DEVELOPMENT OF ACCIDENT PREDICTION MODEL BY USING ARTIFICIAL NEURAL NETWORK (ANN)

MOHD ZAKWAN BIN RAMLI

A project report submitted in partial
fulfillment of the requirement for the award of the
Degree of Master of Civil Engineering

Faculty of Civil and Environmental Engineering
Universiti Tun Hussien Onn Malaysia

MAY 2011

ABSTRACT

Statistical or crash prediction model have frequently been used in highway safety studies. They can be used in identify major contributing factors or establish relationship between crashes and explanatory accident variables. The measurements to prevent accident are from the speed reduction, widening the roads, speed enforcement, or construct the road divider, or other else. Therefore, the purpose of this study is to develop an accident prediction model at federal road FT 050 Batu Pahat to Kluang. The study process involves the identification of accident blackspot locations, establishment of general patterns of accident, analysis of the factors involved, site studies, and development of accident prediction model using Artificial Neural Network (ANN) applied software which named NeuroShell2. The significant of the variables that are selected from these accident factors are checked to ensure the developed model can give a good prediction results. The performance of neural network is evaluated by using the Mean Absolute Percentage Error (MAPE). The study result showed that the best neural network for accident prediction model at federal road FT 050 is 4-10-1 with 0.1 learning rate and 0.2 momentum rate. This network model contains the lowest value of MAPE and highest value of linear correlation, r which is 0.8986. This study has established the accident point weightage as the rank of the blackspot section by kilometer along the FT 050 road (km 1 – km 103). Several main accident factors also have been determined along this road, and after all the data gained, it has successfully analyzed by using artificial neural network.

ABSTRAK

Model ramalan perlanggaran digunakan didalam bidang keselamatan jalan raya. Ia digunakan dalam mengenal pasti faktor-faktor penyumbang atau mendapatkan perhubungan antara kemalangan dan pembolehubahnya. Kayu pengukur bagi mengurangkan kemalangan adalah disebabkan daripada pengurangan halaju, pelebaran jalan, penguatkuasaan halaju, pembinaan pembahagi jalan, atau banyak lagi. Oleh itu, kajian ini bertujuan untuk membangunkan model ramalan kemalangan di jalan persekutuan FT 050 Batu Pahat ke Kluang. Proses kajian melibatkan pengenalpastian lokasi-lokasi hitam kemalangan, pengenalan bentuk-bentuk dan jenis-jenis kemalangan, analisis faktor-faktor yg terlibat, penyiasatan kawasan, dan pembangunan model ramalan kemalangan menggunakan perisian *Artificial Neural Network* yang dipanggil NeuroShell2. Tahap hubungan antara pembolehubah yang dipilih daripada faktor-faktor kemalangan diperiksa untuk memastikan model yang dibangunkan akan memberikan keputusan ramalan yang baik. Prestasi *neural network* dinilai dengan menggunakan *Mean Absolute Percentage Error* (MAPE). Hasil kajian menunjukkan *neural network* yang terbaik untuk model ramalan kemalangan di jalan persekutuan FT 050 adalah 4-10-1 dengan *learning rate* 0.1 dan 0.2 bagi *momentum rate*. Model rangkaian ini mengandungi nilai MAPE terendah dan nilai korelasi linear, r tertinggi iaitu 0.8986. Kajian ini juga telah membentuk *accident point weightage* mengikut *rank* bagi setiap seksyen di sepanjang jalan FT 050 (km 1 – km103). Beberapa faktor utama kemalangan juga telah ditentukan di jalan ini dan ia telah dianalisis dengan jayanya menggunakan *artificial neural network*.

CONTENTS

LIST OF TABLE

LIST OF FIGURES

TABLE **SUBJECT** **PAGE**

LIST OF SYMBOLS AND ABBREVIATIONS

JPJ	-	Jabatan Pengangkutan Jalan
PDRM	-	Polis DiRaja Malaysia
FT 050	-	Federal Route 50 (Batu Pahat-Kluang)
JKR	-	Jabatan Kerja Raya
ANN	-	Artificial Neural Network
KM	-	Kilometer
MAPE	-	Mean Absolute Percentage Error
RSRC	-	Road Safety Research
HPU	-	Highway Planning Unit
m	-	Meter
veh/hr	-	Vehicle per hour
APW	-	Accident Point Weightage
r	-	Correlation coefficient
AP	-	Access Point
HTV	-	Hourly Time Volume
PS	-	Percentile Speed
TA	-	Total Accident
km/hr	-	Kilometer per hour

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background of the study

The main purpose of transportation system is to provide the efficient and safe movement of freight and passenger from one place to another. The economic development is directly and strongly related to the availability of transportation. The soaring number of vehicles on the road had created a major social problem through traffic accidents due to the loss of lives and material. Statistical or crash prediction model have frequently been used in highway safety studies. They can be used in identify major contributing factors or establish relationship between crashes and explanatory variables, such as traffic flows, type of traffic control, and highway geometric variables.

Through the existence of road networks in Malaysia, there has been various type of vehicle on the road such as car, bus, motorcycle, lorry, van and others that used as a basis to move from one destination to other destination. Based on the statistic in year 2010 from Road Transportation Department (JPJ) website as shown in Figure 1.1, the registered public vehicles are increasing every year in Malaysia which showed that road safety is one of the important aspect as it involves most of the people in this country which are majorly traveled by using road transportation.

