 2002, 1.2 million people die as a result of road traffic accidents and 50 million are injured and disabled. It is also the eleventh cause of death in the world and accounts for 2.1% of all deaths globally (World Report on Road Traffic Injury Prevention, 2004)

In Malaysia, a national statistic on road traffic accident (RTA) by the Royal Malaysian Police showed that a very significant proportion of fatal accidents were caused by motorcyclists. Fatal accidents have remained the number one cause of road traffic fatality since 2002 for five consecutive years. In 2002, the number of fatality cases for motorcycle accident was 3,034 cases and it was increased to 3,166 in 2003, reduced to 3,101 in 2004 and subsequently increased to 3,181 in 2005 and 3,243 in 2006. From 2002 to 2006, road accident statistics for four of the most common methods of transportation (bicycle, pedestrian, motorcycle and car) show that, the number of fatal, mild and severe injury caused by RTA remain dominated by motorcycles (Royal Malaysian Police, 2007). Injuries including road traffic accidents are third cause of admission and fifth cause of death in Malaysian government hospitals in 2003. In the year 2003 about 17 people are killed a day. (Health Facts, 2003)

In Malaysia, there are many factors that contribute to this problem. Poor of driving experience and skills among those who did not have any driving license lessons. Once a person earns a driving license in Malaysia they are still on trial period for two years before they can acquire the normal driving license. Most new

licensed drivers are more careful and alert as they unwilling to lose their driving status and opportunity at an early stage. The increase in road accidents is linked to the rapid growth in population, economic, industrialization and motorization industries (Mustafa, 2006). Furthermore, rapid motorization, poor road maintenance, lack of police enforcement, rapid population growth and poor road conditions are a few examples of factors which might lead to an increase in RTA in developing countries (Worley, 2006). One study shows that, the majority of motorcycle crashes in Klang Valley occur between 12.00 p.m. to 6.59 p.m. and more than 50% of fatal crashes occur after mid afternoon (3.00 p.m.) it is significantly higher during weekends (Yen et al., 1999).

According to Hirasawa (2003), travel speeds are high and country roads with only two lanes are prevalent are the factors that contribute to the highly fatality rate and to Hokkaido's record of having the most traffic accidents of any official residence in Japan. Seat belts effectively reduce serious injuries and deaths. The function of seat belts to prevent from injuries, followed by fear of being fined but the facts given for not using the seat belts provided were driving in short distances, unmindful, were in a hurry and this will contribute in road accident.

2.3 Road Accident Factors

Generally, there are three factors contributed to road accident. The factors are road users, road defect and vehicle defect. Table 2.1 shows the percentage of each factor.

Table 2.1: The percentage of total road accident in Malaysia (source: TRL 2005)

Road Accident Factor	Percentage
Road users	80% - 90%
Vehicle defect	10% - 30%

Road defect	5% - 15%

The main factors that make the road user are caused of accidents:

- Excessive speed
- Failure to signal
- Tailgating
- Frequent or unsafe lane change
- Impaired driving
- Disregarding traffic control

A study by the Automobile Association in Great Britain (1995) found that the behaviours listed below directed to road accident:

- Aggressive or rude gestures
- Verbal abuse
- Physical assault
- Aggressive tailgating
- Flashed lighting over them because the other motorist was annoyed
- Deliberate obstruction

Drivers who tent to use emergency lane, unsafe lane change and not pay attention while driving make the matters become worse. As described, modern cars are manufactured to very safe standards, and the environment they're driven in is designed to reduce the injuries suffered during an accident. The most difficult part to change is pugnacious driver attitudes and selfish behaviour.

Manufacturers are required to design and produce vehicles that meet a minimum safety standard. The most type of vehicles failure is loss brake, blowout tire, and suspension component failure. Normally, modern dual-circuit brake systems have made total brake failure an unlikely event which if one side of the damages circuit, the other side is usually sufficient to stop a vehicle. Blowout and worn tires are the next most sedate problem and can also head to tire failure. According to Zakwan (2011), uneven wear is caused by not properly balanced tires, or improperly aligned or broken suspensions. The vehicular faults have the tendency in resulting

higher severe crashes in urban roadways and include faults in tires, wheels, brakes, and windshield. He also mentions that vehicle maintenance is very consequence to ensure the vehicle is in safe condition. Many of drivers give reason that they did not have time to look upon their vehicle's condition before driving which can put their life in danger.

