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MODELLING ON THE ASSOCIATION BETWEEN ROAD ENVIRONMENT
CONTRIBUTORY FACTORS AND ROAD TRAFFIC ACCIDENTS FOR FEDERAL
ROAD 2

(MODEL HUBUNG KAIT ANTARA PERSEKITARAN JALAN RAYA KEPADA
BILANGAN KEMALANGAN JALAN RAYA DI SEPANJANG JALAN
PERSEKUTUAN 2)

INTAN SUHANA BINTI MOHD RAZELAN
PROF.MADYA IR ADNAN DZULKIPLI
AZLINA BINTI HJ.ISMAIL
MOHD ZIUNIZAN BIN HAMZAH
AMIR ASYRAF BIN HJ.IDRIS

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ABSTRACT

MODELLING OF THE ASSOCIATION BETWEEN ROAD ENVIRONMENT FACTORS AND ROAD TRAFFIC ACCIDENT FOR FEDERAL ROAD 2

(*Keywords: Road Environment Factors, Road Traffic Accident, Federal Road 2, Accident Analysis*)

Road safety research has revealed a number of factors that may lead to road traffic accidents such as the driver's fault, vehicle's failure and roadway condition and environment. Many studies have been done extensively focusing on the first two factors and countermeasures always aimed at changing and controlling the human beings in the system. However, road environment also can have strong influences that lead to road crashes for instance the weather and lighting conditions especially when travelling during night time in the raining weather. The possible causes that contribute to those crashes will be poor visibility of lighting, poor sign quality and also might be because of the slippery pavement.

Prior to that issue, this study was conducted to examine the association between road environment factors which directly focusing on the travelling periods of time of the day, day of the week and month of the year to the number of road traffic accidents. To achieve this study, a stretch road of 63km Jalan Kuantan – Maran (Federal Road 2) was selected to serve as a study area. It is a dual 2-lane carriageway that forms the backbone of Kuantan road network which experiences high traffic volume as it caters as a main trunk road that link Kuala Lumpur and east coast region. The main data of road accident cases at this study area were obtained from Royal Police Malaysia, Traffic Units. For the purposes of data processing and interpretation, those accidents cases were disaggregated by six similar sections denoted as Section 1 to Section 6. Then, the *Correlation and Inferential Analysis of Non- Parametric Test* forms the basis for testing the association between each travelling periods of time, day and month to the number of road traffic accidents by using the *Statistical Package for Social Sciences* (SPSS) Version 12.0.

Based on the analysis, the result demonstrated that there was a weak correlation develops on each time of the day, day of the week and also month of the year to the number of road traffic accidents along Jalan Kuantan – Maran (Federal Road 2). Anyhow there is a strong significance value between these factors to the number of accidents. In other words, time, day and month do have influence to the number of accidents along Jalan Kuantan – Maran (Federal Road 2). However, it is recommended that further studies need to be carried out for validation of the result.

Key researchers :

INTAN SUHANA BINTI MOHD RAZELAN

E-mail : [intan @ump.edu.my](mailto:intan@ump.edu.my)
Tel. No. : 095492944
Vote No. : RDU100364

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ABSTRAK

Penyelidikan ke atas keselamatan jalan raya menunjukkan kecuaiannya pemandu, kerosakan kenderaan dan keadaan persekitaran jalan raya merupakan antara faktor yang menyebabkan kemalangan jalan raya. Kebanyakan kajian yang dijalankan terhadap keselamatan jalan raya banyak menumpukan pada faktor kecuaiannya pemandu dan mensasarkan kepada mengubah serta mengawal cara pemanduan pemandu di atas jalan raya. Walaubagaimanapun, faktor persekitaran jalan raya seperti cuaca dan pencahayaan turut memberi pengaruh kepada punca kemalangan jalan raya terutamanya ketika memandu pada waktu malam dan cuaca hujan. Kemalangan ini mungkin berpunca daripada kurang kemampuan penglihatan, papan tanda atau tanda jalan yang tidak berfungsi dengan baik terutamanya pada waktu malam dan juga permukaan jalan raya yang licin.

Oleh yang demikian, kajian ini dilaksanakan untuk melihat hubungan antara faktor persekitaran jalan raya dimana di dalam kajian ini ianya di fokuskan kepada waktu perjalanan iaitu merujuk kepada masa, hari dan bulan terhadap bilangan kes kemalangan. Bagi menjalankan kajian ini, Jalan Kuantan – Maran (Jalan Persekutuan 2) sepanjang 63km telah di pilih sebagai kawasan kajian. Jalan ini merupakan jalan dua lorong dua arah dengan ketumpatan lalulintas yang sangat tinggi memandangkan jalan ini adalah antara jalan utama yang menghubungkan Kuala Lumpur dan negeri-negeri di pantai timur. Data utama yang digunakan di dalam kajian ini adalah data kemalangan yang di perolehi daripada Unit Trafik, Polis Diraja Malaysia. Data kemalangan ini telah dibahagikan kepada enam bahagian kawasan yang sama dan dinamakan sebagai Bahagian 1 hingga Bahagian 6. Ini adalah untuk tujuan pemprosesan maklumat dan interpretasi. Bagi tujuan analisis pula, kaedah *Correlation* dan *Inferential Analysis of Non- Parametric Test* di gunakan untuk mengenalpasti perhubungan antara setiap satu waktu perjalanan mengikut masa, hari dan bulan terhadap bilangan kes kemalangan lalulintas dengan menggunakan persisian *Statistical Package for Social Sciences* (SPSS) Versi 12.0.

Kesimpulan dari hasil kajian mendapati bahawa kolersai yang lemah terbentuk untuk setiap satu waktu perjalanan mengikut masa, hari dan bulan terhadap bilangan kes kemalangan lalulintas. Namun yang demikian, faktor-faktor waktu perjalanan ini mempunyai signifikansi atau pengaruh yang sangat ketara terhadap bilangan kes kemalangan di Jalan Kuantan – Maran (Jalan Persekutuan 2). Walaubagaimanapun, kajian-kajian selanjutnya dan menyeluruh perlu di lakukan untuk membuktikan penemuan ini.

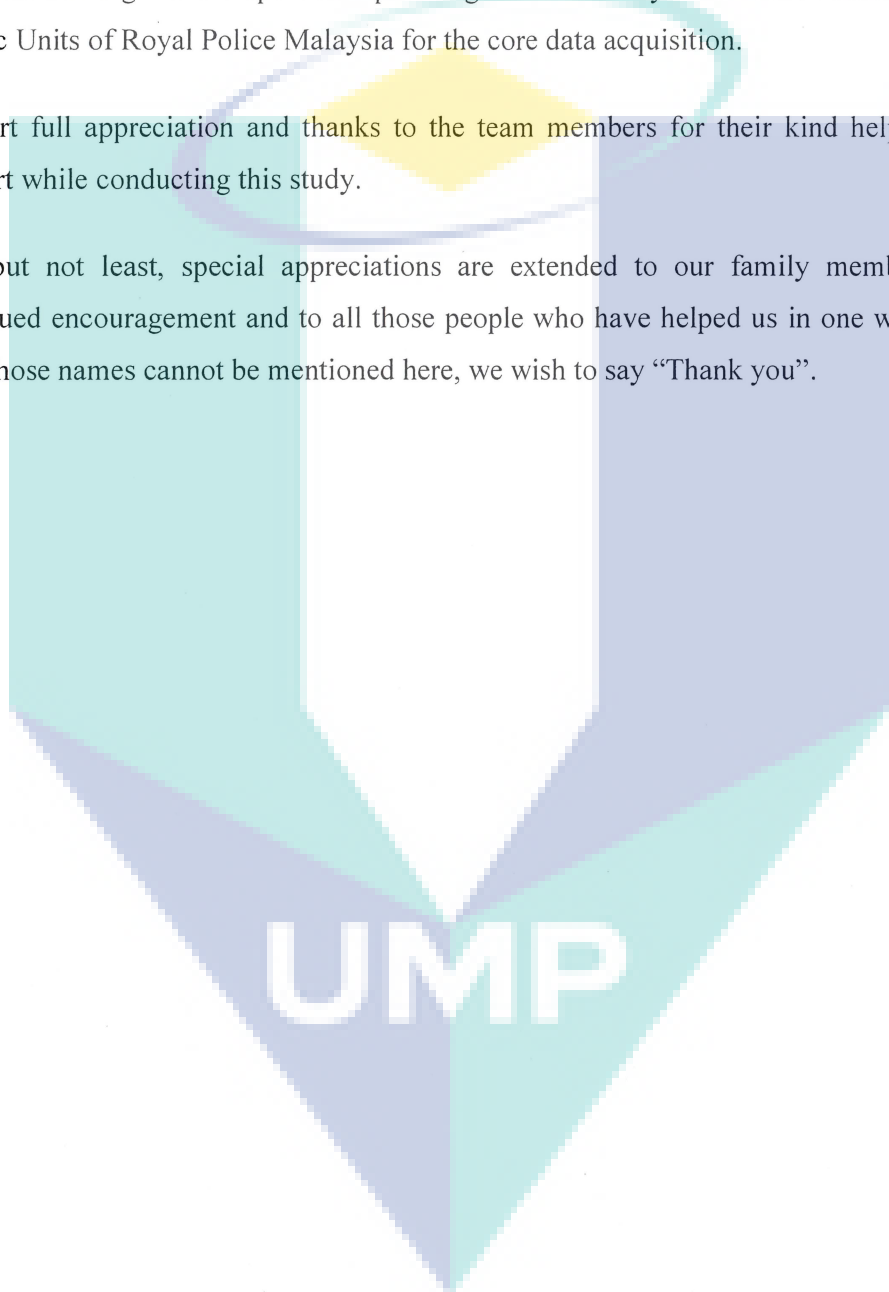
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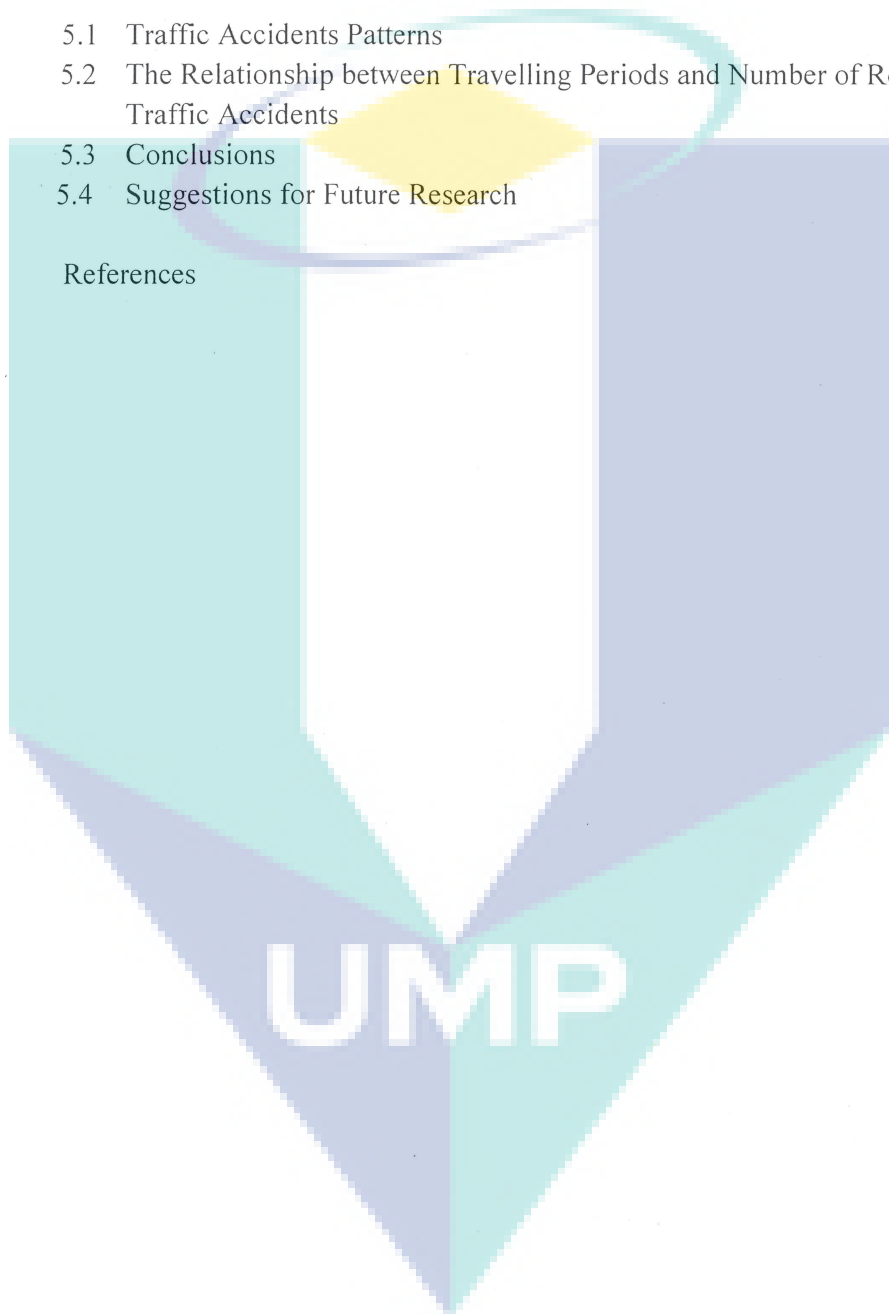
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CHAPTER 1

INTRODUCTION

Every year, more than a million people dies in road crashes around the world and about 70% of these death occurred in developing countries and Malaysia is one the best example (World Bank Report, 2005). In Malaysia, number of accident cases keep on increasing from year to year without any positive signal of declining (RadinUmar RadinSohadi&Hussain Hamid,.1998).

In year 2004, a total of 6,223 road fatalities recorded in Malaysia were caused by accidents part of which Pahang state recorded 445 cases. The major contributor was from cars and motorcycles with 69.8% out of total vehicles involved in road accidents.

1.1 BACKGROUND OF STUDY

In Pahang State, total road accident rates showed a tremendous increase with 5,140 accidents cases in year 1994 to 13,349 cases in year 2004. This 160% increase mainly involved cars and motorcycles. These accidents normally occurred at certain sections of the road and this trend remained the same for five consecutive years starting from the year 2000 to 2005.

The Government was also committed to focus on enforcing traffic management regulations such as reduction of vehicle operating speed by 10 km/h on the expressways and the highways. In addition to that, frequent surveillance by traffic police and road transport department officers was also conducted in the efforts to prevent reckless driving on the road. Road physical conditions were maintained through scheduled pavement resurfacing and improvement of the hazardous road sections, for example by increasing the sight distance on the sharp corners and geometrically steep gradients road sections.

