# SAFETY MANAGEMENT OF ROAD USERS WITH SPECIAL REFERENCE TO PEDESTRIANS

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(149380 V)

Degree of Master of Science in Occupational Safety and Health Management

Department of Building Economics

University of Moratuwa

Sri Lanka

June 2019

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## DECLARATION

I declare that this is my own work and this dissertation 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.

Further, I acknowledge the intellectual contribution of my research supervisor Chartered Quantity Surveyor Professor (Mrs.) B.A.K.S. Perera for the successful completion of this research dissertation. I affirm that I will not make any publication from this research without the name of my research supervisor as contributing author unless otherwise I have obtained written consent from my supervisor.

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…….. ……...
Ch. QS Prof. (Mrs.) B.A.K.S. Perera Date
Dissertation Supervisor

**DEDICATION**

*I dedicate this dissertation*
*to my beloved* ***Amma*** *and* ***Thaththa,***
*for their unwavering love*
*and endless sacrifices*

## ACKNOWLEDGEMENTS

On this moment of submission of my dissertation, I would like to express my sincere gratitude to the University of Moratuwa and all the individuals who supported, inspired and encouraged me throughout my journey.

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**……..**

K. T. Champaka Ariyawansa

June 2019

# ABSTRACT


## SAFETY MANAGEMENT OF ROAD USERS WITH SPECIAL REFERENCE TO PEDESTRIANS

Approximately 600 - 900 pedestrian deaths occur annually during the past 15 years in Sri Lanka. Very less attention has been given to control these deaths. Thus, safety of pedestrian has become one of the important issues in Sri Lanka. This research aimed at identifying strategies to manage better safety conditions of pedestrians to reduce the damage caused by accidents. Identification of current rules and regulations for road users, main causes of pedestrian deaths and injuries, analysis of recorded data, identification of existing road safety conditions in Sri Lanka, UK and Singapore and proposing appropriate road safety measures to Sri Lanka were among the objectives. A mixed research approach was used for this research consisting of a comprehensive literature survey, desk study, collection of statistical data via interviews, local and foreign field observations.

Data analysis revealed that motorcycles accounted for the highest number of fatal accidents. Indicating the highest major and minor injury accidents for last 15 years, motorcycles were the most affected vehicle. Pedestrians accounted for the maximum number of deaths during the last twelve years. Speed driving and overtaking were the major causes of death in road accidents. Accidents by turning and intoxication of drivers were also affected. Weekends have encountered for highest deaths. Vehicle drivers in the age of 26 – 35 have contributed the highest. From 18:00 – 20:00 hrs. at night, accidents occurred heavily. Traffic calming devices and speed limits can be introduced to residential areas and around schools. More provisions for sidewalks in road widening and rehabilitation are required. Raised sidewalks provide better safety conditions for pedestrians. Designing an exclusive pedestrian phase for crossings at highly populated junctions, increasing road signs and constructing appropriate crossings, overpasses or underpasses in towns are proposed. Traffic rules and road safety measures must be included in school syllabi. Enforcement of laws for misconducting traffic rules and strict supervision of vehicle drivers by automated systems is also proposed.



**Key words:** pedestrian, road traffic, accidents, safety management.

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# List of Abbreviations

| | | |
|---|---|---|
| UK | - | United Kingdom |
| RDA | - | Road Development Authority |
| Km | - | Kilo meters |
| USDOT | | United States Department of Traffic |

# CHAPTER 1

# INTRODUCTION

## 1.1 Background

In general, health and safety refers to the regulations and procedures intended to prevent accidents or injury in any workplace or a public environment (Oxford dictionary, 2016). The best-practices in modern road safety strategies mainly focus on preventing serious injuries or death occurring from vehicle crashes. In general road traffic safety refers to any activity aimed to prevent road users from getting seriously injured or even killed. Typical road users include several categories including pedestrians, cyclists, motorists, passengers of vehicles and passengers of on-road public transport.

Accidents between road vehicles and pedestrians are currently a major challenge for public health and traffic safety aspects. Road vehicles have been designed to transport people or cargo on public roads and highways. A pedestrian is typically a person who walks, commonly in an area where vehicles travel (Cambridge Dictionary, 2016). People who use roller skates, scooters and wheelchairs are also considered as pedestrians.