One factor of traffic accident has been caused by road infrastructure, which is not really in the meet the standard of safety. Road defect contributed to some vehicles accident. Local authority and civil engineer all contribute to design of safe road layouts and traffic management. In United Kingdom, road factors contributed 28% of road accidents (TRL, 1995). Poor road maintenance lead to potholes in road surface then resulted to an inequality road design. Irrespective of the crash occurrence area, the variables related with the roadway geometry results in a positive parameter. This implies the fact that when the roadway is not levelled and straight it is more likely to be resulting in a high severity crash. When a crash occurs on an urban or rural interstate or local road the probability of having a more severe injury is less, compared to arterials and collectors (Esnizah, 2008).

Sometimes, accidents can occur due to one factor or combination of the factors. Road users factor is a major contributor to road accidents. These factors include negligence, carelessness and impatience in handling vehicles. According to Sabey and Staughton (1975), road users factors contributed to 95% of road accident and the combination of road users factor and environment factor contributed to 25% of road accidents.

2.4 Classification of Road Accident

Classification of the road accident is recorded by the Royal Malaysian Police (PDRM). This is determine by the severity of the most seriously injured casualty involved either slight, serious or fatal, using the following criteria :

- Fatal – death from injuries sustained, resulting than 30 days after the accident.
- Serious injury – an injury person which is checked in hospital as an "in patient", or any of the following injuries whether or not detention result, fractures, internally injuries, crushing, severe cuts and lacerations, and general shock including medical treatment, injury causing death within 30 days or more days after the accident.
- Slight injury – an injury person of minor character such as a sprain, bruise, cut or laceration not considered to be strict or slight shock requiring roadside attention.
- Damage only – damage on vehicle. It is not include fatal and injured.

2.5 Blackspot

Table 2.2: Overview of definition of road accident blackspot in selected European countries

Country	Reference to population of sites	Sliding window applied	Reference to normal level of safety	Recorded or expected number of accidents	Accident severity considered	Length of identification period
Austria	No	Yes, 250m	Yes, by means of critical values for accident rate	Recorded, minimum critical value 3 – function of traffic volume	No	3 years
Norway	Not when identifying black spots	Yes, 100m (spot) or 1000m (section)	Yes, by means of normal accident rates for	Recorded higher than normal by statistical	Yes, by estimating accident costs and potential	5 years

			roadway elements	test, minimum values 4 (spots) or 10 (sections)	savings	
Hungary	No	Yes, 100m or 1000m	No	Recorded, minimum 4	No	3 years
Flanders	No	Yes, 100m	No	Recorded, weighted by severity	Yes, by means of weights	3 years

In Austria, black spots are defined in the Austrian Guideline Code for the Construction, Planning and Maintenance of Roads (RVS 1.21) published in November 2002. According to this guideline, scenes of accidents are distinguished in black spots and hazardous locations, depending on their recorded crash history. Based on the Table 3, for calculation, a sliding window with a length of 250 m is being used. The window follows the course of the road (network) under surveillance and flags each location where one of the two criteria for a black spot is met. The identification of road accident black spot is determined by using sliding window approach shows in Figure 2.2 (Rune Alvik, 2008).

In Norway, a distinction is made between black spots and black sections. A black spot is any location with a length of not more than 100 metres where at least 4 injury accidents have been recorded in the last 5 years. (Statens vegvesen, håndbok 115, 2006, draft version).