Among the 4 major road accidents causes which is human (70%), vehicle (10%), road environment (10%) and roadway (10%), human and vehicles factors has been widely explored by most of the researchers around the globe (T. Assum and M.Sorensen (2009), C. Tingvall (2009) and Y.E. Papelis (2008).

Although the factors of road environments also contributed about the same percentage as vehicles and roadway but still, the factors of road environments has not been a great interest among researchers until now. Current research have proved that, only local residences can identified and located the black spot areas within their neighbourhood and this information's actually are very important in determining the driving behaviours, safety precautions as well as drivers alertness during the critical situations (W.Kowtanapanichet *al*, 2006). The determination of road environment contributory factors is important for drivers and road users as it's strongly associated with driver's ability to predict hazards and consequently will effect drivers ability to anticipate hazards and it's reaction towards hazards.

If the drivers are successfully in manoeuvring the hazard, the risk of accident can be minimized (M.A Wettonet *al.*, 2009)

Amongst other factors, the surrounding environment during travelling often being disregard while discussing causes of accidents. Time of the day, month of year and day of the week may not be a special interest among researcher but after looking at the numbers of accidents which sometimes slightly higher in nighttime compared to day time, weekend compared to weekdays an end of the year compared to middle of the year, it has triggered the researchers minds on the possible relationship between all these periods to number of accidents especially in federal road. Furthermore, this fact is supported by results from general observations made by the researchers to the local communities scattered along federal roads, many of them had warned road users not to travel in certain period of time as the possibility of accidents is higher compared to another period of time.

By analysing these scenarios, this study has been initiated. The main focused of this study is to developing the relationship between road environment factors and road traffic accidents and after an extensive review has been done, the focused is directed to the factors of travelling period towards number of road traffic accidents by taking one stretch of Federal Road 2 as the study area.

1.2 OBJECTIVES OF THE STUDY

The objectives of this study have been twofold as below:-

- i. To determine the road traffic accidents patterns along Federal Road 2
- ii. To develop a relationship between travelling periods and number of road traffic accidents along Federal Road 2.

1.3 PROBLEM STATEMENT

Road traffic accidents have become one of the major problems in most of developing countries not forgetting Malaysia. Although lots of traffic campaign, forums, awareness programs as well as new regulations has been introduced and carried out, this problem doesn't have any positives signs to decrease yet. In conjunction to these scenarios, many researchers especially those who involved in traffic engineering have taken a step ahead by doing a numbers of extensive studies in an attempt to find the right solution to this problem. In most of the study, the role of human factor in accidents occurrences cannot be put aside as road users contributes more than half of the traffic operational system. However, there are other factors that seem to be forgotten and always been left out while discussing on the road traffic contributory factors and road environment is part of it. Road environments as stated by Peter Larsson from The Swedish Transport Agency in his presentation to Ministry of Works, Malaysia, contributes almost 29% of the overall traffic accidents factors and there's a lots of things are still need to be scrutinized while blaming the road environment as one of the accidents causes; travelling period is one of them. Different times of days may effect one's style of driving, different days of week may triggered different operational condition and different months of year may cause different traffic behaviour for example, most of young drivers loves to travel at night since they can travel in a higher speed compared to day time sure to the low traffic volume at night or rural roads are quite busy during certain period of years especially during school break and consequently high traffic volume will caused high number of accidents especially on divided roads (GirmaHernanu, 2004). Finally by looking at all these cases with an eagle eyes, there is something in common between all cases; the travelling period. Different travelling period triggered different driver's perspective but no study has ever done focusing on this single item alone. This study aims to evaluate the relationship between travelling periods i.e. day of the week, month of the year and time of the day with numbers of road traffic accidents and it is hope that an outcome from this study will be a foundation for any similar study concernigon the effect of travelling period to road traffic accidents in futures.

1.4 IMPORTANCE OF THE STUDY

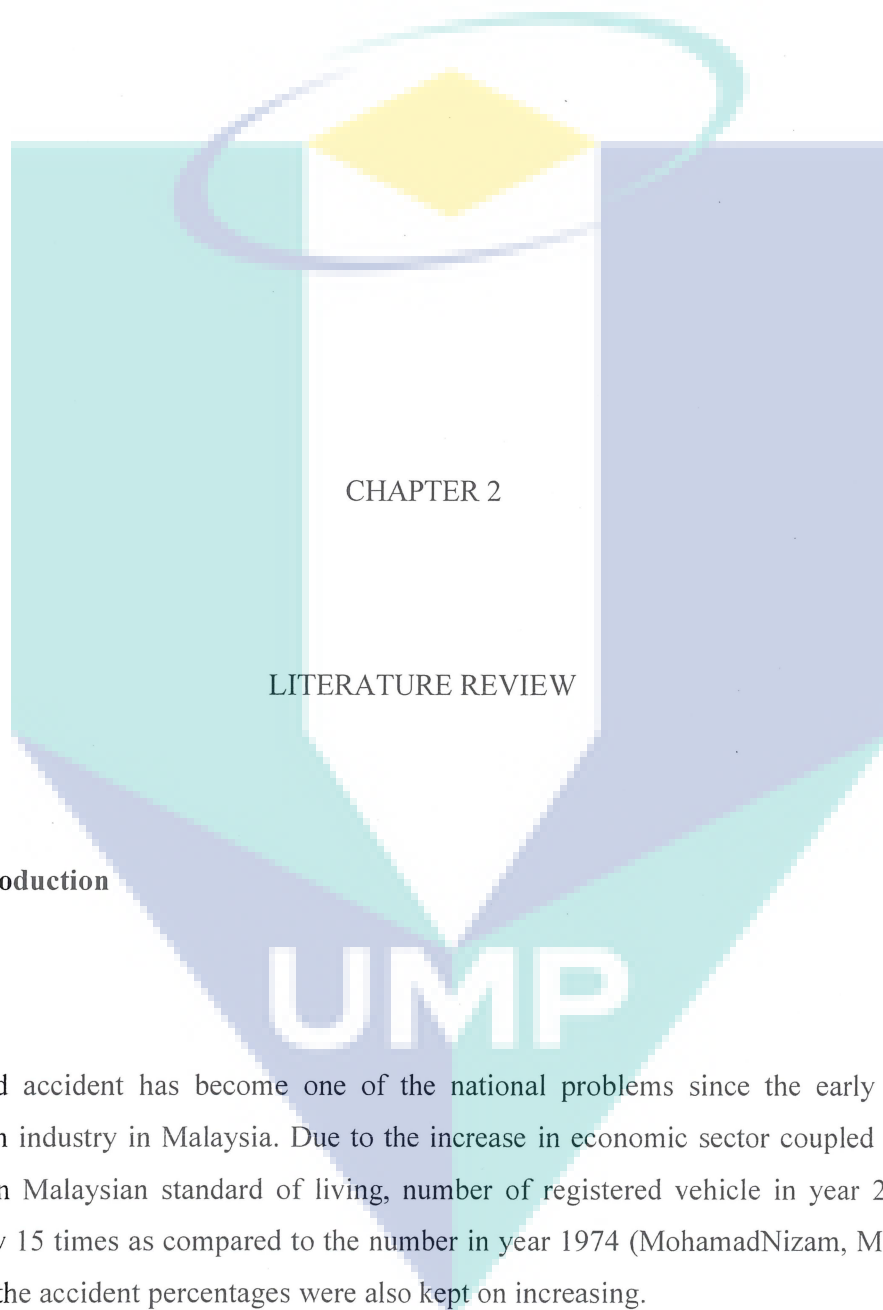
This study aims to create awareness to all parties who have the authority to change the current approach of providing road infrastructure particularly the roadside planning and management. The results of this study can be used as an input to the definition and formulation of accidents for mitigation measures. Also, the results are very much needed by the Local Authorities as a source in providing better and safer facilities for the public. An ability to estimate the effect of accident contributing factors will be an extra credit for all road designers as the future road design will also look into this matter for betterment of road designs techniques.

In line with that, more awareness programmes can be conducted by focusing on the specific types of accident causes occurred on specific locations. As a result, objective of the campaign will be achievable which not only benefit the road users in terms of safety on road but also to governments as well.

1.5 SCOPE OF THE STUDY

The study will focus on JalanKuantan – Maran of Federal Route 2 starting from KM 3 to KM 63 which excludes the CBD area as the study case. By re-examining the raw traffic accident data from Malaysia Royal Police Force (PDRM) the study will touch on the following scope of works:

- Analysis of traffic accident patterns along the study route from year 2000 to year 2005. Therefore, the traffic accident patterns developed from this research are only accurate to be used for the specific year only.
- The travelling period data taking into account for this study are classified into 3 major indicators; time of day, day of the week and month of the year.



2.1 Introduction

Road accident has become one of the national problems since the early days of motorization industry in Malaysia. Due to the increase in economic sector coupled with the increment in Malaysian standard of living, number of registered vehicle in year 2005 has increased by 15 times as compared to the number in year 1974 (MohamadNizam, M., 2005). Since then, the accident percentages were also kept on increasing.

The seriousness of this problem not only becomes the concern of the Government but also to non-governmental agencies, educational institutions and public in general. Many researchers including those from public and local universities take this matter as a challenge in finding the best way to overcome the problem. Malaysian Royal Police Department for example has successfully played his role by running a lot of awareness campaign especially during the festive seasons when the numbers of vehicle traveling on the road are almost double the usual volume.

Department of Road Safety, Malaysia (JKJR) uses electronic and non-electronic media not only to convey important information but also aiming to create awareness among road users. Lately, there is a lot of television advertisement that replay the accident situation focusing on the common mistakes or simple error done by road users. But, if the advertisement were scrutinized or looked closely, it is found that the focus of the campaign is only on the road users especially the vulnerable groups comprising motorcyclist, bicyclist and pedestrian (Hussain, H., et al. 2004). Actually, road accidents are not only caused by road users (vulnerable and non-vulnerable) but also a combination of two or more factors. The widely known contributing factors deduce to road accidents involved human factors, vehicle factors, road and environment factors (Kowtanapanich, W., et al, 2005). However, according to Clarke, D.D., et al. (2005) behavioral factors in road accident are difficult to study by traditional research methods.

Accidents are relatively unpredictable and infrequent, so direct observation is often impossible. Accidents can happen by a combination of tired drivers and poor road geometry or poor vehicle condition with poor weather condition. In addition, the fact that accidents can happen due to poor road environment management should also not to be neglected. Unidentified road environment factors that can activate an accidents together with the unmanageable roadside areas are a hidden factors that seldom been discussed among road safety researchers. In order to achieve the world class standard of road safety, the Malaysia Government has put a target to decrease the death rate to 4 road accident fatalities per 10,000 vehicles by year 2010. A lot of integrated programmed were introduced not only by government agencies but also going down to the communities level.

2.2 GENERAL ISSUES IN ROAD SAFETY

Transportation system are comprised of three major components; road users, vehicles and roadway. An increased in number of road users years by years has automatically increased the number of road traffic accidents as the roads becomes more congested produced a higher traffic volume and consequently generate a high number of accidents. The relationship between traffic volume and number of traffic accidents have been well-known for so many years instead there are more related factors to road traffic accidents has yet been discovered. Cost of accidents are extremely high in terms of economic view so there is a huge needs in overcoming this accidents problems before it becomes unmanageable.

In an attempt to find the suitable solution for this problem, many parts of road safety areas has been well-studied by a number of great researcher in road safety areas. Among the areas that has caught the researchers intention are as listed below:

1. Studies on the new technology or materials to reduce the severity of injuries to the accidents victims.
2. Studied on the effectiveness of the proactive campaigns, awareness programs and surveillance organized by road safety related agencies.
3. Studies on the accidents prediction models by focusing on the different areas on interest.
4. Studies on the new road design features / construction techniques in order to reduce the accident risk.
5. Studies on the interaction between different types of road users in order to evaluate an impact from different types of road users to road traffic accidents.

However, according to MohdRashdan Ibrahim (2003) who has done an extensive studies on the road safety trends in Malaysia, he has concluded that in order to ensure that safety aspects are well blend among Malaysians, enforcement and certification alone is not adequate. The importance of road safety seems to be very difficult to be accepted by our societies and as a results enforcements are quite difficult to be materialised.

Malaysia who has a vision to become among the developed countries in year 2020 also facing the same problems and now is struggling to manage to this accidents problem before it's too late. As reported by Royal Malaysian Police, in year 2009, for every 100,000 people the death rates calculated are 23.83 and for every 10,000 vehicles registered the death rates are 3.55. Among others, the fatalities data in pedestrians are also high; with every 10,000 vehicle registered the death rates for pedestrians are 2.09.

As shared by other developing countries, the Arabian Gulf countries also have recognized accidents problems as a growing health problem that need to be taken care of. As the discovery of oil has extremely increased number of population among these countries, the number of registered vehicle are also increased. As mentioned by Bener et al (2003) in his research on the strategy to improve road safety within developing countries, traffic accidents in developing countries are costing an enormous amount of money that should be paid in higher currency as most of the vehicles are imported. Although many developed countries managed to come out with their own road safety programs, however, this programs cannot be adapt in most of developing countries. The difference in terms of road user behaviour, road environment and social upbringing are important things that should be considered way before an assessment on the potential programs on road safety can be implemented.

In encountering this problem, Malaysian government has set up a few policies to curb this issue and among others are introducing the strategies to reduce disabilities from injuries through accidents reduction and prevention programs. This programs which includes the application of three 'Es': education, engineering and enforcement which involves the solicitation of appropriate safety policies, vehicles inspections, new approach in road engineering and not to be missed a medical and trauma management. This huge steps has been seen as an important steps in making Malaysia as a leader in managing road safety issues.

2.3 ROAD ACCIDENTS FACTOR

Roads are part of human everyday life not only in modern countries but also in developing countries. Kowtanapanich, W., et al. (2005) expressed road as the system with which people have to deal everyday and amongst of all the systems, road traffic system are the most complex and dangerous. Road is a very complex system which hold a blend of peoples, machines and environments at one time. Accident cannot be avoided if one of the contributing factors fails to do its duty. Mustafa, M.N (2005) has concluded in his study that the following factors were believed to be related to accidents:

- Combination of Traffic Composition

No separation between traffic composition whereby most of traffic is a combination of small, medium and heavy vehicle.

- Improper Intersection Design

Improper design at intersection can cause significant increase of accident and are related to lack of safe sight distance.

- Provision of street lighting

Improper street lighting and low visibility especially during nighttime can cause traffic accidents.

- High traffic volume

High traffic volume which usually happens during festive seasons will significantly increase number of traffic accident cases.

- Provision of pedestrian crossing

Inadequate pedestrian crossing or no pedestrian crossing make available by authorities are also associated with an increasing in traffic accident cases.

