IDENTIFICATION OF ACCIDENT CAUSING FACTORS THROUGH DETAIL ANALYSIS OF ROAD ACCIDENT RECORDS IN SRI LANKA

H.H.K.S. Nandana

(118859M)

Master of Engineering in Highway and Traffic Engineering

Department of Civil Engineering

University of Moratuwa

Sri Lanka

September 2015

IDENTIFICATION OF ACCIDENT CAUSING FACTORS THROUGH DETAIL ANALYSIS OF ROAD ACCIDENT RECORDS IN SRI LANKA

H.H.K.S. Nandana

(118859M)

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

Department of Civil Engineering

University of Moratuwa

Sri Lanka

September 2015

Declaration of the Candidate and Supervisor

I declare that this is my own work and this thesis does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Also, I hereby grant to University of Moratuwa the non-executive right to reproduce and distribute my thesis, in whole or in part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as articles or books).

Signature: Date:

The above candidate has carried out research for the Masters under my supervision.

Signature of the supervisor: Date:

ABSTRACT

Road traffic accidents in a country are inevitable and these accidents can be caused due to several different factors. They can vary from place to place and time to time and are in no particular order: excessive speed, inattention, fatigue, alcohol/drugs, behavior, vehicle defects, weather, road environment, road design etc.

The study involved review of police accident records in police divisions to identify the contributing factors that led directly to the accident, through detail analysis of road accidents. Accident records (More than 200 accident records) were obtained from various police divisions of the country particularly in 2013 and 2014 for a selected week. The collection and use of accurate and comprehensive data related to road accident is very important to road safety management. Detail analyses of accidents were conducted by thorough examination of all elements contributing to the accident, resulting in a well-founded explanation of the series of events which occurred based upon the factual data. Its objectives were to determine; what happened?, where the accident occurred?, when the accident occurred?, why the accident occurred?, and who was involved?.

Precipitating and contributory factors were identified is based on the report of police officers collecting data at the scene using their best judgment from evidence gathered after the accident. However, certain information is not reported in the summary sheet prepared for accident reporting. Inevitably some factors may be harder to determine and it is difficult to attribute a single precipitating factor to one participant in the accident.

Human factors are supposed to be the leading contributory factor in accident analysis and road and environmental factor were found to have a potential effect on road crashes whilst vehicle factor makes the lowest impact compared to the human factor and road and environmental factors. The visibility, geometry, lane markings, surface condition and street lighting facilities, weather, have a potential influence on the drivers and react in a dynamic driving condition. The interaction of the road and environment is quite complex with driving behavior and performance.

Key words: Traffic accident; Contributing factor; Precipitating factor

ACKNOWLEDGEMENT

First and foremost, I wish to express my sincere gratitude to University of Moratuwa, Sri Lanka, for giving me the opportunity to follow my post graduate programme at Department of Civil Engineering. I would also like to thank Dr. W.K. Mampearachhci for giving me a chance to complete my study under his supervision. This dissertation would not have been a reality if not for his friendly guidance and shared valuable knowledge.

I shall be thankful to Professor J.M.S.J Bandara, Dr. H.R Pasindu and all other staff members of Transportation Engineering Division, University of Moratuwa, for imparting their experience and knowledge to complete my dissertation.

I would like to express my sincere thanks to Metallurgical Corporation of China Ltd, for granting me leave and providing other needed support to complete my studies at University of Moratuwa.

Last but not least I extend my gratitude and appreciation to my family and friends for their support and motivation. My thanks and blessings go to everyone who supported me to complete this study, successfully.

TABLE OF CONTENTS

LIST OF FIGURES

Page

LIST OF TABLES

LIST OF ABBREVIATIONS

Abbreviation   Description

RTA   Road Traffic Accident

PSV   Parked & Stationery Vehicles

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction

What is a Road Traffic Accident (RTA)?

A road traffic accident occurs when a vehicle collide with another vehicle, pedestrian, animal, road debris or other stationery object such a trees, utility poles, road side monuments and they are considered as one of the major silent killers and for a country, traffic safety is a major factor that should be well addressed by the relevant authorities and the road users.

Road traffic accidents in country are inevitable and these accidents can be caused due to several different factors. They can vary from place to place and time to time. These are in no particular order: excessive speed, inattention, fatigue, alcohol/drugs, behavior and other distractions, lack of knowledge, lack of adequate training, road environment, road design, weather, vehicle defects, inadequate vehicle maintenance etc.

Road traffic accidents can be either fatal, permanent disable, resulting in severe injuries or damage to properties. It is worthwhile to know the cause of a particular accident so that remedial actions can be taken to prevent or at least minimize them in the future.

Road traffic accidents take nearly 1.3 million people annually worldwide and disable millions of people. About 90% of those take place in low or middle income countries. RTA has been recognized as a challenge by the United Nations and its members. In Sri Lanka RTA remain a major cause of mortality and morbidity. Some victims end as permanently disabled people. RTA injuries have reached to epidemic proportion in Sri Lanka ending 2000 deaths and 14000 injuries each year. Government has to spend large amount of money for managing those disable people. Those disabled individuals will be a burden to the family. Death of the bread winner causes financial and social crisis to a family. Identification of risk factors enables to plan a preventive strategy for RTA.

Further, an accident is an event that produces injury and/or property damage, involves a motor vehicle in transport, and occur on a traffic way or while the vehicle is still in motion after running off the traffic way. Common vernacular could define "accident" as an event occurring by chance or from unknown causes. However, in this case of transportation safety events, only a small percentage of events that are dealt with can be considered as unavoidable events or true accidents. Many agree that in the case of roadways, accidents are not just a matter of luck or misfortune, but a combination of multiple conditions or actions. The application of safety principles to the field of transportation has been primarily directed toward crash investigation, with the express purpose of finding those conditions and combinations of factors that lead to undesirable traffic accidents. For the most part, causes of accidents are categorized within four basic groups: person, vehicle, roadway and environment. Consider the person to be defined as the vehicle operator, a vehicle passenger, a pedestrian, or a bystander; the vehicle as the transportation conveyance such as automobile, truck, van, train, motorcycle just to name a few; the roadway as the total infrastructure of pavement, shoulder, signs, signals marking, safety devices, right-of-way and the maintenance of each in addition to the prevailing traffic conditions; and the environment as the weather and lighting conditions, which affect visibility and traction at minimum.

1.1.1 Causes of Traffic Accidents

The term "cause" refers to an at-fault determinant of a crash or a determinate that increases crash risk or severity. Investigating causes of traffic crashes is complicated by the fact that a given crash seldom has a single unambiguous cause. Crash causes are often a sequence of causes. For example, the initial cause of a pedestrian crash may be the pedestrian darting out in the road. If the vehicle driver subsequently is distracted, fails to see the pedestrians and safely stop the vehicle or manoeuvre around the pedestrian, both the pedestrian action and the driver lack of attention will likely be listed as cause of the crash. In addition there may be circumstances that took 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 in turn reflects on poor vehicle maintenance.

The important question is "what are the causes of these traffic crashes?" The causes of crashes and fatalities are usually complex and involve many factors. Based on studies conducted in different part of the world, it is possible to construct a list of categories that could influence the occurrence of road traffic crashes. If the factors that have contributed to the crash are identified it is then possible to modify and improve the transportation system. Crashes are caused by many factors, sometimes singly but more frequently in combination. Traffic crashes are caused due to interaction of vehicle, driver, roadway and environmental factors.

1.1.2 Data Collection

The collection and use of accurate and comprehensive data related to road accidents is very important. The road accident data are necessary not only for statistical analysis in setting priority targets but also for detail study in identifying the contributory factors to have a better understanding of the chain of events. Having the inconsistencies in the aims of the police and the road safety engineers, the data analysis and its interpretation usually does not result in proper countermeasures. Sometimes a lack of proper knowledge of crash and proper training of the police officers in charge on systematic data collection procedures from a crash scene adds to the diverging nature of the role of the police and the road safety professionals. These problems have become a burning issue for developing countries addressing road safety without completed crash data due to the negligence of concerned authorities.

