# IDENTIFICATION OF ACCIDENT BLACK SPOTS AND CAUSING FACTORS ON "A9" ROAD IN NORTHERN PROVINCE

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June 2018

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Dissertation submitted in partial fulfillment of the requirements for the degree of Master of Engineering in Highway and Traffic Engineering

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**Declaration of the candidate & Supervisor**

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## Abstract

A9 (Kandy-Jaffna Highway) was opened for traffic after renovation of section from Vavuniya to Jaffna in 2013. Even though it has provided several safety precautions, the most number of accidents reported along the highway have occurred in the district of Jaffna, Kilinochchi and Vavuniya. Therefore identifying accident black spot locations and cause for the accidents where majority of the accidents taken place are essential for immediate safety measures and improvements.

The main research objectives are to identify accidents black spot locations, identify possible causes for the accident and calculate the accident rate based on vehicle travel kilometre.

According to this research study, fifteen most critical accident black spot locations were identified by using three scientific method namely Accident rate, Accident frequency and Weighted severity index in the A9 road section from Vavuniya to Jaffna. Accident locations were grouped into nearest 100m distance and the fifteen most critical locations are 300+000 –300+100 km, 303+000-303+100 km, 177+000-177+100 km, 312+200-312+300 km, 307+000-307+100 km, 299+100-299+200 km, 305+000-305+100 km, 301+100-301+200 km, 176+800-176+900 km, 298+400-298+500 km, 309+000-309+100 km, 176+700-176+800 km, 308+100-308+200 km, 305+100-305+200 km and 176+100-176+200 km. Primary causing factor for the accidents, as per the accident records, is human and environment also act as a key factor for some accidents. Accidents happened during day time are twice higher than that of night time. However, this trend was same in each of the section along the road.

Even though the highest accident rate of around $1.31 \times 10^{-6}$ veh km was noted from Palai to Meesalai east section. Accident rates in each section have increased from year 2012 to 2014. When comparing A9 road section from Vavuniya to Jaffna with A9 road section from Kandy to Vavuniya with same corridor geometry in 2014, A9 road section from Vavuniya to Jaffna shows higher accident rate ($0.68 \times 10^{-6}$ per vehicle kilometre travelled) than other corridors ($0.47 \times 10^{-6}$ per vehicle kilometre travelled). In addition, fatality rate in A9 road section from Vavuniya to Jaffna has increased from 2012 to 2014, which is considerably a higher value than fatality rates of road accidents in most of the other countries.

Key Words: Black spots identification, Weighted Severity Index, Accident rate, Accident frequency, Causing factors

**Acknowledgement**

I convey my deepest acknowledgment to many, who helped and supported me during this research.

First and foremost, my heartfelt thanks are due to my research supervisor Prof. J. M. S. J. Bandara, for his immense guidance, instructions, and encouragement given to me throughout the research period. I would never be able to complete my research and prepare this report, if not for his valuable support.

I wish to extend my gratitude to Prof. W. K. Mampearachchi and Dr. H.R. Pasindu for all instructions given to me throughout my M.Eng course and research period.

Also, I am deeply indebted to Mr. G. J. D. Croos, Provincial Director, Road Development Authority, Northern Province; Mr. V. Suthakar, Chief Engineer, Road Development Authority, Jaffna; Mr. P. Kugananthan, Executive Engineer, Road Development Authority, Mullaitivu; for providing accident and traffic data of A9 road.

I extend my profound gratitude to DIG (Traffic), Sri Lanka Police and Director (Highway), Sri Lanka Police for providing accident data for our research.

Finally, I wish to offer my best regards and sincere appreciation to all who supported in every aspect during completing this research.

M. M. M. Munas

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**List of Abbreviations**

| | |
|---|---|
| AADT | - Annual Average Daily Traffic |
| ATV | - Annual Traffic Volume |
| A9 | - Kandy to Jaffna highway |
| GNP | - Gross National Product |
| IRTAD | - International Road Traffic and Accident Databases |
| NG | - Non Grievous |
| PRT | - Perception Reaction Time |
| RDA | - Road Development Authority |
| VKT | - Vehicle kilometre travelled |
| WSI | - Weighted Severity Index |

# CHAPTER 1. INTRODUCTION

## 1.1 Problem Statement and Background

Road Accident has become a noticeable socio economic problem in Sri Lanka. First it seemed unimportant especial developing countries when compared to the critical problem such as scarcity of financial and economic resources, malnutrition and unemployment

According to Police records, there are over a 170 road accidents per day with seven to eight people killed. The economic cost of accidents has been valued Rs.10.25 billion or close to 2% GNP apart from the value of human contribution to the society

Over the decade 2005 to 2014, an average 2,247 number of people died annually in Sri Lanka from road accidents. In year 2014, 35,967 crashes were reported where 6% of them are fatal followed by 2440 fatalities. Motorcycles individually accounts for more than 50% of the vehicles registered in the country and has involved over 50% of the total fatalities in the year 2014.

Three wheelers, being the second highest vehicle category in the country, have contributed for 16% of the fatalities in the same year. Road accidents can't be totally prevent/ stop, but by using suitable traffic engineering, safety plan and management measures the accident rate can be decreased. One of the most important factors to reduce traffic is identification of black spots and finding the causes for these accidents and taking proactive counter measures have become of great importance.

After 30 years of war the Kandy – Jaffna highway (A9) road (section from Vavuniya to Jaffna) constructed and officially declared opened 15 June 2013 and it passes through four districts in Northern Province such as Vavuniya, Mullaitivu, Kilinochchi and Jaffna. This road designed to speed of 80km/h, allowable operation speed is 70km/h.

Following typical cross section (Figure 1.1) has been provided in A9 road (section from Vavuniya to Jaffna) with two lanes undivided running one lane in one direction.

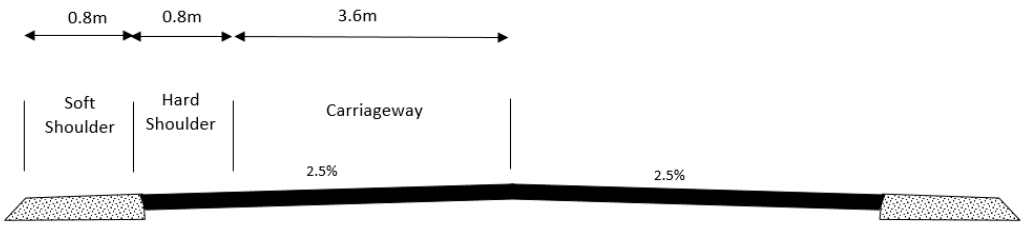


Figure 1.1: Typical cross section of A9 road Section from Vavuniya to Jaffna
Source: (RDA)

Government of Sri Lanka expected to achieve several benefits by constructing this section such travel time reduction.

Some of the direct benefits are:

1. Travelling in an uniform speed throughout the journey
2. Minimal congestion and obstruction to traffic
3. Reduction of fuel consumption and vehicle maintenance cost

Some of the indirect benefits are:

1. Expand tourism
2. Attract private sector investors who consequently contribute to job market Expansion
3. Development of towns adjacent to A9 road as Economic Centres
4. Value enhancement of land and property in the region

Despite the benefits and privileges offered to the country, an unsafe road environment will have negative impacts to the economy as it leads physical losses. The losses become more severe, when those take place in the form of loss of human lives in fatal accidents

Therefore, Road Development Authority provided few safety precautions in A9 Road (section from Vavuniya to Jaffna) to assure a safe road environment to road user. Some such measures to prevent accidents and minimize the damages are:

1. Speed limits
2. Guard fence and stones at the edges of the shoulders at cut and fill sections
3. Two separate lane for the opposite travelling directions by centerline marking
4. Lighting at town areas
5. Provision of road studs and reflectors at the centerline and Guard fence
6. Provision of Road Markings and Signs along the roadway
7. Establishment of highway traffic patrol for enforcements of traffic rules and regulations

However, 1029 numbers of accidents were reported in A9 Road (section from Vavuniya to Jaffna) during the 48 months period of 2011 to 2014. Out of those, 108 accidents were fatal according to the data from police department. Since large numbers of accidents have been taken placed within a short period of 2 years, a negative image has gradually developed in people's minds with respect to A9 Road (from Vavuniya to Jaffna) after rehabilitation. Therefore, it is vital to identify the black spot locations and the causing factors for the accidents to provide safety improvements and remedial measures immediately.

Accident rate and severity index are considered as a very good indicators for road safety. Since with available traffic and accident data of A9 Road (section from Vavuniya to Jaffna) from RDA and police department were possible to conduct a scientific study to identify black spots.

### 1.2 The Area of Study

This research study is an initial study of accident investigation and analysis of accidents in "A9" road (section from Vavuniya to Jaffna) through a scientific and comprehensive approach to find out the black spots, causing factors and accident rate in VKT.

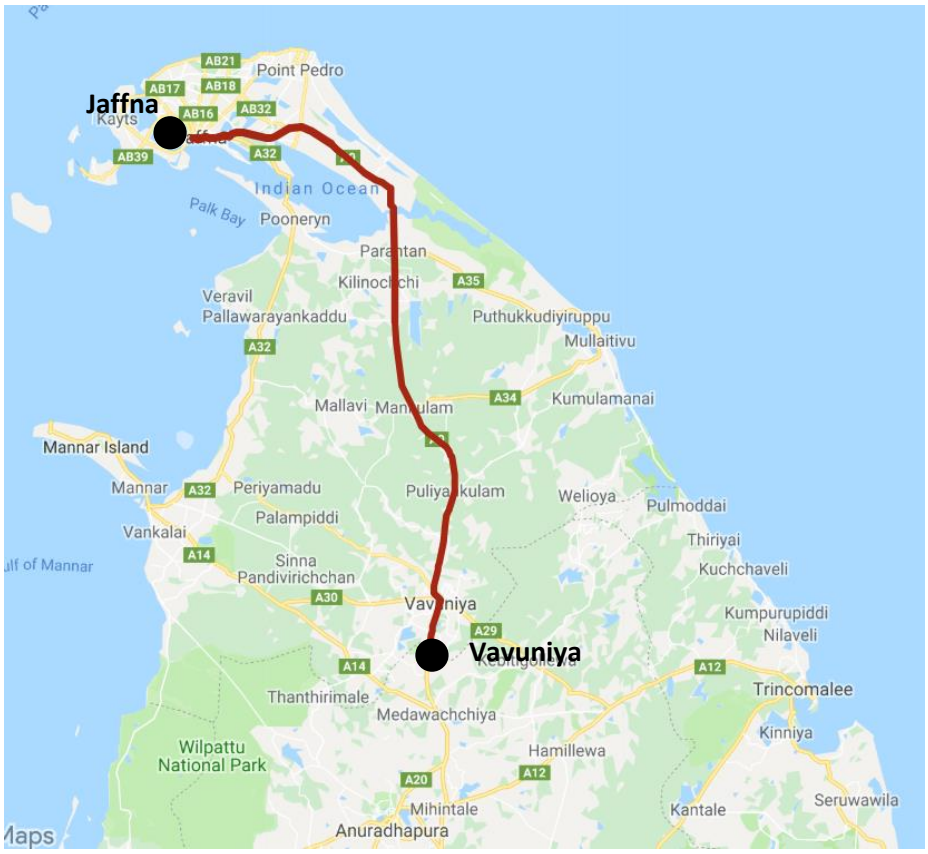


Figure 1.2: Study stretch of A9 road from Vavuniya to Jaffna
Source: (Google map)

### 1.3 Causes of Traffic Accident

The term “Causes” refers to an at-fault determinant of a crash or a determinant that increases crash risk or severity. Investigating causes of traffic crashes is complicated by the fact that given crash seldom has a single unambiguous cause. Crash causes are often a sequences of causes. For example, the initial cause of a pedestrian crash may be the pedestrian crossing the road. If the vehicle driver subsequently is distracted, fails to see the pedestrians and safely stop the vehicle or maneuver around the pedestrian.

Both the pedestrian action and the driver lack of attention will likely to be listed as cause of the crash. In addition there may be circumstances that look place prior to the crash that may have contributed to its occurrence. For instance the pedestrian may have been distraught an emotional condition that could have led to lack of care and

diminished observational awareness of surroundings. While the driver of the vehicle may have had defective brakes which reflects on poor vehicle maintenance.

The important question is “What are the causes of these traffic accidents?” the causes of accidents are usually complex and involve many factors. Based on the studies conducted by experts, it is possible to tabulate a list of categories that could influence the occurrence of road traffic accidents. If the factors that have contributed to the accidents are identified it is then possible to modify and improve the transportation system. Accidents are caused by singly or many factors but more frequently in combination.

### 1.4 Objectives

Objectives of this research study are:

1. Identification of black spots by using different methods to prioritize hazardous locations in the road stretch from Vavuniya to Jaffna
2. To identify various causing factors for accidents
3. Estimate the accident rate based on Vehicle Kilometer Travelled

# CHAPTER 2. LITERATURE REVIEW

A number of research efforts have attempted to identify the black spots of a road stretch, accident causing factors in the world but no any study has been done in A9 road section in Northern Province of Sri Lanka. These studies have indicated that improvements to safety could significantly reduce the number of vehicle accidents.

## 2.1 Related findings

### 2.1.1 Black spots identification

Various methods adopted to identify accidents black spots on National Highway -55 in Orissa, India. Using methods of analysis namely Accident Rate method and Accident Frequency method, the ranking of the identified black spots were done. Detailed analysis was then carried out on the top ranked black spots. (A.N Dehury et al., 2013)

Identifying the major accident black spots on National Highway-3 in India and suggested necessary measures for improvement. The study was carried out by collecting secondary accident data from the police stations and prioritizing the accident prone area by using Accident Severity Index method. (Vivek and Rakesh Saini., 2015)

To identify the accident black spots on National Highway – 4 in India, three methods of analysis were used, namely Ranking and Severity Index methodology, Accident Density method, Weighted Severity Index method in the stretches. Appearing in all the three methods were taken as the accident black spots. (RR Sorate et al., 2015)

To identify the future impact on Maharagama Town traffic flow and pedestrian safety due to southern expressway and outer circular highway, Weighted Severity Index method was used as a part of analysis to identify high risk accidents locations. (AS Samarasinghe, AI Gurusinghe, and KS Weerasekara., 2012)

From all the methods used, the Accident rate method, Accident Frequency method and Weighted Severity Index method were found to be most suitable to the concerned area of study. Thus all the three methods were used to identify the accidents black spots on the A9 road section from Vavuniya to Jaffna.

### 2.1.2 Accident factors

The factors contributing to road traffic accidents are commonly grouped into three categories as described below:

- Human Factors (Road Users)

Human error contributes to accidents in 90% of cases. It is either the driver of the truck or the other road user that makes the mistake that contributes to the accident. The main problem areas identified in accidents where the truck driver was the cause of the accident are: speeding, fatigue, rollover the bend, careless driving and overconfidence. (European Accident research and safety report 2013: Volvo trucks)

The driver is the main factor for the occurrence of an accident (Elvik, Vaa, Erke, & Sorensen, 2009). Previous studies indicate that many elements contribute to determine an unsafe and a distracted driving behavior related to driver's psychophysical conditions, his mental workload, reduction of the attention threshold, and the increase of the perception-reaction time (PRT) (Rosolino et al., 2014).

Further, a study based on a dataset of 100 vehicles for a year revealed that distractions and inattention (e.g. fatigue) contribute to approximately 80% of crashes, and distraction contribute to around 65% of rear-end crashes (Rosolino et al., 2014).

- Environmental Factors

Two most common environmental factors contributing to accidents are "Slippery road (due to weather)" and "Road layout (bend, hill, narrow carriageway etc.)" (European Accident research and safety report 2013:Volvo trucks)

According to recent analysis, 30% of accidents are related to road characteristics, such as the pavement (in a percentage of 10%), geometry (10%), and other factors such as signals, guardrails, safety barriers, etc. (Rosolino et al., 2014).

- Vehicle Related Factors

If the vehicle is found to be the main contributing factor to a road traffic accident, a more detailed classification shows that the issue is related to neglected maintenance, technical faults in subsystems or to conceptual shortcomings. (European Accident research and safety report 2013: Volvo trucks]

Vehicles are also a cause to road accidents when their owners fail to properly maintain and regularly inspect the vehicle during operation. Therefore, road accidents occur due to reasons such as brake failure, tire blowout, power steering failure, and headlight failure. Only 10% of contributing factors are attributed to technical issues related to the vehicles according to the analysis (Rosolino et al., 2014).

A significant proportion of accidents are caused by a combination of the above all three categories.

As per the study of "Analyzing Traffic Accidents in Gampaha District Colombo – Kandy Road" by Sandeera (WAJK Sandeera., 2016), he has found that the causes for the accidents are negligence of drivers/riders, lack of knowledge about traffic and road rules, driving techniques and mechanical defects.

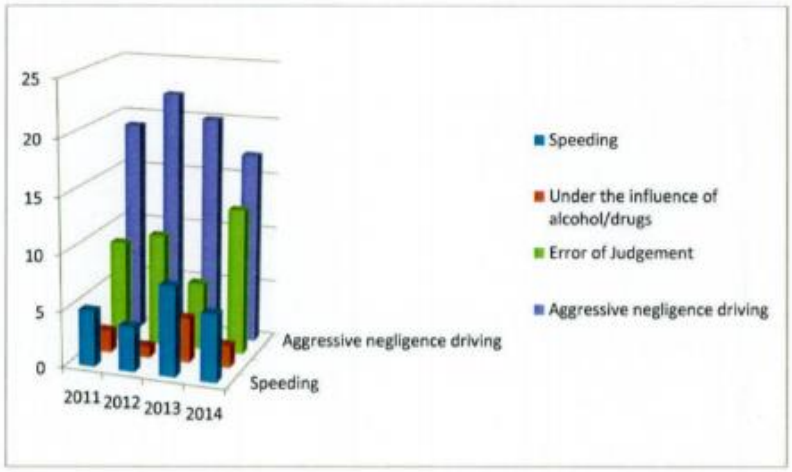


Figure 2.1: Accidents causing factors
Source: (Analyzing Traffic Accidents in Gampaha District Colombo – Kandy road, 2016)

### 2.1.3 Accident rate

Accident rate indicate the safety level of a certain road or the place, and it can be stated as Population based rates or Exposure based rate.

Population based rates are static in nature and not depend on the vehicle usage or total amount of travel. It is used in quantifying the overall risk to individuals on a comparative basis; for example, number of accidents per 100 populations, number of accidents per vehicle.
Road fatalities calculated for 100,000 inhabitants in 2015 of IRTAD countries are presented in Figure 2.2.

Exposure based rates reveal the accident rates based on Vehicle Miles/Kilometers Travelled or Vehicle Hours Travelled. It attempts to measure the amount of travel for exposure to risk.

For analyzing a road, exposure based rates are more accurate and important to get better image of the present situation than other method. Road fatalities calculated for Billion Vehicle Kilometers in 2015 of IRTAD countries are presented in Figure 2.3.

To calculate accident rate based on the Vehicle Kilometers Travelled (VKT), it need to find the VKT. The annual VKT estimation models based on traffic counts use the data collected on a sample of monitored road sections to estimate the VKT of the entire network. Traffic flow, usually represented by the Annual Average Daily Traffic (AADT), and length of the sampled road sections, are the main variables used. To calculate annual value, it is multiplied by the number of days in a year. In estimating VKT using traffic counts, it is customary to assume that a vehicle counted on a section of road travels the entire length of the section. Under this method, some vehicles travelling only a portion of the section will be counted while others will not, depending on whether they cross the counting location (Hossain and Gargett, 2011).

### 2.1.4 Accident rate in VKT for Sri Lanka

As per the study of "Estimation of Vehicle Kilometers Travelled in Sri Lanka" by Darshika Jayasekera (Jayasekera, 2013), VKT for different types of vehicles in year 2012 is presented in Table 2.1

Table 2.1: Vehicle Kilometre Travelled in 2012 in Sri Lanka

| Vehicle type | Vehicle | | VKT x $10^6$ |
|---|---|---|---|
| Diesel | Three wheelers | | 1,660 |
| | Cars & S/Wagons | | 505 |
| | Pick Ups | DP Vehicle | 515 |
| | SUV | | 466 |
| | Passenger Van | | 1,550 |
| | Goods Van | | 585 |
| | Mini Bus | Bus | 250 |
| | Bus | | 647 |
| | Light Truck | Truck | 1,284 |
| | Medium Truck | | 1,403 |
| **Total VKT for diesel vehicles** | | | 8865 |
| Petrol | Motor Cycles | | 15,410 |
| | Three wheelers | | 8,103 |
| | Cars & S/Wagons | | 3,911 |
| | Jeep & Pajero | DP Vehicle | 481 |
| | Passenger Van | | 707 |
| **Total VKT for petrol vehicles** | | | 28,612 |
| **Total for Both type of vehicles** | | | **37,477** |

According to the accident statistics of Sri Lanka Police, road accidents in several severity levels are given in Table 2.2.

Table 2.2: Road accidents summary based on severity in Sri Lanka within past years

| Severity | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|
| Fatal | 2,570 | 2,491 | 2,203 | 2,189 | 1,914 |
| Grievous | 6,121 | 6,956 | 6,971 | 6,872 | 6,102 |
| Non Grievous | 12,540 | 13,176 | 14,200 | 13,526 | 11,079 |
| Damaged only | 16,378 | 17,562 | 17,542 | 15,293 | 12,426 |
| **Total no of accidents** | **37,609** | **40,185** | **40,916** | **37,880** | **31,521** |

Source: (Sri Lanka Police Department)

When total number of accidents are considered, accidents seems to be increased drastically within 2011 and increased slightly up to 2012 while opposite trend has generated year 2013. In year 2014 number of accidents is considerably lower compared to year 2013. Similar trend can be observed with respect to crashes damage only type as well. However, when fatal crashes are considered, a reduction can be seen from 2010 to 2014. According to the above figures fatal accidents reported in Sri Lanka out of total road accidents is around 6% within past few years.

Accidents rate per VKT in 2012 can be estimated for each of the severity level based on the information provided in Table 2.1 and Table 2.2. Results are tabulated in Table 2.3 and according to that accident rate for the entire Sri Lanka for year 2012 is $1.092 \times 10^{-6}$ per VKT.

Table 2.3: Accident rate per VKT in Sri Lanka

| **Severity** | **Accident rate per VKT x $10^{-6}$** |
|---|---|
| Fatal | 0.059 |
| Grievous | 0.186 |
| Non Grievous | 0.379 |
| Damaged only | 0.468 |
| **Total no of accidents** | **1.092** |

## 2.2 Accident reporting

Reporting an accident at the correct time with all required information is an important task as those data reveal the causes for the accident and assist further activities. Once an accident occurs, it should immediately be reported before erasing the evidences. Accidents can be reported with several formats. Accident reporting mainly happens through the Police. In case the victim of the accident is injured or dead, it is reported to the hospital.

The driver of a vehicle must reports a traffic crash, if the incident happened on a road or any place commonly used by the public (e.g. car parks), if the incident resulted in a bodily harm to any person, if the total value of property damaged to all involved parties exceeds a certain value, or if the owner or representative of any damaged property is not present (Western Australia Police: http://www.police.wa.gov.au/).

Following information is required to report a traffic accident accurately:

- Date of crash
- Time of crash
- Precise location of crash
- Personal details (from driver's license)
- Driver's license number and expiry details
- Vehicle license plate and expiry details
- Details of other involved drivers/passengers/owners/vehicles/witnesses
- Details of injuries and other person's injuries
- Crash features (traffic control, road features, road alignment, other conditions)
- Total estimated cost of damage to all vehicles and property
- Description of the manner in which the crash happened
- Optional - digital images of the crash incident

However, it is not reliable if the data only depends on the police. Results from many countries have shown wide variation between official (i.e. Police) statistics and information from other sources. For example in the Philippines, only one out of five medically reported road deaths are included in police statistics.

Under reporting appears to be high in China, which already has the world's highest reported number of road deaths. Thus, the Beijing Research Institute of Traffic Engineering has estimated that the actual number of people killed in road accidents in 1994 was about 111,000, over 40% higher than the 78,000 officially reported by the police. Using results from several studies indicated that in developed countries, under reporting of fatalities was minimal (between 2-5%), whilst in developing

countries, upper and lower adjustment factors were between 25-50% increase of those numbers reported by the police (Jacobs et al, 2000).

Deaths and severe injuries are more likely to be reported than minor injuries; drivers and passengers also have a greater likelihood of being recorded by traffic police than pedestrians, cyclists, and other non-motorized road users. There is also evidence that injuries occurring in the under-served urban communities and amongst children are less likely to be reported (Odero et al., 1997).

There should be a medical community, led by the World Health Organization to monitor road accident victims and include road accidents in national hospital surveillance systems. Accident databases in many developing countries should be improved through greater use of accident reporting and recording systems.

Therefore, using accident information from hospital data and sources like Insurance Companies can complement evidence obtained from police records.

### 2.3 Accident data collection in Sri Lanka

Road accidents recorded by police divisions includes the following information: Accident location and Time (based on road, road link, closest node, coordinates of the location, day, date and time), Accident classification (based on four types; fatal, grievous, non-grievous and damage only), Pre crash factors contributing to the accidents (Human, Pedestrian, Road, and Vehicle) etc.

The road traffic on the A9 road between Vavuniya to Jaffna is regulated by the following nine police stations.

i. Iretperiyakulam
ii. Vavuniya
iii. Puliyankulam
iv. Kanakarayankulam
v. Mankulam
vi. Kilinochchi
vii. Palai
viii. Chavakachcheri
ix. Jaffna

The accident records acquired from the above police divisions were filtered to extract the relevant records from each of the police areas along the road.
Traffic data are collected from Road Development Authority, Sri Lanka for A class roads.