- Signal light

Wrongly design traffic light especially in urban areas can increase chances of traffic accident especially at junctions.

- Vehicle Speed

Not suitable or unrealistic speed limit at certain areas may cause a traffic accident due to the misinterpretation of the drivers or road users.

Driving is more like a dangerous game which we are not only dealing with simple situation but sometimes we have to prepare ourselves to overcome a hard and complex situation. Driving does not always took place in an ideal condition, in which a well rested, well trained and well behaving individual interacts with a simple and undemanding road environment. One issue that can make driving performance sub optimal is distraction, both from within the vehicle and from the road environment (Horberry, T. & Anderson, J. et al., 2005). But somehow, drivers sometimes do not know what constitutes dangerous traffic behavior and as a result they cannot refrain from behaving dangerously (Vanlaar&Yannis, 2005).

One of the factors that will constitutes dangerous driving is the road environment factor. Road environment plays a major role leading to a safe and comfort driving. Poor road condition, high traffic volume, high vehicle composition and highly speeding traffic may remove the factor of safe and comfort driving. Moreover, these factors are actually directly related to the factors of travelling period. Why one driver chose to travel at night and the other driver opts for driving at the early hours of the day? They must have their own reasons which directly related to their driving comfort. Also if the police accidents data were examined very closely we can see there a huge differences between number of accident cases between times of the day for example and this facts were normally been ignored while modelling the effect of road environment towards number of road traffic accidents.

2.4 ROAD ENVIRONMENT FACTOR

As cited by Peter Larsson from The Swedish Transport Agency in his presentation to Ministry of Work (MOW) Malaysia, he pointed out that more than 29% of the road accidents factors are caused by road environment. Somehow, road environment itself before the operational systems comes in are safe in terms of design aspect and procedure but the problems started to show when the roads is in operation. Judgement about safe driving may depend on the road environment as in UK, more fatal accidents on rural roads than on urban roads (Samantha Jamson, 2008). The main difference between well-design features during design stage and during operational stage is the road environment. Road environment itself covers many aspects such as road conditions, roadside conditions, traffic volumes, operational speed and not to be missed out the driving ambience itself. Putting aside the other mentioned factors, this study tried to focus on the factors of driving ambience as a road environment factor that influenced the traffic safety condition that may results to accidents occurrences.

The installation of in-vehicle distracter that although improved drivers' alertness however had greater detrimental effect on driving performance and in a complex driving environment drivers had to be extra careful (Horberry, T. & Anderson, J., 2005). For instance, one of the causes of accident during nighttime as well as in poor weather condition is poor visibility. Poor visibility is not only imposed danger to drivers but also to vulnerable road users. High risk for fatal road traffic accidents were found on urban roads, during nighttime and with poor visibility especially in the darkness, sunset and sunrise (Jovic, A.V., et al., 2005) since urban roads were busier during these times as compared to rural roads. As a result, risks of fatality during these hours were more significant at urban roads than in rural roads.

Advertisements display in the roadside areas also disturbed the visibility demands of drivers as claimed by Horberry, T. & Anderson, J. (2005) that drivers distraction is not just related to what is happening inside the vehicle but also from the outside of the vehicle since this is one aspects of road environment that need to be preserved. Most drivers tend to look

at the advertisements while driving according to Horberry, T. & Anderson, J. et al. (2005). Visual clutter using big advertisements display in the road environment almost certainly had negative safety implications especially for older and younger drivers. Horberry, T. & Anderson, J. et al. (2005) also stated beside that excessive in-vehicle entertainment system could also be one of the main sources of visual distraction since at times it could cause the drivers to take their eyes off the road.

Infrastructure and environment of roadway played a limited but significant role in traffic accidents risks (Eckhardt, N &, Thomas, I., 2004). Urban roads are more likely to experience traffic accidents caused by intense roadside development as compared to rural roads. Jovic, A.V., et al., (2005) stated that design of streets with traffic signals and stop signs as well as overall management of road traffic by the police, were major factors that influenced the frequency and severity of motor vehicle collisions for urban roads. Their study also proved that accidents on urban roads and urban junctions were more fatal or severe than their rural counterparts.

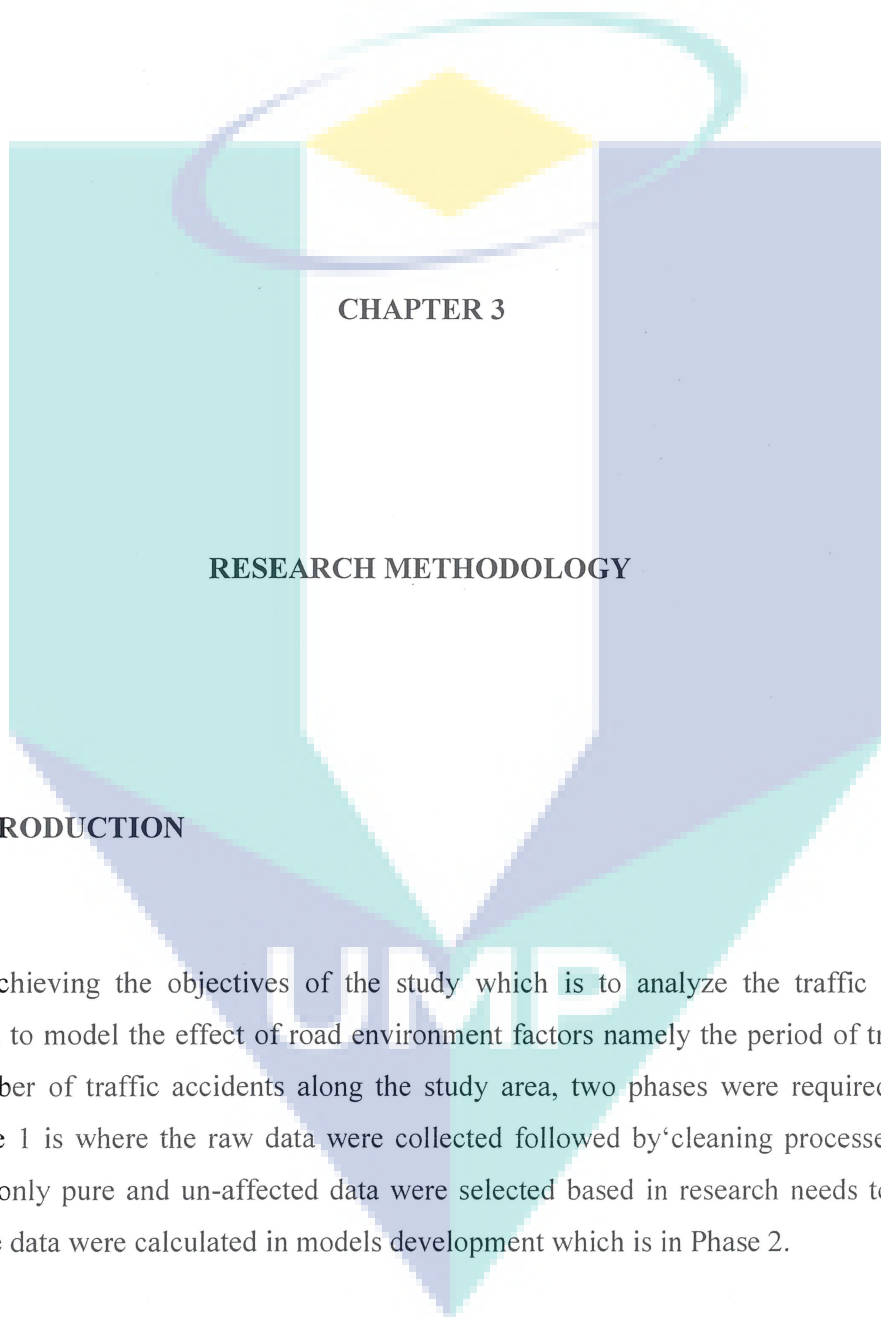
Xuesong Wang et la. (2009) who investigate the relationship between Level of Service and Safety indicated that most researchers believed that operational condition has an effect on safety. However the relationship between operation and safety is not clear, not until now. In regards of the driving environments, he also included one variable that resembles the effect of time of the day towards numbers of road traffic accidents and he managed to shows that P.M peak experienced more crashes that other period. This finding relatively related to the niche area of this study. It had proven that travelling period does have an impact on the number of road traffic accidents and further study need to be done on these issues, not just to explore one small factor that seems to be forgotten but also as a foundation to a deeper study on the factors of road environment in defining road accidents cases. Outputs generated from this study can helps local authorities, policy makers as well as enforcement agencies to set up a new rules, campaigns, awareness activities and many more to make peoples aware on the effect of choosing the right travel period to the risk of accidents they may encountered.

2.5 SUMMARY

Safety is one of the important aspects in our life. Humans deals with traffic system almost every day and mistakes either made by human itself or by other moveable or non-moveable components will lead to a accidents occurrences. Adopting traffic in our life is not complete if we only understand the surface of the system only. It is the role of every level of societies to appreciate as well as grow the road safety awareness in one self. By doing this, it is not surprise if one day Malaysia in specific be a champion in managing road safety issues worldwide. As a developing country, safety aspects must be thoroughly applied in every aspect of production, construction, design and operation. We must realise that the responsibilities of educating the public lies in the hand of everybody since everybody from now and then is the road users.



UMP



CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

In achieving the objectives of the study which is to analyze the traffic accident patterns and to model the effect of road environment factors namely the period of travelling on the number of traffic accidents along the study area, two phases were required in this study. Phase 1 is where the raw data were collected followed by 'cleaning processes' of the data where only pure and un-affected data were selected based in research needs to ensure only reliable data were calculated in models development which is in Phase 2.

Data collection activities commenced in September 2010 and the first data collected was traffic accident data for the whole study route since it dictates the scope of study for quantitative research that is used to measure the relationship between road environment and number of traffic accidents. In order to investigate the effects of road environment on the number of traffic accident cases, a list of research hypotheses is designed. The research hypotheses designed for this study are as follows:-

- i. There is NO significant influence between time of accidents and number of road traffic accidents along KM 3 to KM 53 of Federal Road 2.
- ii. There is NO significant influence between days of accidents and number of road traffic accidents along KM 3 and KM 53 of Federal Road 2.
- iii. There is NO significant influence between months of accidents and number of road traffic accidents along KM 3 to KM 53 of Federal Road 2.

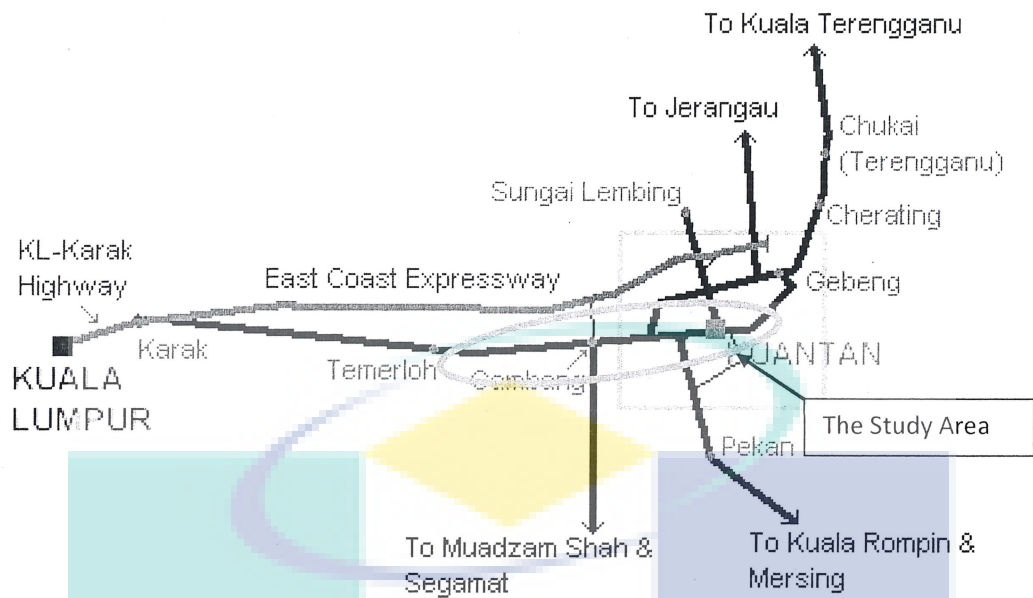


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3.2 BACKGROUND OF STUDY AREA

The proposed study area, Jalan Kuantan-Marang was chosen as the study area after an intensive investigation on the road environment features were made in every possible aspect particularly on the level of safety of the route. Jalan Kuantan- Marang that is forming part of Federal Route 2 falls under the category of rural and primary road when it was first constructed. As a primary road it functions as a major road, forms the backbone of the road network for the State of Pahang.

Before the opening of the East Coast Expressway, Jalan Kuantan-Marang is the only route to commute residents from Marang to Kuantan and vice-versa. Since the volume of traffic travelled along this road was calculated to be uncontrollably increased from year to year coupled with an increased in residential and business developments i.e. business activities, shops, schools, higher educational institutions and also shopping zones who had taken place along the roadside areas it was upgraded from single lane road to dual 2-lane carriageway in mid 90's. Along with an increased in the roadside developments, the traffic flow was also gradually increased until now. At present, with similar road features in terms of speed limits and geometric design, the road has now becoming less effective to cater for the current needs of the road users. Figure 3.1 below shows the location of study area where it crosses several towns namely Gambang, Srijaya and Marang along the it's 63-kilometers length route.



Source: Pusat Teknologi Maklumat IP JKR (MyLibrary)

Figure 3.1 : Location of Study Area

As shown in above Figure 3.1, the study area which is part of Jalan Kuantan-Maran consists of 63 kilometre long where part of it are 2-lane dual carriageway road (from KM 3 until KM 29) and another part are a single carriageway(KM 29 until KM 63). The study area covers the area from the 3-legged signalised junction at Jalan Wong Ah Jang to 63 kilometre ahead which ends at Maran town. This road is also connected to Jalan Kuantan-Pekan at KM 8, Jalan Kuantan-Kemaman at KM 14, intersection to Muadzam Shah and Lebuhraya Pantai Timur exit at KM 27. It is clearly shows that the traffic flow catered by Jalan Kuantan-Gambang is relatively heavy and becoming much heavier in festive seasons.

