

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

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For my beloved mother, father and my country.



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## 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 pelanggaran 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 pengenalanpastian 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 dibangun 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*.

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## 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

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## 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.

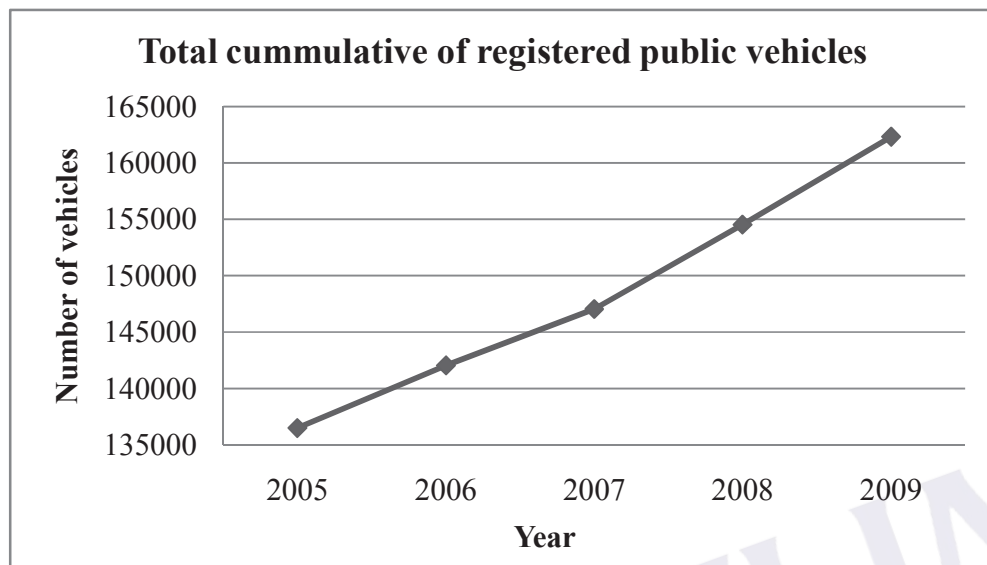


Figure1.1: Total cumulative of registered public vehicles in Malaysia from year 2005 to 2009 (JPJ, 2010)

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
<b>Total Accidents</b>	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
<b>TOTAL ACCIDENTS</b>	<b>15,911</b>	<b>15,996</b>	<b>85</b>	<b>0.5</b>

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.

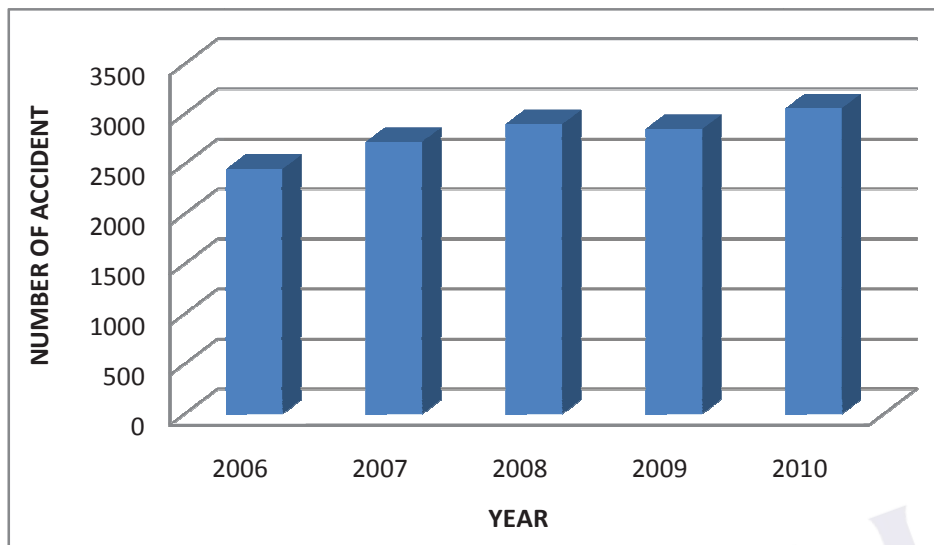


Figure 1.2: Total of road accidents at FT 050 from year 2006 to 2010 (PDRM, 2011)

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.

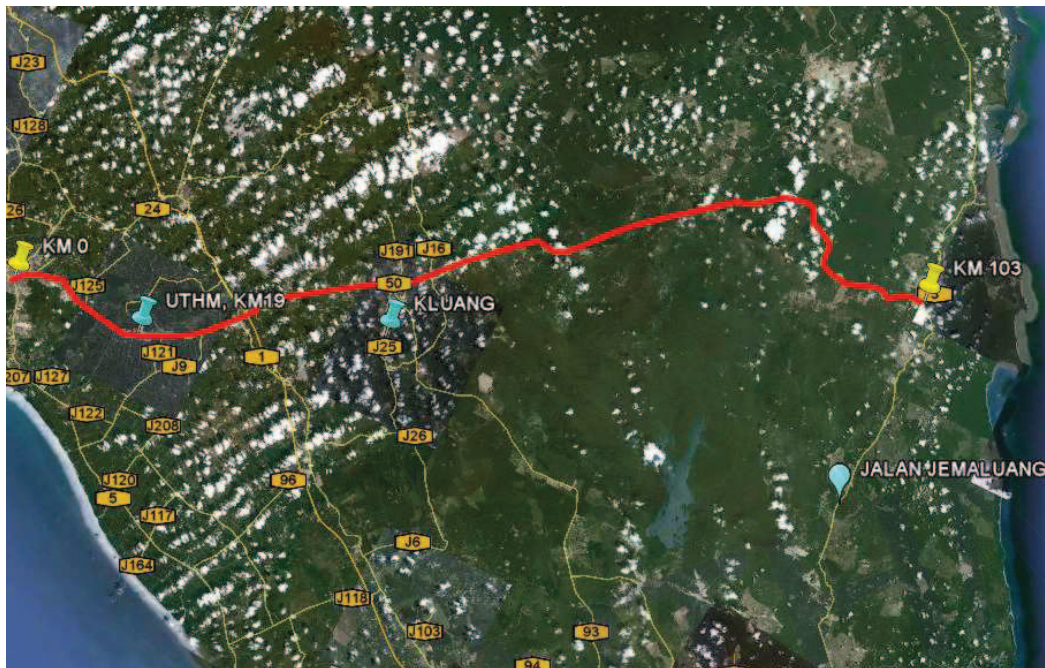


Figure 1.3: Study area from KM 0 to KM 103 in FT 050 (Google, 2011)

### 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



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