Collection of information on road accidents involving human injury gives considerable information about the circumstances of the accident including who the victims are, what types of vehicles are involved and what they are doing at the time of accident and general

conditions at the time. However, it does not include information on the main reasons why road accidents happen.

Analysis of traffic accidents are of great importance because the analysis of traffic accidents is relevant for conclusions that create the ability to manage traffic safety. Depending on which level of analysis is necessary, it can implement various types of analysis of traffic accidents.

1.1.3 Accident Investigation

This research is an initial study attempting to conduct accident investigation to analyze accidents through a systematic and comprehensive approach to find out the causes and prevent future accidents. Accident investigation is the thorough examination of all elements contributing to the accident, resulting in a well-founded explanation of the series of events which occurred based upon the factual data. Its objectives are to determine; what happened?, where the accident occurred?, when the accident occurred?, why the accident occurred?, and who was involved?. The obtained data will provide the foundation of such in-detail accident analysis on human, vehicle, road and environmental factors.

1.2 Objectives

The principal objective of the research is to provide a detail analysis of the contributing factors or causes of the traffic accidents so that appropriate actions can be initiated to improve safety on the road network. The goal of this project is to go beyond the data currently available from the police reports, incorporating data from additional resources including crash scenes, photographs, and site visits where necessary. Major objectives of the research are:

1. Investigate accident records (more than 200) obtained from various police divisions of the country particularly in 2013 and 2014 for a selected time period.
2. Identify data elements to be potential contributory factors for accidents.

3. Analyze crash data; investigate behavioral (human), vehicle, roadway and environmental related causes of crashes through case study analysis.

4. Find out percentages of individual and combined contribution factors of the accident.

CHAPTER 2

LITERATURE SURVEY

2.1 Introduction

Numerous studies have been conducted to identify the accident causing factors of the road crashes. These studies have indicated that improvements to road safety could significantly reduce the number of vehicular accidents.

2.2 Related Findings

According to **Austroads (1994),** road accidents occur as the result of one, or more than one of the following factors:

- Human factors
- Vehicle factors
- Road and environmental factors

Human factors are described as that which the person did, or did not do at the time of the accident. It includes the following characteristics: speeding, inappropriate speed for circumstances, traffic violations, alcohol, drugs, negligence, driver error and age. Vehicle factors refer to design or mechanical faults of a vehicle, which includes a lack of maintenance. Road environment factors include all aspects of road design and maintenance, construction work, weather conditions and problems with signage and lighting.

Treat JR, from 1972 to 1977, the "Tri Level Study" was undertaken at the Indiana University in America to determine the causes of road accidents. The following were analyzed:

- 13 568 accident reports
- 2258 on scene investigations
- 420 in depth investigations

Factors that caused accidents were classified as definite, probable or possible and found that the human factor was again the greatest contributor.

According to the South African Department of Transport, the three factors contribute to accidents in the following proportions.

- Human factors (70-80%)
- Vehicle factors (10-15%)
- Road environment factors (5-10%)

Hendricks et al (1999) performed a study on unsafe driving acts in serious traffic crashes to determine the specific driver behaviors and unsafe driving acts that led to crashes, and the situational, driver and vehicle characteristics associated with these behaviors. They used an 11 step process to evaluate the crash, determine the primary cause of each crash, and uncover contributing factors. To meet the needs of the study, researchers, redefined the crash types to simplify and improve the analysis being performed. The crash types were recorded into seven classes with operational differences that were likely to be associated with driver behavior/performance.

The schematic representation of the analysis used to determine the causes of crashes in a study of unsafe driving acts in serious traffic crashes, broke crash causation into five main categories; vehicle condition, environmental condition, driver behavior, roadway condition and other/unknown. In that study it was reported that driver behavior caused or contributed to 99% of the crash investigated, with the six casual factors that accounted for most of the problem behaviors, in decreasing order of frequency, being driver attention, vehicle speed, alcohol impairment, perceptual errors, decision errors, and incapacitation.

Hamilton and Kennedy (2005), found that

- Young drivers and motorcyclists are disproportionately involved in accidents on rural roads.

- Driver behavior factors are a key issue in rural road accidents. The main driver behavior factors are: speed and speeding; alcohol drug use; driver fatigue and sleepiness; and driver distraction.

- The most common accident types on rural roads are: head on; run off the road; and junction accidents.

- Other factors identified as contributing to rural road accidents are: wild animals; darkness.

- Single vehicle accidents account for around one third of all rural single carriageway accidents. They are most likely to occur on B or C class roads at night, on bends and involve young drivers.

- Road width, horizontal and vertical alignment, roadside characteristics, and junction frequency and design are all identified as factors contributing to rural road safety.

2.2.1   Accident Statistics in Sri Lanka

2.2.1.1 Sri Lanka Police Department

According to the Police an accident is an undesired or unintended happening and accidents may occur

- Between vehicle and other vehicle
- Vehicle collided with a person
- Vehicle colliding with movable or unmovable property.
- When a vehicle goes off the road
- A person being knocked down with another person
- Due to natural or man-made disaster

Twenty five reasons for accidents have been identified by the police and key recommendations to prevent road accidents also have been presented.

2.2.1.1.1 Traffic Accident Statistics

Table 1: Vehicles Involved in Traffic Accidents

Element Type	Year				
	2006	2007	2008	2009	2010
Motor car	8613	8263	7814	10047	11094
Dual purpose vehicle	10171	8686	7988	8932	10054
Lorry	7464	6817	6225	6606	7924
Cycle	2946	2782	2456	2430	2654
Motor cycle/moped	11941	13025	13067	13924	16240
Three wheeler	6494	6016	5414	6246	7927
Articulated vehicle	403	386	358	378	355
SLT - Bus	1377	1485	1320	1324	1292
Private bus	5544	4893	4163	4349	4631
Intercity bus	99	82	73	75	66
Land vehicle/ tractor	587	560	527	499	630
Animal drawn vehicle	24	14	7	12	10
Total	55663	53029	49412	54822	62877

Source: Sri Lanka Police Department - 2010 (www.police.lk/index.php/traffic-police/56)

Table 2: Fatalities and Number (Fatalities by Road User Groups)

Category	Year					Total
	2006	2007	2008	2009	2010	
Driver/Rider	918	1050	1059	1124	1203	5354
Pedestrian	695	827	748	785	898	3953
Passenger/Pillion passenger	507	439	433	428	531	2338
Passenger falling of vehicle	78	58	60	54	45	295
Passenger entering or leaving bus	40	28	28	22	44	162
Total	**2238**	**2402**	**2328**	**2413**	**2721**	**12102**

Source: Sri Lanka Police Department, 2010 (www.police.lk/index.php/traffic-police/56)

Table 3: Number of persons Injured (Grievous & Non Grievous Injury) in Road Accidents by Road User Groups

Category	Year					Total
	2006	2007	2008	2009	2010	
Driver/Rider	9835	10311	10173	11821	12517	54657
Pedestrian	5490	5962	5540	6246	6083	29321
Passenger/Pillion passenger	6105	5924	5709	6465	7587	31790
Passenger falling of vehicle	581	547	520	482	372	2502
Passenger entering or leaving bus	521	394	376	268	288	1847
Total	**22532**	**23138**	**22381**	**25282**	**26847**	**120117**

Source: Sri Lanka Police Department, 2010(www.police.lk/index.php/traffic-police/56)

Table 4: Casualties by Age and Type of Road User - 2011

Age	Driver/Rider	Pedestrian	Passenger/ Pillion Passenger	Passenger Failing of Vehicle	Passenger Entering or Leaving bus	Total
0	0	2	0	0	0	2
00-05	0	16	29	4	0	49
06-10	3	20	18	4	0	45
11-15	15	4	13	1	1	34
16-20	80	15	43	2	3	143
21-25	197	27	64	0	5	293
26-30	162	27	81	7	4	281
31-35	136	36	58	3	2	235
36-40	112	39	36	3	2	192
41-45	91	54	30	2	2	179
46-50	86	75	30	4	6	201
51-55	89	102	39	4	5	239
56-60	72	89	32	3	4	200
61-65	70	97	31	2	4	204
66-70	30	79	8	1	3	121
71-75	28	87	10	2	0	127
76-80	19	67	8	2	3	99
81-85	10	41	1	0	0	52
86-90	2	15	0	1	0	18
91-95	1	6	0	0	0	7
Total	**1203**	**898**	**531**	**45**	**44**	**2721**

Source: Sri Lanka Police Department, 2011 (www.police.lk/index.php/traffic-police/56)

CHAPTER 3

METHODOLOGY

3.1   Research Methodology

In this study, the accident investigation was conducted on the records of road accidents occurred during the time period of 2013/2014 in various police divisions of the country. Having gone through the accident records, it was collected all important information about the crash including the followings and all information were used in the analysis to describe the events of crash, injury mechanism, and finally the contribution factors of such accident.