Back in the 90's, the traffic flow on Jalan Kuantan – Maran was the only link for both the short and the long distance users. With the opening of the East-Coast Expressway however, the long distance road users is having the choice whether to use the expressway or keep on the existing road. For expressway, the two adjacent interchanges located at Gambang and Jalan Sungai Lembing becomes the gateways to Kuantan. However, Jalan Kuantan – Gambang continues to be the popular route for long distance traffic despite the availability of the new expressway as most of the expressway users chose to use Gambang interchange

rather than Kuantan Interchange. At present, the 30 km road from Kuantan to Gambang which is part of Jalan Kuantan-Marang has been upgraded to urban road (JKR U5 Standard) as a dual-carriageway road. This part of road has been chosen to undergo upgrading works since the traffic volume along this section is the highest among other sections since it is the closest area to Kuantan town. But still, very little consideration is given to manage the roadsides activities along those sections. This resulted in inadequate attention provided for the segregation of the local and long distance traffic as illustrated in the Figure 3.2 about ingress and egress junctions along the route (Adnan Z., 2006).

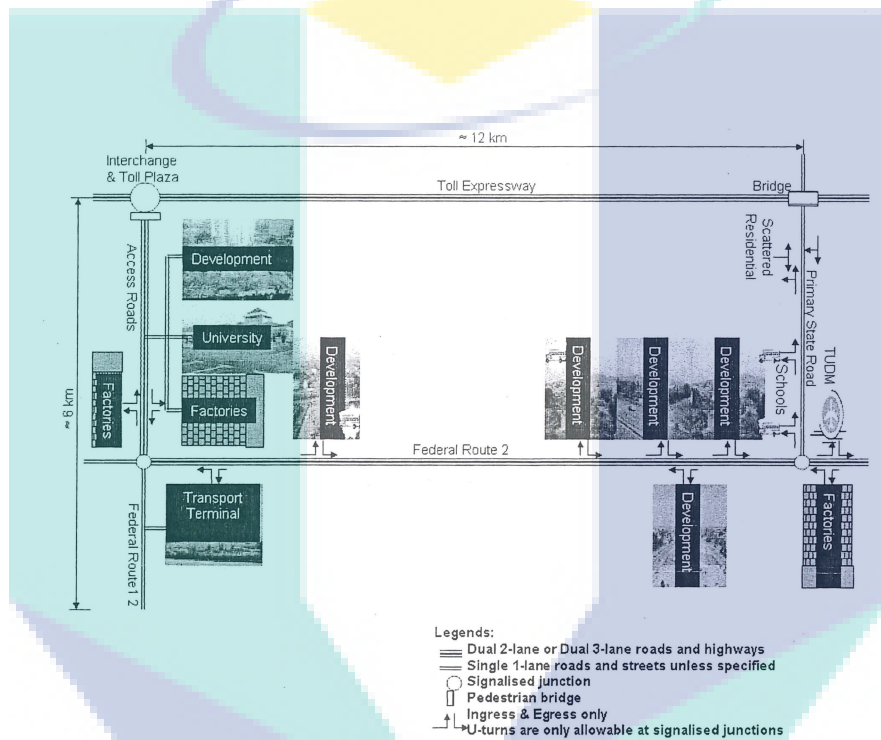


Figure 3.2 : Illustration of the Existing Traffic Management along Federal Route 2 (Jalan Kuantan - Gambang)

Figure 3.2 shows an illustration of an existing traffic management along one of the sections located within the proposed study area. It displays an existing development took place in this particular section and from here it is clearly shows that there is still a lot of space available for future developments.

While the long distance traffic continues to be catered for, more u-turns were provided for the use of the newly developed areas in between the ingress/egress junctions. As a result, with vehicle queuing-up in the middle lane for making u-turn, the through traffic will make use of the outer lane and directly increasing conflict with the local traffic. This situation is expected to contribute to higher traffic accident cases. If this current trend of traffic management prolonged and roadside developments are allowed to progress by having direct access to the Federal Route as illustrated in Figure 3.3, traffic volumes along JalanKuantan-Gambang will be reaching its saturation level.

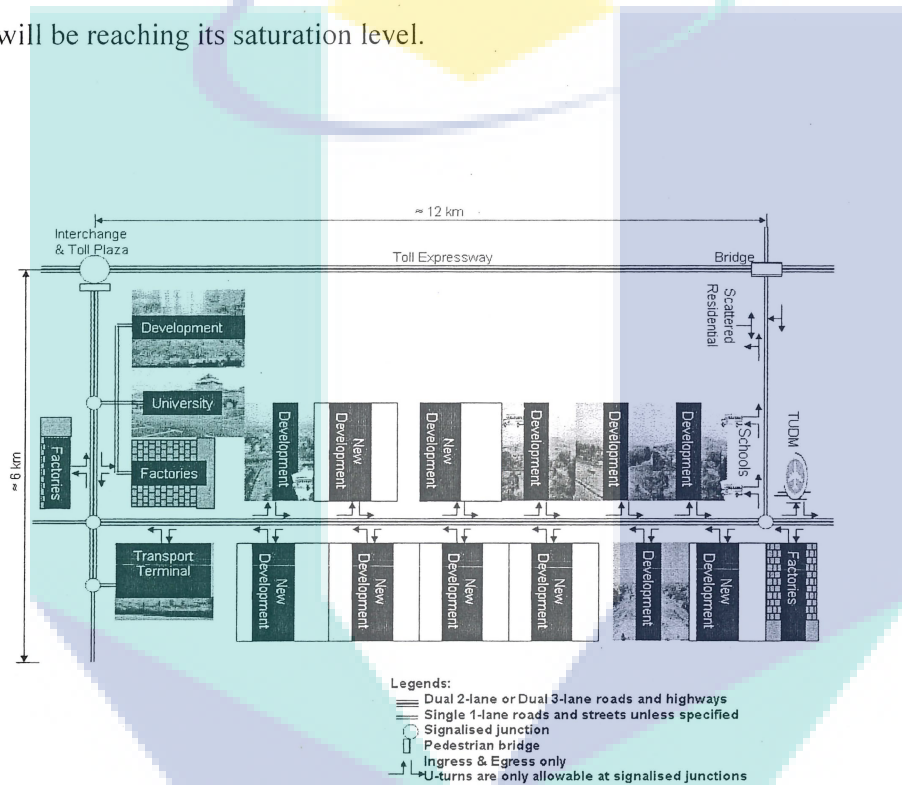


Figure 3.3 :Illustration of the Future Traffic Management alongFederal Route 2 (JalanKuantan – Gambang)

Figure 3.3 illustrates the expected traffic management along part of JalanKuantan-Maran in future years as more developments will be taken place along the road. If the development were not controlled especially within an urbanized area along the road, the following dramatic impacts can be observed:

- i. The traffic volume along the trunk route will increase;
- ii. The types and behaviors of the local traffic is not catered for by the route; and
- iii. The pattern of these types of roadside developments will not permit the required safety features of an urban route.

These impacts can be managed by the provision of alternative local routes and provision of new signalized junctions along the Federal Route as shown in Figure 3.4.

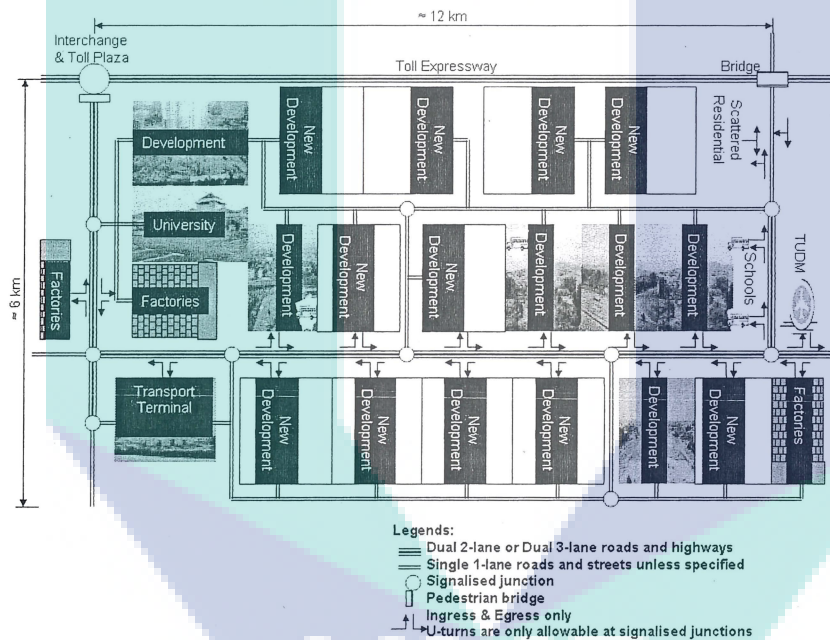


Figure 3.4 : New Alternative Routes and Signalized Junctions for the Local Traffic

Figure 3.4 shows the proper traffic management including new alternative routes and signalized junctions connecting the new development areas along KM 12 and KM 27 of JalanKuantan-Maran. If the proper traffic management was adopted, the effect of roadside development on traffic accident can be limited.

In this study the 63 km length of JalanKuantan – Maran was divided into 6 sections for the purpose of data collection, interpretation and processing as follows:

- Section 1 : KM 3 – KM 13
- Section 2 : KM 13 – KM 23
- Section 3 : KM 23 – KM 33
- Section 4 : KM 33 – KM 43
- Section 5 : KM 43 – KM 53
- Section 6 : KM 53 – KM 63

Perez, I. (2006) has suggested that a similar section must be achieved when dividing a research area; it must be as uniform as possible so that they would share the same physical, geometrical and traffic characteristics. The discussions on the rest of this chapter were focused on these 6 sections.



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3.3 ROAD ACCIDENT DATA

Road accident data consisted details on the number of traffic accidents as reported to PDRM who kept the state-wide databases on traffic accidents occurred at all major roads in Pahang. The police report contains information on the number of traffic accidents happened on these roads for the whole year. It also included important information's such as the time and the locations where the accidents occurred. Police files were chosen, partly because they were convenient and suitable for the purpose as emphasizes by Clarke, D.D. et. al. (2005).

Number of traffic accidents were defined as all type of accidents occurred along JalanKuantan-Maran that caused death, injuries and damages (properties and facilities). In certain aspects, the number of traffic accidents was grouped in year to year basis and in other instance the number of traffic accidents was classified according to section by section basis. After all traffic accidents data were collected, the data were interpreted according to the needs and objectives of this study. For the purpose of this study, only relevant data that suited the needs of the study were extracted from the records. Naji, J.A., and Djebarni, R. (1999) suggested that during the early stage, researchers tend to collect all sorts of traffic accident data and most of these data had been collected without much thought for the need for uniform, relevant and reliable data. The processing of data was carried out inline with the research objectives and the needs for the analyses. Finally, a datasets that was useable and relevant to the study were produced. Clarke, D.D et al (2005) even suggested that only specific type of traffic accident was targeted in order to cut down the diversity of the sample, thus improving the chances of getting meaningful results which were consistent across cases.

Greibe, P. (2003) had suggested that variables describing the road environment, number of parallel roads, parking facilities and speed limit proven to be significant and important in predicting the number of traffic accidents and the most important element in anticipating the traffic accident causes were the reliability of the data. The traffic accident treatment process was a continuous program of work which comprised both macro and micro levels. At the macro level, traffic accident prone areas were identified and prioritized according to the extent of the problem under study (Liang, L.Y., et al, 2003).

Clarke, D.D et al. (2005) had suggested that the review of selected traffic accident reports was an essential element before going to the analytical process. The analysis considered only:-

- i. Accidents that happened from KM 3 to KM 63 of the study route.
- ii. Accidents happened on the residential area streets, roundabout areas, flyovers, factory areas and at the alternative route were not counted as the valid number of traffic accidents.
- iii. Police records without specifying the accident location were discarded from the datasets.

The number of traffic accidents was collected for the period of 4 years starting from year 2006 until year 2009 to ensure that the traffic accidents data portrayed the current situation encountered by the study route in terms of accident rates. Within the 4-year period, traffic accident patterns along the study route are expected to be able to be predicted. The number of traffic accidents for every year by sections was tabulated from year 2006 to year 2009. From the table, traffic accident patterns from year 2006 to year 2009 were analysed. At this stage, traffic accident prone areas were also identified as suggested by Karlaftis, M.G and Golias, I (2002) that the ability of predicting the traffic accident rates was very important because it could help in identifying hazardous locations and sites which required treatments.

After completely going through all levels in phase 1, the traffic accidents data were ready to be used as dependent variables in phase 2 which is the modelling process. In phase 2, relationship between road environments and number of traffic accidents along the study route were investigated. The following sections would discuss the definitions, characteristics and criteria of roadside feature, population and traffic volume data and also explained how the data were collected, interpreted and processed.

3.4 ROAD ENVIRONMENT DATA

Road environment data covers wide areas in road traffic fields. It covers all types of components in road and traffic operational system such as road conditions, roadside condition, operational condition and also driving condition. Since most of the research conducted earlier were focused on the effect of road condition, roadside condition as well as operation condition towards an increased in road traffic accidents, in this study, the researchers tried to emphasis only on one small part of road environment that often been neglected but somehow very common in every single road types and condition; the travelling period.

This accidents aspect managed to catch the researchers attention after reviewing the road accidents reports supplied by the Royal Malaysian Police. While examining the reports, it has been found out that there was some sort of pattern or trends between accidents occurred during night time and day time, various times of the day and also in different months of the year. This odd situation was suspected to be related to driver's fatigue while travelling in different times of the day, different traffic operational surrounding i.e. traffic volume, vehicle's speed and number of pedestrian while travelling in different days of the week and different months of the year. But, is this assumptions correct?

The only way to determine whether assumptions made by the researcher as well as by peoples who resides besides the road areas who also warned the road users for not to travel during certain period of time are true are by doing an extensive analysis and furthermore develop a relationship between travelling period and road traffic accidents by taking one stretch of JalanKuantan-Maran as the study area.

Data on the travelling period were taken directly from the accident report gathered from Royal Malaysian Police. This report contained complete information on the location of accidents, date of accidents (where months and day of accidents can be determined) and also time of accidents (where time of day where the accident took place can be determined). 500 numbers of accidents were taken out from this report and these raw data were tabulated again according to date of accidents in ascending trend. After the whole data have successfully going through the re-arranging processes, tables contained needed information of accidents for the analyses were produced.

The road environment data which is the time of the day, day of the week and month of the year were segregated into several classes as follow:-

- Time of the day
 - Small Hours (00.00 – 06.00 hours)
 - AM (06.00 – 12.00 hours)
 - PM (12.00 – 18.00 hours)
 - Evening (18.00 – 00.00 hours)

- Day of the week
 - Weekday
 - Weekend

- Month of the year
 - 1st quarter of the year (January, February, March)
 - 2nd quarter of the year (April, May, June)
 - 3rd quarter of the year (July, August, September)
 - 4th quarter of the year (October, November, December)

Each and every cases of accidents extracted from the police reports were closely examine in order to determine the day of the accidents occurrence, which class of time of day did the accident happened and which quarter of years the accidents took place. After the identifications of time, day and months for all the 500 accidents cases were accomplished, the data were tabulated as in below Table 3.1.