### 2.4 Accident trends in developed countries

Considering the accident trends in developed countries, most countries could reduce fatalities with time by following several policies and actions.
In Britain, even though motor traffic levels have more than doubled since recording began in 1949, the relative risk of road deaths has fallen significantly (from 1949 to 2013). The fatality rate has halved in the past decade, from 10.6 fatalities per billion vehicle miles in 2004 to 5.6 fatalities per billion vehicle miles in 2013. In addition, the number of children killed in reported road accidents has fallen significantly since 1979. The 2013 level of 48 child fatalities is over 90% lower than the 1979 figure (Department for Road Fatalities, 2013).

Several reasons and improvements listed below have caused this trend:

- Sustained periods of snow and ice - comparable periods of bad weather were not observed from 2011
- Technological and engineering improvements to vehicles and highways
- Improved education and training is likely to have produced better and safer drivers
- Improvements in trauma care (and in England, particularly with the introduction of major trauma care centers) and emergency services responses are likely to have improved outcomes after an accident

If it is considered the road user made accidents due to Driver/Rider impaired by alcohol, careless, reckless or in a hurry, aggressive driving, poor turn or maneuver, loss of control, exceeding speed limit etc. Fatalities have significantly reduced during past period up to 2013 (Department for Road Fatalities, 2013).

Member countries of the International Traffic Safety Data and Analysis Group (IRTAD) are Argentina, Austria, Belgium, Cambodia, Canada, Chile, Czech Republic, Denmark, Finland, Fence, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Jamaica, Japan, Korea, Lithuania, Luxembourg, Malaysia, Morocco, Netherlands, New Zealand, Nigeria, Norway, Poland, Portugal, Serbia, Slovenia, Spain, Sweden, Switzerland, United Kingdom, and United States. As per the Road Safety Annual report 2015 of IRTAD, number of road fatalities declined by an overall 42% between 2000 and 2013 in the 32 countries. Greatest reductions were achieved in Spain with more than 70% and Portugal with almost 70%. Many other countries had achieved over 50% of reductions notably Denmark, France, Slovenia, and Lithuania. Most non-European IRTAD members achieved a lower than average reduction in the number of road fatalities (Figure 2.2 & Figure 2.3).

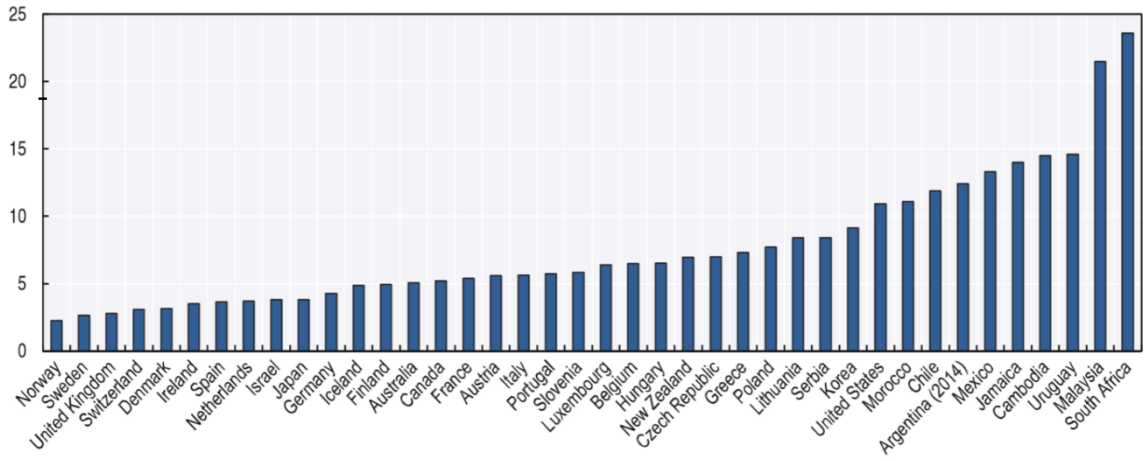


Figure 2.2: Road fatalities per 100 000 inhabitants in 2015 of IRTAD countries
Source: (Road Safety Annual Report, IRTAD, 2017)

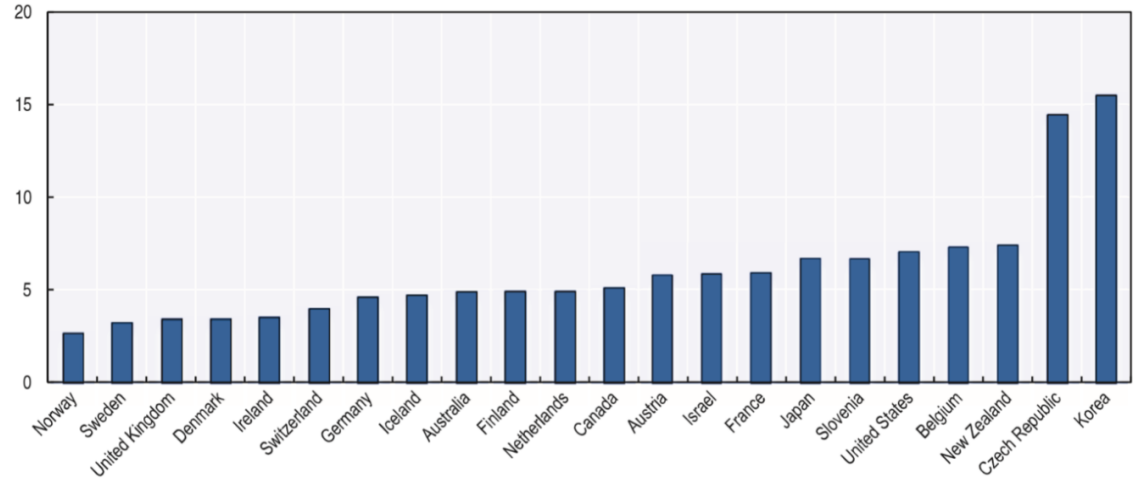


Figure 2.3: Road fatalities per billion vehicle kilometers in 2015 of IRTAD countries
Source: (Road Safety Annual Report, IRTAD, 2017)

Main causes for this performance were the implementation of systematic road safety strategies and programs that tackle main risk factors for traffic crashes (speed, alcohol, non-compliance with traffic rules), advancing technical standards for road infrastructure and vehicles, improved emergency and heath care, and economic conditions (Road Safety Annual Report, IRTAD, 2017)

As per the IRTAD Road Safety Annual Report 2017, 90% of global casualties have reported from low- and middle-income countries.

### 2.5 Accident trends in developing countries

About 1.3 million persons die worldwide due to road accidents, and this is set to double by 2030 if this status continues. It is the developing countries that account for overwhelming part of the current fatalities, and forecasted accident fatalities. In particular, there are local and global initiatives to address the safety issues in developing countries. However, in developing countries there are emerging issues that may result in safety trend, which is different from industrialized countries (Mohamed et al., 2013).

Apart from the humanitarian aspect of reducing road deaths and injuries in developing countries, a strong case can be made for reducing road accident deaths on economic grounds alone, as they consume massive financial resources that the countries can ill afford to lose. Therefore, even within the boundaries of the transport and highway sector, hard decisions have to take on the resources that a country can devote to road safety (Jacobs, 2000).

Motor vehicle accidents are the leading cause of death in adolescents and young adults worldwide. Nearly three-quarter of road deaths occur in developing countries and men comprise a mean 80% of casualties (Odero et al., 1997).

# CHAPTER 3. METHODOLOGY

## 3.1 Data type and data collection methods

Table 3.1: Data collection method

| Data | Data type | Source |
|---|---|---|
| Accident Data | Secondary | Sri Lanka Police Department |
| Road Inventory | Primery | Raod Developent Authority |
| Annual Average Daily Traffic | Primery | Raod Developent Authority |
| Digital maps | Secondary | Google maps |

Primary and secondary data were collected for the study. Secondary data includes the collection of required accident data for the four years from 2011 to 2014 in section from Vavuniya to Jaffna in A9 road from the concerned police department.

Primary data collection includes road inventory data and traffic volume count from the identified accident prone stretches.

## 3.2 Identification of black spots

Accident location map with four years accident data for A9 road section from Vavuniya to Jaffna was created by using line diagram to show accident distribution along the selected stretch. And they were analyzed to obtain the fifteen most accident black spots. Three methods namely: Accident Rate Method, Accident Frequency Method and Weighted Severity Index Method were used for identifying the black spots on the aforesaid section. The methods were adopted by dividing the entire road into smaller sections.

In accident rate method, the accident rates of each section were evaluated by using the mathematical formula

Accident Rate = M/L

Where; M = Total number of accidents in a stretch
L = Length of stretch

In accident frequency method, the accident frequency of each section was calculated and then the cumulating frequency of these sections were evaluated; mathematically

Accident Frequency = (M/T) x 100

Where; M = Total number of accidents in a stretch
T = Total number of accidents along the whole road

Weighted Severity Index method is a dimensionless value indicating hazardous of a location was used by considering the number of fatal accidents (F), the number of grievous accidents (G), and the number of Non Grievous accidents (NG). Mathematically it was being designated by

$WSI = N_f W_f + N_g W_g + N_{ng} W_{ng}$

Where; $N_f$ = Number of fatal accident in a stretch
$W_f$ = Weight assigned to fatal accident
$N_g$ = Number of Grievous accident in a stretch
$W_g$ = Weight assigned to Grievous accident
$N_{ng}$ = Number of Non Grievous accident in a stretch
$W_{ng}$ = Weight assigned to Non Grievous accident

As per accident data from police records it was able to identify fifteen high risk accident black spots. Weightages were given to different type of accidents in weighted severity index method and compared with other two methods to identify black spots and ranked them.

According to gravity of accident category weightages of 5, 3 and 1 were assigned for fatal, grievous and non-grievous accidents respectively.

### 3.3 Causing factors

Road traffic accidents are primarily influenced by three main factors

- Human (drivers, riders, occupants. pedestrians and cyclists)
- Vehicle (vehicle design, mass, equipment such as tires, brake)
- Infrastructure/Environment (roadway, signage, weather)

The causing factor system was designed to summarize the events that led directly to the accident, to be simple and to cover circumstances leading to the majority of accidents. For each accident, record the reasons as much as, why the accident happened by identifying each contributory factor in detail.

If necessary, depend on the accident, it was required to investigate the accident location in detail and make the judgement of reasons for the accident. In some accidents, the data collected reflects the view of the reporting police officer and the information is not the result of detailed accident investigation.

#### 3.3.1 Simplifying the causing factors

The reasons why accident happened by identifying contributory factors from the detailed list annexed in the table A1 of Appendix A, leading to the principal factors of human, vehicular and infrastructure/ environment then were divided into four categories only to enhance the statistical analysis. They are

- Driver behavior & Negligence: The accident would not have occurred if the driver were not negligent. Examples are loss of control due to excessive speed, unsafe overtaking, colliding with oncoming vehicle in the opposite or same direction, Impairment of Alcohol & drugs.
- Fatigue: Long distance driving is the reason for accident.

- Vehicle defects: A burst tire, defective brakes, faulty lights or any other vehicle faults that caused the accident.
- Road environment: Potential accident causing factors such as glare from sun and headlights, location such as T or Y junction, poor road marking and slippery road.

The above causing factors then divided into three primary accident causing factors

Human Factors: Driver behavior & Negligence, Fatigue.

Vehicle Factors: Vehicle defects

Infrastructure/ environment: Road environment

### 3.4 Identification of accident rate

Severity level of A9 road section from Vavuniya to Jaffna was compared with the corridor with same geometrical condition, therefore section from Kandy to Vavuniya was selected for comparison.

To derive the accident rate based on Vehicle Kilometre Travelled it is therefore necessary to know the vehicle kilometre this is simply the length of road multiplied by its flow and it was then converted to Annual traffic volume. The length of each of section of road was measured manually and Annual Average Daily Traffic (AADT) flow data was collected form Road Development Department.

The accident rate per Vehicle Kilometre Travelled was calculated using following equation

Accident rate in VKT = Number of accidents / Total Vehicle Kilometre Travelled

# CHAPTER 4. DATA ANALYSIS

## 4.1 Analysis of black spots identification

### 4.1.1 Basic data analysis

All types of accidents occurred and its distribution along the whole section of "A9" road from Vavuniya to Jaffna in Years 2011 to 2014 as shown in below figure 4.1

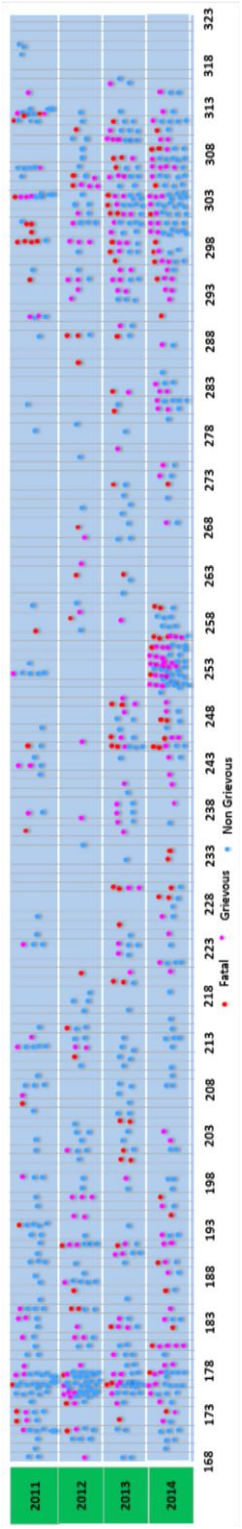


Figure 4.1: Accident distribution diagram along concerned section

Percentage of total accidents in each 5 Km of intervals of “A9” road section from Vavuniya to Jaffna as shown in figure 4.2

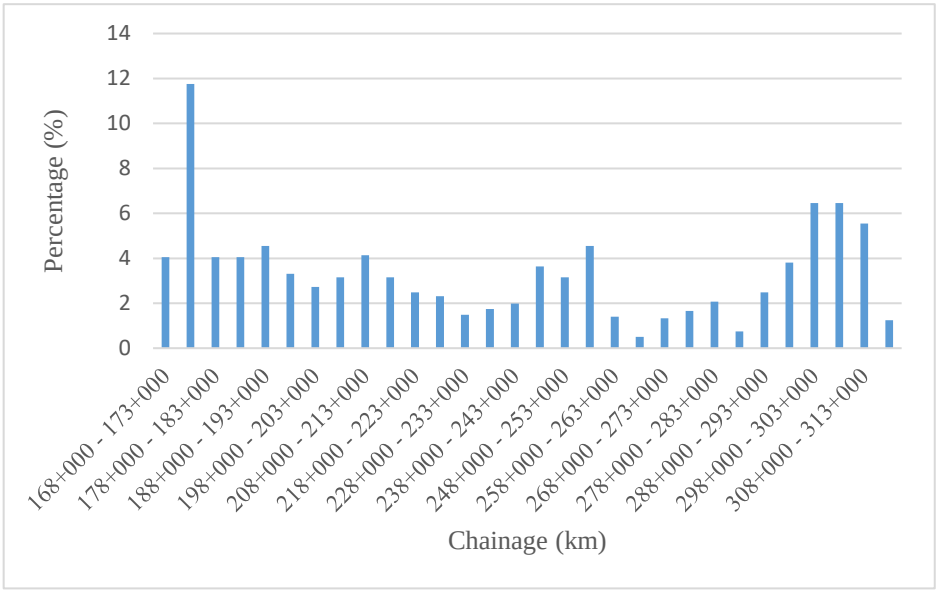


Figure 4.2: Total number of accidents in study area along chainage

Percentage of total accidents with severity in each 5 Km of intervals of “A9” road section from Vavuniya to Jaffna as shown in figure 4.3

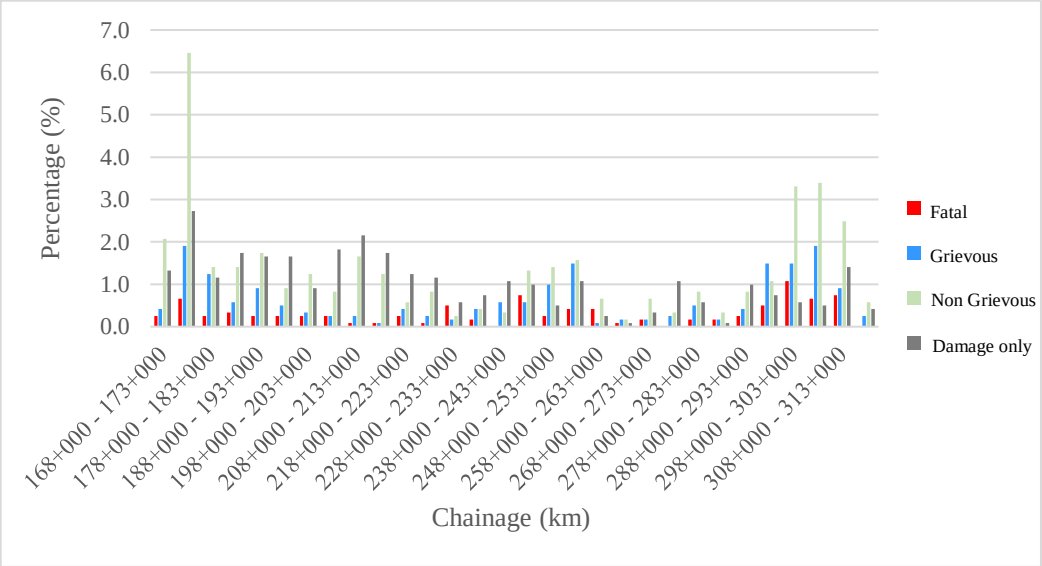


Figure 4.3: Total number of accidents with severity along chainage

The whole section of study stretch was divided into 30 respective stretches each of 5 km while last section is 7 km as shown in table 4.1

Table 4.1: Location of each 5 km stretch

| Sn | Location | Stretch (km) | Length (km) |
|---|---|---|---|
| 1 | Galkandegama - Iretperiyakulam | 168+000 - 173+000 | 5 |
| 2 | Iretperiyakulam - Vavuniya Town | 173+000 - 178+000 | 5 |
| 3 | Vavuniya Town - Thandikulam | 178+000 - 183+000 | 5 |
| 4 | Thandikulam - Omanthai | 183+000 - 188+000 | 5 |
| 5 | Omanthai - Irambaikulam | 188+000 - 193+000 | 5 |
| 6 | Irambaikulam - Panikaniravi | 193+000 - 198+000 | 5 |
| 7 | Panikaniravi - Puliyankulam | 198+000 - 203+000 | 5 |
| 8 | Puliyankulam - Parasankulam | 203+000 - 208+000 | 5 |
| 9 | Parasankulam - Kanakarayankulam | 208+000 - 213+000 | 5 |
| 10 | Kanakarayankulam - Kollapuliyankulam | 213+000 - 218+000 | 5 |
| 11 | Kollapuliyankulam - Mankulam | 218+000 - 223+000 | 5 |
| 12 | Mankulam -Panikkankulam | 223+000 - 228+000 | 5 |
| 13 | Panikkankulam - Pulichettakulam | 228+000 - 233+000 | 5 |
| 14 | Pulichettakulam - Murikandi | 233+000 - 238+000 | 5 |
| 15 | Murikandi - Kanakambikaikulam | 238+000 - 243+000 | 5 |
| 16 | Kanakambikaikulam - Kilinochchi | 243+000 - 248+000 | 5 |
| 17 | Kilinochchi - Paranthan | 248+000 - 253+000 | 5 |
| 18 | Paranthan - Umayalpuram | 253+000 - 258+000 | 5 |
| 19 | Umayalpuram - Elephantpass | 258+000 - 263+000 | 5 |
| 20 | Elephantpass - Iyakkachchi | 263+000 - 268+000 | 5 |
| 21 | Iyakkachchi - Sorapattu | 268+000 - 273+000 | 5 |
| 22 | Sorpattu - Palai | 273+000 - 278+000 | 5 |
| 23 | Palai - Muhamalai | 278+000 - 283+000 | 5 |
| 24 | Muhamalai - Mirusuvil | 283+000 - 288+000 | 5 |
| 25 | Mirusuvil - Kodikamam | 288+000 - 293+000 | 5 |
| 26 | Kodikamam - Meesalai | 293+000 - 298+000 | 5 |
| 27 | Meesalai - Chavakachcheri | 298+000 - 303+000 | 5 |
| 28 | Chavakachcheri - Madduvil | 303+000 - 308+000 | 5 |
| 29 | Madduvil - Kaithadi | 308+000 - 313+000 | 5 |
| 30 | Kaithadi - Jaffna | 313+000 - 320+000 | 7 |

### 4.1.2 Analysis of black spot stretch

- Accident Rate Method

Using the data obtained from police department, the accident rate for each stretch was determined as shown in table 4.2 and figure 4.4

Specimen calculations in stretch 168+000 – 173+000

Accident Rate = 49/5

= 9.8 Nos/ km

Table 4.2: Accident rate of each 5km stretch

| Location | Stretch (km) | Length (km) | Accident Rate |
|---|---|---|---|
| Galkandegama - Iretperiyakulam | 168+000 - 173+000 | 5 | 9.8 |
| Iretperiyakulam - Vavuniya Town | 173+000 - 178+000 | 5 | **28.4** |
| Vavuniya Town - Thandikulam | 178+000 - 183+000 | 5 | 9.8 |
| Thandikulam - Omanthai | 183+000 - 188+000 | 5 | 9.8 |
| Omanthai - Irambaikulam | 188+000 - 193+000 | 5 | 11 |
| Irambaikulam - Panikaniravi | 193+000 - 198+000 | 5 | 8 |
| Panikaniravi - Puliyankulam | 198+000 - 203+000 | 5 | 6.6 |
| Puliyankulam - Parasankulam | 203+000 - 208+000 | 5 | 7.6 |
| Parasankulam - Kanakarayankulam | 208+000 - 213+000 | 5 | 10 |
| Kanakarayankulam - Kollapuliyankulam | 213+000 - 218+000 | 5 | 7.6 |
| Kollapuliyankulam - Mankulam | 218+000 - 223+000 | 5 | 6 |
| Mankulam -Panikkankulam | 223+000 - 228+000 | 5 | 5.6 |
| Panikkankulam - Pulichettakulam | 228+000 - 233+000 | 5 | 3.6 |
| Pulichettakulam - Murikandi | 233+000 - 238+000 | 5 | 4.2 |
| Murikandi - Kanakambikaikulam | 238+000 - 243+000 | 5 | 4.8 |
| Kanakambikaikulam - Kilinochchi | 243+000 - 248+000 | 5 | 8.8 |
| Kilinochchi - Paranthan | 248+000 - 253+000 | 5 | 7.6 |
| Paranthan - Umayalpuram | 253+000 - 258+000 | 5 | 11 |
| Umayalpuram - Elephantpass | 258+000 - 263+000 | 5 | 3.4 |
| Elephantpass - Iyakkachchi | 263+000 - 268+000 | 5 | 1.2 |
| Iyakkachchi - Sorapattu | 268+000 - 273+000 | 5 | 3.2 |
| Sorpattu - Palai | 273+000 - 278+000 | 5 | 4 |
| Palai - Muhamalai | 278+000 - 283+000 | 5 | 5 |
| Muhamalai - Mirusuvil | 283+000 - 288+000 | 5 | 1.8 |
| Mirusuvil - Kodikamam | 288+000 - 293+000 | 5 | 6 |
| Kodikamam - Meesalai | 293+000 - 298+000 | 5 | 9.2 |
| Meesalai - Chavakachcheri | 298+000 - 303+000 | 5 | **15.6** |
| Chavakachcheri - Madduvil | 303+000 - 308+000 | 5 | **15.6** |
| Madduvil - Kaithadi | 308+000 - 313+000 | 5 | **13.4** |
| Kaithadi - Jaffna | 313+000 - 320+000 | 7 | 3 |

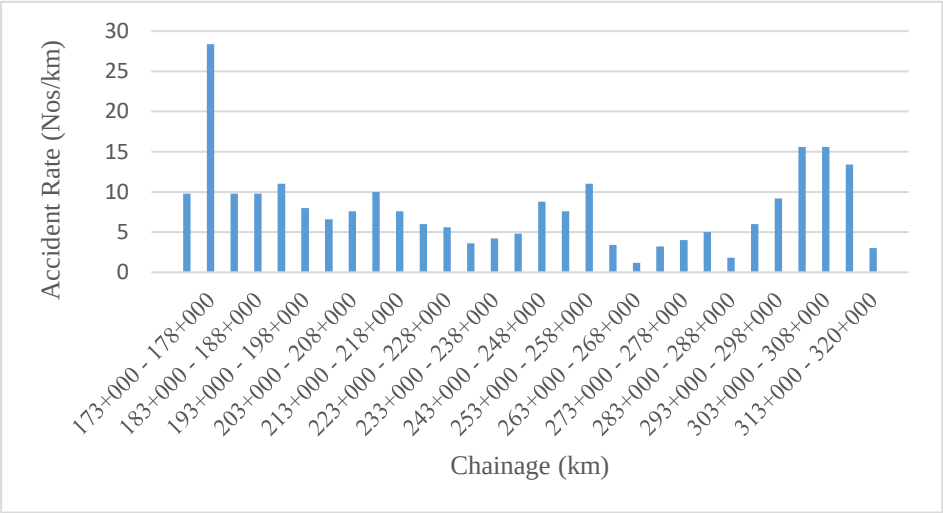


Figure 4.4: Accident rate with chainage in study area

In the accident rate method, the section from highest value to lowest value has been considered as the region within which the black spots are located.

- Accident Frequency Method

In this method, the frequency of accident along each stretch was determined using this formula

Specimen calculations in stretch 168+000 – 173+000

Accident Frequency = (49/1208) X 100

= 4.06

The results obtained were then arranged into the form of table 4.3 and figure 4.5

The section with highest value of frequency has been considered as the region within the black spots are located.