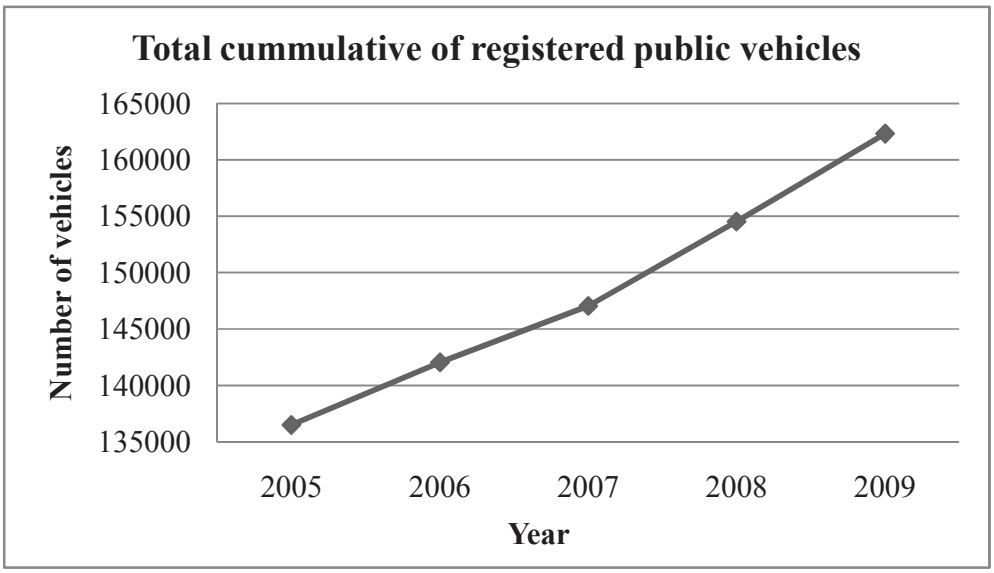

Figure1.1: Total cumulative of registered public vehicles in Malaysia from year 2005 to 2009 (JPJ, 2010)

Based on the development of total scenario about motor vehicle for that period, it is quite concerned. This is because, in line with diversity development of motor vehicle on the road, accident rate which occurred in Malaysia also pitched in increase. this situation needs to be investigate and research must be done to know the main problems that causes the accident and it is also important to ensure that the existing transportation system in Malaysia are in a perfect condition in serving various types of vehicle users in this country.

Factors that affect the risk of increased injury of occupants in the event of an automotive accident include demographic or behavioural characteristics of the person (age, gender, seatbelt usage, or use of drugs or alcohol while driving), environment factors, road conditions at the time of accident occurrence (surface, weather or light conditions, the direction of impact, vehicle role or occurrence of a rollover), as well as technical characteristics of the vehicle itself (vehicle age and body type).

According to the Royal Malaysian Police (PDRM) accident statistics in their Laporan Tahunan PDRM 2008, every year traffic accident in Malaysia constantly increases year by year as shown in Table 1.1. The accident problems in Malaysia are getting more critical every year as it more critical with the increases of number of fatal cases in the road accident which also contributes to the ranking of Malaysia as one of the most high in fatal cases in road accident among developing countries around the world. This highly increases problem should be study to reduce and avoid road accident in the future.

Table 1.1: Total of road accident according to its type in Malaysia for year 2007 and 2008 (PDRM, 2009)

Type of Accident	**2007**	**2008**	**Total Difference**	**Percentage (%)**
Fatal	5,672 (1.6%)	5,974 (1.6%)	302	5.3
Serious Injury	7,384 (2.0%)	7,384 (2.0%)	-365	-4.9
Slight Injury	13,979 (3.8%)	12,893 (3.5%)	-1,086	-7.8
Damage Only	336,284 (92.6%)	347,185 (93.0%)	10,901	3.2
Total Accidents	363,319	373,071	9,752	2.7

The ANN has been shown to be a powerful tool, particularly in dealing with prediction and classification problems. There are many of study nowadays applying ANN for future prediction studies. Therefore, primary interest of this study is to examine the road accident at high accident location and to analyze accident prediction model by using ANN.

1.2 Problem statement

Many factors can contribute to the road accident but certain factors only can appeared at certain roads or highways. According to the statistics from Royal

Malaysian Police (PDRM) in Laporan Tahunan PDRM 2008 for the total of road accident follows of road category for Ops Sikap 2007 and 2008 in Malaysia, Table 1.2 showed the accident occurs in federal route jotted the highest accident occurs compared to other roads for both 2007 and 2008. The numbers recorded at Ops Sikap XIII 2007 was 15,911 with the number of fatal accidents of 203. Whereas in Ops Sikap XVII 2008, the accident number that being recorded was 15,996 where it showed increased compared to the previous year. The number of accidents in federal road was recorded to be increased as much as 3.8% that is 168. Although the rate of accidents and death recorded of inclined with not exceeding 10 %, the precaution steps should not be taken lightly, but on the other hand this should be increased from time to time.

Table 1.2: Accident follows of road category (PDRM, 2009)

Accidents	**Ops Sikap XIII 2007**	**Ops Sikap XVII 2008**	**Total Difference**	**Percentage (%)**
Highway	1,658	1,592	-66	-4.0
Federal Route	4,433	4,601	168	3.8
State Road	2,872	2,738	-134	-4.7
Municipal Road	6,174	6,322	148	2.4
Other Roads	774	743	-31	-4.0
TOTAL ACCIDENTS	**15,911**	**15,996**	**85**	**0.5**

As shown in Figure 1.2, federal road FT 050 is among the most critical road which having road accidents increases year by year. Accident data that has been recorded by Royal Malaysian Police (PDRM) in Kluang and Batu Pahat district database showed that from year 2006 to year 2010, the increment of number of accident along FT 050 are critically increase and this worried all the government agencies because of this road has and will continue kill lots of people that use the road. The problem in this road must be investigated to ensure safety to all the road users in this area which is one of the most black spot areas in Malaysia.