Table 3.1 Number of accidents cases by year, time, days and month.

No	Year	Time				Type of Days		Quarter of months			
		SH	AM	Eve	PM	WKDYS	WKND	1st	2nd	3rd	4th
	2006	12	18	28	26	62	22	20	15	30	19
		4	6	3	5	15	3	4	7	5	2
		1	3	6	7	10	7	4	5	4	4
		1	4	16	4	18	7	5	8	5	7
		0	4	1	5	7	3	4	1	3	2
		1	2	5	1	8	1	3	2	2	2
		0	0	1	1	2	0	1	1	0	0
		0	3	3	7	10	3	3	6	3	1
		3	2	6	3	10	4	5	3	4	2
		1	1	2	1	3	2	1	2	1	1
	2007	9	12	35	20	59	17	17	23	18	18
		0	2	5	10	14	3	3	5	2	7
		1	2	6	5	11	3	3	0	7	4
		3	9	3	4	16	3	6	4	6	3
		0	4	7	4	13	2	5	3	1	6
		1	1	0	2	3	1	0	2	1	1
		0	1	1	3	2	3	2	0	3	0
		4	1	6	5	6	10	5	2	2	7
		3	5	6	1	11	4	2	5	3	5
		1	1	1	1	1	3	2	1	1	0
	2008	20	27	55	38	104	36	46	32	34	28
		1	1	12	8	12	10	5	11	0	6
		1	6	10	3	18	2	4	4	9	3
		0	9	9	10	18	10	6	10	10	2
		4	7	3	2	8	8	6	3	7	0
		0	3	4	3	8	2	5	1	1	3
		4	3	9	10	18	8	6	5	6	9
		4	10	7	15	25	11	7	14	8	7
		2	12	23	6	23	20	14	13	3	13
		2	1	7	5	12	3	5	0	3	7
	2009	5	6	17	17	37	8	10	13	12	10
		0	4	7	4	13	2	4	3	7	1
		0	6	8	3	10	7	7	4	3	3
		1	3	6	6	11	5	2	6	8	0
		4	0	3	2	8	1	2	0	5	2
		1	2	1	8	8	4	3	0	5	4
		1	2	4	1	5	3	1	2	3	2
		1	2	3	1	6	1	1	1	3	2
		4	5	6	2	10	7	6	6	2	3
		0	2	1	1	3	1	1	0	1	2

Above table shows the number of accidents in according to it's time, day and months of occurrences. From this table, trends of accidents in regards to it's travelling period can be developed. However, during the analysis process using Statistical Packages for Social Sciences (SPSS) were done, accident cases were inserted once again one by one into the datasheet for a total of 500 numbers of accidents.

3.5 DATA ANALYSIS AND MODELING

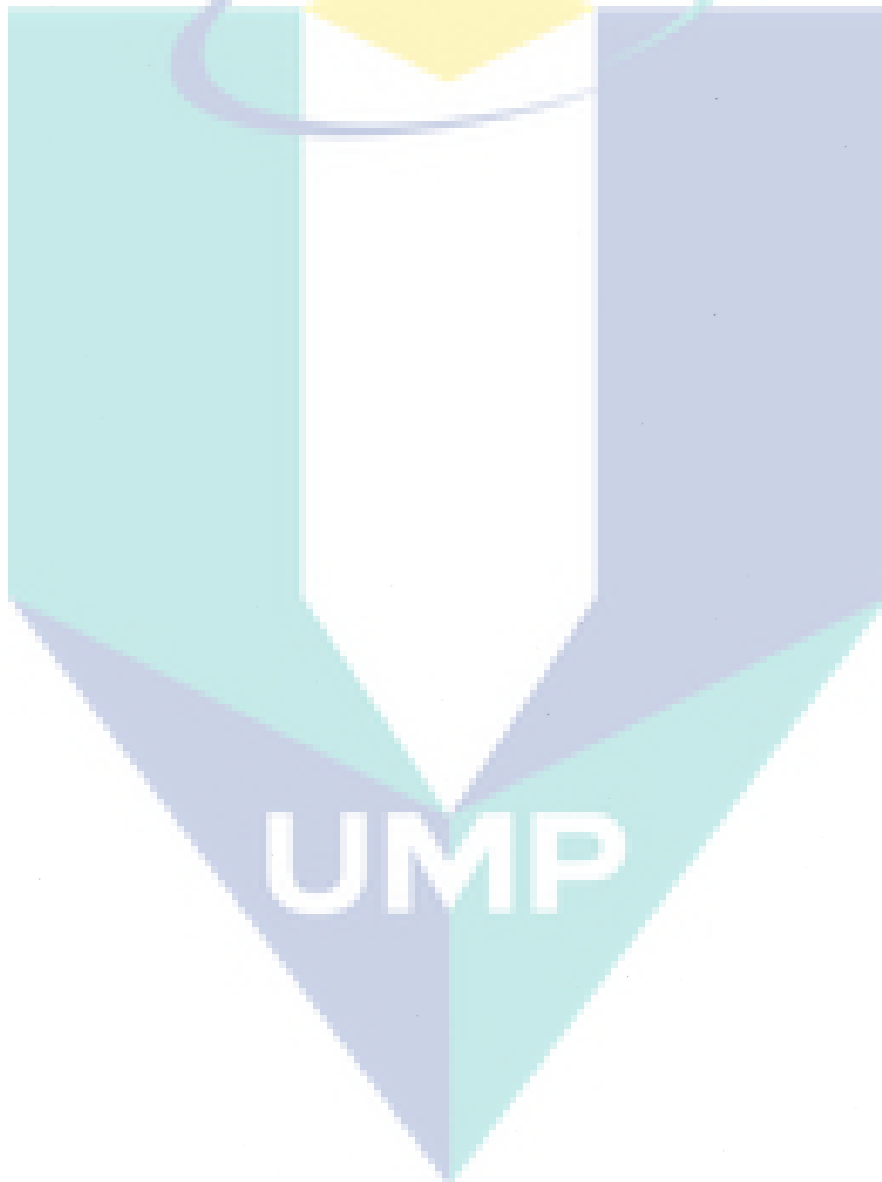
In this phase, the modeling activities were to model the effect of road environment on the number of traffic accidents for the study route using *Statistical Package for Social Sciences* (SPSS) version 12.0. In this study, SPSS was applied to determine the coefficients and parameters for linear modeling of propose sets of dependent and independent variables.

Modelling process would involved several steps as follows;

- Preparation of new datasets comprising number of traffic accidents, time of accidents, days of accidents, months of accidents for year 2006 until year 2009.
- Correlation analysis between dependent variables and independent variables and also between all independent variables.
- Inferential analysis based on results of normality test were done, if the normality test shows that all variables were normally distributed then the normal parametric test will be done otherwise, the non-parametric test will be conducted.
- Derivation of model that measure the effect of road environment on number of traffic accidents.

3.6 SUMMARY

The purpose of this study was to determine the effect of road environment on number of traffic accidents. The process of data collection, interpretation and processing was done in a selective way to make sure that data analysis and modeling process were carried out systematically. At the end of phase 1, traffic accident patterns for the study route were obtained and suitable datasets were prepared for modeling process in phase 2. The next chapter presents results of the study follows by the discussion on the findings.





CHAPTER 4

RESULTS AND DATA ANALYSIS

4.1 INTRODUCTION

Data analyses are crucial steps to be completed in order to required relevant results from the study done by the researchers. The outcomes from the study were acquired mostly from the data analyses stage and most importantly the outcomes from the study will indicate whether the objectives of the study were met or vice-versa.

Aware of the importance of this stage, researcher has carefully planned all the related works, tests and analyses so it can possibly portrayed the real situation occurred along the study area and finally the road environment factors which are strongly associated with an increase in number of road traffic accidents can be identified before further works can be proposed.

4.2 DEMOGRAPHIC DATA OF BOTH VARIABLES

Demographic data of both road traffic accidents data and road environment factors is tabulated to ensure that data were more accurately presentable for better understanding. Road traffic accidents data will be referred to number of road traffic accident occurred from KM 3 until KM 63 along Federal Road 2 which part of connecting Port Kuantan to Port Klang. Meanwhile, road environment factors is referring to situation or period of accidents occurrences and three main period were taken into account; months of accidents, days of accidents and times of accidents and at the end of the research, a relationship between road traffic accidents and road environment factors which includes those three parameters will be developed.

4.2.1 Road Traffic Accidents Data

A 63 km length research area has been segregated into 6 similar stretches with 10 km long in each stretch. The data collection started at KM 3 and ended at KM 63 and the demographic data of the number of road accidents cases are as shown in below table.

Table 4.1 Number of Road Traffic Accidents Details

Accident Locations	Frequency of Accidents	Percentage of Accidents (%)
KM 3 - KM13	202	40.4
KM 13 – KM 23	142	28.3
KM 23 – KM 33	62	12.4
KM 33 – KM 43	67	13.4
KM 43 – KM 53	19	3.8
KM 53 – KM 63	8	1.6
Total	500	100

As shown in the table above, a total of 500 accidents were occurred along KM 3 until KM 63 with the highest number of accidents were contributed by KM 3 until KM 13 whereas the lowest number of accidents was at KM 53 until KM 63. The balance of the number of accidents was shared by 4 other sections with most them were equally contributed except for section 2 (KM 13 – Km 23). As this data were taken for the period of 4 years, it can be expected that in a period of one week, more than 2 accidents will took place along this route.

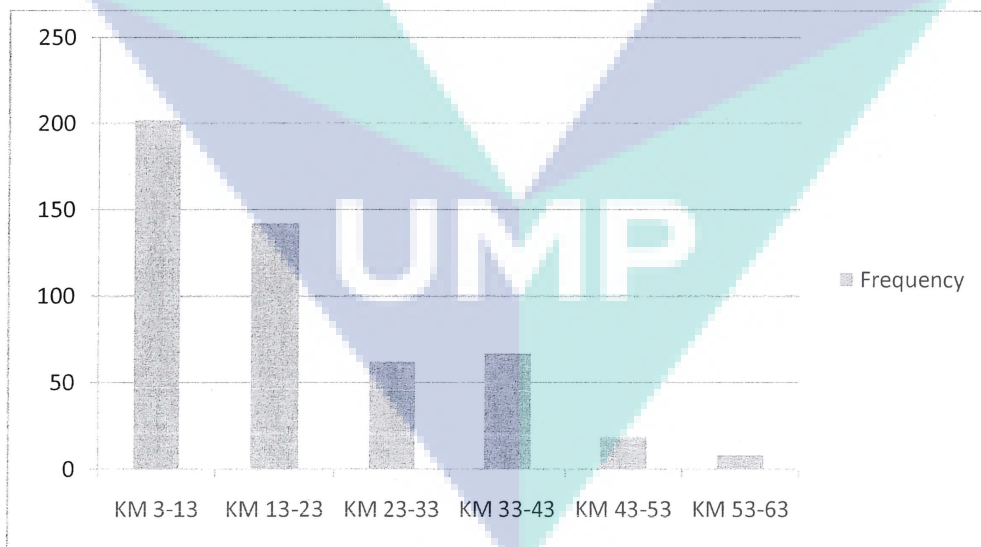


Figure 4.1 Numbers of Road Traffic Accidents by Locations

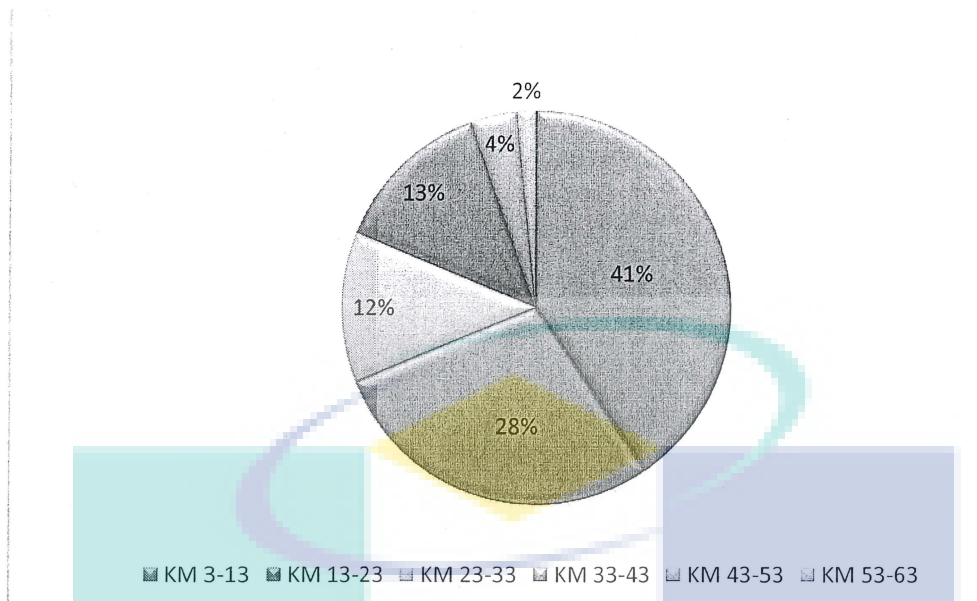


Figure 4.2 Percentages of Road Traffic Accidents by Locations

Above figures shows the accidents statistics in more detail format. By looking at this figure, it can clearly concluded that 3 most dangerous stretch along this study area are the one that is closer to town with 200 and 142 number of accidents respectively for section 1 (KM 3 – KM 13) and section 2 (KM 13 – KM 23)

4.2.2 Road Environment Factors

Road environment factors that were taken into considerations in this research are days of accidents, months of accidents and times of accidents occurrences. All these data can be taken directly from police accidents database and from the raw data; the data were simplified and tabulated accordingly for better understanding of all readers. First, let's check on the demographic data of days of which the accidents occurred. The days of accidents were classified into two main class; weekdays and weekend and the tabulation of accidents within these days are as below table.

Table 4.2 Number of road accidents by days

Type of days	Frequency of accidents	Percentage of accidents (%)
Weekdays	357	71.4
Weekend	143	28.6
Total	500	100

Type of days were suspected to be one of the factors contributing to number of road traffic accidents since traffic were more heavy during weekdays as compared to weekends due to heavy movements from people from/to work, children to/from school etc. By looking at the table above, researcher earlier assumption seems to be true as more than 70% of accidents were happened during weekdays compared to weekend.