Table 4.3: Accident frequency of entire stretch in 5 km interval

| Distance From Origin | Stretch (km) | Accident Frequency |
|---|---|---|
| 0 - 5 | 168+000 - 173+000 | 4.1 |
| 5 - 10 | 173+000 - 178+000 | **11.8** |
| 10 - 15 | 178+000 - 183+000 | 4.1 |
| 15 - 20 | 183+000 - 188+000 | 4.1 |
| 20 - 25 | 188+000 - 193+000 | 4.6 |
| 25 - 30 | 193+000 - 198+000 | 3.3 |
| 30 - 35 | 198+000 - 203+000 | 2.7 |
| 35 - 40 | 203+000 - 208+000 | 3.1 |
| 40 - 45 | 208+000 - 213+000 | 4.1 |
| 45 - 50 | 213+000 - 218+000 | 3.1 |
| 50 - 55 | 218+000 - 223+000 | 2.5 |
| 55 - 60 | 223+000 - 228+000 | 2.3 |
| 60 - 65 | 228+000 - 233+000 | 1.5 |
| 65 - 70 | 233+000 - 238+000 | 1.7 |
| 70 - 75 | 238+000 - 243+000 | 2.0 |
| 75 - 80 | 243+000 - 248+000 | 3.6 |
| 80 - 85 | 248+000 - 253+000 | 3.1 |
| 85 - 90 | 253+000 - 258+000 | 4.6 |
| 90 - 95 | 258+000 - 263+000 | 1.4 |
| 95 - 100 | 263+000 - 268+000 | 0.5 |
| 100 - 105 | 268+000 - 273+000 | 1.3 |
| 105 - 110 | 273+000 - 278+000 | 1.7 |
| 110 - 115 | 278+000 - 283+000 | 2.1 |
| 115 - 120 | 283+000 - 288+000 | 0.7 |
| 120 - 125 | 288+000 - 293+000 | 2.5 |
| 125 - 130 | 293+000 - 298+000 | 3.8 |
| 130 - 135 | 298+000 - 303+000 | **6.5** |
| 135 - 140 | 303+000 - 308+000 | **6.5** |
| 140 - 145 | 308+000 - 313+000 | **5.5** |
| 145 - 152 | 313+000 - 320+000 | 1.2 |

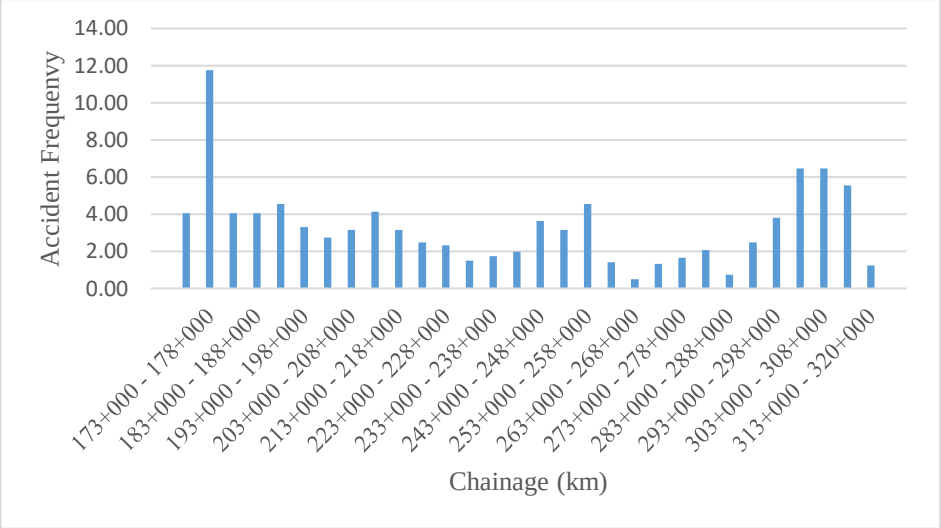


Figure 4.5: Accident frequency with chainage in study area

- Weighted Severity Index Method

Accident severity index values were calculated for entire section using the mathematical formula

$$WSI = (5xF) + (3xG) + (1xNG)$$

Specimen calculations in stretch 168+000 – 173+000

$$WSI = (5x3) + (3x5) + (1x25)$$

$$= 55$$

From this method, the section with the highest WSI value has been considered as the region within which the black spots are located and according to the literature the most accurate method is found to find out black spots location is WSI.

However, by using these 3 methods it has been found four number of section by ranking from highest value to lowest value as shown in table 4.4 for further analysis to find black spots locations in 100m intervals.

Table 4.4: Accident black spots ranking

| Chainage | Accident Rate | Accident Frequency | Weighted Severity Index | Rank |
|---|---|---|---|---|
| 168+000 - 173+000 | 9.8 | 4.06 | 55 | 12 |
| 173+000 - 178+000 | 28.4 | 11.75 | 187 | **1** |
| 178+000 - 183+000 | 9.8 | 4.06 | 77 | 8 |
| 183+000 - 188+000 | 9.8 | 4.06 | 58 | 11 |
| 188+000 - 193+000 | 11 | 4.55 | 69 | 9 |
| 193+000 - 198+000 | 8 | 3.31 | 44 | 13 |
| 198+000 - 203+000 | 6.6 | 2.73 | 42 | 14 |
| 203+000 - 208+000 | 7.6 | 3.15 | 34 | 21 |
| 208+000 - 213+000 | 10 | 4.14 | 34 | 20 |
| 213+000 - 218+000 | 7.6 | 3.15 | 23 | 26 |
| 218+000 - 223+000 | 6 | 2.48 | 37 | 18 |
| 223+000 - 228+000 | 5.6 | 2.32 | 24 | 24 |
| 228+000 - 233+000 | 3.6 | 1.49 | 39 | 17 |
| 233+000 - 238+000 | 4.2 | 1.74 | 30 | 22 |
| 238+000 - 243+000 | 4.8 | 1.99 | 25 | 23 |
| 243+000 - 248+000 | 8.8 | 3.64 | 2 | 7 |
| 248+000 - 253+000 | 7.6 | 3.15 | 68 | 10 |
| 253+000 - 258+000 | 11 | 4.55 | 98 | 5 |
| 258+000 - 263+000 | 3.4 | 1.41 | 36 | 19 |
| 263+000 - 268+000 | 1.2 | 0.50 | 13 | 30 |
| 268+000 - 273+000 | 3.2 | 1.32 | 24 | 25 |
| 273+000 - 278+000 | 4 | 1.66 | 13 | 29 |
| 278+000 - 283+000 | 5 | 2.07 | 38 | 16 |
| 283+000 - 288+000 | 1.8 | 0.75 | 20 | 27 |
| 288+000 - 293+000 | 6 | 2.48 | 40 | 15 |
| 293+000 - 298+000 | 9.2 | 3.81 | 97 | 6 |
| 298+000 - 303+000 | 15.6 | 6.46 | 159 | **2** |
| 303+000 - 308+000 | 15.6 | 6.46 | 150 | **3** |
| 308+000 - 313+000 | 13.4 | 5.55 | 108 | **4** |
| 313+000 - 320+000 | 3 | 1.24 | 16 | 28 |

### 4.1.3 Analysis of the identified accident black spot stretches


Figure 4.6: Identified accident black spot stretches from 298+000 – 313+000

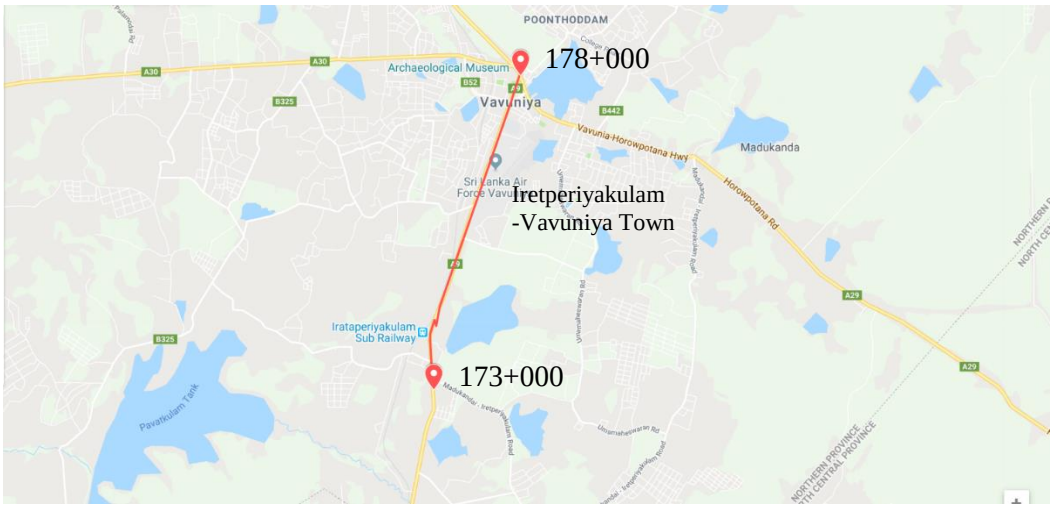


Figure 4.7: Identified accident black spot stretch from 173+000 – 178+000

As shown in figure 4.6 and 4.7, each of the accident black spot stretches (5 km) were again divided into 100m interval and already analysed three methods were used to find black spot location more accurately.

**Location 173+000 – 178+000**

- Accident Rate Method

The results of analysis of section 173+000 – 178+000 in 100m intervals were tabulated as shown in table 4.5

Table 4.5: Accident rate of stretch 173+000-178+000 in 100m interval

| Stretch (km) | Accident Rate | Stretch (km) | Accident Rate |
|---|---|---|---|
| 173+000 - 173+100 | 0 | 175+500 - 175+600 | 30 |
| 173+100 - 173+200 | 10 | 175+600 - 175+700 | 20 |
| 173+200 - 173+300 | 30 | 175+700 - 175+800 | 20 |
| 173+300 - 173+400 | 0 | 175+800 - 175+900 | 60 |
| 173+400 - 173+500 | 20 | 175+900 - 176+000 | 20 |
| 173+500 - 173+600 | 20 | 176+000 - 176+100 | 50 |
| 173+600 - 173+700 | 0 | 176+100 - 176+200 | 90 |
| 173+700 - 173+800 | 10 | 176+200 - 176+300 | 10 |
| 173+800 - 173+900 | 0 | 176+300 - 176+400 | 50 |
| 173+900 - 174+000 | 0 | 176+400 - 176+500 | 60 |
| 174+000 - 174+100 | 40 | 176+500 - 176+600 | 10 |
| 174+100 - 174+200 | 30 | 176+600 - 176+700 | 30 |
| 174+200 - 174+300 | 10 | 176+700 - 176+800 | 70 |
| 174+300 - 174+400 | 10 | 176+800 - 176+900 | 100 |
| 174+400 - 174+500 | 10 | 176+900 - 177+000 | 50 |
| 174+500 - 174+600 | 10 | 177+000 - 177+100 | 120 |
| 174+600 - 174+700 | 0 | 177+100 - 177+200 | 40 |
| 174+700 - 174+800 | 10 | 177+200 - 177+300 | 50 |
| 174+800 - 174+900 | 0 | 177+300 - 177+400 | 20 |
| 174+900 - 175+000 | 0 | 177+400 - 177+500 | 20 |
| 175+000 - 175+100 | 50 | 177+500 - 177+600 | 10 |
| 175+100 - 175+200 | 50 | 177+600 - 177+700 | 20 |
| 175+200 - 175+300 | 30 | 177+700 - 177+800 | 50 |
| 175+300 - 175+400 | 0 | 177+800 - 177+900 | 30 |
| 175+400 - 175+500 | 30 | 177+900 - 178+000 | 20 |

The sections with more than a predetermined number of accidents are then classified as possible black spot locations

The average number of accidents occurring per unit length is taken as the predetermined number of accidents

$$\text{Average accident rate} = \frac{\text{Total number of accidents}}{\text{Length of entire section}}$$

$$= 142/5$$

$$= 28.4$$

Therefore, the section with accident rate greater than 28.4 were classified as possible black spot locations as shown in figure 4.8

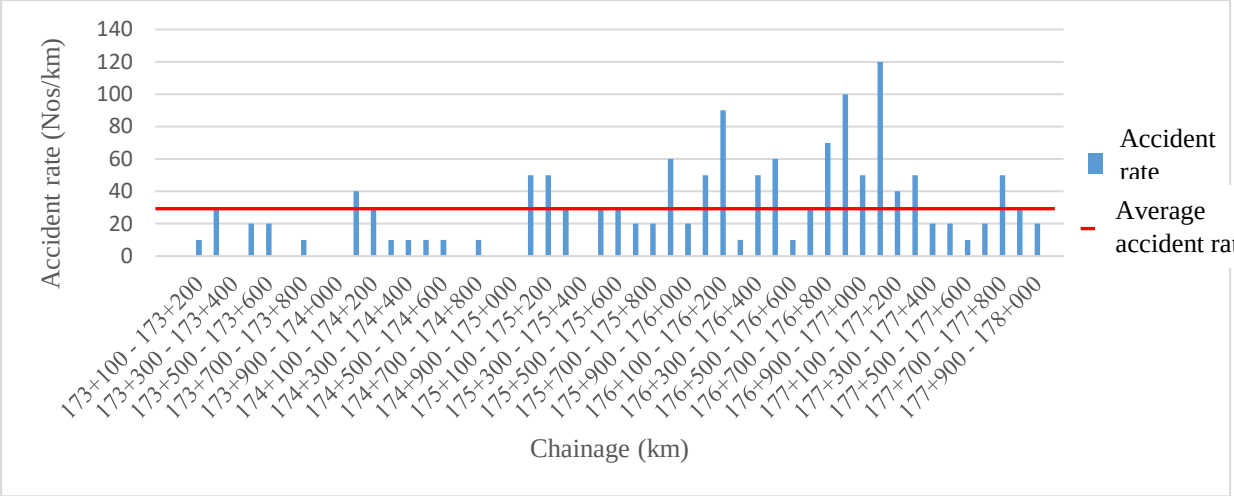


Figure 4.8: Average accident rate in chainage from 173+000 – 178+000

- Accident Frequency Method

Table 4.6: Accident frequency of stretch 173+000-178+000 in 100m interval

| Stretch (km) | Accident Frequency | Stretch (km) | Accident Frequency |
|---|---|---|---|
| 173+000 - 173+100 | 0.00 | 175+500 - 175+600 | 2.11 |
| 173+100 - 173+200 | 0.70 | 175+600 - 175+700 | 1.41 |
| 173+200 - 173+300 | 2.11 | 175+700 - 175+800 | 1.41 |
| 173+300 - 173+400 | 0.00 | 175+800 - 175+900 | 4.23 |
| 173+400 - 173+500 | 1.41 | 175+900 - 176+000 | 1.41 |
| 173+500 - 173+600 | 1.41 | 176+000 - 176+100 | 3.52 |
| 173+600 - 173+700 | 0.00 | 176+100 - 176+200 | 6.34 |
| 173+700 - 173+800 | 0.70 | 176+200 - 176+300 | 0.70 |
| 173+800 - 173+900 | 0.00 | 176+300 - 176+400 | 3.52 |
| 173+900 - 174+000 | 0.00 | 176+400 - 176+500 | 4.23 |
| 174+000 - 174+100 | 2.82 | 176+500 - 176+600 | 0.70 |
| 174+100 - 174+200 | 2.11 | 176+600 - 176+700 | 2.11 |
| 174+200 - 174+300 | 0.70 | 176+700 - 176+800 | 4.93 |
| 174+300 - 174+400 | 0.70 | 176+800 - 176+900 | 7.04 |
| 174+400 - 174+500 | 0.70 | 176+900 - 177+000 | 3.52 |
| 174+500 - 174+600 | 0.70 | 177+000 - 177+100 | 8.45 |
| 174+600 - 174+700 | 0.00 | 177+100 - 177+200 | 2.82 |
| 174+700 - 174+800 | 0.70 | 177+200 - 177+300 | 3.52 |
| 174+800 - 174+900 | 0.00 | 177+300 - 177+400 | 1.41 |
| 174+900 - 175+000 | 0.00 | 177+400 - 177+500 | 1.41 |
| 175+000 - 175+100 | 3.52 | 177+500 - 177+600 | 0.70 |
| 175+100 - 175+200 | 3.52 | 177+600 - 177+700 | 1.41 |
| 175+200 - 175+300 | 2.11 | 177+700 - 177+800 | 3.52 |
| 175+300 - 175+400 | 0.00 | 177+800 - 177+900 | 2.11 |
| 175+400 - 175+500 | 2.11 | 177+900 - 178+000 | 1.41 |

Here, the section with highest accident frequency has been classified as the possible black spot locations

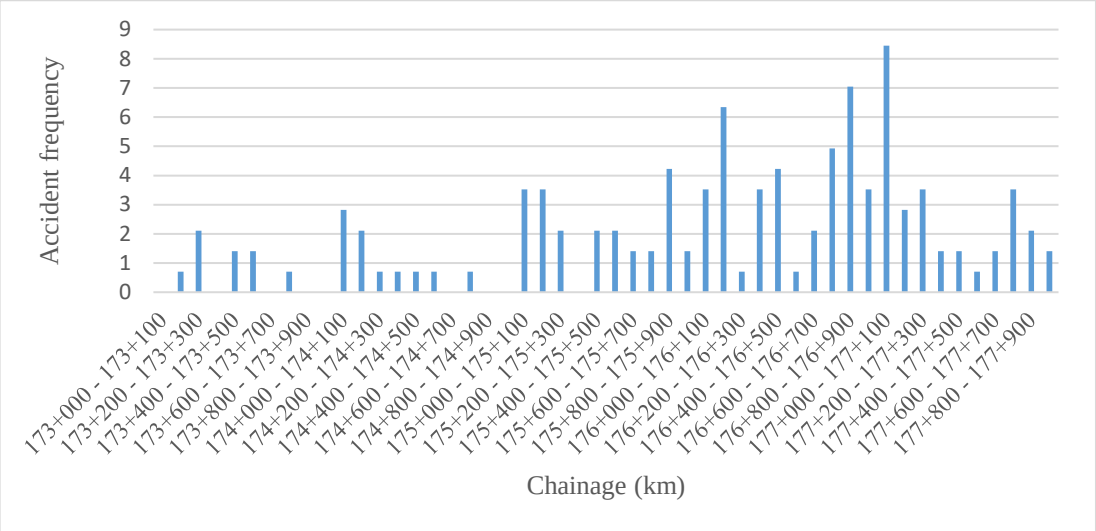


Figure 4.9: Accident frequency in chainage from 173+000 – 178+000

- Weighted Severity Index Method

Table 4.7: WSI of stretch 173+000-178+000 in 100m interval

| Stretch (km) | Weighted Severity Index | Stretch (km) | Weighted Severity Index |
|---|---|---|---|
| 173+000 - 173+100 | 0 | 175+500 - 175+600 | 3 |
| 173+100 - 173+200 | 0 | 175+600 - 175+700 | 6 |
| 173+200 - 173+300 | 4 | 175+700 - 175+800 | 4 |
| 173+300 - 173+400 | 0 | 175+800 - 175+900 | 6 |
| 173+400 - 173+500 | 3 | 175+900 - 176+000 | 2 |
| 173+500 - 173+600 | 6 | 176+000 - 176+100 | 5 |
| 173+600 - 173+700 | 0 | 176+100 - 176+200 | 9 |
| 173+700 - 173+800 | 5 | 176+200 - 176+300 | 1 |
| 173+800 - 173+900 | 0 | 176+300 - 176+400 | 2 |
| 173+900 - 174+000 | 0 | 176+400 - 176+500 | 9 |
| 174+000 - 174+100 | 4 | 176+500 - 176+600 | 0 |
| 174+100 - 174+200 | 3 | 176+600 - 176+700 | 5 |
| 174+200 - 174+300 | 0 | 176+700 - 176+800 | 12 |
| 174+300 - 174+400 | 0 | 176+800 - 176+900 | 13 |
| 174+400 - 174+500 | 3 | 176+900 - 177+000 | 4 |
| 174+500 - 174+600 | 3 | 177+000 - 177+100 | 18 |
| 174+600 - 174+700 | 0 | 177+100 - 177+200 | 6 |
| 174+700 - 174+800 | 5 | 177+200 - 177+300 | 5 |
| 174+800 - 174+900 | 0 | 177+300 - 177+400 | 1 |
| 174+900 - 175+000 | 0 | 177+400 - 177+500 | 3 |
| 175+000 - 175+100 | 5 | 177+500 - 177+600 | 1 |
| 175+100 - 175+200 | 2 | 177+600 - 177+700 | 4 |
| 175+200 - 175+300 | 4 | 177+700 - 177+800 | 6 |
| 175+300 - 175+400 | 0 | 177+800 - 177+900 | 7 |
| 175+400 - 175+500 | 6 | 177+900 - 178+000 | 2 |

As shown in table 4.7, the section having WSI values greater than a predetermined value are then classified as possible black spot locations

To determination of WSI limit let us assume a section about 100m, where a minimum of 1 fatal accident has been reported over the last 4 years is called an accident black spot

$$WSI = (5x1) + (3x0) + (1x0)$$
$$= 5$$

Thus, all the section having WSI value above 5 are classified as accident black spots.

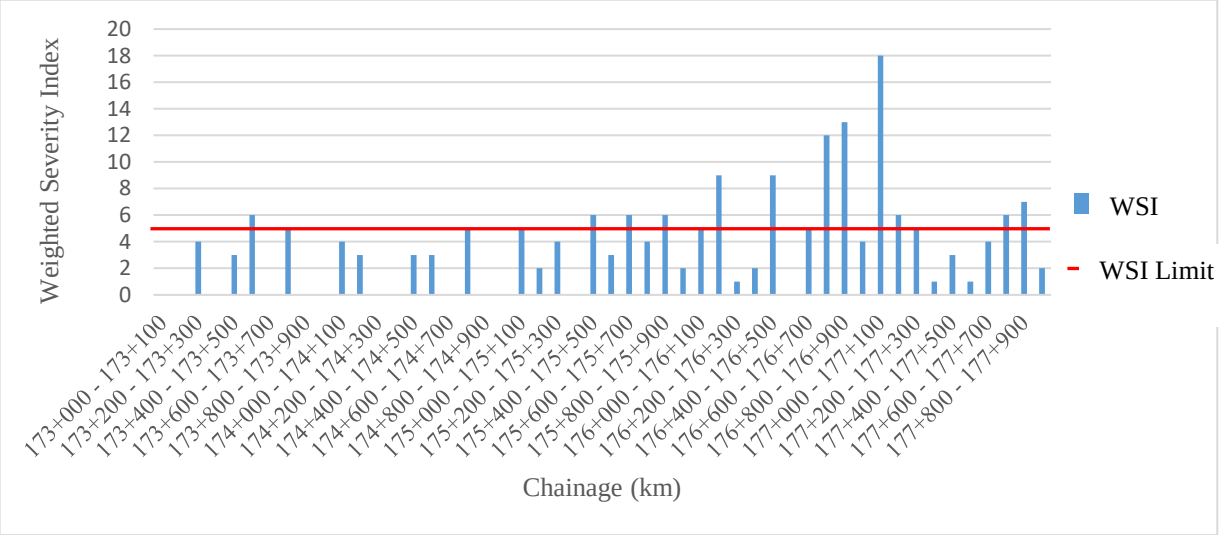


Figure 4.10: WSI in chainage from 173+000 – 178+000

Selected locations above threshold value from the three methods were ranked with respect to severity level as shown in table 4.8.