- Location of the accident
- Date & time
- Involved parties
- Number of injuries
- Accident case (in detail)
- Statements of witnesses
- Collision type
- Vehicle data
- Road type & condition
- Weather & visibility
- Sketch of the accident situation

3.1.1   Traffic Accident Data Collection

- Traffic accident data at various police divisions of the country were taken.
- The contributory factor system was designed to summarize the events that led directly to the accident, to be simple & 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, the respective police officer was called where the information was not the result of detailed accident investigation as the data collected reflects the view of the reporting police officer.

- If necessary, depend on the accident, it was required to investigate the accident location in detail and make the judgment of reasons for the accident.

- Collision diagrams available, analysis of accident data, site visit were used to analysis of dangerous locations.

- In some incidents, the data collected reflects the view of the reporting police officer and the information is not the result of detailed accident investigation.

3.1.2 Verifying Accident Type

Aside from analyzing the accident reports to deduce the causes of the accidents, the classification of accident type were also checked for every accident analyzed based on the precipitating and contributing factors. This was done to ensure the risk factors are set up correctly.

Out of more than 200 accidents analyzed, 10% of them were corrected to more accurate classifications for the purpose of this study. This was done with great caution and only when it was obvious from the information on the accident report that the current classification was wrong.

3.1.3 Precipitating and Contributory Factors

Collection of contributory factors was designed to summarize the events that led directly to the accident, to be simple to use and sufficiently comprehensive to cover circumstances leading to the majority of accidents based on human, vehicular and road and environmental factors and the system had two distinct phases. (Mosedale, Purdy, Clarkson (2003).

3.1.3.1 Precipitating Factor

The first stage records what went wrong by identifying the factor leading directly to the accident: this is called **precipitating factor** and is chosen a list of 14 factors. (Mosedale J, Purdy A, Clarkson E)

- Failed to stop (mandatory sign)
- Failed to give way
- Failed to avoid pedestrian (Pedestrian not to blame)
- Failed to avoid vehicle or object in carriageway
- Failure to signal/misleading signal
- Loss of control of vehicle
- Pedestrian entered carriageway without due care
- Passenger in or near PSV
- Swerved to avoid object in carriageway
- Sudden braking
- Poor turn/manoeuvre
- Poor overtaking
- Drove wrong way
- Other

3.1.3.2 Contributing Factors

The second stage recorded the reasons why the accident happened by identifying contributory factors from a detailed list annexed in the Table A1 of Appendix A, leading to the principal factors of human, vehicular and road/environment.

3.1.4 Simplifying of the Contributory Factors

Detailed contributory factors were divided into six categories only to enhance the statistical analyses. They are explained below.

- Driver behavior & Negligence – The accident would not have occurred if the driver were not negligent. Examples are unsafe overtaking, colliding with an oncoming vehicle in the opposite or same direction, following too close, inattention, aggressive driving, loss of control due to excessive speed, nervous, asleep, tiredness etc.

- Pedestrians in road – when a pedestrian crosses the road in an unsafe manner or walking on the road and causing an accident.

- Impairment of alcohol & drugs – A driver is being suspected of being over the alcohol limit.

- Vehicle defects – A burst tire, faulty lights, defective brakes or any other vehicle faults that caused the accident.

- Road condition – This includes an accident scene, oil, water (slippery road), pothole or rock on the road, poor road markings, road signs, poor or no street lightings, steep hill, narrow road, bend/winding road and road works obstructing a road.

- Road Environment – Potential accident causing factors such as glare from the sun and headlights, surrounding (stationery or parked vehicles, buildings, fences), weather, animal crossing the road.

The above causes are divided into three contributing principle factors as follows.

Human Factors

- Negligence
- Pedestrian in road
- Impairment of alcohol & drugs

Vehicle Factors

- Vehicle Defects

Road/Environment Factors

- Road Condition
- Road environment

3.1.5 Crash Scene

There were several crash scene observed and after the arrival at the crash location, the necessary information was collected with the field sketches, drawings, and photographs of the crash scene and damaged vehicles from different angles. The physical evidence (e.g. tire marks, broken glass, oil and blood spatter, etc) at the crash scene were carefully collected particularly for the skid marks that were measured according to direction and coordinates from a reference point. The roadside infrastructure was referenced and taken into consideration. In addition, the police report was also gathered and damaged vehicles taken to police station were also carefully investigated.

The evidence at the crash scene, interviews of eyewitnesses in the vicinity of the crash location and the police reports were gathered and interpreted to visualize the events prior to the crash according to the available information.

3.1.6 Limitations for Data Collection

- In some cases accident data are not gathered at the time of accident but produced from information provided when an accident was reported subsequently at a police station.

- In this case, the evidence may not be available to cover the full range of contributory factors.

- It was also clear that where an accident was reported at a police station, there would not be sufficient information available to allow the police to make a judgment as to the cause & fewer accidents were therefore attributed to impairment due to alcohol or excessive speed.

16

3.1.6.1 Under-Reporting of Crashes with less Severe Injuries

It is well documented that crashes resulting in no injuries, or less severe injuries, are more likely to be under-reported and thus do not appear in crash reports. In the presence of such under-reporting, the observed distribution of accidents (from reported crashes) among the injury-severity categories will differ from the actual distribution of crashes among severity categories.

CHAPTER 4

ANALYSIS & RESULTS

4.1   Basic Data Analysis

Table 5 – Types of Vehicles involved in the accidents considered

Type of Vehicle	Number	%
Motorcycle	105	30.1
Foot bicycle	5	1.4
Trishaw	46	13.2
Bus	47	13.5
Car	44	12.6
Lorry	46	13.2
Others	56	16.0
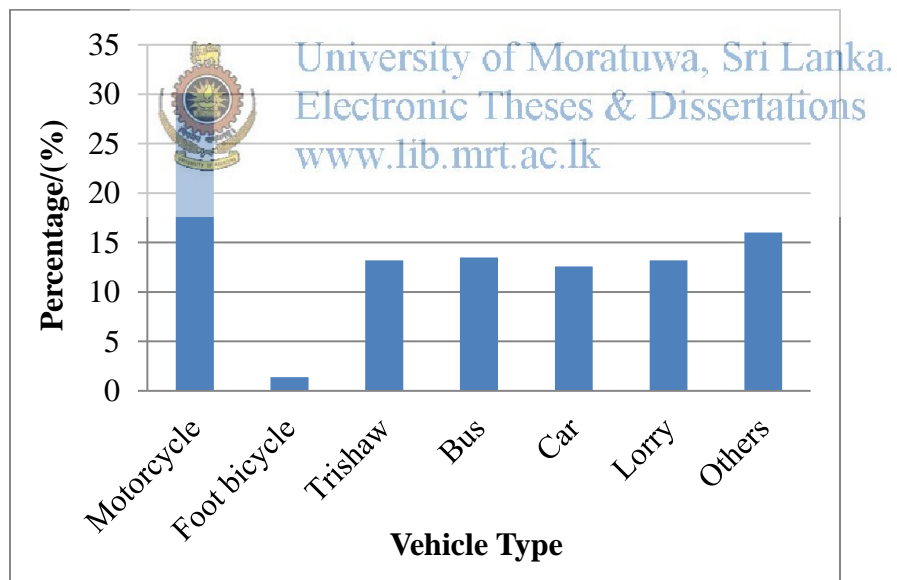
Figure 1: Accidents occurrence against vehicle type