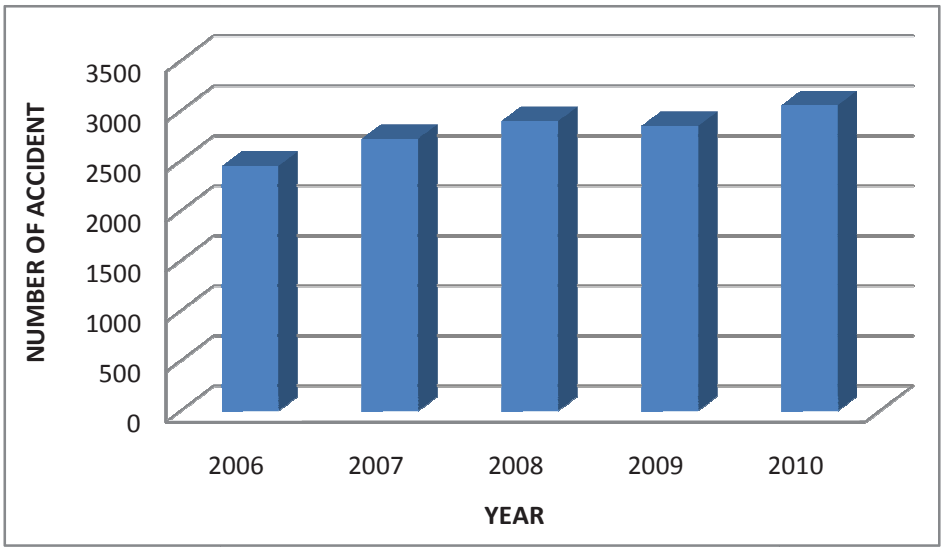

Figure 1.2: Total of road accidents at FT 050 from year 2006 to 2010 (PDRM, 2011)

Many of agencies especially government agencies are facing problems to identify the factors that contribute to the accidents that occurred on certain critical roads or highways. The measurements to prevent accident are maybe from the speed reduction, widening the roads, speed enforcement, or construct the road divider, or other else. These different types of factors can be identified to prevent the accident on the critical roads or highways for the future. It also can help many of agencies such as Royal Malaysian Police (PDRM), Public Work Department (JKR), Road Transportation Department (JPJ) and local authorities in investigation process, planning process or in remedy process for the road after accident. It comes into a serious part when all the road users or agencies cannot know the exact measurement of how the accident can be occur. There are also many of prediction model that has been developed to analyze the accident variables but none of them can analyze all the variables. It also difficult for other users to implement or use the model that has been developed due to hardly understands and it uses complicated mathematical model.

It is important to conduct this study to get all the variables as many as possible in developing the accident prediction model and to propose an accident prediction with improvement of accident statistical model. Artificial Neural Networks (ANN) model is usually used for prediction cases. By using ANN model, these factors can be determined by collecting the input data from the critical road or highway. The input data can be process by the ANN applied software to get the predict result for the forecasting purposes for the road or highway. This ANN applied software is also easy and ready to use for any level of users which they can implement or analyze all the parameters and accident data for the future prediction.

All the problems stated above showed that it is important to study the accident factors especially on the federal route which having the high number of accident increment every year. ANN will be the analyzing tool which it is one of the highly performance tool in developing prediction model. This study will propose an appropriate accident prediction model which can be use by any users that can help them in providing the safety precautions and future work for safety issues especially for related agencies and for the road users in the future.

1.3 Objectives

This study was conducted based on several objectives which are:

(a) To analyze the accident trend, accident critical area and accident parameters at FT050.
(b) To determine the critical accident variables for accident prediction purposes.
(c) To utilize Artificial Neural Network (ANN) as a tool for accident prediction analysis.

(d) To develop an Accident Prediction Model at FT050 by using Artificial Neural Network (ANN) applied software.

1.4 Scopes and limitation of study

The scopes of this study are more on to model all the parameters and accident data which are included:

(a) The historical accident data collection from the valid sources such as Royal Malaysian Police (PDRM), Road Transportation Department (JPJ), Road Safety Department (JKJR), and other local authorities.
(b) Blackspot sections in FT 050 route which are determined from the analysis of the historical accident data from year of 2006 to year of 2010.
(c) Accident parameters analysis that are related to the cause of the accident in FT 050 which are vehicles speed, vehicles gap, vehicles hourly volume, and access points.
(d) Site surveys and site studies, which are includes road condition and traffic studies such as speed study, volume study, and gap study on the blackspot area in federal route FT 050. The study area is as shown in Figure 1.3 which was retrieved on May 2011 from Google Earth application.
(e) Develop the accident prediction model by developing the architectural design of neural network model in Neuroshell2 software that using the Artificial Neural Network model system.

Figure 1.3: Study area from KM 0 to KM 103 in FT 050 (Google, 2011)

1.5 Brief study flow

The first step of all in this study is by finding the problem that related to the study area. The critical problem that can be seen almost all the time is road accident. By identified the problem, it is important to choose the study location which was identified by the collection of historical data from the local authorities. Federal FT 050 road is one of the major contributors in the number of road accident statistics in Malaysia. This FT 050 road then has been choose in this study as it is also being used by most of the vehicles that are travel from south to north and vice versa in state of Johor.

The main objectives of this study is collecting historical road accident data and present data which consists of accident variables identification and also

present data collection of accident variables in FT 050. Historical road accident data was analyzed to get the top ten road accident ranked sections along FT 050 which then these sections are used for the present data collection sites. The historical data then are used as the output in the development of the neural network prediction model.

Significance level of all the identified variables are checked to ensure all the variables are significant and a set of data can be plan wisely before proceed to the data collection process. After the data set was planned, the data collection process are then been proceed and all the data are analyzed in traffic engineering study approached by using statistical method.

All the analyzed data sets are then analyzed in the artificial neural network computer applied software called Neuroshell2 software. The process consists many of analysis step to obtain the best architectural design in neural network that are having the least error in the data results. The result was endorsed by using the Mean Absolute Percentage Error (MAPE) method in the validation process.