Table 4.8: Ranking of accident black spots in 173+000-178+000 in 100m interval

| Chainage | Accident Rate | Accident Frequency | Weighted Severity Index | Rank |
|---|---|---|---|---|
| 173+000 - 173+100 | 0 | 0.00 | 0 | |
| 173+100 - 173+200 | 10 | 0.70 | 0 | |
| 173+200 - 173+300 | 30 | 2.11 | 4 | |
| 173+300 - 173+400 | 0 | 0.00 | 0 | |
| 173+400 - 173+500 | 20 | 1.41 | 3 | |
| 173+500 - 173+600 | 20 | 1.41 | 6 | XII |
| 173+600 - 173+700 | 0 | 0.00 | 0 | |
| 173+700 - 173+800 | 10 | 0.70 | 5 | |
| 173+800 - 173+900 | 0 | 0.00 | 0 | |
| 173+900 - 174+000 | 0 | 0.00 | 0 | |
| 174+000 - 174+100 | 40 | 2.82 | 4 | |
| 174+100 - 174+200 | 30 | 2.11 | 3 | |
| 174+200 - 174+300 | 10 | 0.70 | 0 | |
| 174+300 - 174+400 | 10 | 0.70 | 0 | |
| 174+400 - 174+500 | 10 | 0.70 | 3 | |
| 174+500 - 174+600 | 10 | 0.70 | 3 | |
| 174+600 - 174+700 | 0 | 0.00 | 0 | |
| 174+700 - 174+800 | 10 | 0.70 | 5 | |
| 174+800 - 174+900 | 0 | 0.00 | 0 | |
| 174+900 - 175+000 | 0 | 0.00 | 0 | |
| 175+000 - 175+100 | 50 | 3.52 | 5 | |
| 175+100 - 175+200 | 50 | 3.52 | 2 | |
| 175+200 - 175+300 | 30 | 2.11 | 4 | |
| 175+300 - 175+400 | 0 | 0.00 | 0 | |
| 175+400 - 175+500 | 30 | 2.11 | 6 | X |
| 175+500 - 175+600 | 30 | 2.11 | 3 | |
| 175+600 - 175+700 | 20 | 1.41 | 6 | XI |
| 175+700 - 175+800 | 20 | 1.41 | 4 | |
| 175+800 - 175+900 | 60 | 4.23 | 6 | VII |
| 175+900 - 176+000 | 20 | 1.41 | 2 | |
| 176+000 - 176+100 | 50 | 3.52 | 5 | |
| 176+100 - 176+200 | 90 | 6.34 | 9 | IV |
| 176+200 - 176+300 | 10 | 0.70 | 1 | |
| 176+300 - 176+400 | 50 | 3.52 | 2 | |
| 176+400 - 176+500 | 60 | 4.23 | 9 | V |
| 176+500 - 176+600 | 10 | 0.70 | 0 | |
| 176+600 - 176+700 | 30 | 2.11 | 5 | |
| 176+700 - 176+800 | 70 | 4.93 | 12 | III |
| 176+800 - 176+900 | 100 | 7.04 | 13 | II |
| 176+900 - 177+000 | 50 | 3.52 | 4 | |
| 177+000 - 177+100 | 120 | 8.45 | 18 | I |
| 177+100 - 177+200 | 40 | 2.82 | 6 | IX |
| 177+200 - 177+300 | 50 | 3.52 | 5 | |
| 177+300 - 177+400 | 20 | 1.41 | 1 | |
| 177+400 - 177+500 | 20 | 1.41 | 3 | |
| 177+500 - 177+600 | 10 | 0.70 | 1 | |
| 177+600 - 177+700 | 20 | 1.41 | 4 | |
| 177+700 - 177+800 | 50 | 3.52 | 6 | VIII |
| 177+800 - 177+900 | 30 | 2.11 | 7 | VI |
| 177+900 - 178+000 | 20 | 1.41 | 2 | |

**Location 298+000 – 303+000**

- Accident Rate Method

Table 4.9: Accident rate of stretch 298+000-303+000 in 100m interval

| Stretch (km) | Accident Rate | Stretch (km) | Accident Rate |
|---|---|---|---|
| 298+000 - 298+100 | 10 | 300+500 - 300+600 | 0 |
| 298+100 - 298+200 | 30 | 300+600 - 300+700 | 0 |
| 298+200 - 298+300 | 10 | 300+700 - 300+800 | 10 |
| 298+300 - 298+400 | 30 | 300+800 - 300+900 | 0 |
| 298+400 - 298+500 | 30 | 300+900 - 301+000 | 10 |
| 298+500 - 298+600 | 0 | 301+000 - 301+100 | 40 |
| 298+600 - 298+700 | 0 | 301+100 - 301+200 | 60 |
| 298+700 - 298+800 | 20 | 301+200 - 301+300 | 20 |
| 298+800 - 298+900 | 0 | 301+300 - 301+400 | 0 |
| 298+900 - 299+000 | 0 | 301+400 - 301+500 | 10 |
| 299+000 - 299+100 | 30 | 301+500 - 301+600 | 10 |
| 299+100 - 299+200 | 80 | 301+600 - 301+700 | 0 |
| 299+200 - 299+300 | 10 | 301+700 - 301+800 | 20 |
| 299+300 - 299+400 | 10 | 301+800 - 301+900 | 0 |
| 299+400 - 299+500 | 0 | 301+900 - 302+000 | 20 |
| 299+500 - 299+600 | 0 | 302+000 - 302+100 | 40 |
| 299+600 - 299+700 | 0 | 302+100 - 302+200 | 80 |
| 299+700 - 299+800 | 0 | 302+200 - 302+300 | 10 |
| 299+800 - 299+900 | 0 | 302+300 - 302+400 | 0 |
| 299+900 - 300+000 | 20 | 302400 - 302+500 | 0 |
| 300+000 - 300+100 | 110 | 302+500 - 302+600 | 0 |
| 300+100 - 300+200 | 30 | 302+600 - 302+700 | 0 |
| 300+200 - 300+300 | 10 | 302+700 - 302+800 | 0 |
| 300+300 - 300+400 | 0 | 302+800 - 302+900 | 0 |
| 300+400 - 300+500 | 10 | 302+900 - 303+000 | 10 |

Average accident rate = 78/5

= 15.6

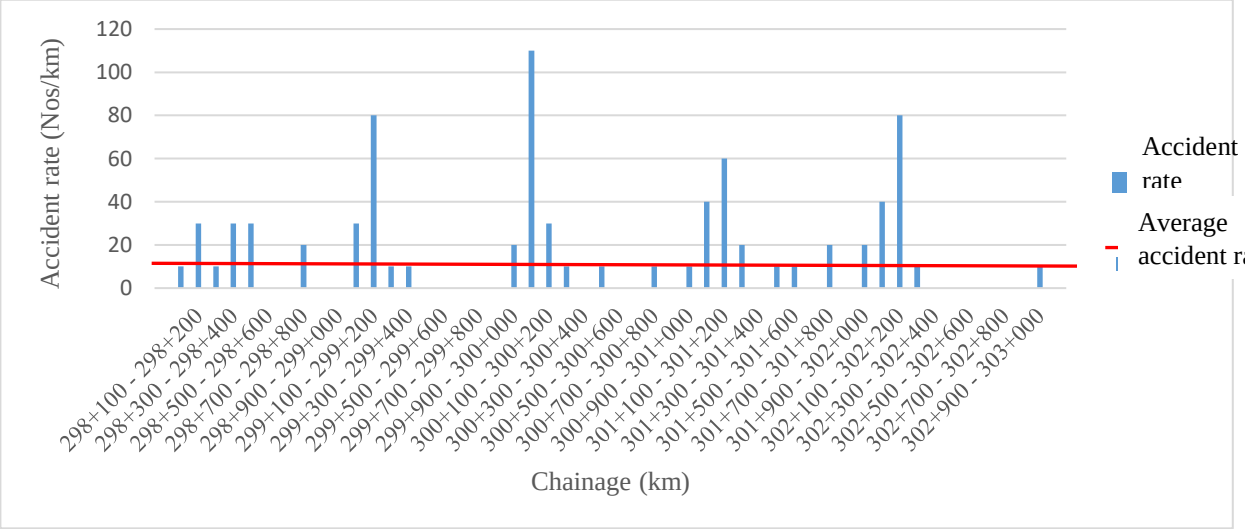


Figure 4.11: Average accident rate in chainage from 298+000 – 303+000

- Accident Frequency Method

Table 4.10: Accident frequency of stretch 298+000-303+000 in 100m interval

| Stretch (km) | Accident Frequency | Stretch (km) | Accident Frequency |
|---|---|---|---|
| 298+000 - 298+100 | 1.28 | 300+500 - 300+600 | 0.00 |
| 298+100 - 298+200 | 3.85 | 300+600 - 300+700 | 0.00 |
| 298+200 - 298+300 | 1.28 | 300+700 - 300+800 | 1.28 |
| 298+300 - 298+400 | 3.85 | 300+800 - 300+900 | 0.00 |
| 298+400 - 298+500 | 3.85 | 300+900 - 301+000 | 1.28 |
| 298+500 - 298+600 | 0.00 | 301+000 - 301+100 | 5.13 |
| 298+600 - 298+700 | 0.00 | 301+100 - 301+200 | 7.69 |
| 298+700 - 298+800 | 2.56 | 301+200 - 301+300 | 2.56 |
| 298+800 - 298+900 | 0.00 | 301+300 - 301+400 | 0.00 |
| 298+900 - 299+000 | 0.00 | 301+400 - 301+500 | 1.28 |
| 299+000 - 299+100 | 3.85 | 301+500 - 301+600 | 1.28 |
| 299+100 - 299+200 | 10.26 | 301+600 - 301+700 | 0.00 |
| 299+200 - 299+300 | 1.28 | 301+700 - 301+800 | 2.56 |
| 299+300 - 299+400 | 1.28 | 301+800 - 301+900 | 0.00 |
| 299+400 - 299+500 | 0.00 | 301+900 - 302+000 | 2.56 |
| 299+500 - 299+600 | 0.00 | 302+000 - 302+100 | 5.13 |
| 299+600 - 299+700 | 0.00 | 302+100 - 302+200 | 10.26 |
| 299+700 - 299+800 | 0.00 | 302+200 - 302+300 | 1.28 |
| 299+800 - 299+900 | 0.00 | 302+300 - 302+400 | 0.00 |
| 299+900 - 300+000 | 2.56 | 302400 - 302+500 | 0.00 |
| 300+000 - 300+100 | 14.10 | 302+500 - 302+600 | 0.00 |
| 300+100 - 300+200 | 3.85 | 302+600 - 302+700 | 0.00 |
| 300+200 - 300+300 | 1.28 | 302+700 - 302+800 | 0.00 |
| 300+300 - 300+400 | 0.00 | 302+800 - 302+900 | 0.00 |
| 300+400 - 300+500 | 1.28 | 302+900 - 303+000 | 1.28 |

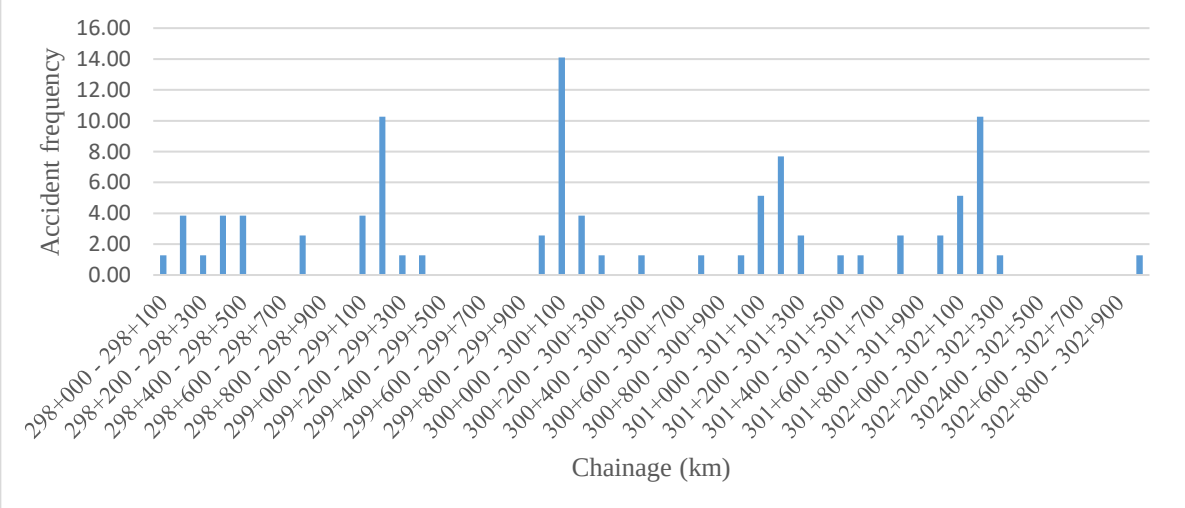


Figure 4.12: Accident frequency in chainage from 298+000 – 303+000

- Weighted Severity Index Method

Table 4.11: WSI of stretch 298+000-303+000 in 100m interval

| Stretch (km) | Weighted Severity Index | Stretch (km) | Weighted Severity Index |
|---|---|---|---|
| 298+000 - 298+100 | 3 | 300+500 - 300+600 | 0 |
| 298+100 - 298+200 | 11 | 300+600 - 300+700 | 0 |
| 298+200 - 298+300 | 1 | 300+700 - 300+800 | 0 |
| 298+300 - 298+400 | 11 | 300+800 - 300+900 | 0 |
| 298+400 - 298+500 | 13 | 300+900 - 301+000 | 1 |
| 298+500 - 298+600 | 0 | 301+000 - 301+100 | 8 |
| 298+600 - 298+700 | 0 | 301+100 - 301+200 | 14 |
| 298+700 - 298+800 | 8 | 301+200 - 301+300 | 0 |
| 298+800 - 298+900 | 0 | 301+300 - 301+400 | 0 |
| 298+900 - 299+000 | 0 | 301+400 - 301+500 | 1 |
| 299+000 - 299+100 | 5 | 301+500 - 301+600 | 1 |
| 299+100 - 299+200 | 15 | 301+600 - 301+700 | 0 |
| 299+200 - 299+300 | 1 | 301+700 - 301+800 | 8 |
| 299+300 - 299+400 | 1 | 301+800 - 301+900 | 0 |
| 299+400 - 299+500 | 0 | 301+900 - 302+000 | 2 |
| 299+500 - 299+600 | 0 | 302+000 - 302+100 | 10 |
| 299+600 - 299+700 | 0 | 302+100 - 302+200 | 10 |
| 299+700 - 299+800 | 0 | 302+200 - 302+300 | 1 |
| 299+800 - 299+900 | 0 | 302+300 - 302+400 | 0 |
| 299+900 - 300+000 | 2 | 302400 - 302+500 | 0 |
| 300+000 - 300+100 | 22 | 302+500 - 302+600 | 0 |
| 300+100 - 300+200 | 7 | 302+600 - 302+700 | 0 |
| 300+200 - 300+300 | 1 | 302+700 - 302+800 | 0 |
| 300+300 - 300+400 | 0 | 302+800 - 302+900 | 0 |
| 300+400 - 300+500 | 1 | 302+900 - 303+000 | 1 |

WSI limit = 5

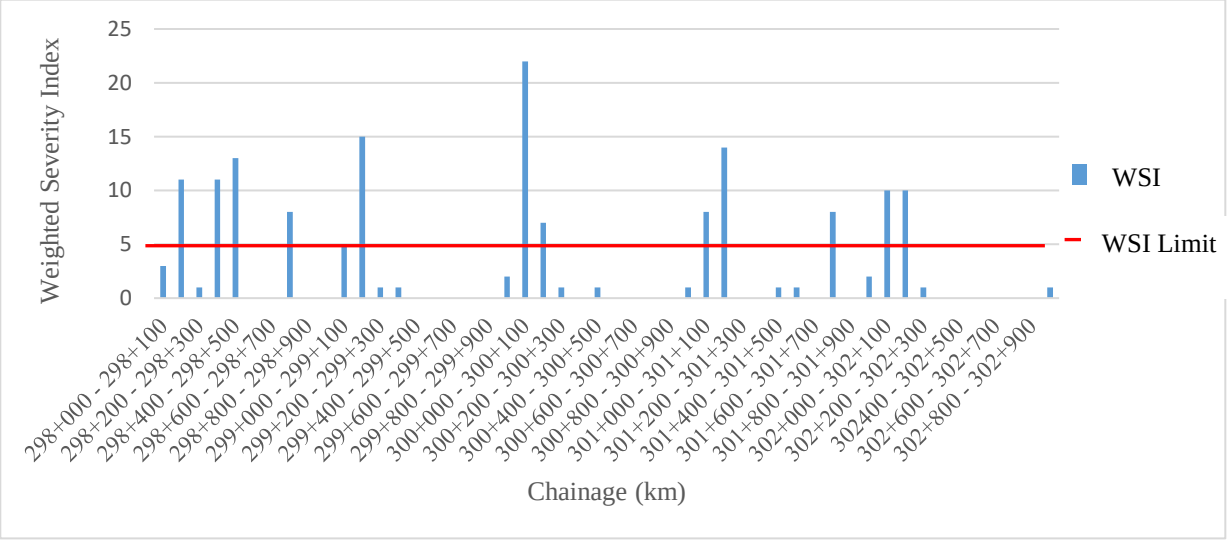


Figure 4.13: WSI in chainage from 298+000 – 303+000

Selected locations above threshold value from the above three methods were ranked with respect to severity level as shown in table 4.12.

Table 4.12: Ranking of accident black spot in 298+000-303+000 in 100m interval

| Chainage | Accident Rate | Accident Frequency | Accident Severity Index | Rank |
|---|---|---|---|---|
| 298+000 - 298+100 | 10 | 1.28 | 3 | |
| 298+100 - 298+200 | 30 | 3.85 | 11 | VI |
| 298+200 - 298+300 | 10 | 1.28 | 1 | |
| 298+300 - 298+400 | 30 | 3.85 | 11 | V |
| 298+400 - 298+500 | 30 | 3.85 | 13 | IV |
| 298+500 - 298+600 | 0 | 0.00 | 0 | |
| 298+600 - 298+700 | 0 | 0.00 | 0 | |
| 298+700 - 298+800 | 20 | 2.56 | 8 | XI |
| 298+800 - 298+900 | 0 | 0.00 | 0 | |
| 298+900 - 299+000 | 0 | 0.00 | 0 | |
| 299+000 - 299+100 | 30 | 3.85 | 5 | |
| 299+100 - 299+200 | 80 | 10.26 | 15 | II |
| 299+200 - 299+300 | 10 | 1.28 | 1 | |
| 299+300 - 299+400 | 10 | 1.28 | 1 | |
| 299+400 - 299+500 | 0 | 0.00 | 0 | |
| 299+500 - 299+600 | 0 | 0.00 | 0 | |
| 299+600 - 299+700 | 0 | 0.00 | 0 | |
| 299+700 - 299+800 | 0 | 0.00 | 0 | |
| 299+800 - 299+900 | 0 | 0.00 | 0 | |
| 299+900 - 300+000 | 20 | 2.56 | 2 | |
| 300+000 - 300+100 | 110 | 14.10 | 22 | I |
| 300+100 - 300+200 | 30 | 3.85 | 7 | XII |
| 300+200 - 300+300 | 10 | 1.28 | 1 | |
| 300+300 - 300+400 | 0 | 0.00 | 0 | |
| 300+400 - 300+500 | 10 | 1.28 | 1 | |
| 300+500 - 300+600 | 0 | 0.00 | 0 | |
| 300+600 - 300+700 | 0 | 0.00 | 0 | |
| 300+700 - 300+800 | 10 | 1.28 | 0 | |
| 300+800 - 300+900 | 0 | 0.00 | 0 | |
| 300+900 - 301+000 | 10 | 1.28 | 1 | |
| 301+000 - 301+100 | 40 | 5.13 | 8 | IX |
| 301+100 - 301+200 | 60 | 7.69 | 14 | III |
| 301+200 - 301+300 | 20 | 2.56 | 0 | |
| 301+300 - 301+400 | 0 | 0.00 | 0 | |
| 301+400 - 301+500 | 10 | 1.28 | 1 | |
| 301+500 - 301+600 | 10 | 1.28 | 1 | |
| 301+600 - 301+700 | 0 | 0.00 | 0 | |
| 301+700 - 301+800 | 20 | 2.56 | 8 | X |
| 301+800 - 301+900 | 0 | 0.00 | 0 | |
| 301+900 - 302+000 | 20 | 2.56 | 2 | |
| 302+000 - 302+100 | 40 | 5.13 | 10 | VIII |
| 302+100 - 302+200 | 80 | 10.26 | 10 | VII |
| 302+200 - 302+300 | 10 | 1.28 | 1 | |
| 302+300 - 302+400 | 0 | 0.00 | 0 | |
| 302400 - 302+500 | 0 | 0.00 | 0 | |
| 302+500 - 302+600 | 0 | 0.00 | 0 | |
| 302+600 - 302+700 | 0 | 0.00 | 0 | |
| 302+700 - 302+800 | 0 | 0.00 | 0 | |
| 302+800 - 302+900 | 0 | 0.00 | 0 | |
| 302+900 - 303+000 | 10 | 1.28 | 1 | |

**Location 303+000 – 308+000**

- Accident Rate Method

Table 4.13: Accident rate of stretch 303+000-308+000 in 100m interval

| Stretch (km) | Accident Rate | Stretch (km) | Accident Rate |
|---|---|---|---|
| 303+000 - 303+100 | 90 | 305+500 - 305+600 | 0 |
| 303+100 - 303+200 | 50 | 305+600 - 305+700 | 0 |
| 303+200 - 303+300 | 30 | 305+700 - 305+800 | 0 |
| 303+300 - 303+400 | 0 | 305+800 - 305+900 | 0 |
| 303+400 - 303+500 | 30 | 305+900 - 306+000 | 10 |
| 303+500 - 303+600 | 10 | 306+000 - 306+100 | 40 |
| 303+600 - 303+700 | 10 | 306+100 - 306+200 | 0 |
| 303+700 - 303+800 | 40 | 306+200 - 306+300 | 20 |
| 303+800 - 303+900 | 0 | 306+300 - 306+400 | 10 |
| 303+900 - 304+000 | 10 | 306+400 - 306+500 | 10 |
| 304+000 - 304+100 | 40 | 306+500 - 306+600 | 10 |
| 304+100 - 304+200 | 30 | 306+600 - 306+700 | 30 |
| 304+200 - 304+300 | 20 | 306+700 - 306+800 | 10 |
| 304+300 - 304+400 | 0 | 306+800 - 306+900 | 0 |
| 304+400 - 304+500 | 0 | 306+900 - 307+000 | 20 |
| 304+500 - 304+600 | 0 | 307+000 - 307+100 | 60 |
| 304+600 - 304+700 | 0 | 307+100 - 307+200 | 20 |
| 304+700 - 304+800 | 0 | 307+200 - 307+300 | 10 |
| 304+800 - 304+900 | 0 | 307+300 - 307+400 | 10 |
| 304+900 - 305+000 | 0 | 307+400 - 307+500 | 10 |
| 305+000 - 305+100 | 70 | 307+500 - 307+600 | 0 |
| 305+100 - 305+200 | 40 | 307+600 - 307+700 | 0 |
| 305+200 - 305+300 | 20 | 307+700 - 307+800 | 10 |
| 305+300 - 305+400 | 10 | 307+800 - 307+900 | 0 |
| 305+400 - 305+500 | 0 | 307+900 - 308+000 | 0 |

Average accident rate = 78/5

= 15.6

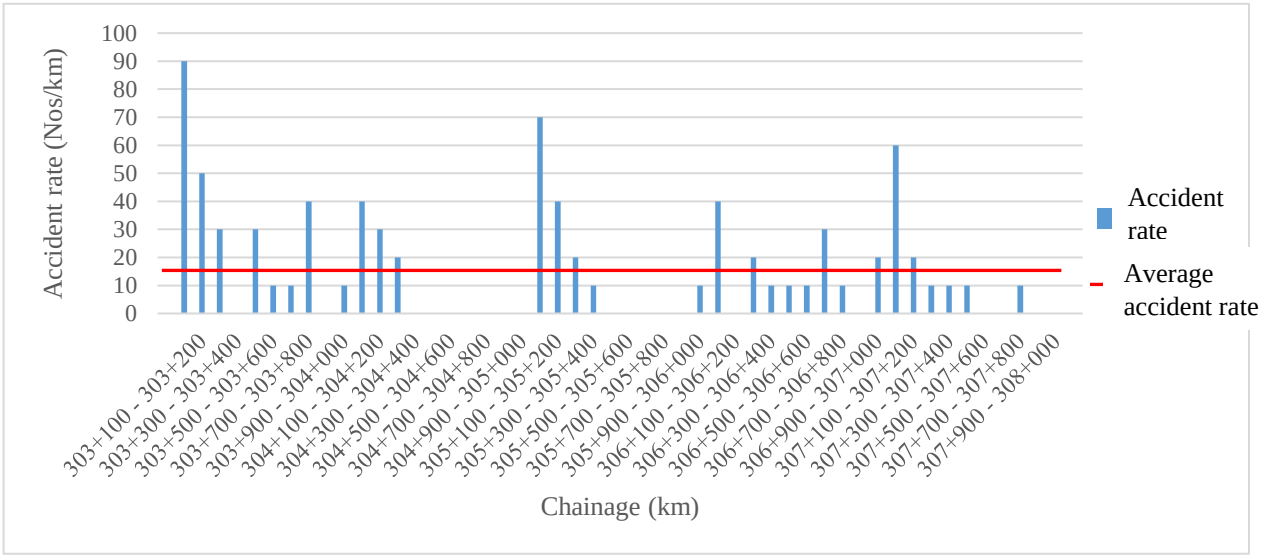


Figure 4.14: Average accident rate in chainage from 303+000 – 308+000

- Accident Frequency Method

Table 4.14: Accident frequency of stretch 303+000-308+000 in 100m interval

| Stretch (km) | Accident Frequency | Stretch (km) | Accident Frequency |
|---|---|---|---|
| 303+000 - 303+100 | 11.54 | 305+500 - 305+600 | 0.00 |
| 303+100 - 303+200 | 6.41 | 305+600 - 305+700 | 0.00 |
| 303+200 - 303+300 | 3.85 | 305+700 - 305+800 | 0.00 |
| 303+300 - 303+400 | 0.00 | 305+800 - 305+900 | 0.00 |
| 303+400 - 303+500 | 3.85 | 305+900 - 306+000 | 1.28 |
| 303+500 - 303+600 | 1.28 | 306+000 - 306+100 | 5.13 |
| 303+600 - 303+700 | 1.28 | 306+100 - 306+200 | 0.00 |
| 303+700 - 303+800 | 5.13 | 306+200 - 306+300 | 2.56 |
| 303+800 - 303+900 | 0.00 | 306+300 - 306+400 | 1.28 |
| 303+900 - 304+000 | 1.28 | 306+400 - 306+500 | 1.28 |
| 304+000 - 304+100 | 5.13 | 306+500 - 306+600 | 1.28 |
| 304+100 - 304+200 | 3.85 | 306+600 - 306+700 | 3.85 |
| 304+200 - 304+300 | 2.56 | 306+700 - 306+800 | 1.28 |
| 304+300 - 304+400 | 0.00 | 306+800 - 306+900 | 0.00 |
| 304+400 - 304+500 | 0.00 | 306+900 - 307+000 | 2.56 |
| 304+500 - 304+600 | 0.00 | 307+000 - 307+100 | 7.69 |
| 304+600 - 304+700 | 0.00 | 307+100 - 307+200 | 2.56 |
| 304+700 - 304+800 | 0.00 | 307+200 - 307+300 | 1.28 |
| 304+800 - 304+900 | 0.00 | 307+300 - 307+400 | 1.28 |
| 304+900 - 305+000 | 0.00 | 307+400 - 307+500 | 1.28 |
| 305+000 - 305+100 | 8.97 | 307+500 - 307+600 | 0.00 |
| 305+100 - 305+200 | 5.13 | 307+600 - 307+700 | 0.00 |
| 305+200 - 305+300 | 2.56 | 307+700 - 307+800 | 1.28 |
| 305+300 - 305+400 | 1.28 | 307+800 - 307+900 | 0.00 |
| 305+400 - 305+500 | 0 | 307+900 - 308+000 | 0.00 |