Table 6 – Time of the accidents occurred

Time Period	Numbers	%
6 p.m - 12 midnight	48	22.1
12 midnight – 6 a.m	13	6.0
6 a.m – 12 noon	71	32.7
12 noon – 6 p.m	85	39.2
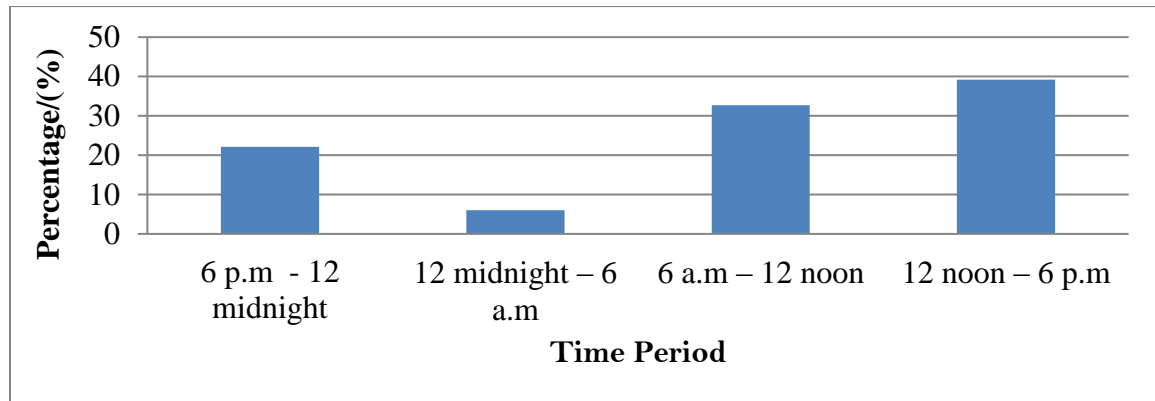
Figure 2: Accident occurrence against time

Table 7 – Type of victims

Victim	Number	%
Driver/Rider	126	60.3
Passengers	25	12.0
Pedestrians	58	27.7
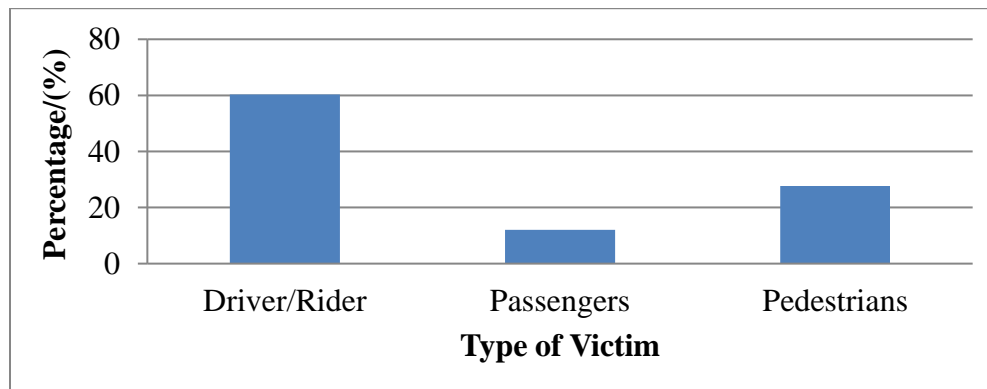
Figure 3: % of accident rate against victim

4.2 Accidents by Vehicle Manoeuvre

The following types of vehicle manouvre have been identified in the police records; (a) stationery, (b) Starting (from stationery position), (c) turning right, (d) turning left, (e) overtaking, (f) emerging from minor road, (g) reversing and (h) proceeding head. The accident rates resulting from each of these manouvres (from the precipitating factor of poor turn/manouvre) for each of the vehicle types is given in Table 8 and illustrated in Figure 4. However, incomplete vehicle records were eliminated from the analysis in some instances. For example, every record that did not indicate the vehicle manouvre has not been considered in any cross tabulation that includes vehicle manouvre.

Table 8: Vehicle types with high accident rates by vehicle manouvre

Vehicle Manouvre	% of All Vehicles Involved in Accidents	Vehicle types with high Accident Rates	Common factor Identified
Going Ahead	78.9	Motor cycles, three wheelers	Sudden manouvres
Stationery	5.4	Cars	Medium size vehicle
Overtaking	7.2	Cars, buses	Competitive driving habit with over speed
Turning Right	3.3	Motor cycles, cars	No proper signal & sudden turn
Reversing	1.2	Lorries	Poor visibility
Emerging from minor road	3.1	Motor cycles & land vehicles	Small vehicles attempting to share the right of way
Turning Left	0.6	Buses & lorries	No signal
Starting from stationery position	0.3	Buses	Competitive driving habits, no rear view mirror
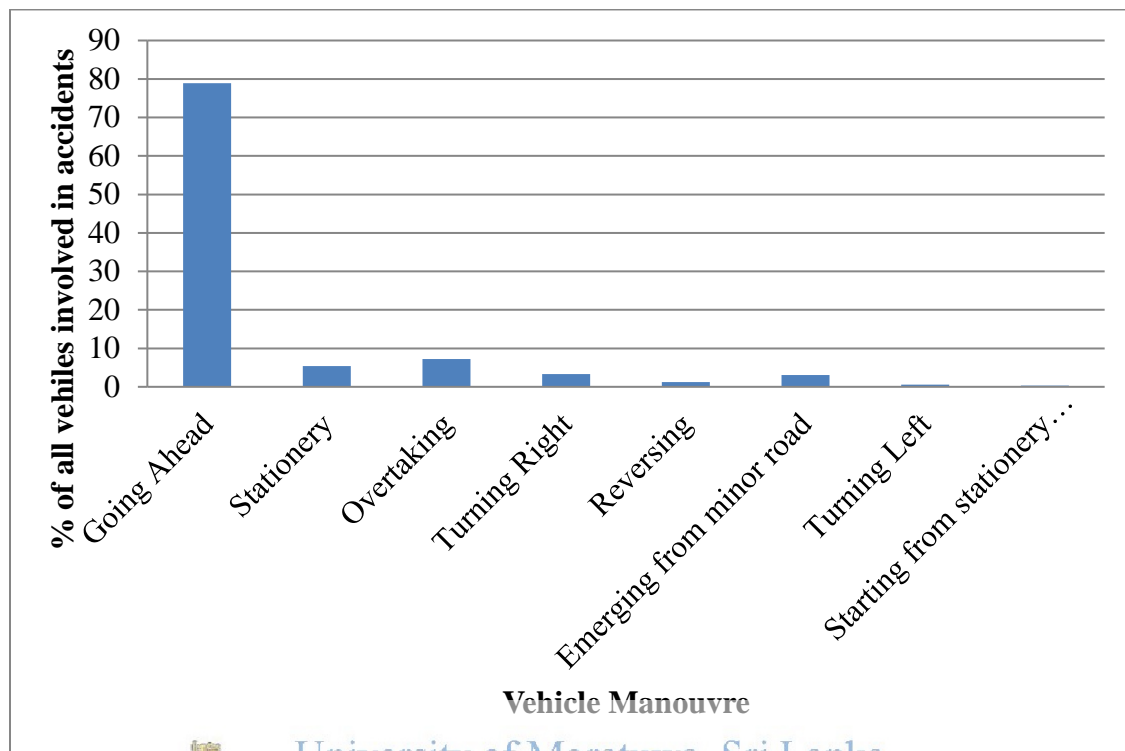
Figure 4: Percentage of accident rates against vehicle manouvre

4.3 Accidents by Driver Action

The police records indicate a number of driver actions associated with each accident. These are (a) lost control; (b) wrong side; (c) failure to signal; (d) high speed; (e) avoiding an accident; (f) collision with street furniture; (g) skid and (h) no unusual action. These are given in Table 9 and Figure 5.