The neural network model design then can be use for future prediction or forecast the pertaining number of accident in FT 050 federal road. All the data also can be applied for future analysis purposes in FT 050 road especially for traffic engineering study field.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Every year, the rapidly increasing number of vehicles owned by Malaysian citizen contributes to the highly volume of vehicles on the road. This will bring to development of the road facilities and technologies to ensure the road safety issues are always been looked as priority for the road users. For the time being, it is also showed that this scenario affected the increasing number of road accidents in Malaysia, generally. Road accident is one of the major contributors of human deaths in Malaysia. It is been more critical nowadays since road is the major transportation mode that are been used by Malaysian people. Therefore, road safety is an important component that will be use as a part in the road design for the future road transportation development.

In developing countries, by contrast, road safety responsibility is confused and fragmented and very little coordination occurs where a single agency is supposed to be responsible for improving road safety. It may have little or no contact with the various other agencies which can influence the road safety situation and little or no powers of implementation in other fields. The problem can only be tackled effectively through coordinated action aimed at reducing the

deficiencies in each of the main areas affecting road safety. Effort should be made to get the key agencies to collaborate so that they reinforce each other's effort.

Therefore, road safety is an important component that goes to make a city safe. This is because traffic accidents have become one of the most common causes of death and injury. In addition to loss of human lives and personal sufferings, road accidents are a burden to the community due to funeral costs, the expenditures of medical treatment and the costs of repair of vehicle damages.

2.2 Factors of accident contribution

The term accident is commonly accepted as an occurrence involving one or more transportation vehicles in a collision that results in property damage, injury, or death. The term accident also implies a random event that occurs for no apparent reason other than "it just happened" (Lester et al., 2010).

A road accident is defined as an occurrence on the public or private road due to the negligence or omission by any party concerned (on aspect of road users conduct , maintenance of vehicle and road condition) or due to environmental factor (excluding natural disaster) resulting in a collision (including "out of control" cases and collision or victims in a vehicle against object inside or outside the vehicle such as bus passenger) which involved at least a moving vehicle whereby damage or injury is caused to any person, property, vehicle, structure or animal and is recorded by the police (Fajaruddin, 2005).

In the year of 2006, 341,252 accidents were recorded, resulting in an average 18 deaths from road accidents every single day. Federal Route 50 from Batu Pahat to Kluang experienced 5,917 road accidents between the years 2000 and 2006, killing 188 people and injuring 1,330 people (Fajaruddin et al., 2008). The causes of road accidents are usually complex and involve many factors. Based

on studies conducted in different part of the world, it is possible to construct a list of main categories that could influence the occurrence of road accidents. Accidents are caused by many factors, sometimes singly but more frequently in combination. Road accidents are caused due to interaction of vehicle, driver, roadway and environmental factors (Aworemi et al., 2010). Accident influenced by many factors, there are four main factors causing accident which are driver related factors, road factors, environmental factors, and vehicular factors (Esnizah, 2008).

2.2.1 Driver factors

The major contributing factor in most accident situations is considered to be the performance of the driver of one or both (in multiple vehicles accident) of the vehicles involved. Driver error can occur in many ways, including inattention to the roadway and surrounding traffic, failure to yield the right of way, and disobedience of traffic laws. These "failures" can occur due to unfamiliarity with roadway conditions, traveling at high speeds, drowsiness, drinking, using a cell phone, or dealing with other distractions within the vehicle (Lester et al., 2010). The driver behavior and attitude is very important in judging the driver's actions. Human factors are without doubt are the most complex and difficult to isolate as they are almost all very temporary in nature. Consider sensory capabilities, knowledge, attitude, alertness, health, driving skill, age, customs, habits, weight, strength, and freedom of movement. Of these, the emotional factors are the greatest variable attributes and the most difficult to identify.

2.2.1.1 Age

Old driver which is in ages of 60 above, have a bad vision which were not clear and they tend to drive slowly. While younger driver which is in ages of 16 to 25 year is tend to drive fast and have lack of experience in driving which lack of skill in handling motor vehicle especially when they are facing an accident (Esnizah, 2008).

2.2.1.2 Alcohol and drugs

When alcohol or drugs are involved in the crash, it is more likely to be ended as a high severity crash in both types of highways as the relevant variables has positive parameter in both of the case. The alcohol involvement has been recorded as whether alcohol presented or alcohol contributed towards the crash based on the judgment made by the police officer.

The risk of accident and accident injury is the effect from alcohol. Drivers and motorcyclists with any blood alcohol content greater than zero are at higher risk of an accident than those whose blood alcohol content increases from zero. Many type of drugs detected in accident victims are liable to impair driving skills, there is still uncertainty as to whether this translates to an increased accident risk.

2.2.1.3 Driver fatigue

Fatigue or sleepiness is associated with range of factors. This factor always happened when the driver are in long distance driving. This case happened often when drivers are driving while sleepy, driving after five hours of sleep which is the

recommendation for the driver to take a break while driving is two hours. Drivers should take a break after every two hours of driving to avoid exhaustion and sleepiness while driving.

2.2.1.4 Driver behavior (speed)

The speed of motor vehicles is at the core of the road traffic injury problem. Speed influences both crash risk and crash consequence. The risk of accident and accident injury is the effect also from speed. It is becoming more difficult and shorter time for a driver to stop and avoid an accident when the vehicle is at a higher speed. Accident risk increases as speed increases, especially at road junctions and while overtaking as road users underestimate the speed and overestimate the distance of an approaching vehicle.

2.2.2 Vehicle factors

A small percentage of accidents are caused by mechanical failure of a vehicle, such as some form of tire failure, brake failure, or steering failure (Aworemi et al., 2010). Faulty brakes can cause accident between vehicles or vehicle with other things. Worn tires also can cause the vehicle involve in an accident. The vehicular faults have the tendency in resulting higher severe crashes in urban roadways and include faults in tires, wheels, brakes, and windshield. Vehicle maintenance is very important to make sure 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.