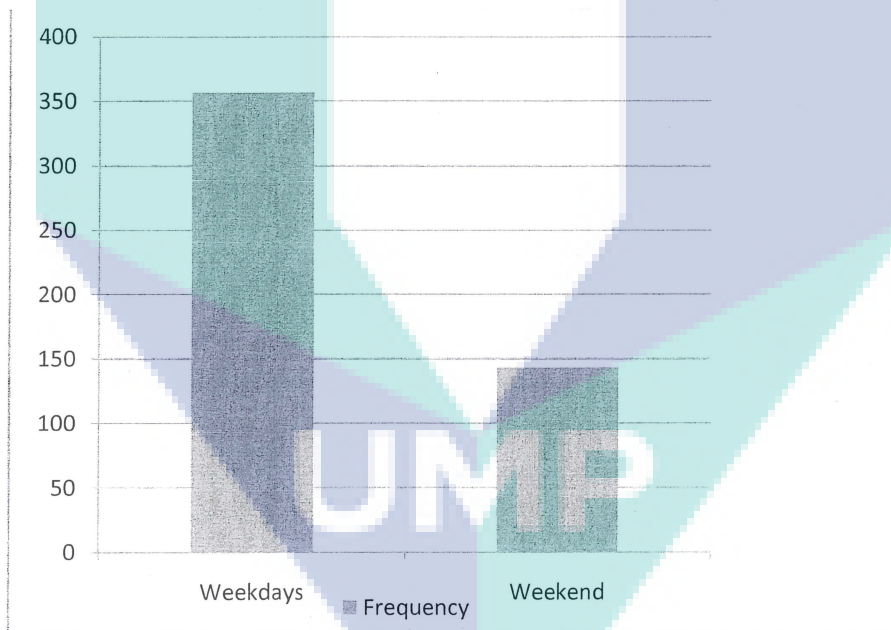


Figure 4.3 Frequency of accidents by types of days

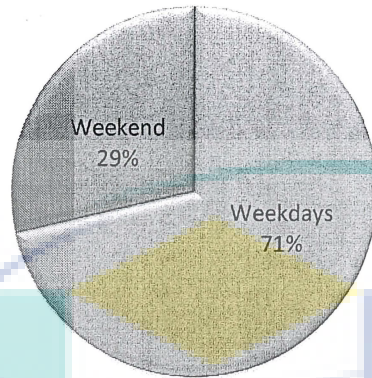


Figure 4.4 Percentages of accidents by type of days

Also, the frequencies and percentages of accidents shows that number of accident during weekdays are almost 3 times higher than number of accidents during weekend. This is quite a worrying fact since people seems to have no choice either than facing a bad traffic with a bad accidents history for their daily routine. Again the above statement was quite true by looking at the number of accidents in each section according to type of day in below figure 4.5.

Those two sections of road which is the nearest to the town centre (KM 3 – KM 13 and KM 13 – KM 23) seems to have high number of accidents during weekdays compared to section 6 (KM 53 – 63) where the areas are surrounded by plantation and village areas. Here in section 6, types of days appeared as having no difference since number of accident during weekdays and weekend were almost the same.

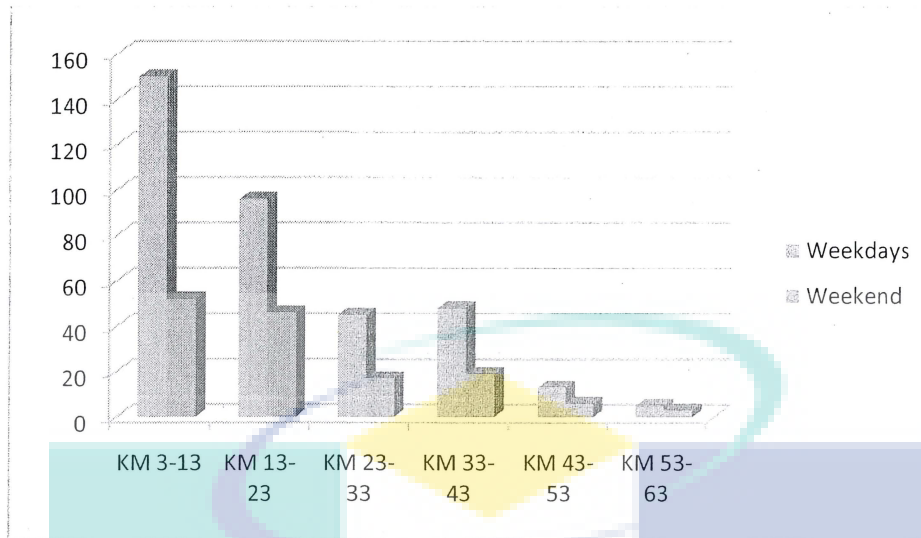


Figure 4.5 Number of accidents by type of days for each section

Along with types of days, the numbers of accident cases along KM 3 to KM 63 were also classified based on months of accidents occurrences. In order to check which period of months of the year is actually dangerous, the 12 months of the year is classified in to 4 quarters; first quarter of the months (January, February, March), second quarter of the months (April, May, June), third quarter of the months (July, August, September) and fourth quarter of the months (October, November, December). The tabulation of number of accidents cases by months is as below table and figures.

Table 4.3 Number of accidents by months details

Quarter of Months	Frequencies of accidents	Percentages of accidents (%)
First Quarter	140	28.0
Second Quarter	113	22.6
Third Quarter	131	26.2
Fourth Quarter	116	23.2
Total	500	100

The reason why this factor was included is originally based on the surrounding's influences. We often heard people argued whether it is safe or not to travel during raining season which normally fall within October until December as the risk of accidents are quite high due to the bad road conditions, poor sight distances and many more but the questions is, do month of travelling really influence traffic accident? Table 4.5 shows that the number of accident cases for all 4 quarters of years with all number of accidents were calculated to be above 100 accident cases for all quarters.

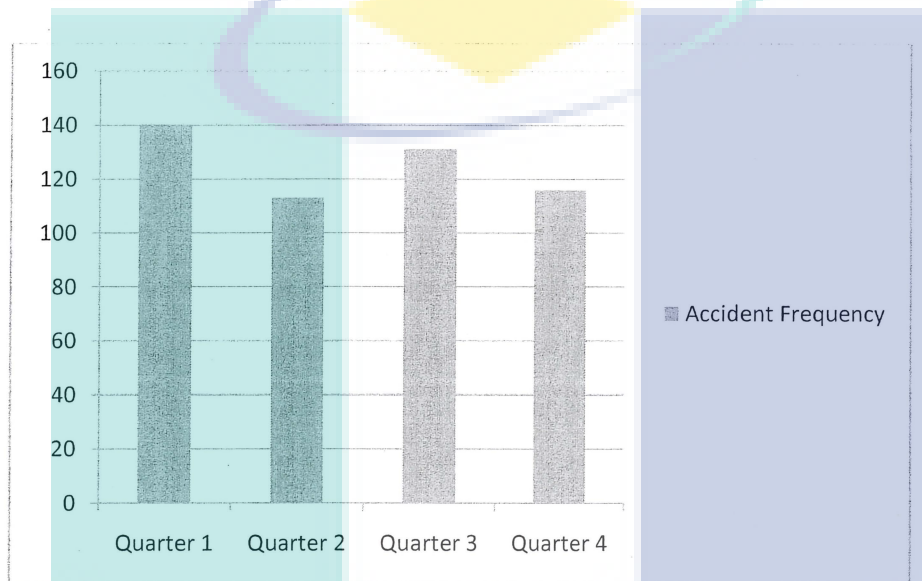


Figure 4.6 Number of accidents by months

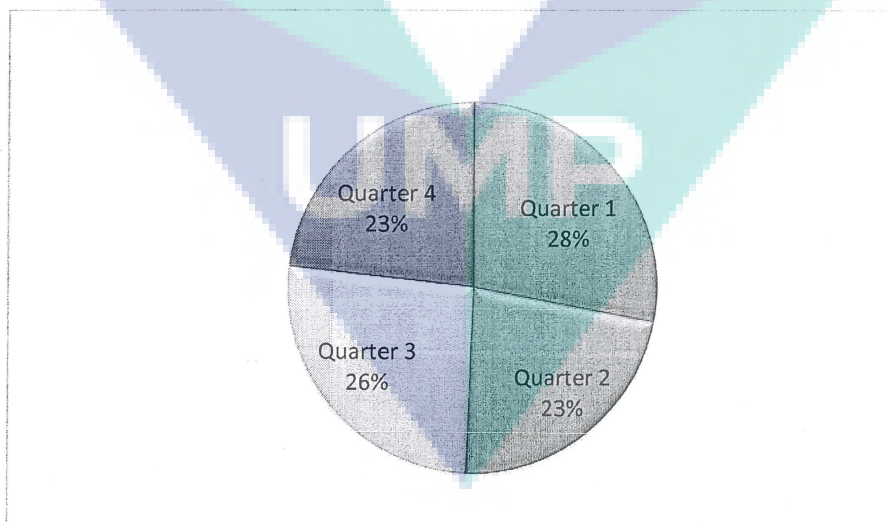


Figure 4.7 Percentages of accidents by quarter of months

By looking at the figure in the above Figure 4.6 and Figure 4.7, we can see that number of accidents cases are equally distributed within 4 quarters of years with the third quarter of year which is between July and September had experienced the highest number of accident cases. So, at first glance, it is obvious those months cannot be blamed as one of the elements that can triggered an accidents. Nevertheless, the correlation analysis done after this would clearly prove whether this statement is true or not.

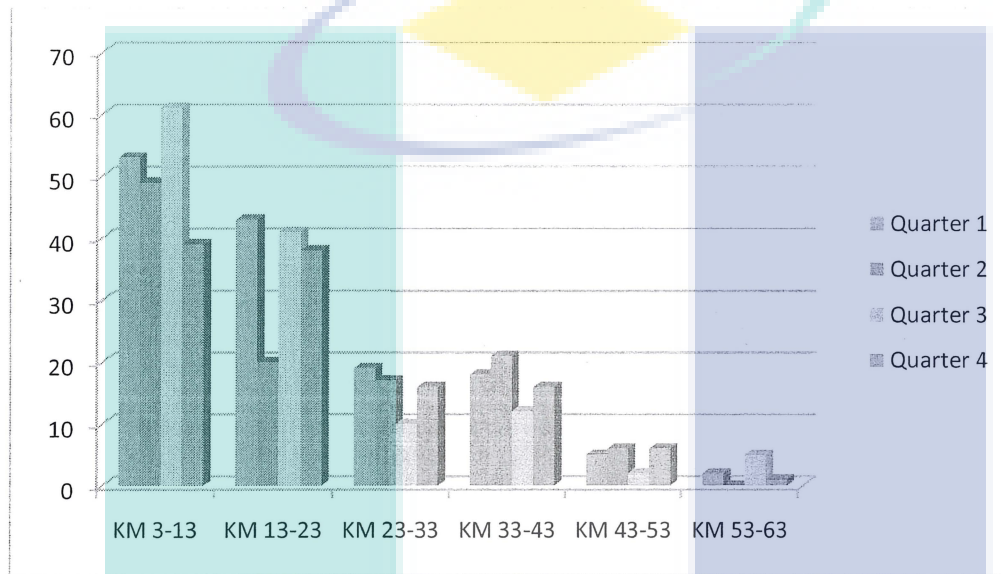


Figure 4.8 Number of accidents by quarter of months for each section

As portrayed in Figure 4.8, the numbers of accident cases were distributed by sections and parallel to distribution by days, section 1 which is between KM3 – KM 13 was still the highest in number of accident compared to other quarters.

Similarly, the times of accidents occurrences were also been taking into account to see whether the factors of accidents times have a high effect on the numbers of accidents cases. Times of the day are again classified into several groups for better and accurate analysis. Four classes of times were developed within 24-hours which is; Small Hours (00.00 – 06.00), AM (06.00- 12.00), PM (12.00 – 18.00) and Evening (18.00- 24.00). The tabulations of number of accidents by times of accidents are as below table and figures.

Table 4.4 Number of accidents by times details

Times of the day	Frequency of accidents	Percentages of accidents
Small Hours	140	28.0
AM	113	22.6
PM	131	26.2
Evening	116	23.2
Total	500	100

Times of the day are also one of the road environment factors that should be well taken care of. For instance, one of the causes of accident during nighttime as well as in poor weather condition is poor visibility. Poor visibility is not only imposed danger to drivers but also to vulnerable road users. High risk for fatal road traffic accidents were found on urban roads, during nighttime and with poor visibility especially in the darkness, sunset and sunrise (Jovic, A.V., et al., 2005) since urban roads were busier during these times as compared to rural roads. As a result, risks of fatality during these hours were more significant at urban roads than in rural roads.

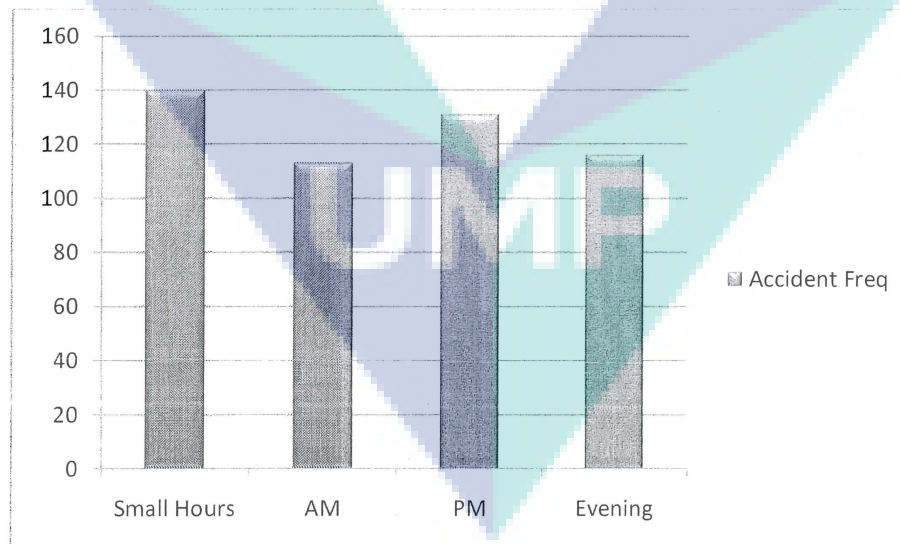


Figure 4.9 Number of accidents by times of the day

According to Table 4.4 and Figure 4.9 above, the highest numbers of accidents cases were recorded between 00.00 hours until 06.00 hours which is definitely the darkest hours of the day. So, poor visibility due to the dark environment surrounds the driving condition could be one of the reasons why number of accident cases were quite high during this time compared to other period of time although roads are relatively busier during the daytime compared to nighttime,

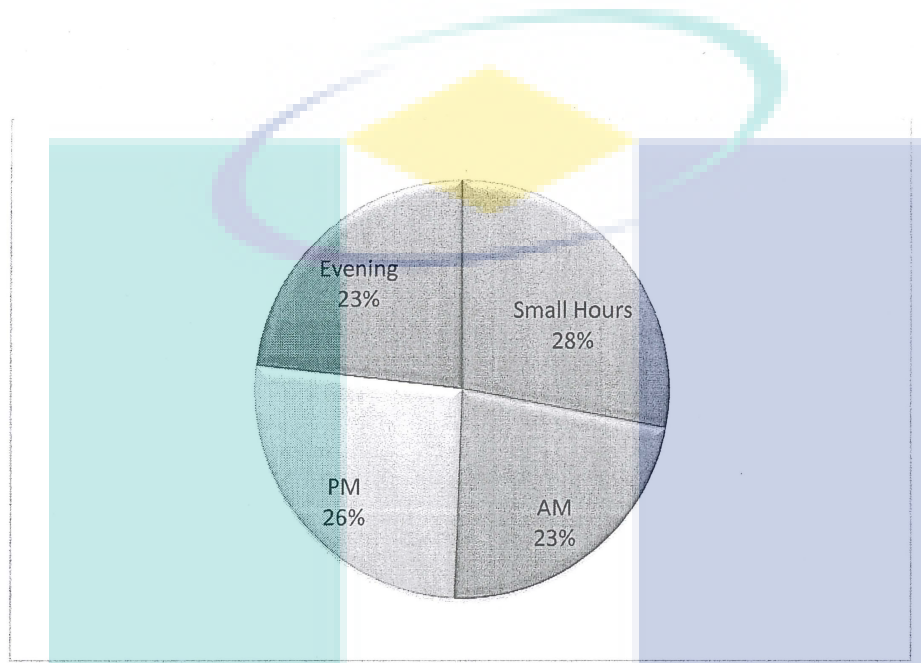


Figure 4.10 Percentages of accidents by times of the day

However, by studying the percentage of accident cases in Figure 4.10, besides the Small hours period who's leading the chart, PM periods which is between 18:00 until 00.00 hours was stated to be at second place. And once again, darkness of the road environment could be the triggering elements as during this hour, sunlight starts to hiding behind the clouds to make way for the moon.