Table 9: Vehicle Types with High Accident Rates by Driver Action

Driver Action	% of Vehicles Involved in Accidents	Vehicle Types with High Accident Incidence	Common Factor Identified
Lost control	38.5	Motor cycles, three wheelers	Unstable design
Skidded	2.9	Motor cycles, bus, cars	Rain, tire
Wrong side of road	2.0	Motor cycles, foot bikes	Short trips
High speed	22.5	Buses, cars, lorries	Heavy vehicles need longer breaking distance
Avoiding an accident	0.8	Lorries	
Failure to signal	1.1	Motor cycles, buses	No signal
Collision with street furniture	3.7	Lorries, motor cycles	Night driving, loss of control

Figure 5: Percentage of accident rate against driver action

4.4 Accidents by Driver Condition

The police records identify (a) intoxication; (b) defective eye sight; (c) fatigue and (d) other physical defects as condition of driver at time of action. Howe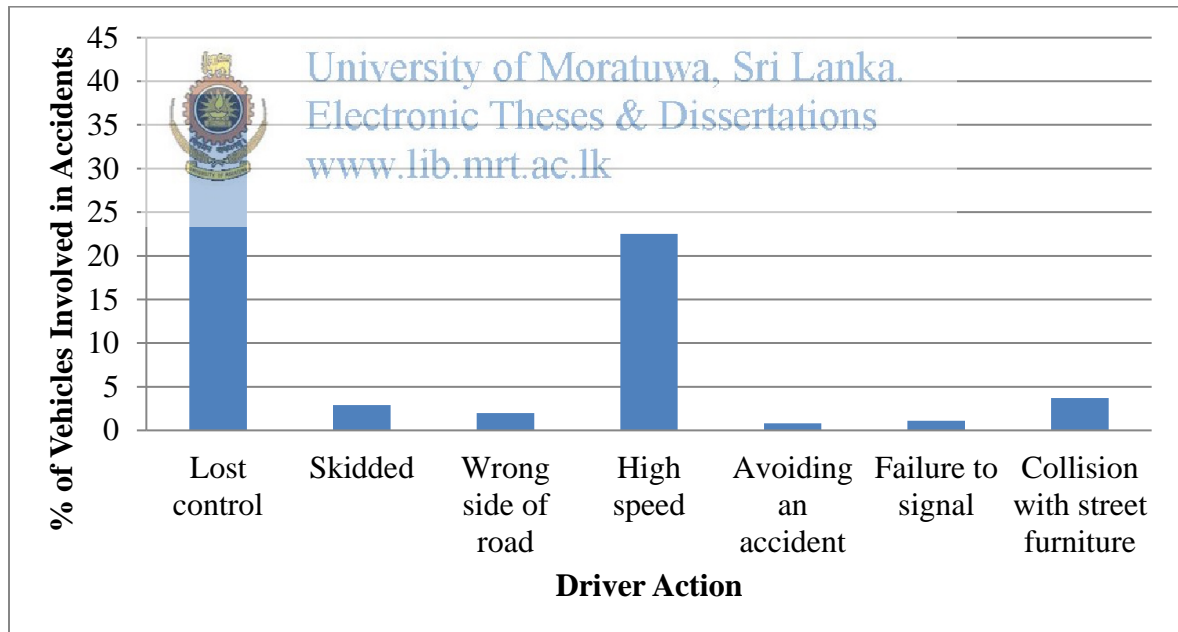ver, only 12.4% of drivers involved in accidents had any of the above reported. That is 87.6% of all vehicles involved in accidents reported other conditions of driver behavior and distraction.

4.5 Accidents by Vehicle Defects

Vehicle defects have been classified as those relating to the improper function of (a) brakes; (b) tires; (c) steering; (d) lights and (e) load defects. The analysis given as Table 10 and Figure 6 indicate that 95.1% of vehicles involved in accidents did not report a vehicle with any one of the above defects. With respect to defects recorded, 3.3% of vehicles involved in accidents were relating to brake defects, 1.1% due to tire defects, 0.1% pertaining to load defects, and 0.2% due to steering and light defects. The vehicle wise analysis of "high accident rate" vehicles due to vehicle defect recorded is given in Table 10.

Table10: Vehicle Types with High Accident Rate by Vehicle Defects

Vehicle Defect	% of Vehicles Involved in Accidents	Vehicle Types with High Accident Incidences	Common Factor Identified
Brake	3.3	Buses, lorries	Heavy vehicles
Tyre	1.1	Lorries	Poor maintenance, overload
Load	0.1	Lorries	Difficult terrain
Steering	0.2	Land vehicles	Vehicle design, no maintenance
Light	0.2	Bicycles	Generally no lighting
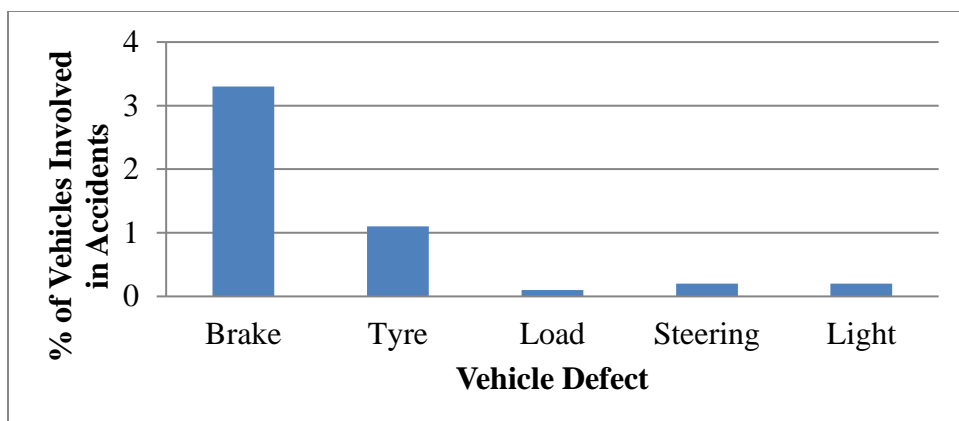
Figure 6: Percentage of accident rate against vehicle defects

4.6 Accident Severity

The severity of accidents has been reported with respect to vehicle types, driver action and other circumstances of the death. The driver condition has been analyzed with the severity of the accident. The severity of accident has been classified as (a) fatal; (b) grievous; (c) non-grievous; and (d) non-injury. Table 11 and Figure 7 show that accidents involving intoxicated drivers are more severe. The same trend is seen for accidents where the driver condition is listed as fatigued. The analysis clearly indicates that intoxication and fatigue in particular are especially contributory to an increase in the severity of accidents.