2.2.3 Road factors

The condition and quality of the road, which include the pavement, shoulders, intersection and the traffic control system, can be a factor in accident. The road must be designed to provide adequate sight distance at the design speed or motorists will be unable to take remedial action to avoid an accident. The roadside equipment such as, street lightning, makings or signs and all equipment for road also must be provided to ensure safety for the road users. Traffic signals must provide adequate decision sight distance when the signal goes from green to red. The superelevation of highway must be carefully laid out with the correct radius and the appropriate transition sections to assure that vehicles can negotiate curves safely (Lester et al., 2010).

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 leveled 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).

This may be due to the fact that when people drive in local roads, they might be more careful and also there might be lesser vehicular interactions due to the low traffic volumes on those highways. On interstates, the decreasing trend in having more severe injuries may be due to the high safety attributes available on those highways almost uniform travel speed conditions.

2.2.4 Environmental factors

The climatic and environmental conditions can also be a factor in road transportation crashes. The most is weather. Transportation systems function at

their best when the weather is sunny and the skies are clear. Weather on roads can contribute to crashes; for example wet pavement reduces friction and flowing or standing water can cause the vehicle to hydroplane. Many severe crashes have occurred during conditions of smoke or fog which can greatly reduce visibility (Aworemi et al., 2010).

When the crash occurs on a wet road surface which indeed has less skid resistance, it seems to be ended with a lesser severe crash in both urban and rural roadways as the variable related to the road surface condition gives a negative parameter. This may be due to the fact that drivers are more cautious under severe weather conditions and try to maintain lower driving speeds under these conditions. On the other hand, when the crash occurs under dark or unlit conditions in urban areas, the severity of the crash is going to be higher. However, this variable is non-significant in rural areas.

2.3 Classification of road accident

Single vehicle crashes are significant over two vehicle crashes and animal-vehicle crashes in increasing the severity of a crash in rural areas. This is provided by having positive parameters for rollover crashes and negative parameter for crashes that occur on the roadway.

That is when the crash occurs off the roadway there is a higher risk for having a severe crash. However, in urban areas, both the single vehicle and multi vehicle crashes are significant but crashes related to animals are non-significant towards the severity of the crash.

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 :

(a) Slight injury – an injury of minor character such as a sprain, bruise, cut or laceration not judged to be severe or slight shock requiring roadside attention.

(b) Serious injury – an injury for which a person is detained in hospital as an "in patient", or any of the following injuries whether or not detention result, fractures, concussion, internal injuries, crushing, severe cuts and lacerations, severe general shock requiring medical treatment, injuries causing death 30 or more days after the accident.

(c) Fatal – death from injuries sustained, resulting than 30 days after the accident.

(f) Damage only – damage on vehicle. It is not include fatal and injured.

2.4 Accident data

Collection and investigation of accident data is an important element of any reduction and prevention strategy. It is because an efficient road safety must be base on these data since realistic targets can only be established by using accident related information.

All accident data originated with the recording of details by the police either at the scene of an accident or as subsequently reported at local police station. The accident details are first recorded in the police office's notebook and a simple record is made in the 24 hour incident book at the police station in which a unique reference number is assigned to the accident.

If human injury has occurred or a prosecution is likely, an accident investigation file is opened, having a reference number. This contains all documents associated with the accident, example for witness statements,

photograph, description and sketch diagram of the scene as found by the police officer report. This file is required in the law courts in the event of a prosecution.

The details of each accident are filled up by the police, the original copy of forms (printed on a white paper) are dispatched to the State Police Contingent which are subsequently dispatched monthly to the Traffic Branch Police Headquarters, Bukit Aman. At this Branch, all forms are checked and delivered, batch by batch, to the Computer Branch, Bukit Aman. The data are than keyed-in into the data entry terminals and doubled-checked by police personnel. Any miscoding of accident data is returned to the Traffic Branch for further investigation. The forms a stocked temporarily in a special store room at Bukit Aman before dispatching them to the Road Safety Research (RSRC) Universiti Putra Malaysia. At this centre, the forms were carefully classified, catalogued and bound for easy access for safety research (Fajaruddin, 2005).

The traffic accident report form, POL27 is a pre-printed standard form and is the basis of all computerized data. It is also completed by the police accident reporting officer. The information in a report form POL27 includes a general nature such as the police station, accident reference number, time and data of the accident, number of vehicles and casualties, road type and condition, road geometry, collision type, weather and lightning condition, details of vehicles involved in the accident (example is type vehicles, model registration number and damage suffered) and detail vehicle's driver or rider (example is sex and age) (Taib, personal communication, 2010).

The second copy of the form which contains only the first and last pages of POL27 (Amendment 1/91) is taken to the Public Works Department (PWD) at the respective PWD districts. The district engineers or his assistants are required to check the location data and forward the forms to the Highway Planning Unit (HPU), Ministry of Works Malaysia. This is followed by further checking, coding and key-in of the location codes by HPU. Copies of the forms may also be obtained from the Highway Planning Unit, Ministry of Works Malaysia (Fajaruddin, 2005).

All of the method is related to road in Malaysia. Road in Malaysia have five categories:

(a) Expressway (toll)
(b) Federal
(c) State
(d) Urban
(e) Other (District Council or Private)

For rural road (type expressway as toll, federal, state, or other as District Council or Private), kilometer posts should be used the network coding system. The police report officer should estimate the position of the accident (to the nearest 100 m) from the closest kilometer post. On expressway this task is made easier as 100 m post have also been installed. The national grid coordinate system should be included on all maps used such that the position of the accident can be read off easily. For urban areas (type urban and other as District Council or Private), a Node System needs to be devised where each major road junction is given a unique number (Esnizah, 2008).