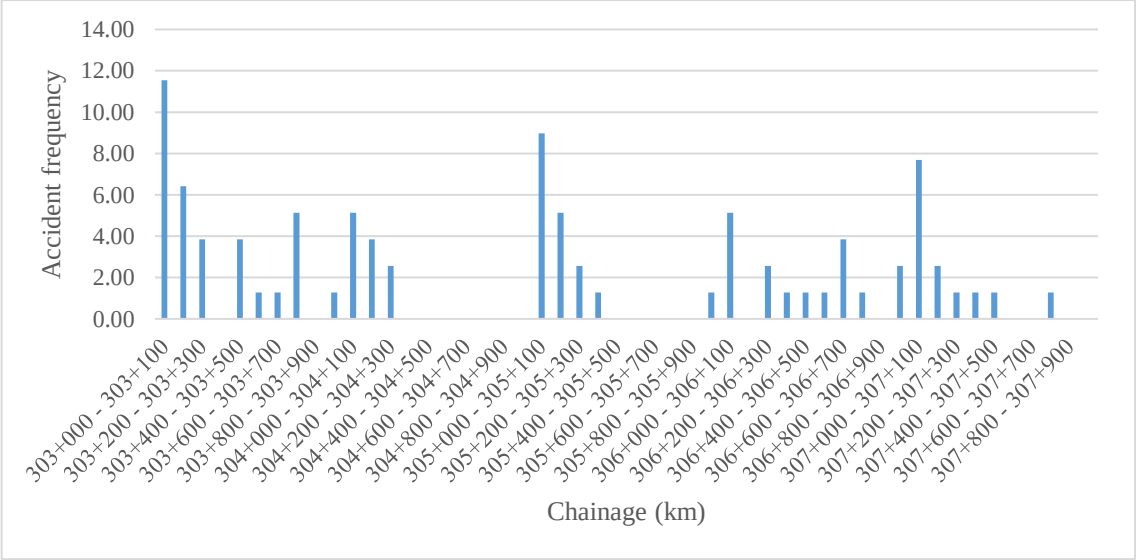


Figure 4.15: Accident frequency in chainage from 303+000 – 308+000

- Weighted Severity Index Method

Table 4.15: WSI of stretch 303+000-308+000 in 100m interval

| Stretch (km) | Weighted Severity Index | Stretch (km) | Weighted Severity Index |
|---|---|---|---|
| 303+000 - 303+100 | 21 | 305+500 - 305+600 | 0 |
| 303+100 - 303+200 | 4 | 305+600 - 305+700 | 0 |
| 303+200 - 303+300 | 7 | 305+700 - 305+800 | 0 |
| 303+300 - 303+400 | 0 | 305+800 - 305+900 | 0 |
| 303+400 - 303+500 | 7 | 305+900 - 306+000 | 0 |
| 303+500 - 303+600 | 1 | 306+000 - 306+100 | 8 |
| 303+600 - 303+700 | 1 | 306+100 - 306+200 | 0 |
| 303+700 - 303+800 | 7 | 306+200 - 306+300 | 4 |
| 303+800 - 303+900 | 0 | 306+300 - 306+400 | 1 |
| 303+900 - 304+000 | 1 | 306+400 - 306+500 | 3 |
| 304+000 - 304+100 | 8 | 306+500 - 306+600 | 3 |
| 304+100 - 304+200 | 7 | 306+600 - 306+700 | 6 |
| 304+200 - 304+300 | 8 | 306+700 - 306+800 | 1 |
| 304+300 - 304+400 | 0 | 306+800 - 306+900 | 0 |
| 304+400 - 304+500 | 0 | 306+900 - 307+000 | 2 |
| 304+500 - 304+600 | 0 | 307+000 - 307+100 | 16 |
| 304+600 - 304+700 | 0 | 307+100 - 307+200 | 0 |
| 304+700 - 304+800 | 0 | 307+200 - 307+300 | 1 |
| 304+800 - 304+900 | 0 | 307+300 - 307+400 | 3 |
| 304+900 - 305+000 | 0 | 307+400 - 307+500 | 1 |
| 305+000 - 305+100 | 15 | 307+500 - 307+600 | 0 |
| 305+100 - 305+200 | 10 | 307+600 - 307+700 | 0 |
| 305+200 - 305+300 | 2 | 307+700 - 307+800 | 1 |
| 305+300 - 305+400 | 1 | 307+800 - 307+900 | 0 |
| 305+400 - 305+500 | 0 | 307+900 - 308+000 | 0 |

WSI limit = 5

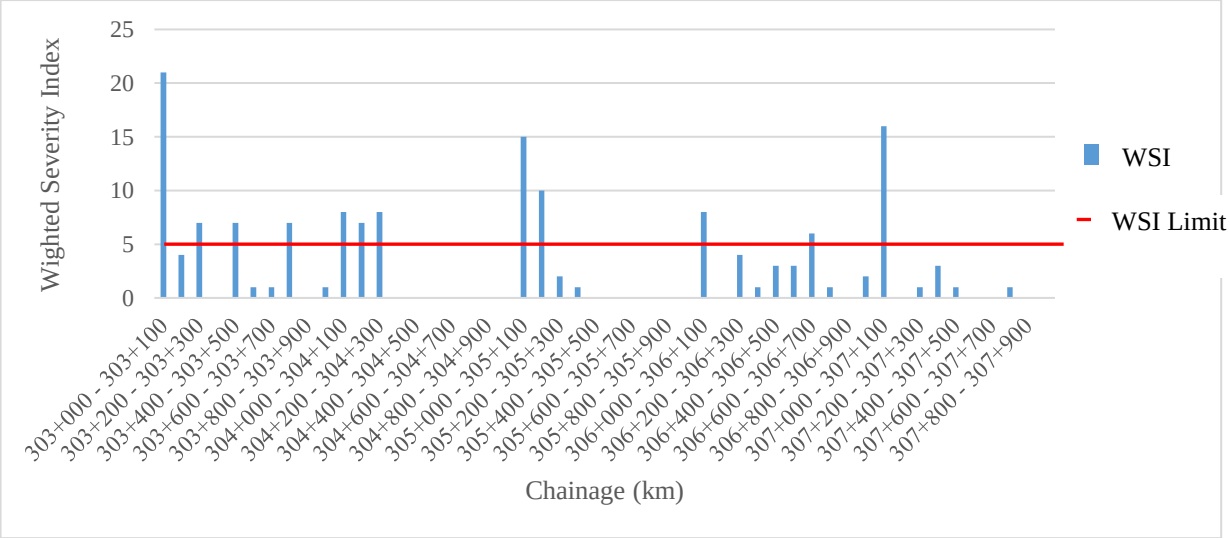


Figure 4.16: WSI in chainage from 303+000 – 308+000

Selected locations above threshold value from above three methods were ranked with respect to severity level as shown in table 4.16.

Table 4.16: Ranking of accident black spot in 303+000-308+000 in 100m interval

| Chainage | Accident Rate | Accident Frequency | Accident Severity Index | Rank |
|---|---|---|---|---|
| 303+000 - 303+100 | 90 | 11.54 | 21 | I |
| 303+100 - 303+200 | 50 | 6.41 | 4 | |
| 303+200 - 303+300 | 30 | 3.85 | 7 | XI |
| 303+300 - 303+400 | 0 | 0.00 | 0 | |
| 303+400 - 303+500 | 30 | 3.85 | 7 | X |
| 303+500 - 303+600 | 10 | 1.28 | 1 | |
| 303+600 - 303+700 | 10 | 1.28 | 1 | |
| 303+700 - 303+800 | 40 | 5.13 | 7 | VIII |
| 303+800 - 303+900 | 0 | 0.00 | 0 | |
| 303+900 - 304+000 | 10 | 1.28 | 1 | |
| 304+000 - 304+100 | 40 | 5.13 | 8 | V |
| 304+100 - 304+200 | 30 | 3.85 | 7 | IX |
| 304+200 - 304+300 | 20 | 2.56 | 8 | VII |
| 304+300 - 304+400 | 0 | 0.00 | 0 | |
| 304+400 - 304+500 | 0 | 0.00 | 0 | |
| 304+500 - 304+600 | 0 | 0.00 | 0 | |
| 304+600 - 304+700 | 0 | 0.00 | 0 | |
| 304+700 - 304+800 | 0 | 0.00 | 0 | |
| 304+800 - 304+900 | 0 | 0.00 | 0 | |
| 304+900 - 305+000 | 0 | 0.00 | 0 | |
| 305+000 - 305+100 | 70 | 8.97 | 15 | III |
| 305+100 - 305+200 | 40 | 5.13 | 10 | IV |
| 305+200 - 305+300 | 20 | 2.56 | 2 | |
| 305+300 - 305+400 | 10 | 1.28 | 1 | |
| 305+400 - 305+500 | 0 | 0.00 | 0 | |
| 305+500 - 305+600 | 0 | 0.00 | 0 | |
| 305+600 - 305+700 | 0 | 0.00 | 0 | |
| 305+700 - 305+800 | 0 | 0.00 | 0 | |
| 305+800 - 305+900 | 0 | 0.00 | 0 | |
| 305+900 - 306+000 | 10 | 1.28 | 0 | |
| 306+000 - 306+100 | 40 | 5.13 | 8 | VI |
| 306+100 - 306+200 | 0 | 0.00 | 0 | |
| 306+200 - 306+300 | 20 | 2.56 | 4 | |
| 306+300 - 306+400 | 10 | 1.28 | 1 | |
| 306+400 - 306+500 | 10 | 1.28 | 3 | |
| 306+500 - 306+600 | 10 | 1.28 | 3 | |
| 306+600 - 306+700 | 30 | 3.85 | 6 | XII |
| 306+700 - 306+800 | 10 | 1.28 | 1 | |
| 306+800 - 306+900 | 0 | 0.00 | 0 | |
| 306+900 - 307+000 | 20 | 2.56 | 2 | |
| 307+000 - 307+100 | 60 | 7.69 | 16 | II |
| 307+100 - 307+200 | 20 | 2.56 | 0 | |
| 307+200 - 307+300 | 10 | 1.28 | 1 | |
| 307+300 - 307+400 | 10 | 1.28 | 3 | |
| 307+400 - 307+500 | 10 | 1.28 | 1 | |
| 307+500 - 307+600 | 0 | 0.00 | 0 | |
| 307+600 - 307+700 | 0 | 0.00 | 0 | |
| 307+700 - 307+800 | 10 | 1.28 | 1 | |
| 307+800 - 307+900 | 0 | 0.00 | 0 | |
| 307+900 - 308+000 | 0 | 0.00 | 0 | |

**Location 308+000 – 313+000**

- Accident Rate Method

Table 4.17: Accident rate of stretch 308+000-313+000 in 100m interval

| Stretch (km) | Accident Rate | Stretch (km) | Accident Rate |
|---|---|---|---|
| 308+000 - 308+100 | 40 | 310+500 - 310+600 | 0 |
| 308+100 - 308+200 | 40 | 310+600 - 310+700 | 10 |
| 308+200 - 308+300 | 0 | 310+700 - 310+800 | 0 |
| 308+300 - 308+400 | 10 | 310+800 - 310+900 | 0 |
| 308+400 - 308+500 | 0 | 310+900 - 311+000 | 30 |
| 308+500 - 308+600 | 0 | 311+000 - 311+100 | 50 |
| 308+600 - 308+700 | 20 | 311+100 - 311+200 | 40 |
| 308+700 - 308+800 | 0 | 311+200 - 311+300 | 0 |
| 308+800 - 308+900 | 0 | 311+300 - 311+400 | 50 |
| 308+900 - 309+000 | 0 | 311+400 - 311+500 | 20 |
| 309+000 - 309+100 | 60 | 311+500 - 311+600 | 0 |
| 309+100 - 309+200 | 30 | 311+600 - 311+700 | 0 |
| 309+200 - 309+300 | 0 | 311+700 - 311+800 | 10 |
| 309+300 - 309+400 | 0 | 311+800 - 311+900 | 0 |
| 309+400 - 309+500 | 0 | 311+900 - 312+000 | 0 |
| 309+500 - 309+600 | 0 | 312+000 - 312+100 | 10 |
| 309+600 - 309+700 | 0 | 312+100 - 312+200 | 60 |
| 309+700 - 309+800 | 0 | 312+200 - 312+300 | 70 |
| 309+800 - 309+900 | 0 | 312+300 - 312+400 | 30 |
| 309+900 - 310+000 | 0 | 312+400 - 312+500 | 0 |
| 310+000 - 310+100 | 30 | 312+500 - 312+600 | 0 |
| 310+100 - 310+200 | 10 | 312+600 - 312+700 | 0 |
| 310+200 - 310+300 | 30 | 312+700 - 312+800 | 0 |
| 310+300 - 310+400 | 10 | 312+800 - 312+900 | 0 |
| 310+400 - 310+500 | 0 | 312+900 - 313+000 | 0 |

Average accident rate = 66/5

= 13.2

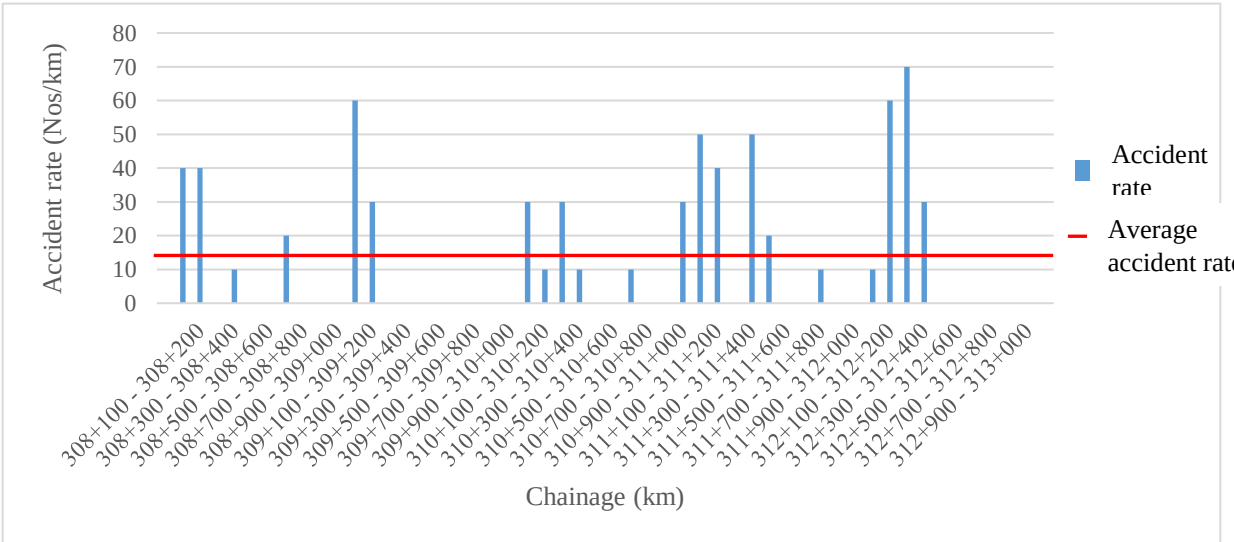


Figure 4.17: Average accident rate in chainage from 308+000 – 313+000

- Accident Frequency Method

Table 4.18: Accident frequency of stretch 308+000-313+000 in 100m interval

| Stretch (km) | Accident Frequency | Stretch (km) | Accident Frequency |
|---|---|---|---|
| 308+000 - 308+100 | 6.06 | 310+500 - 310+600 | 0.00 |
| 308+100 - 308+200 | 6.06 | 310+600 - 310+700 | 1.52 |
| 308+200 - 308+300 | 0.00 | 310+700 - 310+800 | 0.00 |
| 308+300 - 308+400 | 1.52 | 310+800 - 310+900 | 0.00 |
| 308+400 - 308+500 | 0.00 | 310+900 - 311+000 | 4.55 |
| 308+500 - 308+600 | 0.00 | 311+000 - 311+100 | 7.58 |
| 308+600 - 308+700 | 3.03 | 311+100 - 311+200 | 6.06 |
| 308+700 - 308+800 | 0.00 | 311+200 - 311+300 | 0.00 |
| 308+800 - 308+900 | 0.00 | 311+300 - 311+400 | 7.58 |
| 308+900 - 309+000 | 0.00 | 311+400 - 311+500 | 3.03 |
| 309+000 - 309+100 | 9.09 | 311+500 - 311+600 | 0.00 |
| 309+100 - 309+200 | 4.55 | 311+600 - 311+700 | 0.00 |
| 309+200 - 309+300 | 0.00 | 311+700 - 311+800 | 1.52 |
| 309+300 - 309+400 | 0.00 | 311+800 - 311+900 | 0.00 |
| 309+400 - 309+500 | 0.00 | 311+900 - 312+000 | 0.00 |
| 309+500 - 309+600 | 0.00 | 312+000 - 312+100 | 1.52 |
| 309+600 - 309+700 | 0.00 | 312+100 - 312+200 | 9.09 |
| 309+700 - 309+800 | 0.00 | 312+200 - 312+300 | 10.61 |
| 309+800 - 309+900 | 0.00 | 312+300 - 312+400 | 4.55 |
| 309+900 - 310+000 | 0.00 | 312+400 - 312+500 | 0.00 |
| 310+000 - 310+100 | 4.55 | 312+500 - 312+600 | 0.00 |
| 310+100 - 310+200 | 1.52 | 312+600 - 312+700 | 0.00 |
| 310+200 - 310+300 | 4.55 | 312+700 - 312+800 | 0.00 |
| 310+300 - 310+400 | 1.52 | 312+800 - 312+900 | 0.00 |
| 310+400 - 310+500 | 0.00 | 312+900 - 313+000 | 0.00 |

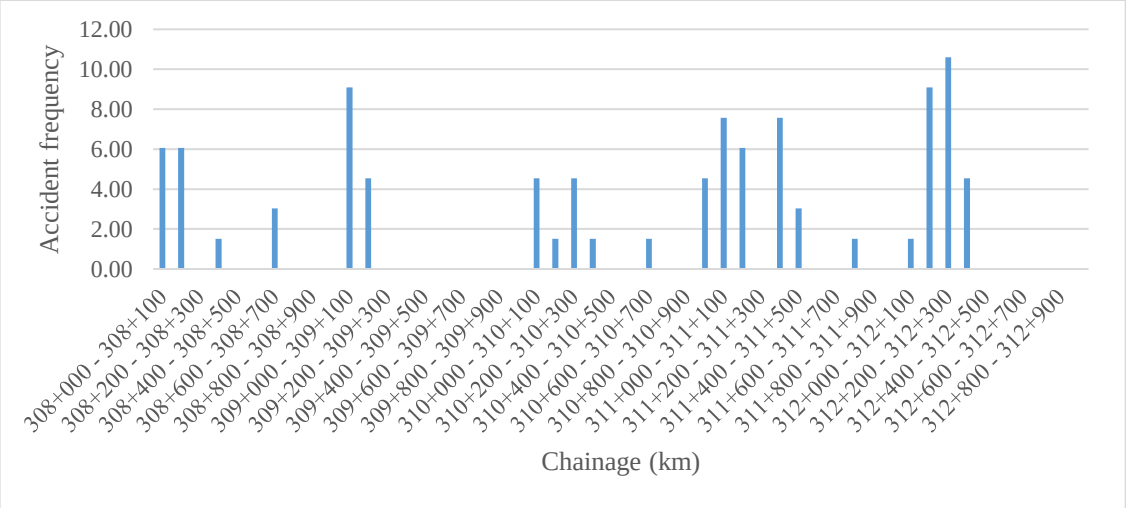


Figure 4.18: Accident frequency in chainage from 308+000 – 313+000

- Weighted Severity Index Method

Table 4.19: WSI of stretch 308+000-313+000 in 100m interval

| Stretch (km) | Weighted Severity Index | Stretch (km) | Weighted Severity Index |
|---|---|---|---|
| 308+000 - 308+100 | 3 | 310+500 - 310+600 | 0 |
| 308+100 - 308+200 | 11 | 310+600 - 310+700 | 5 |
| 308+200 - 308+300 | 0 | 310+700 - 310+800 | 0 |
| 308+300 - 308+400 | 1 | 310+800 - 310+900 | 0 |
| 308+400 - 308+500 | 0 | 310+900 - 311+000 | 7 |
| 308+500 - 308+600 | 0 | 311+000 - 311+100 | 5 |
| 308+600 - 308+700 | 1 | 311+100 - 311+200 | 4 |
| 308+700 - 308+800 | 0 | 311+200 - 311+300 | 0 |
| 308+800 - 308+900 | 0 | 311+300 - 311+400 | 2 |
| 308+900 - 309+000 | 0 | 311+400 - 311+500 | 0 |
| 309+000 - 309+100 | 12 | 311+500 - 311+600 | 0 |
| 309+100 - 309+200 | 5 | 311+600 - 311+700 | 0 |
| 309+200 - 309+300 | 0 | 311+700 - 311+800 | 5 |
| 309+300 - 309+400 | 0 | 311+800 - 311+900 | 0 |
| 309+400 - 309+500 | 0 | 311+900 - 312+000 | 0 |
| 309+500 - 309+600 | 0 | 312+000 - 312+100 | 1 |
| 309+600 - 309+700 | 0 | 312+100 - 312+200 | 7 |
| 309+700 - 309+800 | 0 | 312+200 - 312+300 | 17 |
| 309+800 - 309+900 | 0 | 312+300 - 312+400 | 7 |
| 309+900 - 310+000 | 0 | 312+400 - 312+500 | 0 |
| 310+000 - 310+100 | 3 | 312+500 - 312+600 | 0 |
| 310+100 - 310+200 | 3 | 312+600 - 312+700 | 0 |
| 310+200 - 310+300 | 6 | 312+700 - 312+800 | 0 |
| 310+300 - 310+400 | 0 | 312+800 - 312+900 | 0 |
| 310+400 - 310+500 | 0 | 312+900 - 313+000 | 0 |

WSI limit = 5

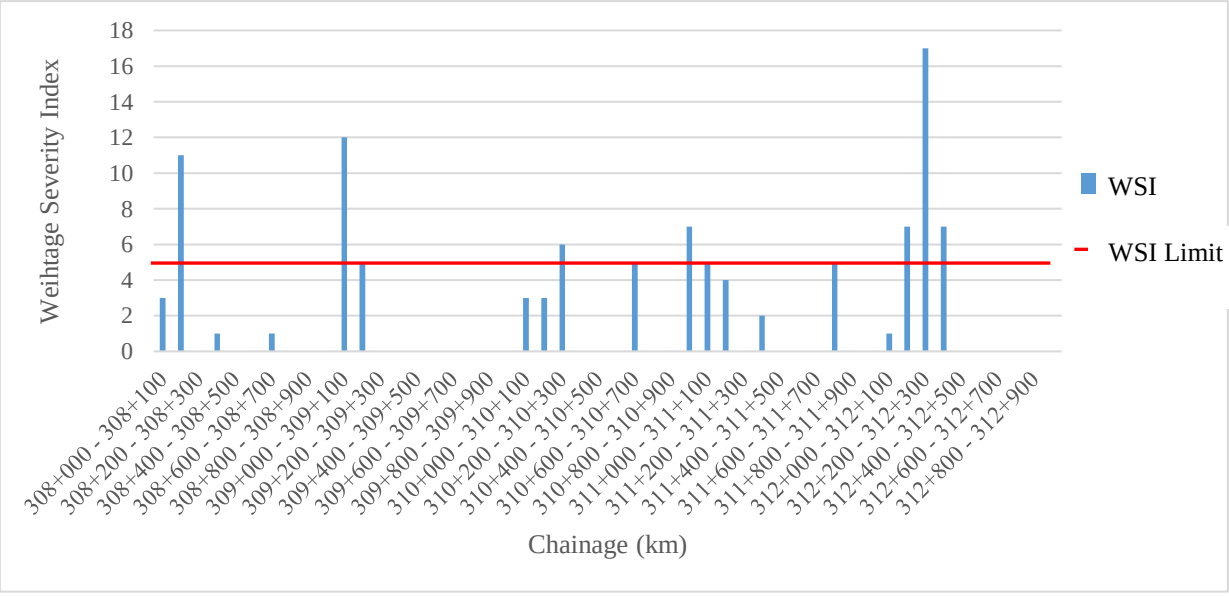


Figure 4.19: WSI in chainage from 308+000 – 313+000

Selected locations above threshold value from above three methods were ranked with respect to severity level as shown in table 4.20.