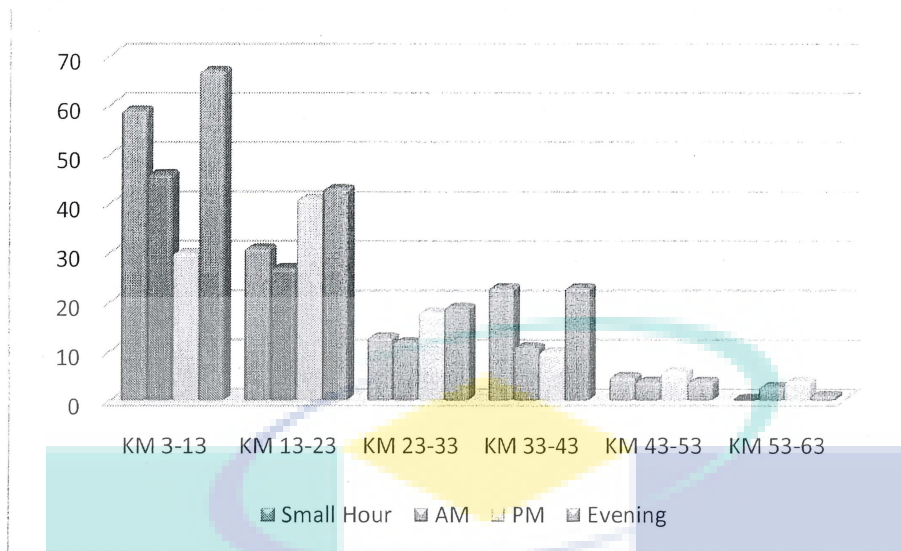


Figure 4.11 Number of accidents by time of accidents for each section

When the number of accident cases by hours of the day was tabulated by sections, we can see that almost all sections having a problem during small hours and PM period of time except for section 6 (KM 53-63). This possibly caused by the surroundings nature of the roads since all roadside areas were filled with plantations, roads cannot be as busier as sections located near to town centre.

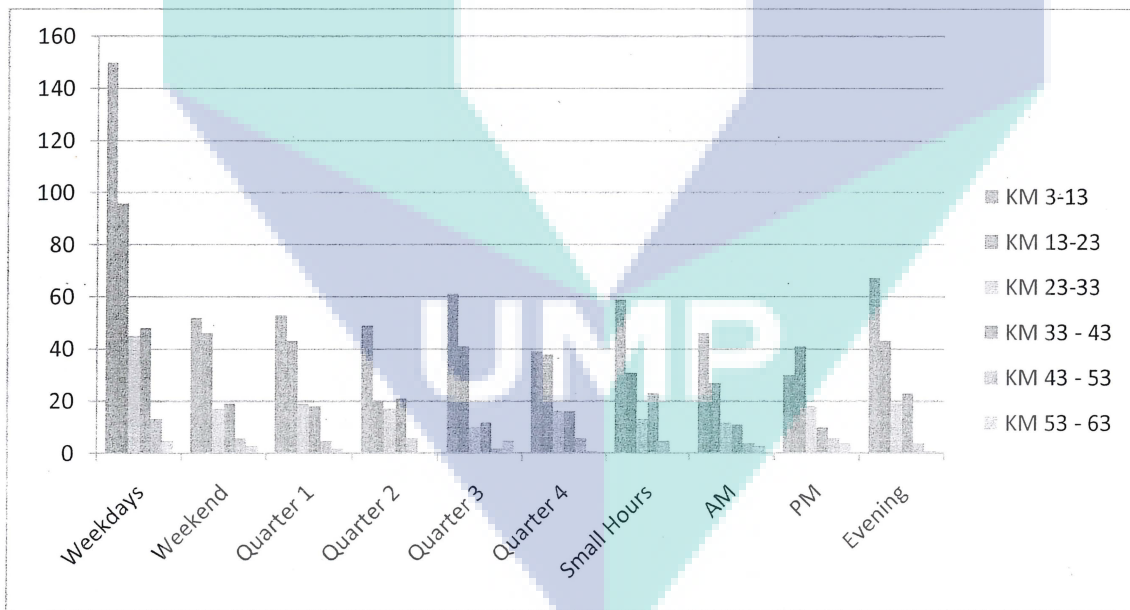


Figure 4.12 Tabulation of numbers road traffic accidents by road environment factors

Figure 4.12 actually supplied us with a very important fact. One major conclusion that can be made here is, of all the road environment factors, from types of days until times of the day, KM 3 until KM 13 happened to records the highest number of accidents cases in every aspects. Or in other words, this section is mostly dangerous to the road users regardless of what days, months and times they travelled.

4.3 DESCRIPTIVE ANALYSIS OF ROAD TRAFFIC ACCIDENTS AND ROAD ENVIRONMENT FACTORS

Descriptive analysis will be looked into the aspect of goodness of the data. All dependent and independent variables data will have to go through the descriptive analysis to make sure that the data is ready to be used in further analysis stage.

4.3.1 Road Traffic Accidents

Road traffic accidents data as mentioned above is segregated into several categories and in each categories, it covers 10 km length of research area. Below are the table shows the results of the descriptive analysis done on the road accident data.

Table 4.5 Descriptive analysis of road accident data

Road Accident data	mean	mode	median	Standard deviation	skewness
N = 500	2.166	1.00	2.000	1.279	0.971

500 accident cases were taken into consideration in this study which the accident cases were collected between KM 3 until KM 63 along Federal Road 2: Port Kuantan-Port Klang. By looking at the above table 4.5, the mean scores generated from the road accident data is 2.166 which shows that in average most of the accidents occurred within KM 13-23 (1: KM 3-13, 2: KM 13-23, 3: KM 23-33, 4: KM 33-43, 5: KM43-53, 6: KM 53-63) but if we looking at the results of closely, we can see that between KM 3-13 has recorded the highest accidents concentration (mode = 1.00).

The differences between mean and mode value maybe given by outliers either towards the right or the left side of the data. Although 2.166 which mean stretch no 2 is the central tendency of the data but in terms of calculating the highest number of accident in one stretch, mode value is more precise to be used and since stretch no 1 is the most frequent value occur in the datasets, so stretch no 1 which is between KM 3-13 is the one that recorded highest number of accidents compared to stretch no 2.

Also, the results from the standard deviations (SD: 1.279) shows that most of the accidents were fall between stretch no 1 and stretch no 3 [$0.887(2.166 - 1.279) - 3.445(2.166 + 1.279)$] and this true by looking at the mean value (mean = 2.166) and it can be concluded that, of all the 500 number of accident cases, most of the accident cases are fall between KM 3 until KM 33 and this results gives an impact to the skewness of the data, as most of the data are pulled towards the right side of the data, the shape of the data is more likely are skewed to the right but since the value of skewness is 0.971 which is very close to 1 (normal distribution), the distribution of the data is acceptable and can be used for further analysis.

4.3.2 Road Environment Factors

Road environment data are comprised of days of accidents, months of accident and times of accidents with each type are classified again in other small scales classifications. For days of accidents, the researcher has classified it into two main groups i.e. weekdays and weekend, for the months of accidents, the number of accident cases were grouped into four main groups i.e. first quarter of the months, second quarter of the months, third quarter of the months and fourth quarter of the months. All 12 months in a year are divided into this group made up of 3 months in each group.

As for the times of accidents, the 24 hours of the day were grouped into 4 major groups i.e. small hours, AM, PM and Evening and by dividing 24 hours with 4 groups, we have exactly 6 hours in each group. According to these groups of environment factors, all 500 numbers of accidents were classified according to the accident's day, month and time of its occurrences. Below table shows the results of the descriptive analysis made for the number of accidents according to its road environment factors.

Table 4.6 Descriptive analysis for number of accident cases by road environment factors.

N = 500	Mean	Median	Mode	Standard Deviation	Skewness
Days	1.2860	1.000	1.00	0.4523	0.950
Months	2.4460	2.000	1.00	1.1286	0.034
Times	2.5840	3.000	4.00	1.1823	-0.107

Mean value given by accident cases in days shows that the tendency of accident to happen during weekdays is higher compared to accidents during weekends and this result is supported by median and mode values of 1.00 shows that most of accidents is actually

happened during weekdays than in weekend. The value of standard deviation for days also concluded the concentration of accidents is higher in weekdays compared to weekends. In terms of distribution of data, number of accidents according to days of accidents shows a well-shaped curve with skewness value is closer to 1 (skewness = 0.950).

As for the months of accidents, the central tendency of data shows that most of accident occurred during second quarter of the months i.e. April, May, June (mean = 2.446, median = 2.000) but if we looked at the value of mode, it clearly stated that most of accident took place within January to March but again if we looked at the value of standard deviations, it clearly suggested that most accidents are actually occurred during January until September of the year with the highest accident concentration is between January to March. This resulted to a curve that is highly skewed to the right as the high number of accidents within first quarter of the year had pulled the curve much to the right hand side (skewness = 0.034).

Finally, for the factor of times of accidents, there is not much differences in the values of mean and median (mean = 2.5840, median = 3.000) as those two values suggested that accidents were mostly occurred during 12.00 – 18.00 hours but according to the value of mode (mode=4.00), it's clearly stated that within 18.00 until 0.00 hours is the most dangerous times as most of the accidents occurred during this period of times. Somehow, the standard deviations value has recommended that most of the accidents are well distributed amongst all times of the day but since the 18.00 -00.00 hours of the days has indicated as the most frequent times of accidents occurrence, it had pulled the curve much to the left side of the graph and resulted to a negative value of skewness (skewness = 0.107).

4.4 EVALUATION OF RELATIONSHIP BETWEEN ROAD TRAFFIC ACCIDENTS AND ROAD ENVIRONMENT FACTORS

Before proceeded with evaluation the relationship between road traffic accidents and road environment, the normality of the data should be checked first to ensure the type of analysis that should be used and furthermore a correct relationship could be build.

4.4.1 Normality Test

Normal distribution is referring to sets of data having all scores piled up around the particular value, which in this case mean value. If the data is not normally distributed, it will affect the originality of the model developed later on.

The results from the descriptive analysis shows that of all the accidents data by locations, by times of the days, by months and by days, only accidents data that is segregated by locations and by days are quite close to a shape of a normal distribution curve and this is supported by it'sskewness value, while others were having either a skewed to the right curve or skewed to the left curve which can be classified as not normally distributed.

Other than assessing the normality of the by using the mean, median and mode value, another test have been done to check on the reliability of the data. From SPSS reliability test, the tables below shows the results of a reliability test for all 4 variables.

Table 4.7 Reliability Test results

N = 500	
Cronbach's Alpha value	Number of items
0.033	Items = 4

From this reliability test, it is clearly shows that the data is not reliable since all data were not normally distributed. Also, because most of the data were not quite normally distributed, the internal consistency between variable were quite weak and because the cronbach's alpha value are way below 0.70, it shows that the relationship between road traffic accidents and road environment factor cannot be evaluated by using only a single factor. The results from the correlation analysis after this will prove either this statement is true or not.

4.4.2 Research Hypothesis

Before development of the model to interpret the relationship between road environment and road traffic accidents can be realized, related research hypotheses must be developed first. A hypothesis is a tentative statement that explains a particular phenomenon which can be testable. Although there are 2 types of hypotheses available to be used, in this research, the null hypothesis will be used instead of the alternative hypothesis.

As the null hypothesis is a research statement that is not supported the researcher's predictions, below hypotheses are developed in such a way that it is totally opposites from researcher's earlier predictions. Research hypotheses for this study are as listed below:

- i. There is NO significant influence from time of accidents to number of road traffic accidents along KM 3 to KM 53 of Federal Road 2.
- ii. There is NO significant influence from days of accidents to number of road traffic accidents along KM 3 and KM 53 of Federal Road 2.
- iii. There is NO significant influence from months of accidents to number of road traffic accidents along KM 3 to KM 53 of Federal Road 2.

These hypotheses were developed to ensure that along the analyses stage, the researchers are well kept to its original research needs and other than that, development of hypotheses is initial as a statement that have been put forward because the researchers believes that it is true and at the end of this stage, results gathered from all tests will answers the hypotheses and also directly fulfil the needs of the research objectives.

4.4.3 Correlation Analysis

Correlation analysis was done to evaluate the causal relationship between variables namely the dependent variables and the independent variables. In this analysis, the correlations between each independent variable towards the dependent variables were checked and furthermore, the degree of correlation and also the significance of one variable to another also were formed.