2.5 Accident prediction model

Accident prediction models are usually used to monitor the effectiveness of various road safety policies that have been introduced to minimize accident occurrences. They also give an idea to transportation planners and/or engineers to determine new policies and strategies about road safety. Over the past 60 years, many models have been developed to estimate traffic accidents all over the world (Akgungor and Dogan, 2009).

The most common methodological approach used in modeling the relationship between highway geometrical elements, traffic characteristics and accident frequency was conventional linear regression. However, recent research

has shown that linear regression has undesirable statistical properties when applied to accident analysis which the results such as vehicle kilometers traveled are directly proportional to variance of the accident frequency, is in a direct violation of the homogenous assumption of linear regression. The effect of this violation invalidates hypothesis tests because confidence intervals are erroneous, thus making it difficult to assess the significance of the estimated coefficients (Jovanis and Chang, 2004).

Another problem is that linear regression is not restrained from predicting negative accident frequency. This would be a significant factor where a main highway section has a low or no accident frequency for some period of time. Negative accident prediction will bias the estimated coefficients, invalidating the model unless corrective measures are taken (Ahmed, 2005).

Lately, artificial neural networks (ANN) have been utilized to develop accident models in road safety studies. Mussone et al. (1999) used ANN approach to develop a model for the analysis of vehicular accidents in Milan, Italy. The study showed that intersection complexity might determine a higher accident index depending on the regulation of intersection. Akgungor and Dogan (2008) introduced accident prediction models for Turkey using ANN and nonlinear regression approaches to estimate the number of accidents, injuries and deaths. They compared ANN and nonlinear models in terms of various error expressions. The study showed that ANN model had better results against the nonlinear regression models. The same researchers performed another study employing artificial intelligence (AI) for metropolitan city of Istanbul, Turkey. They established ANN and genetic algorithm (GA) models for number of accidents, injuries and fatalities separately. The study results showed that the ANN models had minimum errors for training and testing data.

The use of artificial neural networks (ANN) is a new promising approach to simulate engineering problems (Sharma et al., 2000). It has been applied to several transportation problems. Najjar et al. (2000) applied back-propagation ANN for setting the speed limits on Kansas Two-lane highways. They used 4-input

roadway related parameters: shoulder width, shoulder type, ADT and no passing zone percent. The ANN model was developed to predict the 85th percentile speeds and also to predict the potential effects of the changes in certain roadway and traffic related parameters. The developed ANN was accurate enough to predict the 85^{th} percentile speed with an average degree of accuracy of about 96% (it is ± 4% average deviation from actual value). Some of the related parameters are discussed further on the next subtopic.

2.5.1 Vehicle speed versus road accident

Speed is one of the contributory factors to road accidents. Higher speeds reduce the amount of time any driver has to respond to the unexpected and increases the force of any impact. The importance of lower speeds can be reflected in the following text published by the Association of British Drivers, "Virtually the only factor that road accidents have in common is that all would have been avoided if those involved had known with certainty, a few seconds in advance, that an accident was about to occur.". Therefore, lower speeds provide those extra few seconds.

Speed is used to measure the quality of traffic flow. It is a scalar quantity which has a magnitude component and it was defined as a rate of motion expressed as distance per unit of time, generally as kilometers per hour (km/hr). The equivalent vector quantity to speed is velocity. As velocity, speed is measured by the same physical units of measurement, but speed does not contain the elements of direction that velocity has.

The Transportation Research Laboratory in its Report TRL 421 (2000) mentions that the faster the traffic moves on average, the more crashes there are. The report also concluded that the crash frequency increases approximately with the square of average traffic speed and that higher speed drivers are associated

with a significantly greater crash involvement than are slower speed drivers. It is also noted that for every 1 mph reduction in average speed, crashes are reduced by between 2-7 %. More specifically, the crash reduction figure for urban road with low average speeds is 6%, for medium speed urban road and lower rural main roads is 4%, and for higher speed urban roads and rural main roads is 3% (TRL, 2000).

There are various speeds on the road and it was difference depends on the every area. This difference was determined by the difference posted speed limit on that area. The posted speed limit was achieved by the determination of 85th percentile speed.

2.5.1.1 85th percentile speed

Determining the 85th percentile speed is the first step in establishing a reasonable speed limit for a section of road or street. The 85th percentile speed is the speed at or below which 85 percent of the motorists drive on a given road unaffected by slower traffic or poor weather. This speed indicates the speed that most motorists on the road consider safe and reasonable under ideal conditions. It is a good guideline for the appropriate speed limit for that road (Ghani et al., 2008). The 85th percentile speed was obtained from the cumulative frequency distribution curve which is get from the conducted of the spot peed study. Figure 2.1 is the example of cumulative percent graph and how the 85th percentile was determined.

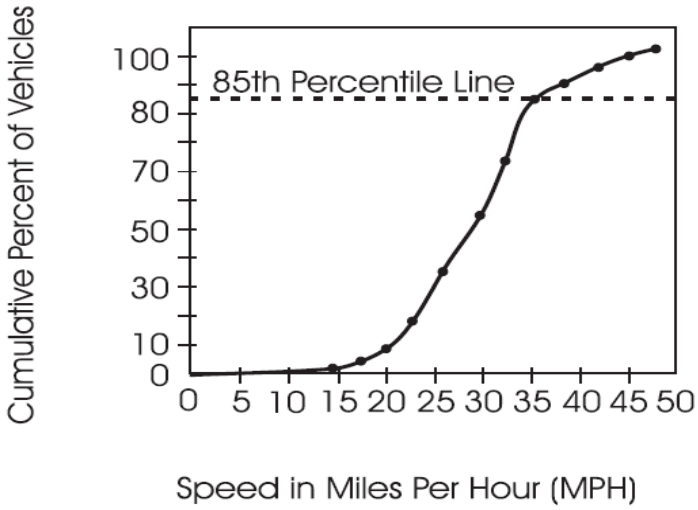

Figure 2.1: Cumulative speed distribution curve (ITE, 2001)

A studies of crashed on the road was carried out in year 2000 in United State. Studies have shown that a crash rates are lowest at around the 85th percentile speed. Drivers traveling significantly faster or slower than this speed are at a greater risk for being in a crash. It is not high speeds alone that relate to crash risk; it is the variation of speed within the traffic stream based.