Table 4.20: Ranking of accident black spot in 308+000-313+000 in 100m interval

| Chainage | Accident Rate | Accident Frequency | Accident Severity Index | Rank |
|---|---|---|---|---|
| 308+000 - 308+100 | 40 | 6.06 | 3 | |
| 308+100 - 308+200 | 40 | 6.06 | 11 | III |
| 308+200 - 308+300 | 0 | 0.00 | 0 | |
| 308+300 - 308+400 | 10 | 1.52 | 1 | |
| 308+400 - 308+500 | 0 | 0.00 | 0 | |
| 308+500 - 308+600 | 0 | 0.00 | 0 | |
| 308+600 - 308+700 | 20 | 3.03 | 1 | |
| 308+700 - 308+800 | 0 | 0.00 | 0 | |
| 308+800 - 308+900 | 0 | 0.00 | 0 | |
| 308+900 - 309+000 | 0 | 0.00 | 0 | |
| 309+000 - 309+100 | 60 | 9.09 | 12 | II |
| 309+100 - 309+200 | 30 | 4.55 | 5 | |
| 309+200 - 309+300 | 0 | 0.00 | 0 | |
| 309+300 - 309+400 | 0 | 0.00 | 0 | |
| 309+400 - 309+500 | 0 | 0.00 | 0 | |
| 309+500 - 309+600 | 0 | 0.00 | 0 | |
| 309+600 - 309+700 | 0 | 0.00 | 0 | |
| 309+700 - 309+800 | 0 | 0.00 | 0 | |
| 309+800 - 309+900 | 0 | 0.00 | 0 | |
| 309+900 - 310+000 | 0 | 0.00 | 0 | |
| 310+000 - 310+100 | 30 | 4.55 | 3 | |
| 310+100 - 310+200 | 10 | 1.52 | 3 | |
| 310+200 - 310+300 | 30 | 4.55 | 6 | VII |
| 310+300 - 310+400 | 10 | 1.52 | 0 | |
| 310+400 - 310+500 | 0 | 0.00 | 0 | |
| 310+500 - 310+600 | 0 | 0.00 | 0 | |
| 310+600 - 310+700 | 10 | 1.52 | 5 | |
| 310+700 - 310+800 | 0 | 0.00 | 0 | |
| 310+800 - 310+900 | 0 | 0.00 | 0 | |
| 310+900 - 311+000 | 30 | 4.55 | 7 | VI |
| 311+000 - 311+100 | 50 | 7.58 | 5 | |
| 311+100 - 311+200 | 40 | 6.06 | 4 | |
| 311+200 - 311+300 | 0 | 0.00 | 0 | |
| 311+300 - 311+400 | 50 | 7.58 | 2 | |
| 311+400 - 311+500 | 20 | 3.03 | 0 | |
| 311+500 - 311+600 | 0 | 0.00 | 0 | |
| 311+600 - 311+700 | 0 | 0.00 | 0 | |
| 311+700 - 311+800 | 10 | 1.52 | 5 | |
| 311+800 - 311+900 | 0 | 0.00 | 0 | |
| 311+900 - 312+000 | 0 | 0.00 | 0 | |
| 312+000 - 312+100 | 10 | 1.52 | 1 | |
| 312+100 - 312+200 | 60 | 9.09 | 7 | IV |
| 312+200 - 312+300 | 70 | 10.61 | 17 | I |
| 312+300 - 312+400 | 30 | 4.55 | 7 | V |
| 312+400 - 312+500 | 0 | 0.00 | 0 | |
| 312+500 - 312+600 | 0 | 0.00 | 0 | |
| 312+600 - 312+700 | 0 | 0.00 | 0 | |
| 312+700 - 312+800 | 0 | 0.00 | 0 | |
| 312+800 - 312+900 | 0 | 0.00 | 0 | |
| 312+900 - 313+000 | 0 | 0.00 | 0 | |

Highest severity locations in 100m intervals in above analysed four number of sections then were tabulated and ranked to find 15 numbers of black spots among them as showed in table 4.21

Table 4.21: Ranking of 15 numbers of accident black spots locations

| Rank of Blackspot locations in 100m intervals | Blackspot locations in 100m intervals | Accident Rate | Accident Frequency | Accident Severity Index | Rank |
|---|---|---|---|---|---|
| I | 177+000 - 177+100 | 120 | 8.45 | 18 | 3 |
| | 300+000 - 300+100 | 110 | 14.10 | 22 | 1 |
| | 303+000 - 303+100 | 90 | 11.54 | 21 | 2 |
| | 312+200 - 312+300 | 70 | 10.61 | 17 | 4 |
| II | 176+800 - 176+900 | 100 | 7.04 | 13 | 9 |
| | 299+100 - 299+200 | 80 | 10.26 | 15 | 6 |
| | 307+000 - 307+100 | 60 | 7.69 | 16 | 5 |
| | 309+000 - 309+100 | 60 | 9.09 | 12 | 11 |
| III | 176+700 - 176+800 | 70 | 4.93 | 12 | 12 |
| | 301+100 - 301+200 | 60 | 7.69 | 14 | 8 |
| | 305+000 - 305+100 | 70 | 8.97 | 15 | 7 |
| | 308+100 - 308+200 | 40 | 6.06 | 11 | 13 |
| IV | 176+100 - 176+200 | 90 | 6.34 | 9 | 15 |
| | 298+400 - 298+500 | 30 | 3.85 | 13 | 10 |
| | 305+100 - 305+200 | 40 | 5.13 | 10 | 14 |
| | 312+100 - 312+200 | 60 | 9.09 | 7 | 16 |

Then, identified black spot locations were tabulated as shown in table 4.22 and marked on map as shown in figure 4.20 and 4.21

Table 4.22: Identified 15 numbers of accident black spots locations

| Rank | Chainage in 100m intervals | Name of blackspot location |
|---|---|---|
| 1 | 300+000 - 300+100 | Meesalai |
| 2 | 303+000 - 303+100 | Chavakachcheri |
| 3 | 177+000 - 177+100 | Vavuniya Town |
| 4 | 312+200 - 312+300 | Kaithadi |
| 5 | 307+000 - 307+100 | Madduvil |
| 6 | 299+100 - 299+200 | Meesalai |
| 7 | 305+000 - 305+100 | Nunavil |
| 8 | 301+100 - 301+200 | Chavakachcheri |
| 9 | 176+800 - 176+900 | Vavuniya Town |
| 10 | 298+400 - 298+500 | Meesalai |
| 11 | 309+000 - 309+100 | Kaithadi |
| 12 | 176+700 - 176+800 | Vavuniya Town |
| 13 | 308+100 - 308+200 | Madduvil |
| 14 | 305+100 - 305+200 | Nunavil |
| 15 | 176+100 - 176+200 | Thonikkal |

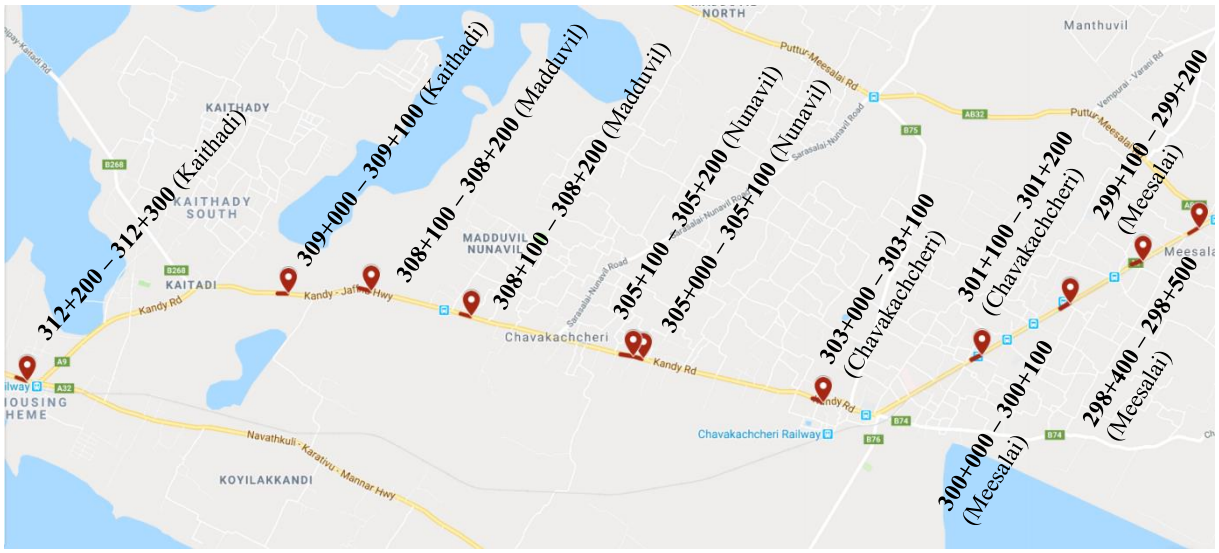


Figure 4.20: Identified black spots form 298+400 – 312+300

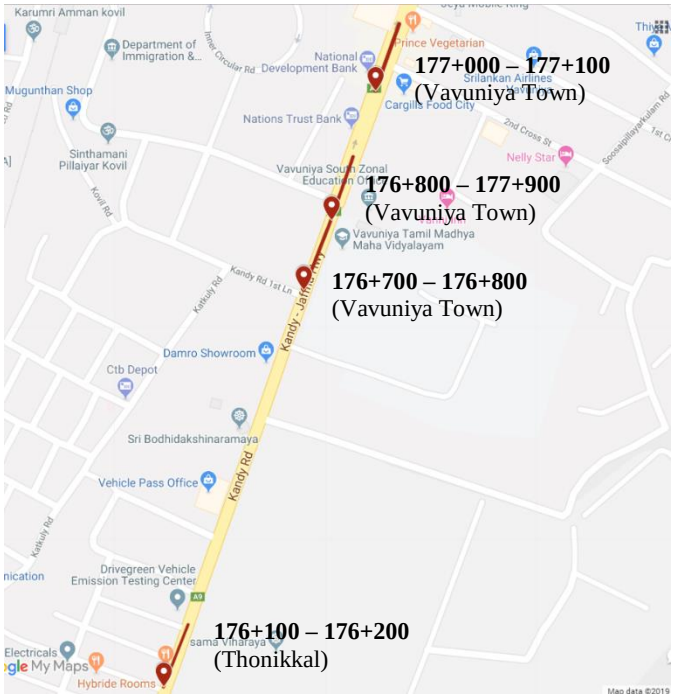


Figure 4.21: Identified black spots form 176+100 – 177+100

## 4.2 Analysis of causing factors

### 4.2.1 Basic data analysis

According to the accident data collected from Sri Lanka Police, contributions of each factors for the accidents entire section of study area are graphically presented in Figure 4.22. As per this figure, contributions of Human errors and road environment are the significant reasons, similar to the literature.

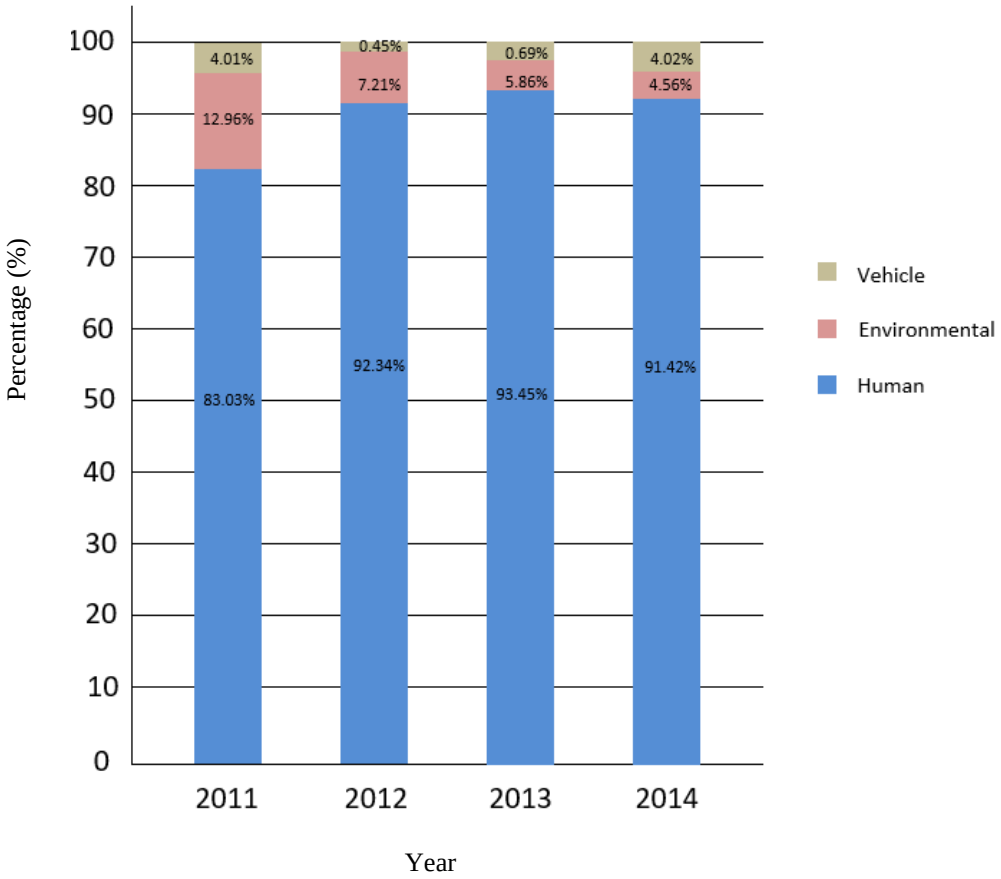


Figure 4.22: Contributing factors of accidents in A9 from Vavuniya to Jaffna as per the police data
Source: (Accident data, Sri Lanka Police, 2014)

Accidents occurrence against the vehicle type in black spot stretches is shown below in the table 4.23.

Table 4.23: Type of vehicles involved in accidents

| Vehicle Type | Numbers | Percentage (%) |
|---|---|---|
| Car | 19 | 2.9 |
| Dual purpose vehicle | 107 | 16.2 |
| Lorry | 86 | 13.0 |
| Cycle | 81 | 12.3 |
| Motor cycle | 201 | 30.5 |
| Three wheeler | 54 | 8.2 |
| Bus | 65 | 9.8 |
| Pedestrian | 47 | 7.1 |

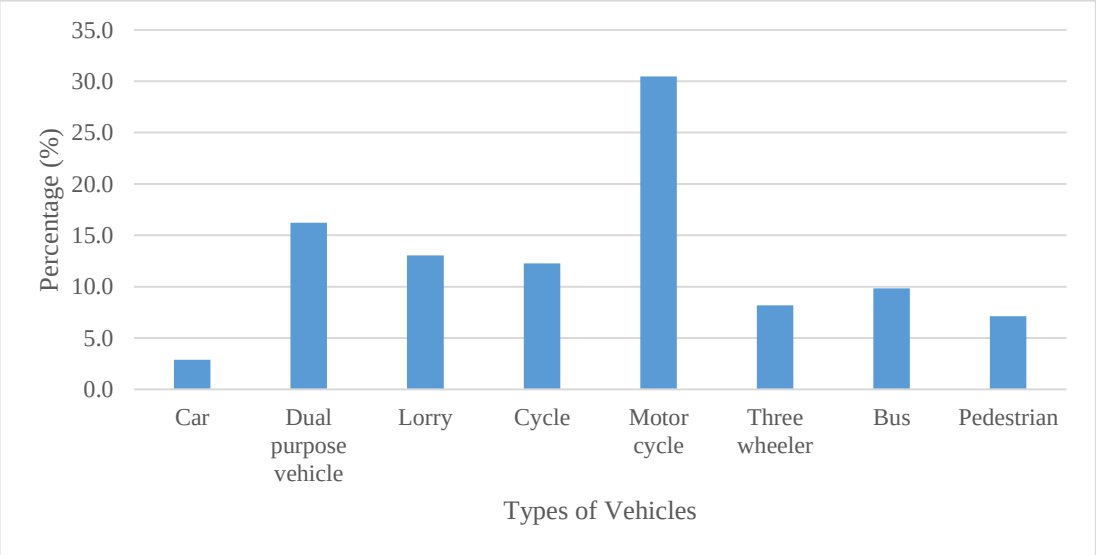


Figure 4.23: Type of vehicles involved in accidents in black spots

Accidence occurrence against the time as shown in table 4.24

Table 4.24: Time period of accidents in black spots

| Time period | Numbers | Percentage (%) |
|---|---|---|
| 12 midnight - 3 am | 9 | 2.4 |
| 3 am - 6 am | 15 | 4.0 |
| 6 am - 9 am | 48 | 12.8 |
| 9 am - 12 noon | 65 | 17.4 |
| 12 noon - 3 pm | 80 | 21.4 |
| 3 pm - 6 pm | 67 | 17.9 |
| 6 pm - 9 pm | 75 | 20.1 |
| 9 pm - 12 midnight | 15 | 4.0 |

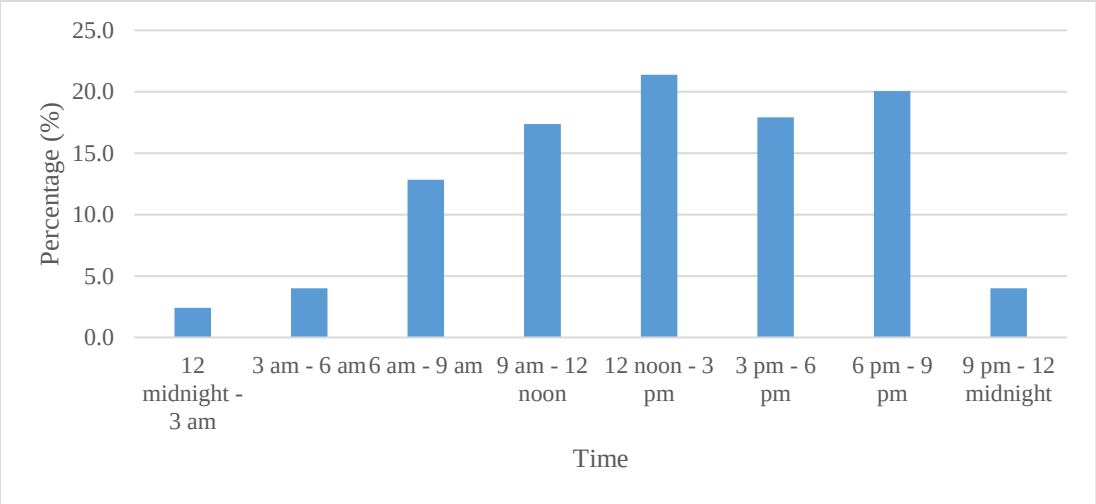


Figure 4.24: Time period of accidents in black spots

### 4.2.2 Accidents by locations

Following table 4.25 shows the number of accidents in percentage occurred in black spot stretches

Table 4.25: Percentage of accidents by location in black spot stretches

| Location Type | Fatal | Grivous | Non Grivous | Damage only | Total | Percentage (%) |
|---|---|---|---|---|---|---|
| Straight section | 5 | 9 | 37 | 19 | 70 | **49.6** |
| T Junction | 3 | 10 | 27 | 9 | 49 | **34.8** |
| Y Junction | 0 | 0 | 3 | 1 | 4 | **2.8** |
| Round about | 0 | 2 | 5 | 3 | 10 | **7.1** |
| 4 Leg Junction | 0 | 1 | 3 | 1 | 5 | **3.5** |
| Multiple cross | 0 | 1 | 2 | 0 | 3 | **2.1** |

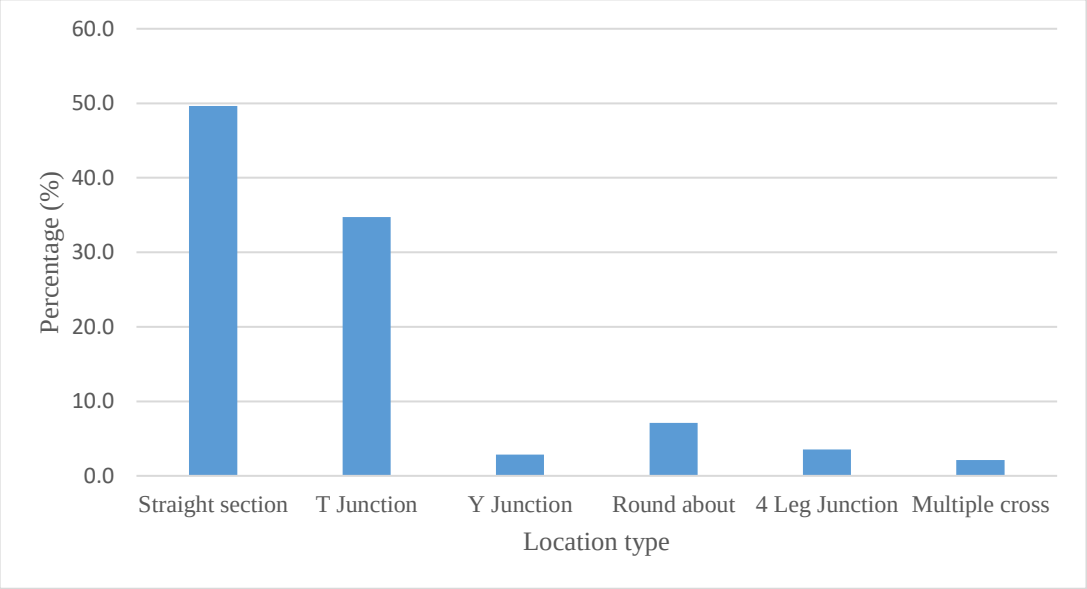


Figure 4.25: Percentage of accidents by location in black spot stretches

### 4.2.3 Accidents by driver behaviour

The police records indicate a number of driver action associated with each accident, these are

1. Speed

2. Loss of control
3. Influenced by alcohol
4. Fatigue

And given in table 4.26 and figure 4.26

Table 4.26: Percentage of accidents by driver behavior in black spot stretches

| Driver behavior | Percentage involved in accident (%) |
|---|---|
| Speed | 28.9 |
| Loss of control | 39.7 |
| Influence by alcohol | 14.6 |
| Fatigue | 5.5 |

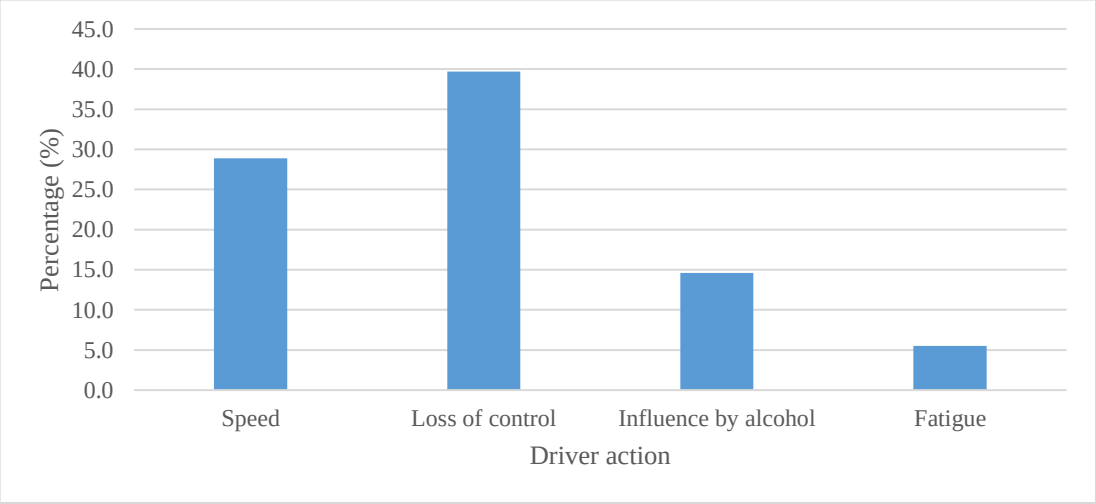


Figure 4.26: Percentage of accidents by driver behavior in black spot stretches

### 4.2.4 Accidents by vehicle defects

Vehicle defects have been classified as those relating to improper function of

1. Brake
2. Over loaded
3. Tyre

The analysis given as table 4.27 and figure 4.27. With respect to defect recorded 7.2% of vehicles involved in accidents were relating to over loaded

Table 4.27: Percentage of accidents by Vehicle defects in black spot stretches

| Vehicle defects | Percentage involved in accident (%) |
|---|---|
| Brake | 4.7 |
| Over loaded | 7.2 |
| Tyre | 6.1 |

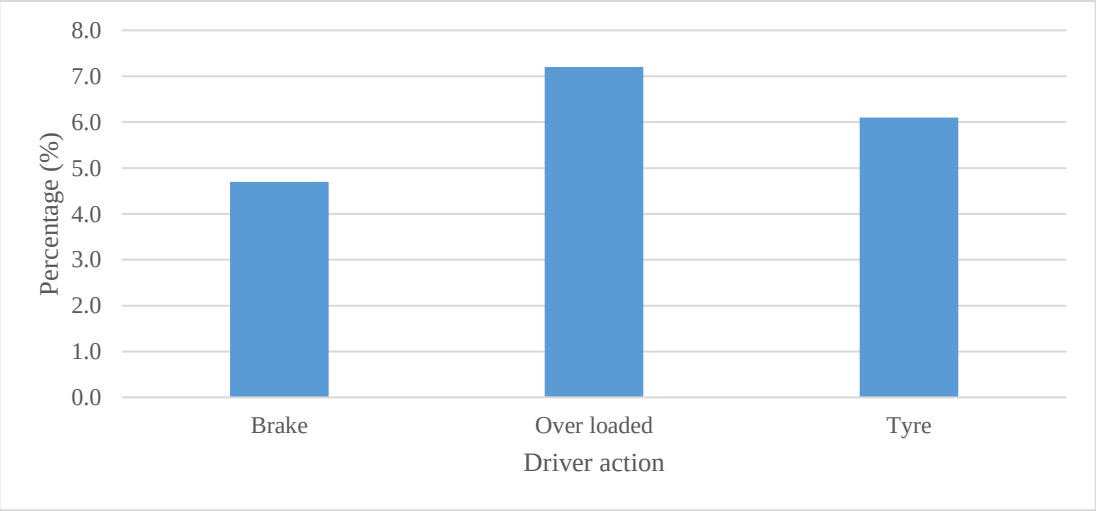


Figure 4.27: Percentage of accidents by Vehicle defects in black spot stretches

### 4.2.5 Identifying primary causing factors

Detailed contributory factors is shown in the table A1 of appendix A were basically divided into four categories only to enhance the statistical analysis and percentage for each cause is given in the table 4.28

Table 4.28: Causes for accidents in black spot stretches

| Cause | No of Contribution | Percentage (%) |
|---|---|---|
| Driver behaviour ( speed, loss of control, fatigue) | 269 | 50.9 |
| Location type | 141 | 26.7 |
| Alcohol Impairment | 53 | 10.0 |
| Vehicle Condition | 65 | 12.3 |

About 50.9% of accidents that occurred can be attributed to driver behaviour and 26.7% by location type. Vehicle contribution caused 12.3% and 10% from the influence of alcohol.