Table11: Severity of Accident by Driver Condition

Accident Type	Intoxicated/(%)	Fatigued/(%)	Other Defects/(%)	No Defects/(%)	Total
Fatal	9.5	7.5	2.2	80.8	100
Grievous	4.9	2.3	4.3	88.5	100
Non-Grievous	1.9	0.3	2.1	95.7	100
No Injury	0.9	0.6	1.8	96.7	100
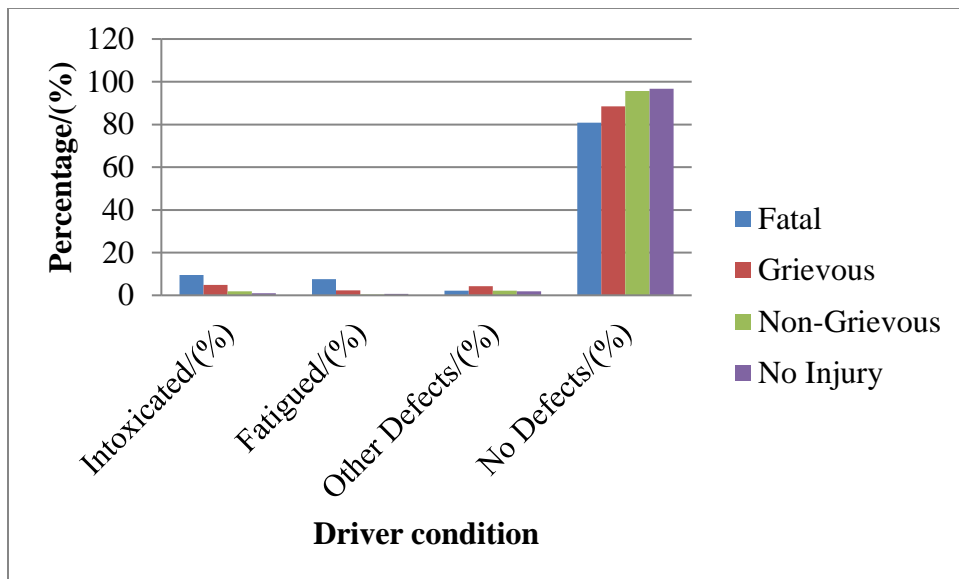
Figure 7: Percentage of accident rate against driver condition

4.7   Percentage of Precipitating Factors

Table 12: Percentages of Precipitating Factors of the Accidents

No	Precipitating Factor	Percentage/ (%)
1	Failed to stop (mandatory sign)	3
2	Failed to give way	15
3	Failed to avoid pedestrian (Pedestrian not to blame)	4
4	Failed to avoid vehicle or object in carriageway	28
5	Failure to signal/misleading signal	1
6	Loss of control of vehicle	19
7	Pedestrian entered carriageway without due care	11
8	Passenger in or near PSV	1
9	Swerved to avoid object in carriageway	1
10	Sudden braking	3
11	Poor turn/manoeuvre	8
12	Poor overtaking	3
13	Drove wrong way	1
14	Other	2

Table 12 shows the percentage of accidents with each precipitating factor. Five of the fifteen precipitating factors listed collectively account for 80% of accidents. The most frequently recorded factor was *failed to avoid vehicle or object in carriageway* (28%) followed by *loss of control of vehicle* (19%), *failed to give way* (15%), *pedestrian entered carriageway without due care* (11%), and *poor turn/manoeuvre* (8%). Only 2% of accidents were given a precipitating factor *other* indicating that in most cases, police officers found it possible to select one of the precipitating factors listed.

4.8   Detailed Contributory Factors of the Accidents

Table A1 in Appendix A shows the detailed contributory factors. Fifteen of the fifty-one contributory factor variables cover over 80% of all contributory factors coded. The most commonly coded factor was *inattention* followed by *failed to judge other person's path or speed*, *looked but did not see*, *behavior-careless/thoughtless/reckless*, and *failed to look*. As up to more than four contributory factors may be recorded for each accident, the percentage for all fifty one factors will add up to more than one hundred.

4.9   Case Study – Accident on Habarana – Polonnaruwa Road on 15th July 2014

The crash occurred between a bus and a pickup truck on an undivided two lane 2 way straight section at about 7.30p.m was considered. A total of two casualties, two fatalities and one serious injury, were reported in this angled head - on collision between two vehicles. All of the casualties were the occupants of the truck. The pickup truck was severely damaged with little deformation in the bus.

4.9.1   Pre-crash Information

Driver Information:

▪ Pickup truck – The driver was 37 years old male and eight passengers were inside the van. A seat belt was used by the driver according to the evidence and he was travelling about 55kmph speed.

- Bus – The bus driver was male (age not reported). He was trying to pass the motorcycle in front of him. He was travelling at about 65kmph speed.

Vehicle Information

- Pickup truck – The 4 wheel pickup truck was locally modified to provide a roof and seats for the passengers in the back. The seating rows were arranged along both sides of the vehicle for the convenience of the passengers. The body was black colour.
- Bus – The 6 wheel bus was white and blue painted.

Road – Environment Information

- Geometry – The road was a 2 lane 2 way road in a rural setting. The lane width was 2.7m in each direction with 1.8m wide shoulders in both directions. The road was flat.
- Surface – The pavement surface was asphalt and the surface condition was dry during the investigation.
- Lane markings – The lane markings were not clearly visible considering the road surface as a background (later it was resurfaced and necessary lane markings done).
- Roadside furniture and area – The small trees and electricity transmission poles were found along the straight section of the road. In addition, some traffic signs were observed along the road near the crash scene. There was a sheltered bus stop on the opposite side. No street light was found on the road. Two minor access roads were also observed on the opposite side of the road section at the crash scene.

Pre-crash Information

Driver information

- Pickup truck - As the pickup truck was travelling in its own lane, there was no sudden expectancy to slow down. Suddenly, the bus appeared into the right of way lane of the pickup truck. Due to sudden and unexpected situation, the pickup truck did not have time to brake and avoid the collision (no skid marks by the pickup truck were found on the driving lane of the road). The pre-impact speed of the truck was 55kmph. Figure 8 shows the driving direction of the pickup truck.

Note: A: Initial travel direction of pick-up truck; B: Rear right & left tire at
point of rest (pick-up truck); C: Blood; D: Debris; E: Initial travel
direction of bus

Figure 8: Driving path of pick-up truck

- Bus – Consequently, the bus was going to the right lane from its driving lane (left lane). Suddenly, the bus driver found that the pickup truck was approaching at a

very close distance. Therefore, the bus driver applied the brakes in 0.63 seconds and made 9.8 m of skid marks before crash. However, the bus could not avoid the collision with the pickup truck. The bus was travelling at about 65kmph and showed down to 47kmph within a very short time. Figure 9 shows the driving direction of the bus.

Note: F: Initial travel direction of bus; G: Right front tire mark of the bus;
H: Rear Right tyre mark of the bus; I: Rear right & left tire mark at point of
rest of the bus and J: Initial travel direction of the pick-up
Figure 9: Driving path of the bus

4.9.2 Post-crash Information

Driver/Vehicle information

- Pickup truck – Due to severe intrusion and damage of the passenger compartment there were fatalities and one serious injury of the occupants.
- Bus – Due to the geometry and mass incompatibility between the vehicles, the bus sustained minor damage compared to the pickup truck.

Road - Environment Information

- Pickup truck – The pickup truck was stopped after going backward on the left side for 6.8m from the point of impact. The rest position of the pickup truck was found at the crash scene on its driving lane but close to the shoulder.
- Bus – The bus stopped after crossing 2.8m ahead from the point of impact on the opposing lane (right lane which is right-of-way of pickup).

4.9.3 Summary

The summary of event analysis could lead to listing the precipitating and detail contributing factors. The human factor of the pickup truck, where the pickup driver could have braked as an evasive action (but actually he did not in the real situation) was influenced by the unexpectancy of the oncoming vehicle (bus) into its (pickup) own right of way. Less attentive driving on the undivided 2 lane 2 way highway at night in the absence of street light facilities is also added. For the bus driver, the misjudgment of a gap between bus and leading vehicle (motorcycle) together with late passing decision of the passing vehicle led to late braking to avoid the collision.

For the vehicle aspect, the compatibility of the bus and smaller vehicle such as a pickup in this case could be taken seriously taken in terms of mass and geometry of the vehicles. In addition, the locally modified body structure of the bus could possibly have late braking response due to the old age of the vehicle.

For the road and environment aspect, no street light facilities particularly during night time driving on the undivided 2 lane – 2 way road could lead to the difficulty in distinguishing the lane separation. Shadows of static objects also contributed to the faulty decisions of the pickup truck and bus drivers. In addition, no speed limit signs along that road section were found during the investigation process.