2.5.2 Traffic volume versus road accident

The number of road accidents naturally depends on the traffic the road carries. The conventional wisdom among the general population is that accident rates should increase with the increasing of traffic volumes, as there is more interaction between vehicles.

Traffic volume studies are conducted to collect data on the number of vehicles that pass a point on a highway facility during a specified time period. This time period varies from as little as 15 minutes to as a year, depending on the

anticipated use of the data (Garber and Lester, 2002). The volume is commonly measured in unit of vehicles per hour (veh/hr).

There are number of researchers have investigated this complex interaction in the past. One of the first such studies was by Gwynn (1967) who analyzed accident and traffic flow on U.S Route 22 through the city of Newark, New Jersey. Crash rates were plotted against hourly volume class, and the author found a distinct U-shape relationship, with more accidents observed at higher and lower traffic volumes. From Masaeid et al. (2004), level of travel and population has a strong influence on urban accident. Reduction of the need for travel and locating major streets on the edge of an urban zone as well as limiting population density could enhance traffic safety.

2.5.3 Number of access points versus road accident

Access point or access control is the condition where the right of owners or occupants of abutting land or other persons to access, in connection with a road is fully or partially controlled by the public authority.

Driveways, median opening and intersections are few of access points commonly found along urban roads. Driveways, either for commercial or private purposes, are roadside openings which lead into business centers, shopping complexes, car parks and hotels. Median openings serve to facilitate vehicles doing right-turning and U-turn. Intersections, signalized or unsignalized, may exist in the form of t-junction, crossroads and roundabouts, all of which serves the purpose of connecting to other roads of the either the same or different hierarchy.

The presence of access points, especially in large numbers, hinders traffic flow, as vehicle require adequate time and space to perform their maneuvers at these point. In addition to this, access points bring about an increase in traffic

REFERENCES

Abbas, M. (2010). Comparison of weighted and simple linear regression and artificial neural network models in freeway accidents prediction (Case study: Qom & Qazvin Freeways in Iran). *Proc. of Second International Conference on Computer and Network Technology*. Tehran, Iran: IEEE.

Ahmed, S. A. (2005). *Prediction of Severe Traffic Accident Rates at Roundabouts Using Artificial Neural Networks*. King Saud University: Master's Thesis.

Akgungor, A. P. & Dogan, E. (2009). An application of modified Smeed, adapted Andreassen and artificial neural network accident models to three metropolitan cities of Turkey. *Proc. of Scientific Research and Essay, vol.4 (9)*. Kırıkkale, Turkey: Academic Journals. pp. 906-913.

Aryani, R.A. & Bahat, Y. S. (2005). Accident Analysis Assessment to the Accident Influence Factor on Traffic Safety Improvement (Case: Palangka Raya_Tangkiling National Road). *Proc. of the Eastern Asia Society for Transportation Studies, Vol. 5*. Surabaya, Indonesia: EASTS. pp 2091 – 2105.

Aworemi, Joshua, R., Abdul, A., Ibraheem, A., Olabode, & Segun, O. (2010). Analytical study of the causal factors of road traffic crashes in southwestern

Carlos, G. (1999). Artificial Neural Networks for Beginners. Retrieved on September 27, 2010, from http://www.cogs.susx.ac.uk/users/davidy/fcs.

Celikoglua, H. B. & Cigizoglub, H. K. (2007). Modelling public transport trips by radial basis function neural Networks, Mathematical and Computer Modelling. 45, pp. 480-489.

Chris, B. (1995). *Interim guide on identifying, prioritizing and treating hazardous locations on roads in Malaysia*. Malaysia: Public Work Department.

Dahee, H. (2005). Development of Traffic Accident Prediction Models by Traffic and Road Characteristics in Urban Areas. *Proc. of the Eastern Asia Society for Transportation Studies, vol. 5*. Kyunggi, Korea: EASTS.

Department of Transportation (2000). *Federal Highway Administration*. United States of America.

Esnizah, M. S. (2008). *A study on Road Safety at High Accident Sites and the Development of Accident Prediction Model at Federal Route FT 50 Batu Pahat to Ayer Hitam*. Universiti Tun Hussein Onn Malaysia: Bachelor's Degree Thesis.

Fajaruddin, M., Ismail, Y., Ismail, R., Aziz, A. S., & Esnizah, M. S. (2008). Blackspot Study and Accident Prediction Model Using Multiple Liner Regression. *Proc. of the First International Conference on Construction in Developing Countries*. Karachi, Pakistan: Universiti Tun Hussein Onn Malaysia.

Fajaruddin, M. (2005). *Treating Hazardous Locations at Federal Route 50*. Universiti Teknologi Malaysia: Master's Thesis.

Garber, N.J. & Hoel, L.A. (2002). *Traffic and Highway Engineering*. 3rd Edition. Minnesota: West Publishing Company.

Ghani, A.R.A., Daniel, B.D., Yusof, I., Zamhari, K.A., Abdullah, M.E., Omar, N. and Termida, N.A. (2008). *Traffic Engineering and Safety Modul*. 2nd Ed. Johor: Penerbit UTHM.

Google Copyright (2011). Google Earth. Retrieved on May 2011 from Google website: http://maps.google.com/

Gwynn, D.W. (1967). *Relationship between Road Accident and Hourly Volumes, Traffic Quartely*. 14(1), pp. 407-418.