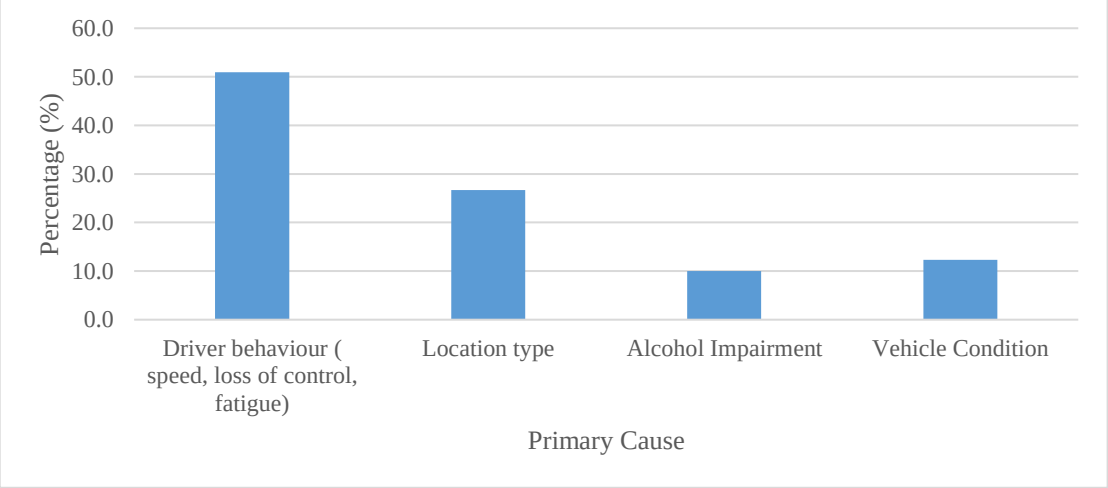


Figure 4.28: Percentage of causes for accidents in black spot stretches

### 4.3 Analysis for accident rate in Vehicle Kilometer travelled

One of the objective of this research study is to estimate accident rate in Vehicle Kilometer Travelled in study area and to make comparisons of accident rates with similar road corridors in the country. The section from Kandy to Vavuniya in the same corridor (A9) has some similarities in traffic and geometric with section from Vavuniya to Jaffna.

#### 4.3.1 Accident rate per VKT for section from Kandy to Vavuniya

According to the crash data collected from Sri Lanka Police Department, total number of accidents in section between Kandy to Vavuniya road corridor is tabulated in Table 4.29 with respect to their severities after sub dividing in to 25km sections

Table 4.29: Accidents with respect to severities in section from Kandy to Vavuniya for year 2014

| Road Section | No of accidents (in year 2014) | | | | |
|---|---|---|---|---|---|
| | Fatal | Grievous | Non Grievous | Damage Only | Total |
| Kandy - Elwala (0 Km - 25km) | 11 | 66 | 92 | 54 | 223 |
| Elwala - Ududeniya (25 Km - 50km) | 9 | 29 | 67 | 32 | 137 |
| Ududeniya - Dambulla (50 Km - 75km) | 2 | 15 | 19 | 9 | 45 |
| Dambulla - Thoniyagala (75 Km - 100km) | 7 | 14 | 6 | 6 | 33 |
| Thoniyagala - Galkulama (100 Km - 125km) | 4 | 15 | 14 | 14 | 47 |
| Galkulama - Ikirikollawa (125Km - 150km) | 3 | 14 | 13 | 2 | 32 |
| Ikirikollawa - Vavuniya (150Km - 168km) | 3 | 10 | 15 | 10 | 38 |
| **Total** | **39** | **163** | **226** | **127** | **555** |

Traffic flow data were collected from RDA from section Kandy to Vavuniya, then was tabulated as shown in table 4.30

Table 4.30: Traffic flow in stations from Kandy to Vavuniya corridor in A9 road

| Station | Average Hourly Traffic flow |
|---|---|
| Elawalla | 1210 |
| Ududeniya | 875 |
| Dambulla | 795 |
| Thoniyagala | 645 |
| Galkulama | 510 |
| Ikirikollawa | 590 |

According to the data in Table 4.30, hourly traffic flow for the each of the road sections were calculated by considering the location of the station within the certain road sub sections. That aids to detect the Annual Average Daily Traffic (AADT) and consequently accident rate for each of the road section were calculated and tabulated in Table 4.31 and 4.32.

Specimen calculation: Consider Kandy – Elwala section

Annual Average Daily Traffic = Hourly traffic flow x 24

= 1,210 x 24

= 29,040

Annual Traffic Volume = AADT x 365

= 29,040 x 365

= 10, 599, 600

Vehicle Kilometer Travelled = ATV x length

= 10,599,600 x 25

= $264.99 \times 10^6$

Accident rate/ VKT = Number of accident/ VKT

= $223/ 264.99 \times 10^6$

= $0.84 \times 10^{-6}$

Table 4.31: VKT in sections from Kandy to Vavuniya in A9 road

| Road section | Road length (km) | AADT | Annual Traffic Volume | VKT x $10^6$ |
|---|---|---|---|---|
| Kandy - Elwala | 25 | 29,040 | 10,599,600 | 264.99 |
| Elwala - Ududeniya | 25 | 25,020 | 9,132,300 | 228.31 |
| Ududeniya - Dambulla | 25 | 20,040 | 7,314,600 | 182.87 |
| Dambulla - Thoniyagala | 25 | 17,280 | 6,307,200 | 157.68 |
| Thoniyagala - Galkulama | 25 | 13,860 | 5,058,900 | 126.47 |
| Galkulama - Ikirikollawa | 25 | 13,200 | 4,818,000 | 120.45 |
| Ikirikollawa - Vavuniya | 18 | 16,680 | 6,088,200 | 109.59 |

Table 4.32: Accident rate per VKT in sections from Kandy to Vavuniya in A9 road

| Road Section | Accident rate per VKT x 10-6 | | | | |
|---|---|---|---|---|---|
| | Fatal | Grievous | Non Grievous | Damage Only | Total |
| Kandy - Elwala | 0.04 | 0.25 | 0.35 | 0.20 | 0.84 |
| Elwala - Ududeniya | 0.04 | 0.13 | 0.29 | 0.14 | 0.60 |
| Ududeniya - Dambulla | 0.01 | 0.08 | 0.10 | 0.05 | 0.25 |
| Dambulla - Thoniyagala | 0.04 | 0.09 | 0.04 | 0.04 | 0.21 |
| Thoniyagala - Galkulama | 0.03 | 0.12 | 0.11 | 0.11 | 0.37 |
| Galkulama - Ikirikollawa | 0.02 | 0.12 | 0.11 | 0.02 | 0.27 |
| Ikirikollawa - Vavuniya | 0.03 | 0.09 | 0.14 | 0.09 | 0.35 |
| **Whole Section** | **0.22** | **0.87** | **1.14** | **0.65** | **0.47** |

### 4.3.2 Accident rate per VKT for section from Vavunya to Jaffna

Annual Average Daily Traffic per each of the road section from Vavuniya to Jaffna for year 2011, 2012, 2013 and 2014 are demonstrated in table 4.33.

Table 4.33: Annual Average daily Traffic of A9 road from Vavuniya to Jaffna section in year 2011, 2012, 2013 & 2014

| | AADT | | | |
|---|---|---|---|---|
| | 2011 | 2012 | 2013 | 2014 |
| **Vavuniya** | | | | |
| **Omanthai** | 10,920 | 13,020 | 13,920 | 14,640 |
| **Puliyankulam** | 6,960 | 7,560 | 7,800 | 8,460 |
| **Mankulam** | 7,320 | 7,980 | 8,280 | 9,000 |
| **Murikandy** | 7,260 | 8,160 | 8,940 | 9,540 |
| **Kilinochchi** | 8,880 | 9,840 | 10,620 | 11,340 |
| **Elephantpass** | 7,740 | 8,340 | 8,820 | 9,420 |
| **Palai** | 5,460 | 6,060 | 6,600 | 7,320 |
| **Meesalai east** | 5,760 | 6,720 | 7,320 | 8,220 |
| **Jaffna** | 7,260 | 8,280 | 9,660 | 11,220 |

Calculated accident rates per VKT for year 2011, 2012, 2013 and 2014 are tabulated separately as in Tables 4.34, 4.35, 4.36 & 4.37.

Table 4.34: Accident rate for year 2011in A9 road considering Vavuniya to Jaffna section

| Road section | Vehicle Travel km x 106 | No. of Accidents | Accident rate Veh.km x 10-6 |
|---|---|---|---|
| Vavuniya - Omanthai (15km) | 59.79 | 87 | 1.46 |
| Omanthai- Puliyankulam (12km) | 30.48 | 45 | 1.48 |
| Puliyankulam- Mankulam(22km) | 58.78 | 51 | 0.87 |
| Mankulam-Murikandy(18km) | 47.69 | 19 | 0.40 |
| Murikandy - Kilinochchi (18km) | 58.34 | 36 | 0.62 |
| Kilinochchi- Elephantpass (20km) | 56.5 | 8 | 0.14 |
| Elephantpass- Palai (14km) | 27.9 | 2 | 0.07 |
| Palai - Meesalai east (18km) | 37.84 | 38 | 1.00 |
| Meesalai east - Jaffna(15km) | 39.75 | 39 | 0.98 |
| **Total** | **417.07** | **325** | **0.78** |

Table 4.35: Accident rate for year 2012 in A9 road considering Vavuniya to Jaffna section

| Road section | Vehicle Travel km x 106 | No. of Accidents | Accident rate Veh.km x 10-6 |
|---|---|---|---|
| Vavuniya - Omanthai (15km) | 71.28 | 64 | 0.90 |
| Omanthai- Puliyankulam (12km) | 33.11 | 30 | 0.91 |
| Puliyankulam- Mankulam(22km) | 64.08 | 55 | 0.86 |
| Mankulam-Murikandy(18km) | 53.61 | 11 | 0.21 |
| Murikandy - Kilinochchi (18km) | 64.65 | 3 | 0.05 |
| Kilinochchi- Elephantpass (20km) | 60.88 | 9 | 0.15 |
| Elephantpass- Palai (14km) | 30.97 | 3 | 0.10 |
| Palai - Meesalai east (18km) | 44.15 | 36 | 0.82 |
| Meesalai east - Jaffna(15km) | 45.33 | 12 | 0.26 |
| **Total** | **468.06** | **223** | **0.48** |

Table 4.36: Accident rate for year 2013 in A9 road considering Vavuniya to Jaffna section

| Road section | Vehicle Travel km x 106 | No. of Accidents | Accident rate Veh.km x 10-6 |
|---|---|---|---|
| Vavuniya - Omanthai (15km) | 76.21 | 47 | 0.62 |
| Omanthai- Puliyankulam (12km) | 34.16 | 23 | 0.67 |
| Puliyankulam- Mankulam(22km) | 66.49 | 40 | 0.60 |
| Mankulam-Murikandy(18km) | 58.74 | 30 | 0.51 |
| Murikandy - Kilinochchi (18km) | 69.77 | 34 | 0.49 |
| Kilinochchi- Elephantpass (20km) | 64.39 | 18 | 0.28 |
| Elephantpass- Palai (14km) | 33.73 | 12 | 0.36 |
| Palai - Meesalai east (18km) | 48.09 | 60 | 1.25 |
| Meesalai east - Jaffna(15km) | 52.89 | 25 | 0.47 |
| **Total** | **504.47** | **289** | **0.57** |

Table 4.37: Accident rate for year 2014 in A9 road considering Vavuniya to Jaffna section

| Road section | Vehicle Travel km x 106 | No. of Accidents | Accident rate Veh.km x 10-6 |
|---|---|---|---|
| Vavuniya - Omanthai (15km) | 80.15 | 54 | 0.67 |
| Omanthai- Puliyankulam (12km) | 37.05 | 18 | 0.49 |
| Puliyankulam- Mankulam(22km) | 72.27 | 30 | 0.42 |
| Mankulam-Murikandy(18km) | 62.68 | 26 | 0.41 |
| Murikandy - Kilinochchi (18km) | 74.5 | 63 | 0.85 |
| Kilinochchi- Elephantpass (20km) | 68.77 | 48 | 0.70 |
| Elephantpass- Palai (14km) | 37.41 | 29 | 0.78 |
| Palai - Meesalai east (18km) | 54 | 71 | 1.31 |
| Meesalai east - Jaffna(15km) | 61.43 | 34 | 0.55 |
| **Total** | **548.26** | **373** | **0.68** |

According to the above data, Palai - Meesalai east section has considerably highest accident rates for year 2011-12-14. However, accident rate for each road section has declined from year 2011to 2014. For the entire road, accident rate has increased from $0.48x10^{-6}$ to $0.68\ x10^{-6}$ from 2012 to 2014 period.

According to literature, road accident rate in A9 road section from Kandy to Vavuniya in year 2014 was $0.47 \times 10^{-6}$ per VKT and hence, A9 road section from Vavuniya to Jaffna shows a higher accident rate ($0.68 \times 10^{-6}$) within the considered period than similar road sections in Sri Lanka.

Details of the fatal accidents in each of the road section are tabulated in Table 4.38.

Table 4.38: Number of Fatal Accidents in each road section in A9 road section from Vavuniya to Jaffna

| Road section | No of Fatal accident | | | |
|---|---|---|---|---|
| | 2011 | 2012 | 2013 | 2014 |
| Vavuniya - Omanthai (15km) | 3 | 3 | 4 | 4 |
| Omanthai- Puliyankulam (12km) | 1 | 4 | 1 | 3 |
| Puliyankulam- Mankulam(22km) | 1 | 2 | 5 | 1 |
| Mankulam-Murikandy(18km) | 1 | 1 | 5 | 5 |
| Murikandy - Kilinochchi (18km) | 1 | - | 5 | 6 |
| Kilinochchi- Elephantpass (20km) | 1 | 3 | 2 | 7 |
| Elephantpass- Palai (14km) | - | 1 | 2 | - |
| Palai - Meesalai east (18km) | 9 | 4 | 8 | 7 |
| Meesalai east - Jaffna(15km) | 4 | 1 | 4 | 3 |
| **Total** | **21** | **19** | **36** | **36** |

In years 2011, 2012, 2013 and 2014, the percentages of fatal accidents out of the total accidents are 6.48%, 8.56%, 12.41% and 9.65% respectively. Following calculation demonstrate the more elaborative picture on whole section of A9 road from Vavuniya to Jaffna of total fatal accident rate per vehicle kilometre travelled.

For year 2011, Fatal Accident Rate per Vehicle Kilometre Travelled

$$= \frac{\text{Number of fatal accidents}}{\text{Total Vehicle Kilometre Travelled (as per Table 4.34)}}$$

$$= \frac{21}{417.07 \times 10^6}$$

$$= 50 \text{ per billion Veh km}$$

For year 2012, Fatal Accident Rate per Vehicle Kilometre Travelled

$$= \frac{\text{Number of fatal accidents}}{\text{Total Vehicle Kilometre Travelled (as per Table 4.35)}}$$

$$= \frac{19}{468.06 \times 10^6}$$

$$= 40 \text{ per billion Veh km}$$

For year 2013, Fatal Accident Rate per Vehicle Kilometre Travelled

$$= \frac{\text{Number of fatal accidents}}{\text{Total Vehicle Kilometre Travelled (as per Table 4.36)}}$$

$$= \frac{36}{504.47 \times 10^6}$$

$$= 71 \text{ per billion Veh km}$$

For year 2014, Fatal Accident Rate per Vehicle Kilometre Travelled

$$= \frac{\text{Number of fatal accidents}}{\text{Total Vehicle Kilometre Travelled (as per Table 4.37)}}$$

$$= \frac{36}{548.26 \times 10^6}$$

$$= 65 \text{ per billion Veh km}$$

This illustrates that risk of fatal accidents have increased from year 2012 to 2013 and reduced in 2014. Vehicle Kilometre travelled per month in year 2012 was 39.0 (= 468.06 veh km/ 12 months), in 2013, it was 42.1 (= 504.47 veh km/ 12 months) while in 2014, it was 45.7 (= 548.26 veh km/ 12 months). Accordingly, number of vehicles running across the section has increased in year 2012, 2013 this may be the reason for increased fatality and year 2014 it was reduced by safety precautions.

Total percentage of Vehicle Kilometre Travelled in the A9 road section from Vavuniya to Jaffna, out of the total country value could be obtained for year 2014 referring the values in Table 2.1 and Table 4.35 as 1.46 % (= 548.26 x $10^6$ / 37477 x $10^6$ x 100).

# CHAPTER 5. CONCLUSION

## 5.1 Summary of findings

1. According to this study, most dangerous 15 numbers of black spot locations in 100m interval were identified.
2. 11 number of black spot locations out of 15 locations are located between chainage 298+400 – 312+300. And 4 sections were identified between 176+100 – 177+100.
3. All the black spot sections are straight in geometrically
4. The most dangerous black spot section was identified as 300+000 – 300+100 in Meesalai with highest Weighted Severity Index of 22 and Accident frequency of 14.1 when comparing other locations.
5. According to study, more than 90% of human factors contribute for accidents while infrastructure/ environment and vehicle factors contribute 7.64% and 2.29% in average respectively in whole study section.
6. Motor cycle was the most involved vehicle type that shows 30.5% of the accidents in black spot locations.
7. Maximum number of accidents occurred during the time period from 12 noon to 6 pm.
8. Most of the accidents occurred in straight section with the percentage of 49.6% while T junction having 34.8%.
9. Loss of control (39.7%) and excessive speed (28.9%) are the most critical factors attributed to the accidents by the driver behavior.
10. Alcohol has affected on driving/ riding performance and driving at excessive speed, while under the influence of alcohol or drugs, while being sleepy or tired. It shows 14.6% of contribution under the driver behavior.
11. Overloaded vehicles give 7.2% of contribution to the accidents in black spot location, because, Jaffna has only one main route (A9) for goods transportation.
12. According to study, the primary causing factors in black spot locations are driver behavior 50.9%, Location type, Alcohol impairment and Vehicle defects are 26.7%, 10% and 12.3% respectively.

13. Accidents rate per VKT in A9 road section from Vavuniya to Jaffna in 2014 is 0.68 x $10^{-6}$ which is higher than the A9 road section from Kandy to Vavuniya with accident rate in VKT is 0.47 x $10^{-6}$.
14. Fatality rate per VKT in A9 road section from Vavuniya to Jaffna is considerably higher (40 accidents per billion VKT in year 2012 and 65 accidents per billion VKT in year 2014) when compared with the international condition (in IRTAD countries, less than 17 billion VKT)

**5.2 Conclusion**

Based on the findings of this study, it was established that road traffic crashes can be ameliorated by embarking on various crashes prevention and reduction strategies such as education, training and traffic enforcement.

The 15 numbers of accidents black spots were identified with available accidents data in police department by using three scientific methods namely Accident rate, Accident frequency and Weighted severity index. Obviously two dangerous section from Meesalai to Kaithadi and Vavuniya Town are identified most critical section A9 road in Northern section and to be given attention.

The police data does not enable the direct identification of the primary cause of an accident. However, by case wise identification of possible defects categories as human, environment and vehicle, it is possible to identify the most probable single cause for accident,

The main causing factor for many accidents was the performance of driver. The driver behavior and attitude are very important in judging the driver actions. These include Speeding, Aggressive/ negligence driving, influenced by alcohol or drugs which could result from confusion or unfamiliarity with roadway. Human factors are without doubt the most complex and difficult to isolate.

A significant percentage of environmental condition by location type that was contributed to the accidents. The visibility, geometry, lane marking, sign boards have a potential influence on the drivers and react dynamic driving condition.

It was found that a small percentage of vehicle factor crashes were caused by overloaded, tire and brake failure. The vehicle and road way interaction like skid resistance play major role in stopping vehicle. Vehicle characteristics like wheelbase and height of center of gravity play an important role in rollover crashes.

Accident rate and fatality rate in Vehicle Kilometer raveled in Study area shows higher value than the compared section and other countries, it gives bad opinion about traffic safety in this section.

### 5.3 Recommendations

Under this research, the accidents in A9 road section from Vavuniya to Jaffna were analyzed within the duration of year 2011 to 2014, to find the black spot locations, causes for the accidents and accident rate in VKT based on the available police data.

Accordingly, fifteen black spot locations were identified where a significant number of accidents happened by human factor.

Therefore, it can recommend that those identified locations have higher possibility for accidents to happen by loss of control, speed and merging. Thus, road users and the road owning authority should pay attention on that.

Those identified locations should be provided with speed calming devices. In addition, speed of the vehicle should be maintained within the allowable limit to have a safe journey. Since this study only considered the primary causes for accidents. It may not be the exact reasons; however, paying attention on these findings can reduce the possibility of accidents.

Accident rate in A9 road section from Vavuniya to Jaffna is near the island value while fatality rate heavily deviates with the international figures leading towards an unsafe trend. Therefore, it is essential to take immediate action to implement a safety improvement program.

Appropriate safety improvement method for each of location can be identified in future through continuation of this research study.

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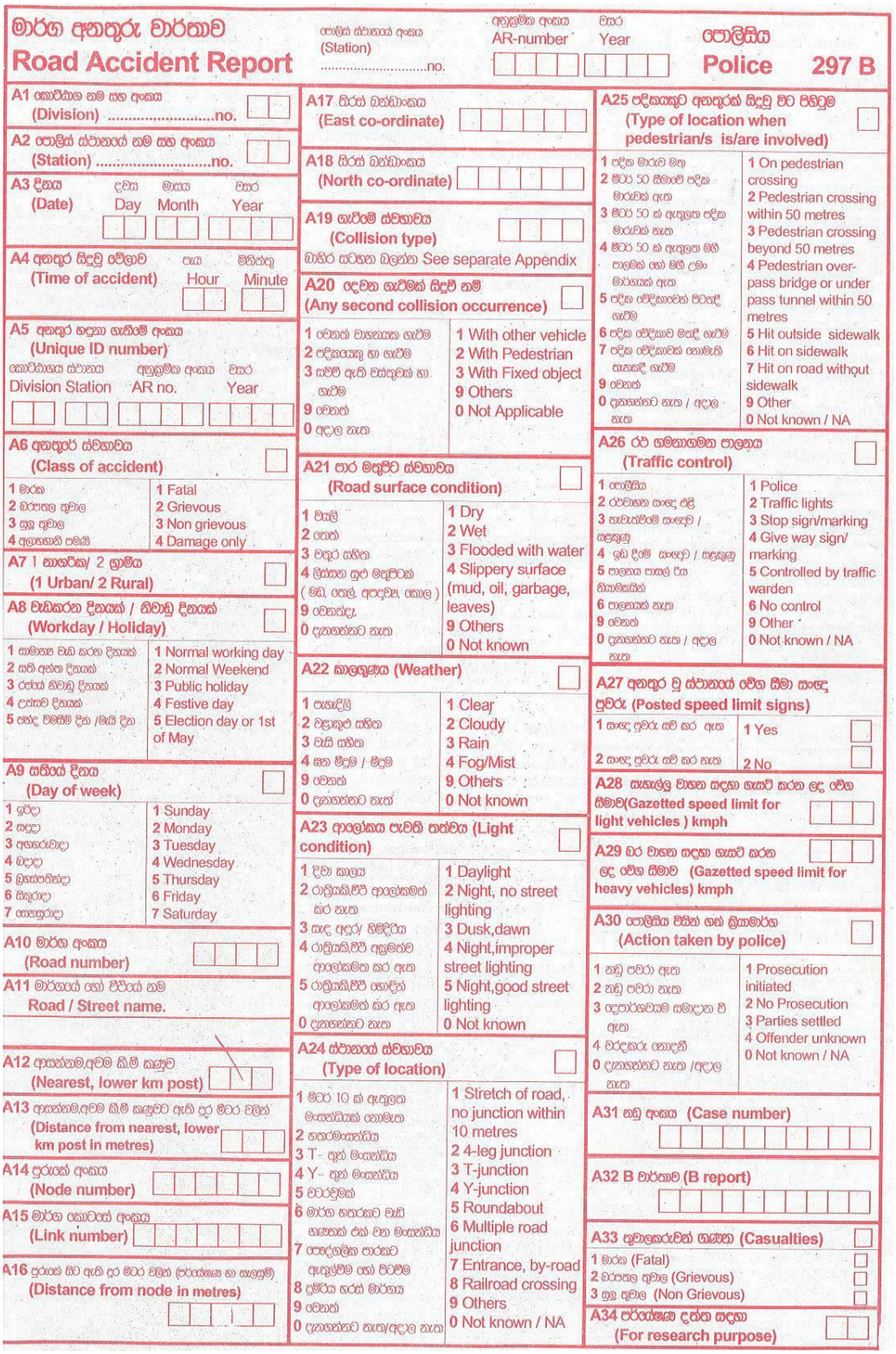
## Appendix A

Table A1: Detail list of contributory factors associated with the primary factors

| | |
|---|---|
| Human Factor | 1 Speeding<br>2 Aggressive/ negligent driving<br>3 Error of judgement<br>4 Influenced by alcohol or drugs<br>5 Fatigue/ fall asleep<br>6 Distracted<br>7 Poor eye sight<br>8 Sudden illness<br>9 Blinded by another vehivle |
| Vehicle Factor | 1 Brakes<br>2 Tyres, wheels<br>3 Lights and lamps<br>4 Steering<br>5 Overloaded or wrongly loaded |
| Infrastructure/ environmental factor | 1 Defective road surface, slippery, poth holes<br>2 Absents or badly maintained road markings<br>3 Road works<br>4 Weather condition<br>5 Poor street lighting |

Appendix B

Accident Recording Form of Sri Lanka Police



මාර්ග අනතුරු වාර්තාව
**Road Accident Report**

පොලිස් ස්ථානයේ අංකය (Station) .....no.
අනුක්‍රමික අංකය AR-number
වසර Year
පොලිසිය **Police** **297 B**