According to the definition by DGV, an accident black spot is a road section with a maximum length of 200 m, with 5 or more accidents and a severity indicator greater than 20, in the year of analysis. (Rune Alvik, 2008)

In Hungary, two definitions of road accident black spo6ts are used. Outside built-up areas, a black spot is defined as a location where at least 4 accidents have been recorded during 3 years on a road section no longer than 1000 metres. Inside built-up areas, a black spot is defined as a location where at least 4 accidents have

been recorded in 3 years on a road section no longer than 100 metres (Rune Alvik, 2008).

According to Rune Alvik, search for black spots with scaled accident sites map or data lists is made by using the so called "sliding window" approach. The 'window' is either 1000 metres or 100 metres wide. Once black spots have been identified, they are ranked for further study. The aim is to perform detailed engineering studies for about 10-15 % of the black spots that have been identified statistically. When ranking black spots, traffic volume is taken into account, so as to identify those black spots that have a higher than normal accident rate. Thus, the Hungarian approach to the definition of black spots in practice comes close to a rate and number method.

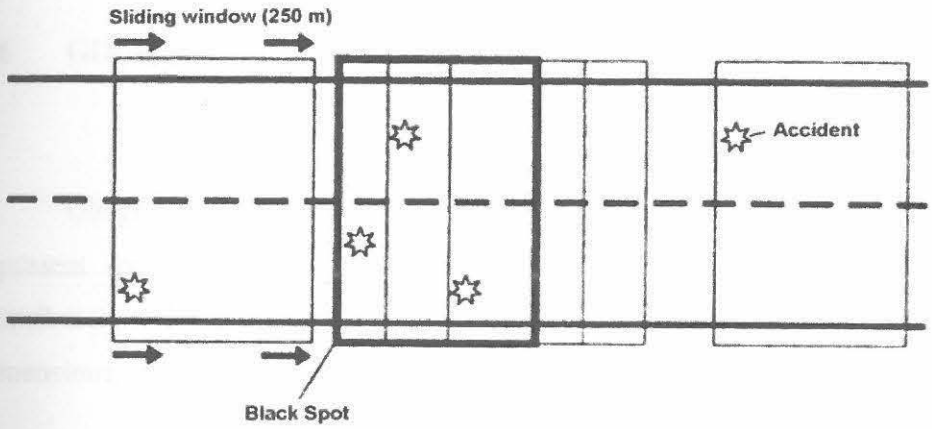

Figure 2.1: Sliding Window Method

In Flanders, this 'black spots' are selected by means of their notable accident data for the period within 3 or more years. Based on the data, each location where in the last three years 3 or more accidents have occurred is selected. Then, a location is deliberated to be dangerous when its highest important value (P), calculated using the following formula, equals 15 or more (Ministry of Flemish Community, 2001)

$$P = X + 3*Y + 5*Z$$

Where,

X = total number of light injuries

Y = total number of serious injuries

Z = total number of deadly injuries

To better an attempt of the traffic safety on these locations, the government of Flemish, starting in 2003 for a term of 5 years, invest almost 100 million EURO to reconstruct the infrastructure of the almost 800 blackspot with the highest ranking priority value. However, the selection for the diverse parameters used in the priority utility formula will greatly induce the dignity and the choice of the most dangerous accident locations and will perform a sensitivity analysis to study the strengths and fragilities of the currently used the procedure to determine and rank black spots. (Geurts & Wets, 2003)

2.6 GIS Application in Road Accident

Geographical Information System (GIS) as a medium that can be used to represent the analysis road accident data in order to accurately identify the contributory of road accident factor through analysis of the road alignment in three dimensions, information data on causes of road accident (Mwatelah, 2001).

Geographical Information System (G.I.S) is new powerful computing tool for managing large amounts of heterogeneous data and would be invaluable in addressing sections of roads with prevalent road traffic accidents occurrences. According to Mwatelah, once the data terrain model have been created, at each of the spot, the attributes which are assessed as having caused the accidents are stored as accurately as possible. This information will then consist of the data that can be easily accessed and or referred to when crucial decisions have to be made in relation to the type of improvement to be done at that particular section of the road (Mwatelah, 2001).

By using this system, the location of blackspot can be determine based on road accident data and analysis can be provided to overcome the problem. Several