Haykin, S. (1999). *Neural Neworks: a Comprehensive Foundation*. 2nd Edition. Prentice Hall. pp 135-155.

Helai, H. & Mohamed, A. A. (2010). Multilevel data and Bayesian analysis in traffic safety. *Accident Analysis and Prevention, 42(2010),* page 1556–1565. Retrieved on October 18, 2010, from www.elsevier.com/locate/aap.

Hizal, H. H. & Sharifah, A. S. M. R. (2009). The Construction of Road Accident Analysis and Database System in Malaysia. *Proc. of IRTAD Conference, vol.4*. Seoul, Korea: IRTAD.

Institute of Transportation Engineers (2001). *Traffic Engineering Handbook*. 6th Ed. New Jersey: Prentice Hall Inc.

Isaac, E. L., Aristidis, L., & Dimitrios, I. F. (1998). Artificial Neural Networks for Solving Ordinary and Partial Differential Equations. *Proc. of Transactions on Neural Networks, vol. 9*. Ioannina, Greece: IEEE.

Jabatan Pengangkutan Jalan (2010). *Statistik Pendaftaran Kenderaan Awam.* Retrieved on May 2011 from Jabatan Pengangkutan Jalan: http://portal.jpj.gov.my/index

Jovanis, P. & Chang, H. (2004). *Modeling the relationship of accidents to miles traveled*. Transportation Research Record 1068, pp 42-51.

Lester A. H. & Garber, N. J., Adel, W. S. (2010). *Transportation Infrastructure Engineering.* SI Edition. Virginia: Thomson Learning.

Masaeid, Hashem, R., Suleiman, & Ghassan (2004). *Relationships between urban planning variables and traffic crashes in Damascus*. Retrieved on March 2011 from CBS Interactive: http://findarticles.com/p/articles/mi_qa3927/is_200412/ai_n9521917/?tag=mantle_skin;content

Miao, M. C., Ajith, A., & Marcin, P. (2004). *Traffic Accident Analysis Using Decision Trees and Neural Networks*. Oklahoma State University, Oklahoma, USA.

Milton, J. & Mannering, F. (1997). The Relationship Among Highway Geometric, Traffic-Related Elements and Motor-Vehicle Accident Frequencies. *The 76th Annual Meeting, Transportation Research Board*, Washington, D.C.

Najjar, Y. M., Stokes, R. W. & Russell, E. R. (2000). Setting Speed Limits on Kansas Two-Lane Highways: A Neuronet Approach. *Transportation Research Board 79th Annual Meeting*. Washington D.C.

Nigeria. *Proc. of Educational Research Vol. 1(4)*. Ogbomoso, Nigeria: International Research Journals. pp. 118-124.

Polis Diraja Malayisa (2009). *Laporan Tahunan Polis Diraja Malaysia 2008*. Retrieved on May 2011, from Polis Diraja Malaysia: http://www.rmp.gov.my/defaultbase.cfm?path=about/AR.cfm?mod=57

Polis Diraja Malaysia (2011). Road Accident Data in Kluang District for Year 2006 to 2010. Retrieved on January 2011 from PDRM Kluang District Database. Cawangan Trafik, Ibu Pejabat Polis Daerah Kluang.

Polis Diraja Malaysia (2011). Road Accident Data in Batu Pahat District for Year 2006 to 2010. Retrieved on January 2011 from PDRM Batu Pahat District Database. Cawangan Trafik, Ibu Pejabat Polis Daerah Batu Pahat.

Radin, U. R. S., Law T. H., & Wong S. V. (2005). The Malaysian Government's Road Accident Death Reduction Target for Year 2010. *IATSS Research, vol.29 no.1*. Serdang, Malaysia: Universiti Putra Malaysia.

Radin, U. R. S., Rodzi, M., & Aminuddin, A. (1992). Model Diagnosis dan Rawatan Kemalangan Jalan Raya di Malaysia. *Proc. of Pertanika J. Science & Technology 1(1)*. Serdang, Malaysia: Universiti Pertanian Malaysia Press. pp 125-151.

Rita, S. (2003). *We're Born to Learn: Using the Brain's Natural Learning Process to Create Today's Curriculum*. Retrieved on May 2011 from Corwin Press: https://people.cnm.edu/personal/nseeking/nanseeking/desharedfiles/Tutorials/NHLP/dendrites.aspx

Robertson, D. & Hummer (1994). *Highway Engineering*. 6th Ed. Canada: John Wiley & sons Inc.

Rodzi, M. & Ehsan, Z. (2009). Intelligent GIS-Based Road Accident Analysis and Real-Time Monitoring Automated System using WiMAX/GPRS. *International Journal of Engineering, vol. 1(1)*. Serdang, Malaysia: Universiti Putra Malaysia.

Samjay, K. S. & Ashish, M. (2002). Road Accident Analysis: A Case Study of Patna City. *Urban Transport Jurnal 2(2). pp 60-75*. Retrieved on October 17, 2010, from Indian Institute of Technology Kanpur, Article No. 208016.

Sanmastri, S. (2006). *Audit Keselamatan Jalan Raya Dalam Kampus Universiti Teknologi Malaysia, Skudai*. Universiti Teknologi Malaysia. Bachelor's Degree Thesis.

Sharma, S. C., Lingras, P., Liu, G. X., & Xu, F. (2000). Estimation of AADT on Low Volume Roads: The Factor Approach Versus Neural Networks. *Transportation Research Board 79th Annual Meeting*. Washington D.C.

Taylor, M., Lynam, D.A. & Baruya, A. (2000). *The effect of drivers' speed on the frequency of accidents*. TRL Report TRL421. Crowthorne: Transport Research Laboratory.

Zakwan, M. (2009). *Accident Prediction Model by Using ANN*. Universiti Tun Hussein Onn Malaysia: Bachelor's Degree Thesis.