**A1** කොට්ඨාශය නම සහ අංකය (Division) .....no.

**A2** පොලිස් ස්ථානයේ නම සහ අංකය (Station) .....no.

**A3** දිනය (Date) දවස Day මාසය Month වසර Year

**A4** අනතුර සිදුවූ වේලාව (Time of accident) පැය Hour මිනිත්තු Minute

**A5** අනතුර හඳුනා ගැනීමේ අංකය (Unique ID number)
කොට්ඨාශය Division ස්ථානය Station අනුක්‍රමික අංකය AR no. වසර Year

**A6** අනතුරේ ස්වභාවය (Class of accident)
1 මරණ — 1 Fatal
2 බරපතල තුවාල — 2 Grievous
3 සුළු තුවාල — 3 Non grievous
4 අලෙඟාණි පමණි — 4 Damage only

**A7** 1 නාගරික/ 2 ග්‍රාමීය (1 Urban/ 2 Rural)

**A8** වැඩකරන දිනයක් / නිවාඩු දිනයක් (Workday / Holiday)
1 සාමාන්‍ය වැඩ කරන දිනයක් — 1 Normal working day
2 සති අන්ත දිනයක් — 2 Normal Weekend
3 රජයේ නිවාඩු දිනයක් — 3 Public holiday
4 උත්සව දිනයක් — 4 Festive day
5 ඡන්ද මැසීම දින /මැයි දින — 5 Election day or 1st of May

**A9** සතියේ දිනය (Day of week)
1 ඉරිදා — 1 Sunday
2 සඳුදා — 2 Monday
3 අඟහරුවාදා — 3 Tuesday
4 බදාදා — 4 Wednesday
5 බ්‍රහස්පතින්දා — 5 Thursday
6 සිකුරාදා — 6 Friday
7 සෙනසුරාදා — 7 Saturday

**A10** මාර්ග අංකය (Road number)

**A11** මාර්ගයේ හෝ වීථියේ නම Road / Street name.

**A12** ආසන්නම,අඩම කිලෝ කණුව (Nearest, lower km post)

**A13** ආසන්නම,අඩම කිලෝ කණුවට ඇති දුර මීටර වලින් (Distance from nearest, lower km post in metres)

**A14** පුරුකේ අංකය (Node number)

**A15** මාර්ග කොටසේ අංකය (Link number)

**A16** පුරුකේ සිට ඇති දුර මීටර වලින් (පුරුකයෙහි හා ඇතුලුව) (Distance from node in metres)

**A17** නිරස් බන්ධාංකය (East co-ordinate)

**A18** නිරස් බන්ධාංකය (North co-ordinate)

**A19** ගැටීමේ ස්වභාවය (Collision type)
බාහිර සටහන බලන්න See separate Appendix

**A20** දෙවන ගැටීමක් සිදුවී නම් (Any second collision occurrence)
1 වෙනත් වාහනයක ගැටීම — 1 With other vehicle
2 පදිකයෙකු හා ගැටීම — 2 With Pedestrian
3 ස්ථිර ඇති වස්තුවක් හා ගැටීම — 3 With Fixed object
9 වෙනත් — 9 Others
0 අදාල නැත — 0 Not Applicable

**A21** පාර මතුපිට ස්වභාවය (Road surface condition)
1 වියලි — 1 Dry
2 තෙත් — 2 Wet
3 වතුර සහිත — 3 Flooded with water
4 ලිස්සන සුළු මතුපිටක් (මඩ, තෙල්, අපද්‍රව්‍ය, කොළ) — 4 Slippery surface (mud, oil, garbage, leaves)
9 වෙනත්ද. — 9 Others
0 දැනගන්නට නැත — 0 Not known

**A22** කාලගුණය (Weather)
1 පැහැදිලි — 1 Clear
2 වළාකුළු සහිත — 2 Cloudy
3 වැසි සහිත — 3 Rain
4 සහ මීදුම / මීදුම — 4 Fog/Mist
9 වෙනත් — 9 Others
0 දැනගන්නට නැත — 0 Not known

**A23** ආලෝකය පැවති තත්වය (Light condition)
1 දිවා කාලය — 1 Daylight
2 රාත්‍රිකාලීන ආලෝකමත් කර නැත — 2 Night, no street lighting
3 සැඳ අඳුර/ හිමිදිරිය — 3 Dusk,dawn
4 රාත්‍රිකාලීන අකාර්යක්ෂම ආලෝකමත් කර ඇත — 4 Night,improper street lighting
5 රාත්‍රිකාලීන ශොභීන ආලෝකමත් කර ඇත — 5 Night,good street lighting
0 දැනගෙනට නැත — 0 Not known

**A24** ස්ථානයේ ස්වභාවය (Type of location)
1 මීටර 10 ක ඇතුලත මංසන්ධියක් නොමැත — 1 Stretch of road, no junction within 10 metres
2 හතරමංසන්ධිය — 2 4-leg junction
3 T- ආකාර මංසන්ධිය — 3 T-junction
4 Y- ආකාර මංසන්ධිය — 4 Y-junction
5 වටරවුමක — 5 Roundabout
6 මාර්ග හතරකට වැඩි ගණනක් එක් වන මංසන්ධිය — 6 Multiple road junction
7 පාදක්ලික පාරකට ඇතුල්වීම හෝ පිටවීම — 7 Entrance, by-road
8 දුම්රිය හරස් මාර්ගය — 8 Railroad crossing
9 වෙනත් — 9 Others
0 දැනගෙනට නැත/අදාල නැත — 0 Not known / NA

**A25** පදිකයකුට අනතුරක් සිදුවූ විට පිහිටුම (Type of location when pedestrian/s is/are involved)
1 පදික මාරුව මත — 1 On pedestrian crossing
2 මීටර 50 සීමාවේ පදික මාරුවක් ඇත — 2 Pedestrian crossing within 50 metres
3 මීටර 50 ක් ඇතුලත පදික මාරුවක් නැත — 3 Pedestrian crossing beyond 50 metres
4 මීටර 50 ක් ඇතුලත මහ පාලමක් හෝ මහ උමං මාර්ගයක් ඇත — 4 Pedestrian over-pass bridge or under pass tunnel within 50 metres
5 පදික වේදිකාවෙන් පිටතදී ගැටීම — 5 Hit outside sidewalk
6 පදික වේදිකාව මතදී ගැටීම — 6 Hit on sidewalk
7 පදික වේදිකාවක් නොමැති තැනදී ගැටීම — 7 Hit on road without sidewalk
9 වෙනත් — 9 Other
0 දැනගන්නට නැත / අදාල නැත — 0 Not known / NA

**A26** රථ ගමනාගමන පාලනය (Traffic control)
1 පොලිසිය — 1 Police
2 රථවාහන සංඥා ලයිට් — 2 Traffic lights
3 නැවැත්වීම් සංඥාව / සලකුණු — 3 Stop sign/marking
4 ඉඩ දීම් සංඥා / සලකුණු — 4 Give way sign/ marking
5 පාලනය පාසල් ළය නිලධාරියින් — 5 Controlled by traffic warden
6 පාලනයක් නැත — 6 No control
9 වෙනත් — 9 Other
0 දැනගන්නට නැත / අදාල නැත — 0 Not known / NA

**A27** අනතුර වූ ස්ථානයේ වේග සීමා සංඥා පුවරු (Posted speed limit signs)
1 සංඥා පුවරු සවි කර ඇත — 1 Yes
2 සංඥා පුවරු සවි කර නැත — 2 No

**A28** සැහැල්ලු වාහන සඳහා ගැසට් කරන ලද වේග සීමාව(Gazetted speed limit for light vehicles ) kmph

**A29** බර වාහන සඳහා ගැසට් කරන ලද වේග සීමාව (Gazetted speed limit for heavy vehicles) kmph

**A30** පොලිසිය විසින් ගත් ක්‍රියාමාර්ග (Action taken by police)
1 නඩු පවරා ඇත — 1 Prosecution initiated
2 නඩු පවරා නැත — 2 No Prosecution
3 අදාර්ශවයම් සමාදාන වී ඇත — 3 Parties settled
4 වරදකරු නොදනී — 4 Offender unknown
0 දැනගන්නට නැත /අදාල නැත — 0 Not known / NA

**A31** නඩු අංකය (Case number)

**A32** B වාර්තාව (B report)

**A33** තුවාලකරුවන් ගණන (Casualties)
1 මරණ (Fatal)
2 බරපතල තුවාල (Grievous)
3 සුළු තුවාල (Non Grievous)

**A34** පර්යේෂණ අරමුණ සඳහා (For research purpose)

## E1 අනතුරට හේතුවූ දෑ (Element type)

| | |
|---|---|
| 01 කාරය | 01 Car |
| 02 ද්විත්ව කාර්ය වාහනය | 02 Dual purpose vehicle |
| 03 ලොරිය | 03 Lorry |
| 04 පාපැදිය | 04 Cycle |
| 05 යතුරුපැදිය, මෝපෙඩ් | 05 Motor cycle, Moped |
| 06 ත්‍රිරෝද රථය | 06 Three wheeler |
| 07 අඳ රථය, ට්‍රැක්ටර් අදින්නෙ යන වාහනය | 07 Articulated vehicle, prime mover |
| 08 ලංගම මහ ප්‍රවාහන බස්රථය | 08 SLTB bus |
| 09 පෞද්ගලික මහ ප්‍රවාහන බස්රථය | 09 Private bus |
| 10 සුඛෝපභෝගී මහ ප්‍රවාහන බස්රථය | 10 Intercity bus |
| 11 ඉඩම් වාහනය /ට්‍රැක්ටරය | 11 Land vehicle/ Tractor |
| 12 සතෙකු අදින්නෙ යන වාහනයක් හෝ සතෙකු පිටනැගි පුද්ගලයෙක් | 12 Animal drawn vehicle or rider on animal |
| 13 පදික‍යා | 13 Pedestrian |
| 19 වෙනත් | 19 Others |
| 00 දැනගන්නට නැත | 00 Not known |

## E5 වාහනයේ අයිතිය (Vehicle ownership)

| | |
|---|---|
| 1 පෞද්ගලික වාහනයක් | 1 Private vehicle |
| 2 පෞද්ගලික ආයතනයක වාහනයක් | 2 Private company own vehicle |
| 3 රජයේ වාහනයක් | 3 Government vehicle |
| 4 අර්ධරජයට, ආයතනයක වාහනයක් | 4 Semi Government vehicle |
| 5 සමුදා වාහනයක් | 5 Service vehicle |
| 6 පොලිස් වාහනයක් | 6 Police vehicle |
| 0 දැනගන්නට නැත | 0 Not Known |

## E7 රියදුරුගේ/ පැදිකරුගේ/ පදික‍යාගේ ස්ත්‍රී පුරුෂ භාවය (Driver / Rider / Pedestrian Sex)

| | |
|---|---|
| 1 පුරුෂ | 1 Male |
| 2 ස්ත්‍රී | 2 Female |
| 0 දැනගන්නට නැත | 0 Not known |

## E10 රියදුරු බලපත්‍රයේ වලංගුභාවය (Validity of driving license)

| | |
|---|---|
| 1 වාහනය සඳහා වලංගු බලපත්‍රයක් ඇත | 1 Valid license for the vehicle |
| 2 වාහනය සඳහා වලංගු බලපත්‍රයක් නැත | 2 Without valid license for the vehicle |
| 3 පුහුණුවීම් බලපත්‍රයක් ඇත | 3 Learner permit |
| 4 තාවකාලික බලපත්‍රය | 4 Probation license |
| 5 ජාත්‍යන්තර බලපත්‍රය | 5 International license |
| 0 දැනගන්නට නැත / අදාල නැත | 0 Not known / NA |

## E13,E14 අනතුර සිදුවීමට රියදුරාගෙන් බලපෑ මූලික හේතු (Human pre crash factors contributing to accident)

| | |
|---|---|
| 01 අධික වේගය | 01 Speeding |
| 02 අවිචාරමී / නොසැලකිලිමත් රිය පැදවීම | 02 Aggressive / negligent driving |
| 03 වැරදි විනිශ්චය | 03 Error of judgment |
| 04 මධ්‍යසාර / මත්ද්‍රව්‍ය වල බලපෑම | 04 Influenced by alcohol / drugs |
| 05 වීඩාව / නිද්‍ර ගම | 05 Fatigue / fall asleep |
| 06 අවධානයෙන් බැහැරවීම (ගුවන් විදුලිය ශ්‍රුතා කරවීම, ජංගම දුරකථන, මානසික ආතතිය ආදී) | 06 Distracted/ inattentiveness (handling radio, mobile phone, mental stress etc.) |
| 07 අක් ඡායාරූපී දුර්වලතා | 07 Poor eye sight |
| 08 හදිසි රෝගී තත්වයක් | 08 Sudden illness |
| 09 වෙනත් චාලක වල එළි / තීව්‍රතාව | 09 Blinded by another vehicle / sun |
| 19 වෙනත් | 19 Others |
| 00 දැනගත්නට නැත / අදාල නැත | 00 Not known / NA |

## E15 අනතුර සිදුවීමට පදික‍යාගෙන් බලපෑ හේතුව (Pedestrian pre crash factor contributing to accident)

| | |
|---|---|
| 1 බලාපොරොත්තු නොවූ පදික‍යාගමන් හැසිරීමක් | 1 Unexpected pedestrian movement |
| 2 සඳහා ඇති පදිකමාරුව නොසළකා හැරීම | 2 Disobey designated crossing |
| 3 මධ්‍යසාර / මත්ද්‍රව්‍ය වල බලපෑම | 3 Influenced by alcohol / drugs |
| 4 පහසුවිම නොපෙනීම | 4 Poor visibility (clothing) |
| 9 වෙනත් | 9 Other |
| 0 දැනගන්නට නැත / අදාල නැත | 0 Not known / NA |

## E16 අනතුර සිදුවීමට මාර්ගයෙන් බලපෑ හේතුව (Road pre crash factor contributing to accident)

| | |
|---|---|
| 1 මතුපිට කඩ නොවූ සහිත මාර්ග, ලිස්සනසුලු මාර්ග, වතුර වලවල්, මඩ කැණිති, විශාල පැලුම්, ට්‍රෑප් හෝ පහත් කසළ කාණු ආවරණ ආදිය | 1 Defective road surface, slippery road, pot holes, water puddles, large cracks, high or low sewer covers etc. |
| 2 සඤ්ඤා, තිස්පරදි නඩත්තු නොකරන ලද මාර්ග සලකුණු හෝ සංඥා හෝ මාර්ග සලකුණු හෝ සංඥා කිසිවක් දක්නට නොමැතිවීම | 2 Defective, absent or badly maintained road markings or signs |
| 3 නියමිත රථ වාහන පාලන සංඥා නොමැතිව මාර්ගයේ වැඩ කරන අවස්ථා | 3 Road works without adequate traffic control devices |
| 4 කාලගුණ තත්වයක් | 4 Weather conditions |
| 5 දුර්වල ලෙස ආලෝකමත් වී ඇති | 5 Poor street lighting |
| 9 වෙනත් | 9 Other |
| 0 දැනගන්නට නැත / අදාල නැත | 0 Not known / NA |

## E17 අනතුර සිදුවීමට වාහනයෙන් බලපෑ හේතුව (Vehicle pre crash factor defects contributing to accident)

| | |
|---|---|
| 1 තිරිංග | 1 Brakes |
| 2 ටයර / රෝද | 2 Tyres, wheels |
| 3 ශුක්කානම | 3 Steering |
| 4 විදුලි එළි, ලාම්පු | 4 Lights, lamps |
| 5 දුර්වල යාන්ත්‍රික තත්වයක් | 5 Poor mechanical condition |
| 6 වැඩියෙන් බර පැටවූ හෝ වැරදි ලෙස බර පැටවූ වාහනයක් | 6 Overloaded or wrongly loaded vehicle |
| 9 වෙනත් | 9 Other |
| 0 දැනගන්නට නැත/අදාල නැත | 0 Not known / NA |

## E18 අනතුරට බරපතලකමට හේතුවූ කරුණු (Crash factor contributing to accident severity)

| | |
|---|---|
| 1 ගසක ගැටීම | 1 Hitting tree |
| 2 කණුවක ගැටීම | 2 Hitting pole / post |
| 3 විශාල ගලක ගැටීම | 3 Hitting stone or boulder |
| 4 මාර්ග ගැටියක් යම්න ගැටීම | 4 Hitting road island, curb etc. |
| 5 බාධකයක් හෝ ආරක්ෂක වැටක ගැටීම | 5 Hitting barrier or guard rail |
| 6 ගම්‍ය ඇති වෙනත් ස්ථාවර තමන ගැටීම | 6 Hitting other fixed object |
| 7 පෙරළීම | 7 Rolled over |
| 0 දැනගන්නට නැත/අදාල නැත | 0 Not known / NA |

## E19 වෙනත් හේතු (Other factors)

| | |
|---|---|
| 1 අනතුරක් වැළැක්වීමට ගෘහණ | 1 Avoiding maneuver |
| 2 නොනවතා පලාගිය | 2 Hit and run |
| 3 පාර වැඩ කරමින් සිටීම | 3 Road works |
| 4 අනතුරෙන් පසු සිදුවන කලබල | 4 Post crash violence |
| 5 හොරකම්කරන ලද වාහනයක් | 5 Stolen vehicle |
| 0 දැනගන්නට නැත/අදාල නැත | 0 Not known / NA |

## E20 මධ්‍යසාර පරීක්ෂාව (Alcohol test)

| | |
|---|---|
| 1 මධ්‍යසාර භාවිතා කර නැත හෝ නීතිමය ප්‍රමාණයට අඩුවෙන් | 1 No alcohol or below legal limit |
| 2 නීතිමය ප්‍රමාණය ඉක්මවා ඇත | 2 Over legal limit |
| 3 පරීක්ෂා කර නැත | 3 Not tested |

## E21 රියදුරු/පැදිකරු/පදික‍යා අනතුරට වගකිවයුතුද (Driver/ Rider/ Pedestrian at fault)

| | |
|---|---|
| 1 ඔව් | 1 Yes |
| 2 නැත | 2 No |
| 0 දැනගන්නට නැත/අදාල නැත | 0 Not known / NA |

# තුවාලකරු පිළිබඳ විස්තර (CASUALTY DETAILS )

## C1 අනතුරට හේතුවූ දෑහි අංකය (Traffic element number)

| | |
|---|---|
| රියදුරෙක් හෝ මගියෙක් තුවාල වී නම් තුවාලකරු ගමන්කරන වාහනයෙහි දැහි අංකය දක්වන්න | If a driver or passenger casualty indicate the vehicle's element number in which the casualty traveled. |
| පදික‍යෙක් තුවාල වී නම් පදික‍යාගේ දැහි අංකය දක්වන්න | If a pedestrian casualty indicate the element number for the pedestrian |

## C2 දණ්ඩ නීති සංග්‍රහයට අනුව තුවාලකරුගේ ගම්භීරත්වය (Severity according to penal code)

| | |
|---|---|
| 1 මාරක | 1 Fatal |
| 2 බරපතල තුවාල | 2 Grievous |
| 3 සුළු තුවාල | 3 Non grievous |

## C3 වර්ගය (Category)

| | |
|---|---|
| 1 රියදුරු /පැදිකරු | 1 Driver / Rider |
| 2 පදික‍යා | 2 Pedestrian |
| 3 මගියා / ගමනුරු පැදිකෙ හෝ පාපැදියෙ පිටුපස ගමනා | 3 Passenger / pillion rider |
| 4 මගියා / ගමනුරු පැදිකෙ හෝ පාපැදියෙ පිටුපස ගමනා වාහනයෙන් වැටීම | 4 Passenger/pillion rider falling off vehicle |
| 5 මගියා බසයකට නැගීම හෝ බසයක් බැසීම | 5 Passenger entering or leaving bus |
| 0 දැනගන්නට නැත | 0 Not known |

## C4 ස්ත්‍රී පුරුෂ භාවය (Sex)

| | |
|---|---|
| 1 පුරුෂ | 1 Male |
| 2 ස්ත්‍රී | 2 Female |
| 0 දැනගන්නට නැත | 0 Not known |

## C6 ආරක්ෂාව (Protection)

| | |
|---|---|
| 1 ආරක්ෂක බන්ධව පළඳා ඇත | 1 Safety belt, worn |
| 2 ආරක්ෂක බන්ධව පළඳා නැත | 2 Safety belt, not worn |
| 3 ආරක්ෂක හිස්වැසුම් පළඳා ඇත | 3 Helmet, worn |
| 4 ආරක්ෂක හිස්වැසුම් පළඳා නැත | 4 Helmet, not worn |
| 5 ළමා ආරක්ෂක ආසනය භාවිතාකර ඇත | 5 Child restrain seat used |
| 0 දැනගන්නට නැත/අදාල නැත | 0 Not known / NA |

## C7 රෝහල් ගත කිරීම (Hospitalized)

| | |
|---|---|
| 1 තුවාල සිදුවීම හා අවම වශයෙන් එක් දිනක් හෝ රෝහල් ගත කිරීම | 1 Injured and admitted to hospital at least 1 day |
| 2 තුවාල සිදුවීම, නමුත් රෝහලේ අතුල් නොකිරීම හෝ එක් දිනකට අඩු කාලයක් සඳහා රෝහල් ගත කිරීම | 2 Injured but not admitted to hospital or admitted less than 1 day |

| අනතුරට හාජනය වූ වාහනයේ අංකය (TRAFFIC ELEMENT) | අංක Traffic Element No. | අංක Traffic Element No. | අංක Traffic Element No. |
|---|---|---|---|
| E1 අනතුරට හාජනය වූ ද? (Element type) | | | |
| E2 වාහනයේ ලියාපදිංචි අංකය (Vehicle Registration number) | | | |
| E3 වාහනය නිපදවූ වර්ෂය (Vehicle year of manufacture) | | | |
| E4 වාහනය කොපමණ පැරණිද යන වග (Age of vehicle) | | | |
| E5 වාහනයේ අයිතිය (Vehicle ownership) | | | |
| E6 ගමන් කරන දිශාව (Direction of movement) | | | |
| E7 රියදුරුගේ / පැදිකරුගේ / පදිකයාගේ ස්ත්‍රී පුරුෂ භාවය (Driver / Rider / Pedestrian sex) | | | |
| E8 රියදුරුගේ / පැදිකරුගේ / පදිකයාගේ වයස (Driver / Rider / Pedestrian age) | | | |
| E9 රියදුරු බලපත්‍රයේ අංකය (Driving License number) | | | |
| E10 රියදුරු බලපත්‍රයේ වලංගු භාවය (Validity of Driving License) | | | |
| E11 රියදුරු බලපත්‍රය නිකුත් කළ වර්ෂය (Year of issue of Driving License) | | | |
| E12 රියදුරු බලපත්‍රය නිකුත් කළ අවස්ථාවේ සිට කාලය ( අවුරුදු ) (Number of years since first issue of driving license) | | | |
| E13 අනතුර සිදුවීමට රියදුරාගෙන් බලපෑ ප්‍රමුඛ හේතුව (Human pre crash factor 1 contributing to accident) | | | |
| E14 අනතුර සිදුවීමට රියදුරාගෙන් බලපෑ දෙවන හේතුව (Human pre crash factor 2 contributing to accident) | | | |
| E15 අනතුර සිදුවීමට පදිකයාගෙන් බලපෑ හේතුව (Pedestrian pre crash factor contributing to accident) | | | |
| E16 අනතුර සිදුවීමට මාර්ගයෙන් බලපෑ හේතුව (Road pre crash factor contributing to accident) | | | |
| E17 අනතුර සිදුවීමට වාහනයෙන් බලපෑ හේතුව (Vehicle pre crash factor contributing to accident) | | | |
| E18 අනතුර බරපතලකමට හේතුවූ කරුණ (Crash factor contributing to accident severity) | | | |
| E19 වෙනත් හේතු (Other factors) | | | |
| E20 මධ්‍යසාර පරීක්ෂාව (Alcohol test) | | | |
| E21 රියදුරු / පැදිකරු /පදිකයා අනතුරට වගකිවයුතුද ? (Driver / Rider / Pedestrian at fault ?) | | | |
| E22 පර්යේෂණ දත්ත සඳහා (For research purpose) | | | |

| තුවාලකරු (CASUALTIES) | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| C1 අනතුරට හාජනය වූ වාහනයේ අංකය (Traffic element number) | | | | | | | |
| C2 දණ්ඩ නීති සංග්‍රහයට අනුව තුවාලකරුගේ ස්වභාවය (Severity according to penal code) | | | | | | | |
| C3 වර්ගය (Category) | | | | | | | |
| C4 ස්ත්‍රී පුරුෂ භාවය (Sex) | | | | | | | |
| C5 වයස (Age) | | | | | | | |
| C6 ආරක්ෂාව (Protection) | | | | | | | |
| C7 රෝහල් ගත කිරීම (Hospitalized) | | | | | | | |

ගැටීමේ සටහන
**(Collision Sketch)**


අතිරේක තොරතුරු හෝ අනතුර සිදුවූ ආකාරය පිළිබඳ ලුහුඬු සටහනක්
**( Discription of accident & additional information)**

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විභාග කරන නිළධාරියා විසින් මෙම වාර්තාව සකස් කරන ලදී. නම / අත්සන:
**This Report has been prepared by the investigating Officer. Name / Signature:** .....

ස්ථානාධිපති (රථ වාහන) විසින් මෙම වාර්තාව නිවැරදි බව සහතික කරන ලදී. නම / අත්සන:
**This Report is certified to be correct by OIC (traffic). Name / Signature:** .....

සංකේත ලිපිකරු විසින් සටහන් හා සංකේත යෙදීම පරීක්ෂා කරන ලදී
**Entring and Coding checked by coding clerk Name / Signature:** .....

ස්ථානාධිපති (සංඛ්‍යාලේඛණ කොට්ඨාශය) විසින් සටහන් හා සංකේත යෙදීම පරීක්ෂා කරන ලදී
**Entring and Coding checked by OIC (Statistics Division) Name / Signature:** .....

H 036008 – 30,000 (2010/11) ශ්‍රී ලංකා රජයේ මුද්‍රණ දෙපාර්තමේන්තුව Swe/28.05.2k3