Possible factors from the summary of event analysis could be listed as follows under contributing factors (i.e human, vehicle and road-environment).

Human

Pickup truck

- Unexpected maneuvering of bus into "wrong lane" in 2 lane road
- Paying less attention to the oncoming vehicles in the opposite lane in undivided road during night time driving.

Bus

- Misjudgment of distance and speed of the leading vehicle (i.e. motorcycle)
- Late in overtaking for small profile vehicle (i.e. motorcycle)
- Inattentive driving for oncoming vehicles from the opposite lane in 2-lane-2-way undivided road

Vehicle

Bus

- Complete stop by applying brakes did not occur due to having short braking time

Road & Environment

Pickup truck

- Lack of street lighting
- Lack of conspicuity of the static road side objects during night time

- Difficult in distinguishing the lane separation clearly due to lack of reflective devices for 2-lane road
- No "Speed limit" sign along the roadside

Bus

- Lack of street lighting
- Unclear vision due to shadow of small trees, advertisement boards
- No "Speed limit" sign or warning sign of curvature ahead along the long straight section.

4.10   Summary of Results

4.10.1 Primary Contributory Factors

Detailed contributory factors in the Table A1 of Appendix A were basically divided into six categories (Primary cause) only to enhance the statistical analyses and percentage for each cause is given in the Table 13.

Table 13 – Primary Contributing Factors

Cause	No. of contribution	%
Driver behavior & negligence (careless, tiredness, asleep, over speed)	218	71.0
Pedestrian in road	6	2.0
Vehicle defects	14	4.5
Alcohol impairment	23	7.5
Road condition	34	11.0
Road environment (weather & glare)	13	4.0

Over 70% of the accidents that occurred can be attributed to negligence. Pedestrians caused further a 2% and 7.5% from the alcohol impairment. Totally road and environment condition contributes 15% for the accidents.

With the help of the above analysis, the main accident contributing factors of human, vehicle and road/environment in conjunction with each factor could be illustrated in the Figure 11.
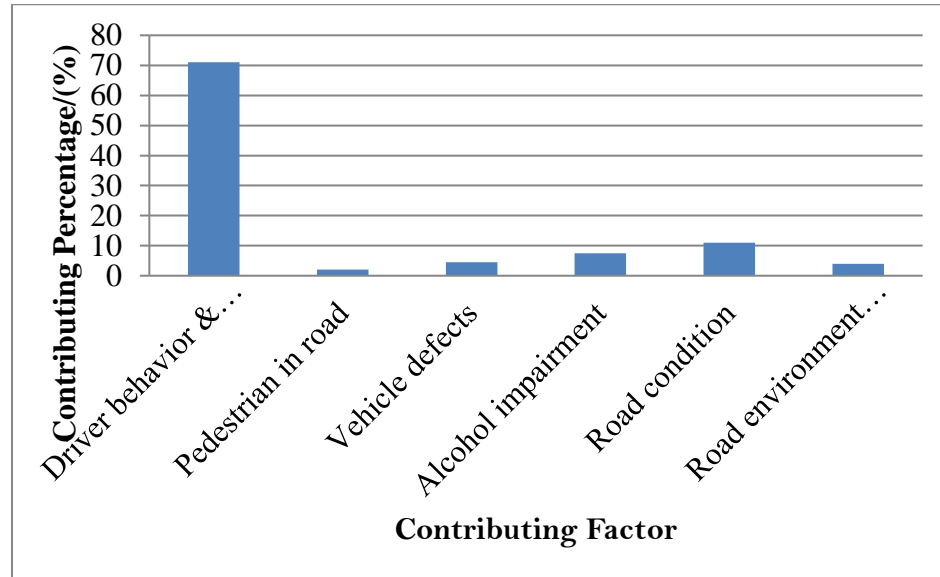
Figure 10: Primary Factor Contribution for accidents
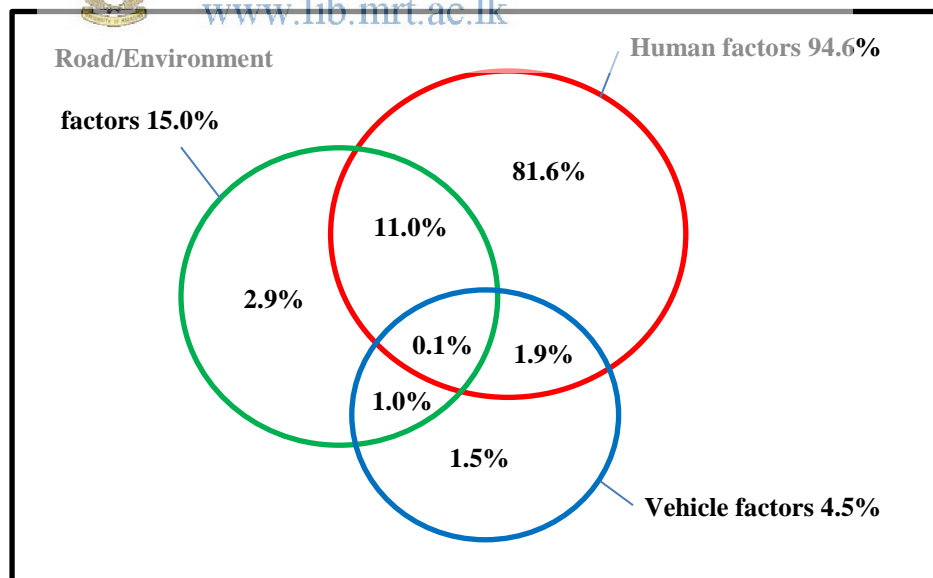
Figure 11: Combination of Principle Accident Contributing Factors

33

4.10.2 Relationships between Human, Vehicle and Road/Environment Factors with Accident Type

The main factors were deduced by the information gained by analyzing the accident reports with the following accident types occurred. Accident types were grouped to classify the accident characteristics corresponding to vehicle movement. It was considered by vehicle travelling direction, driving maneuver, and another vehicle or object involved. Refer Table B1 in Appendices B.

CHAPTER 5

CONCLUSIONS & RECOMMENDATION

5.1   Summary of Findings

1. According to this study, more than 94% of human factors contribute for accidents while road/environment and vehicle factors contribute 15% and 4.5% respectively.

2. Motor cycle was the most involved vehicle type i.e. more than 30%, of the accidents.

3. Maximum number of accidents occurred during the time period from 12 noon to 6 p.m.

4. Based on this study, more than 60% of incidents, driver or rider has become the victim than the passenger and pedestrian, but statics of Sri Lanka Police Department in 2011 showed that it was 44.2%.

5. It was found that "Going ahead" manouvre contributed 78.9% for the accident occurring.

6. Loss of control (38.5%) and excessive speed (22.5%) are the most critical factors attributed to the accidents by driver action.

7. There is a clearly established link between speed and accident frequency, with higher speeds leading to more severe accidents and young male drivers are most likely to drive at excessive speeds.

8. Driver fatigue and sleepiness are almost exclusively a problem due to the greater driver stimulation.

9. Alcohol has directly affected on driving/riding performance and driving at excessive speeds, while under the influence of alcohol or drugs, while being sleepy or tired, when visibility is compromised or without protective gear for all vehicle occupants are major factors in crashes, deaths and serious injuries.

10. A collision with a fixed object is considered as the most harmful event and the injury outcomes are generally more severe than car – to – car crashes. Because the fixed objects are narrow and solidly fixed on the ground, the vehicle needs to absorb all of impact energy from relatively small area.

11. Young drivers and motorcyclists are identified as being particularly at risk.

12. Road width, horizontal and vertical alignment, roadside characteristics are all identified as factors contributing to the road accidents.

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 and training, traffic enforcement, road capacity expansion etc.