While the most of the road environment factors shows a weak correlation with numbers of road traffic accidents, the significance values between all variables are vice-versa. This result suggested that although there is a weak correlation between road environment factors and numbers of road traffic accidents data, there is a strong significance value between these factors and numbers of road traffic accidents. In other words, the days of accidents, months of accidents and times of accidents occurrence is significance to number of accidents cases along Federal Road 2 from KM 3 until KM 63. Table 4.8 below shows the matrix of correlation between all variables involved in this research.

Table 4.8 Matrix of Correlation and significance between all variables

	Accidents cases –locations (significance value)	Accidents cases –days (significance value)	Accidents cases –months (significance value)	Accidents cases –times (significance value)
Accidents cases- locations (significance value)	1	0.032 (0.474)	-0.001 (0.975)	0.009 (0.847)
Accidents cases –days (significance value)	0.032 (0.474)	1	0.111 (0.013)	-0.069 (0.121)
Accidents cases –months (significance value)	-0.001 (0.975)	0.111 (0.013)	1	0.006 (0.900)
Accidents cases –times (significance value)	0.009 (0.847)	-0.069 (0.121)	0.006 (0.900)	1

Correlation values are quite differs from significance value. Each of the value represents different concepts with correlation as it will shows how string the variables are correlated to each other, significance value on the other hand will indicates the degree of influences or degree of implications between variables. This result suggested that although there is a weak correlation between road environment factors and numbers of road traffic accidents data, there is a strong significance value between these factors and numbers of road traffic accidents. In other words, the days of accidents, months of accidents and times of accidents occurrence is significance to number of accidents cases along Federal Road 2 from KM 3 until KM 63.

This result supports the results from reliability test done earlier. As provided by the result from reliability test, all these three factors must be included during the development of the relationship between road environment factors and number of traffic accidents since according to this correlation analysis result, all three of them are highly significance towards number of accident cases along the study area.

4.4.4 Inferential Analysis: Non-parametric Test

Since the parametric test requires the distribution of the populations to be correctly specified and the population of accidents cases is somehow quite impossible to be correctly specified the researcher opted to use the non-parametric test in her inferential analysis. Apart from that, as the results from descriptive analysis and normality test clearly showed that the data taken for this study is not normally distributed, non-parametric test is the best suit test to be used in this statistical analysis. Results of the hypothesis testing using non-parametric test for all hypotheses as listed earlier were summarized in below table.

Table 4.9 Results of non-parametric test for hypotheses testing

Null Hypotheses	Significance value (p-value)	Decisions
There is NO significant influence from months of accidents to number of road traffic accidents along KM 3 to KM 53 of Federal Road 2.	0.162	Accept null-hypothesis
There is NO significant influence from times of accidents to number of road traffic accidents along KM 3 and KM 53 of Federal Road 2.	0.133	Accept null hypothesis

There is NO significant influence from day of week of accidents to number of road traffic accidents along KM 3 to KM 53 of Federal Road 2.	0.401	Accept null hypothesis
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For the relationship between months of accidents and number of road traffic accidents, Kruskal-Wallis Test was used. Results from the test indicated the p-value of 0.162 which is higher than the cut-off point of p-value which 0.05 and therefore it is strongly suggested that by depending on the significance value proposed from this test, the null hypotheses for the relationship between months of year and number of accidents cases were retained. As a result by retaining the null hypothesis, it is concluded that there is NO significance influence from the factor of months of year to number of road traffic accidents.

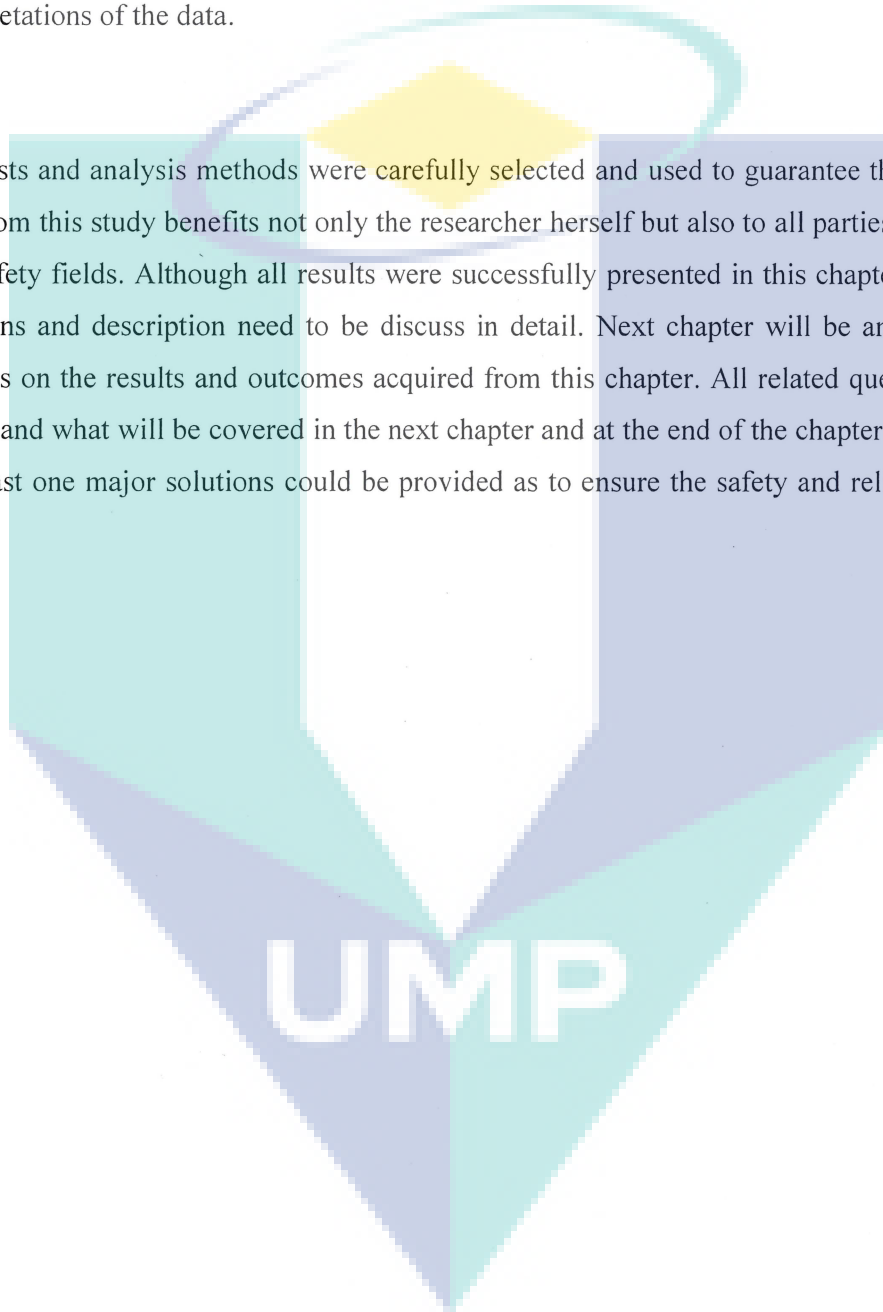
Second relationship that was tested was the relationship between times of the day and number of road traffic accidents. Once again, Kruskal-Wallis test were used to measure the relationship between these two variables. Results from the test had generated a significance value of 0.133 for the p-value of 0.05 and again the value was higher than the significance value cut-off point. Since the significance value was higher than 0.05, the null hypothesis was once again been accepted. By accepting the null hypothesis it has proved that there is NO significant influence from the factor of times of day to number of road traffic accidents along KM 3 until KM 53 of Federal Road 2.

Finally, the third road environment factor which is the days of the week was about to be tested against an increase on number of road traffic accidents. For these variables, Mann-Whitney U test was used. Result generated from this relationship was quite higher compared to those previous two relationships. With a significance value of 0.401 produced from this test it is definitely higher than the significance value cut-off point of 0.05 and once again the null hypotheses for the relationship between days of week and number of road traffic accidents is accepted.

4.5 SUMMARY

Outcomes gathered during the analysis stage are a key point to ensure that research objectives of this study were fulfilled or not. As this stage was quite crucial to this study, the researchers personally put more attention to this stage to minimise miscalculations and misinterpretations of the data.

Tests and analysis methods were carefully selected and used to guarantee that results coming from this study benefits not only the researcher herself but also to all parties involves in road safety fields. Although all results were successfully presented in this chapter, further explanations and description need to be discuss in detail. Next chapter will be an in-depth discussions on the results and outcomes acquired from this chapter. All related questions on how, why and what will be covered in the next chapter and at the end of the chapter it is hope that, at least one major solutions could be provided as to ensure the safety and reliability of this route.





CHAPTER 5

DISCUSSION AND CONCLUSION

Identifying dangerous situations on roadways, determining what factors affect safety, and looking for appropriate solutions to improve overall roadway safety are among the essential tasks to be sought off. Generally, many factors have been identified as critical contributing elements that lead to road crashes, and they can be considered in four separate categories which are the driver, the vehicle, the roadway condition and the environment.

Despite of the all possible factors mentioned above, driver error usually being the major contributing causes of many crash situations (T. Assum and M.Sorensen (2009), C. Tingvall (2009) and Y.E. Papelis (2008)). Studies on the driver error have been carried out extensively. However other critical contributing factors that lead to road crashes should not be put aside as such the road environment. Road environment also can have strong influences that lead to road crashes as it will affect the ability of drivers and their vehicles to travel along the road section. For instance, weather and lighting conditions may restrict the visibility of the road itself, other vehicles and road users while travelling.

Considering those issues, this study was conducted to explore the relationship between road environment and number of road traffic accidents. A stretch road of 63km Jalan Kuantan – Maran (Federal Road 2) was selected to serve as a study area. The analysis was done based on the demographic data of road traffic accidents and road environment factors that mainly focused on time, day and month and followed by a descriptive analysis. Next, the relationship between both road traffic accidents and road environment factors of travelling periods was developed.

5.1 Traffic Accidents Patterns

As discussed in preceded chapter, the study area of Federal Road 2 (Jalan Kuantan – Maran) has been divided into 6 similar sections namely Section 1 started in Kuantan (KM3) to Section 6 ending in Maran (KM63). The separation by sections gave a more detailed description of the nature of the influences in traffic accidents patterns along the study area.

For traffic accidents patterns at the study area, the data analyzed give insight to the following elements: number of traffic accidents associated with road environment factors that mainly focused on time, day and month. From the demographic analysis, show that the highest number of accidents occurred in Section 1 which was closest to town area and the value were kept lessening whilst approaching rural area until Section 6. This is supported by descriptive analysis which the highest accidents concentration (mode=1) in Section 1.

Based on this finding, it can be said that the regardless of time, day and month number of accident is considerably higher in urban environment compared to rural area. These finding had give some indication that this condition was related to the traffic flows generated in the area. As we know, there are more activities occurred in urban areas. Hence, it is found that an increase in traffic volume is associated with increase in traffic accidents. This is seemed to be in line with the study conducted by Graham Amis (1996) where he found that an increase of 1000 vehicles per day is associated with 12% increase in accident.

In addition, the urban area also is a complex maneuvering areas with high number of traffic conflicts of crossing, merging and diverging. There are a lot of junctions were noticed along the road especially in Section 1. With the high traffic volume and variety of traffic

composition on the road those elements might give influences on the increases of number in traffic accidents in Section 1. In contrast with Section 6 where this area is a rural area that surrounding with plantation. Section 6 experienced the lowest number of traffic accidents cases. This is understandable since fewer activities are expected in rural areas with less traffic volume and traffic conflicts.

In summary of the traffic accidents patterns along Federal Road 2, the risk of accidents in an urban environment is significantly higher than rural area. As such special treatments should be made in urban environment to countermeasure the problems.

5.2 The Relationship between Travelling Periods and Number of Road Traffic Accidents

In this study, the statistic in the form of correlation and inferential analysis of Non-Parametric Test forms the basis for testing the relationship between travelling periods to the number of road traffic accidents along Federal Road 2. As mention earlier, the travelling period was classified to time of the day, day of the week and also month of the year. Each of these independent variables was quantified to the number of road traffic accidents by using the approach of correlation analysis.

Based on the analysis, it is noted that there was a strong significance value between time of the day, day of the week and also month of the year to the number of road traffic accidents. This finding was also reinforced by the results obtained from the reliability test done earlier, which stated that those independent variables were importance towards number of road traffic accidents at the study area.

Nevertheless, very interesting finding arose that contradict with above statement. It shows that there was a weak correlation develops on each time of the day, day of the week and also month of the year to the number of road traffic accidents along Federal Road 2. This result was also supported by the Non- Parametric Test which accepted all the null hypothesis in this study. With this finding, it can be concluded that there is no significance influence from time, days and months to the number of road traffic accidents along Federal Road 2 as predicted by the researchers.

5.3 Conclusions

In summary, as in the analysis shows that there is no significance influence from time, days and months to the number of road traffic accidents along Federal Road 2. Therefore it can be said that the environment may not contribute as a factor to the crashes. Perhaps these may due to insufficient elements in the data used in this study.

As in this study, apparently we can assume that the driver errors are the factors of those crashes. It might be because of traveling at the excessive speed. In addition, since we know that most of the crashes occurred closest to town area and during night time. Basically drivers who are on the roads at night are likely to be fatigued and possibly intoxicated. Therefore they are less able to modify their driving as needed to safely negotiate with a sudden condition especially when traveling at higher speed.

Instead of the driver failure, the vehicles condition might be the other factor that contributes to the crashes to occur. For example the faulty of mechanical condition of the vehicles such as breaks not function accordingly, failure of the electrical system, worn tires and others.

Last but not least is on the road condition along the study area. For instance, the unsuitable geometric design, uneven road surface, lack of road furniture facilities and also lack of proper maintenance and rehabilitation on the carriageway might influence to the crashes to occur.



UMP

5.4 Suggestions for Future Research

The finding in this study proved that there is no relationship between travelling periods of time of the day, day of the week and also month of the year to the number of road accidents along Federal Road 2. Nevertheless, these results suggest the need for further study to be done since the strong significance values between travelling periods of time of the day, day of the week and also month of the year to the number of road accidents noted in one of the analysis carried out in this study.

For the future research it is suggested that the addition of elements in database need to be acquired. For example the type of collision, road alignment and the speed of the vehicles at time of crashes occurred. These elements might have some contribution on the investigating the relationship between travelling periods to the number of road traffic accidents.

In addition, the study also could be expanded to a longer stretch so that a more data could be collected. Hence a more reliable and detail analysis could be carried out. Other than that, as in this study the concentration of number of road traffic accidents was in urban environment, therefore the roadside developments elements should be encountered in this study in order to improve the accuracy and reliability of the data. Knowledge on which the environment factors influences on driving is important as it may provides a means to plan, construct and operate ways that remove or at least reduce the incidence of road crashes

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