The police data does not enable the direct identification of the primary cause for an accident. However, by a case wise identification of all possible defects categories as human, vehicle and road condition, it is possible to identify the most probable single cause for accident. No method of collecting contributory factor data will be perfect. Information is based on the opinions of officers collecting data at the scene using their best judgment from evidence gathered after the event. Inevitably some factors may be harder to determine.

In these cases it is difficult to attribute a single precipitating factor to one participant in the accident. A case in point is an accident involving pedestrians and cars where the precipitating factor may have been the pedestrian walking into the road but the car was travelling too fast. It is also clear that where an accident is reported at a police station, there may not be sufficient information available to allow the police to make a judgment as to the cause and fewer accidents are therefore attributed to impairment due to alcohol or excessive speed.

5.2.1 Contributory Factors

5.2.1.1 Human Factor

The main contributing factor for many accidents was the performance of driver in both single vehicle and multi vehicle crashes. The pre-crash driver behavior and attitude is

very important in judging the driver's actions. These include; inattention, medical conditions, alcohol and drug abuse, speeding, disregarding the traffic law and traffic control devices which could result from confusion or unfamiliarity with the roadway. Human factors are without doubt the most complex and difficult to isolate, as they are almost all very temporary in nature. What existed at the time of the crash may not exist moments later. Consider sensory capabilities, knowledge, judgment, and attitude, and alertness, health, driving skill, age, customs, habits, strengths and freedom of movement. Of these, the emotional factors are the greatest variable attributes and the most difficult to identify.

5.2.1.2 Vehicle Factor

A small percentage of crashes are caused by mechanical failure of a vehicle, such as some form of a tyre failure, brake failure or steering failure. The vehicle and roadway interaction like skid resistance play a major role in stopping vehicle from encroaching the off road features like shoulder, median and other traffic signage. Other vehicle characteristics like wheelbase and height of center of gravity play an important role in rollover crashes.

5.2.1.3 Road & Environmental Factor

It was found to have a potential effect on road crashes. The visibility, geometry, lane markings, surface condition and street light facilities and weather have a potential influence on the drivers and react in a dynamic driving condition. The interaction of road and environment is quite complex with driving behavior and performance.

The roadway conditions like the quality of pavements, shoulders, traffic control devices and intersections, can be a factor in the crash. Fewer traffic control devices and complex intersections with excessive signage lead to confusion. Roads must be designed for

adequate sight distances for designed speed for the driver to have enough perception-reaction time. The traffic signals should provide enough time for decision sight distance when the signal changes. The super elevation on highways and specially ramps should be carefully laid with correct radius and appropriate transition zones for the vehicles to negotiate curves safely. Another important factor is the frictional forces between the pavement and tires. If the tires lose contact with the pavement then the vehicle starts fishtailing.

Road factors include, but not limited to lighting, view obstructions, recognizability, signs, signals, surface character, and dimensions. All factors are subjected to modification by outside influences such as the road surface that becomes slick from rainfall. Modifying each of the listed road factors are weather, lighting, road side devices, activities, surface deposits, damage, deterioration and age.

Some roads were not built to serve the current high-volume and/or high-speed traffic needs. The safety of these roads is limited by hazards such as sharp curves, poor signs and pavement markings, and lack of medians to separate oncoming traffic.

The climatic and environmental conditions can also be a factor in transportation crashes. The most is weather. Weather on roads can contribute to crashes; for example wet pavement reduces friction and following or standing water can cause the vehicle to hydroplane. Many severe crashes have occurred during conditions of fog which can greatly reduce visibility.

REFERENCES

1. WHO, 2009, Regional report on Status of road safety: South-East Asia Region

2. WHO, 2013, Global status report on road safety: Supporting a decade of action

3. AUSTROADS, 1994, Road Safety Audit, Sydney

4. Treat JR 1979, Tri level study of the causes of traffic accidents. Research report compiled by the Institute for Research in Public Safety to the US Department of Transport, Washington DC.

5. Hendricks DL, Fell JC, Freedman M (1999), The relative frequency of unsafe driving acts in serious traffic crashes, National Highway Traffic Safety Administration, US Department of Transport Summary Technical Report.

6. Mosedale J, Purdy A, Clarkson E (2003), Transport Statistics: Road safety, Department for Transport, Great Britain.

7. Jacobs GD (1995), Road accident data collection and analysis in developing countries, (TRRL Laboratory Report 676, Crawthorn Transport and Road Research Laboratory)

8. Odero W, Garner P, Zwi A (1997), Road traffic injuries in developing countries: a comprehensive review of epidemiological studies. Trop. Med. Int. Health. 2:445-460.

9. Van K, Donald J (2001), Vehicular accident investigation and reconstruction, CRC Press LLC, Boca Roton, FL.

10. Hamilton K, Kennedy J (2005), Rural road safety: A literature review, research findings No.203/2005, TRL Limited.

Appendix A

Table A1: Detail list of contributing factors associated with the principle factors

Principle Factor	Contributory Factor
Human	Impairment – alcohol
	Impairment – drugs
	Impairment – fatigue
	Impairment – illness
	Distraction – stress/emotional state of mind
	Distraction – physical – in/on vehicle
	Distraction – physical – outside vehicle
	Behaviour – panic
	Behaviour – careless/thoughtless/reckless
	Behaviour – nervous/uncertain
	Behaviour – in a hurry
	Failed to judge other person's path or speed
	Disability
	Failed to look
	Looked but did not see
	Inattention
	Person hit wore dark or inconspicuous clothing
	Personal details – other
	Crossed from behind parked vehicle
	Ignored lights at crossing
	Excessive speed
	Following too close
	Inexperience of driving
	Inexperience of vehicle
	Interaction/competent with other road users
	Aggressive driving
	Lack of judgment of own path
Vehicle	Tyres – wrong pressure
	Tyres – deflation before impact
	Tyres – worn/insufficient tread
	Defective lights or signals
	Defective brakes
	Vehicle defects – other

Road & Environment	Site details – poor road surface
	Site details – poor/no street lighting
	Site details – inadequate signing
	Site details – steep hill
	Site details – narrow road
	Site details – bend/winding road
	Site details – road works
	Slippery road
	Local conditions other
	View - glare from sun
	View – glare from headlights
	Surroundings – bend/winding road
	Surroundings – stationery or parked vehicle
	Surroundings – moving vehicle
	Surroundings – buildings, fences, vegetation
	Weather
	Failed to see pedestrian or vehicle in blind spot
	Animal out of control

Appendix B

Table B1: Relationships between human, vehicle and road/environment factors with accident type

Accident Type	Principle Contribution Factor			Statically Significant Relationships
	Human	Road/Environment	Vehicle	
Head/Rear end	75	5	20	Negligence, close following, speeding, steep gradient, road works, faulty brakes
Sideswipe: same direction	75	20	5	Negligence, dangerous overtaking, sight distance, faulty indicators
Pedestrian	75	25	0	Driving on shoulder, pedestrian visibility, speed, alcohol, pedestrian facilities
Fixed object	80	15	5	Negligence, losing control, speed, alcohol, fatigue, road signs, brakes
Overturned	70	5	25	Lost control, speed, alcohol, fatigue, sight distance, burst tyres
Sideswipe: opposite direction	90	10	0	Dangerous overtaking, speed, sight distance
Vehicle left road	70	5	25	Lost control, inattention, speed, fatigue, curves, pedestrians, burst tyres
At angle: both straight	90	5	5	Negligence, failed to stop, intersections and control, faulty brakes, access spacing, brakes
Hit animal	10	90	0	Speed, fencing, lighting
Turn right in face of oncoming traffic	95	0	5	Negligence, turning in front of traffic, no use of indicators

Head on	95	5	0	Dangerous overtaking, speed, sight distance, road marking, inattention, inconsiderate driving
Turn from wrong lane	95	5	0	Inattention, no use of indicators, road markings and signs
Reversing	90	5	5	Inattention, illegal movement, faulty brakes
At angle: one or both turning	95	5	0	Inattention, road signs