Pedestrian-vehicle crashes have accounted for about one-third of all traffic related fatalities and injuries occur worldwide (Crandall *et al*., 2002). A traffic crash is defined as an incident which involves one or more vehicles, in which at least one of the vehicles is in transport and the crash originates on a public traffic way (USDOT Traffic data 2012). It was estimated that more than one million road users are killed in road accidents every year, and around 50 million are injured (Shoukrallah, 2008),

including 30% to 70% of the children in middle-income countries (www.prb.org). The road safety observatory of the U.K. has stated that there had been 12674 adult pedestrian casualties in Great Britain in 2011 out of which 222 were fatalities (Reported Road Casualties Great Britain: 2016). Of the total of 32479 fatalities in the U.S.A., 4457 were pedestrian fatalities in 2011. Therefore, pedestrians are unarguably one of the most vulnerable traffic participants.

Compared with other vehicle passengers, pedestrians have faced more serious injuries, with simultaneously severe injuries and deaths (Crandall *et al.*, 2002). Although a large number of road crashes occur in middle-income countries, pedestrian casualties represent a high cost for the society in developed nations as well (www.who.org).

According to global road safety facts, traffic collisions are the number one cause of death among children aged 5 to19 in the United States. More than 500 children deaths occur every day due to road traffic accidents around the world and thousands suffer from lifelong disabilities (www.safekids.org). Mc Comas *et al*. (2002) stated that pedestrian damages are a great threat to youngsters and each year, more children are killed or injured in pedestrian-motor vehicle crashes than in any other way. Accordingly, children are at high risk as pedestrians - mainly due to their abilities and decision levels which have not satisfactorily been established and factors such as level of concentration, traffic speed judgment, impulsiveness, and risk-taking behaviour may also influence the occurrence of pedestrian injuries in children. About 70% of the injuries in children under 10 years occur as a result of inappropriately crossing or dashing out into the road (Christopher *et al*., 1996). However, these

pedestrian-vehicle interactions significantly differ as per the country depending on the road traffic conditions and the compliance of users to traffic rules (Alhajyaseen *et al*, 2011). The number of vehicles in the road is expected to double worldwide by 2030. Around 58% of the biosphere's population will live in town areas and will thus be prone to many road accidents (Crandall *et al.*, 2002).

In Sri Lanka as well, it is common to see road accidents frequently in urban areas. The victims of these road accidents are road users like pedestrians, motorcyclists, pillion passengers, cyclist, drivers and passengers etc. According to the records of Police Traffic Administration and Road Safety Division of Sri Lanka, 600 - 900 pedestrian fatalities had occurred annually during the last fifteen years - roughly two pedestrian deaths per day.

However, the reasons for the high occurrence of pedestrian deaths in Sri Lanka still need to be studied and analysed further in order to identify the underlying causes. These causes could be minimized or prevented by practising relevant safety precautions. Even though the legal framework of Sri Lanka with reference to pedestrian safety is well developed, as in most other countries; there is no tendency towards a decrease in pedestrian accidents. Therefore it is important to identify pedestrian safety measures taken in other countries and apply them in this country in order to minimize road accidents among pedestrians.

## 1.2 Problem Statement

In developed countries, the rates of death due to road traffic accidents have decreased since the 1960s mainly due to the fact that successful, research-based interventions such as seat belt safety laws for passengers, enforcement of speed limits for vehicles, warnings of the danger of alcohol consumption with driving, and safer designs of roads and vehicles have been imposed. But in low and middle-income countries, 85% of the road accidents account for pedestrian deaths. In Sri Lanka roughly 600 - 900 pedestrian deaths have occurred annually during the last 15 years indicating minor fluctuations in the death rate. High priority has not, however, been given to control these injuries and deaths; resulting in the consideration of this as an unavoidable by-product of motor vehicle travel.

The Police Traffic Administration and Road Safety Division of Sri Lanka have been collecting data over an extended period of time regarding pedestrian deaths and other such road accidents. Even though the data is available, successful research and analysis have not been done adequately using the data. That information is not available to the public in an easily accessible and understandable format and thus causes of pedestrian deaths and injuries are not widely identified and discussed. Therefore it is important to conduct proper research to identify the relevant gaps in the safety of road users in Sri Lankan conditions. Comparative analysis of existing road safety conditions between Sri Lanka and a few developed countries will widen the knowledge and understanding about the safety issues of road users. Based on this understanding, new safety measures can be proposed to increase the existing safety conditions of road users in Sri Lanka.

### 1.3 Aim of the Study

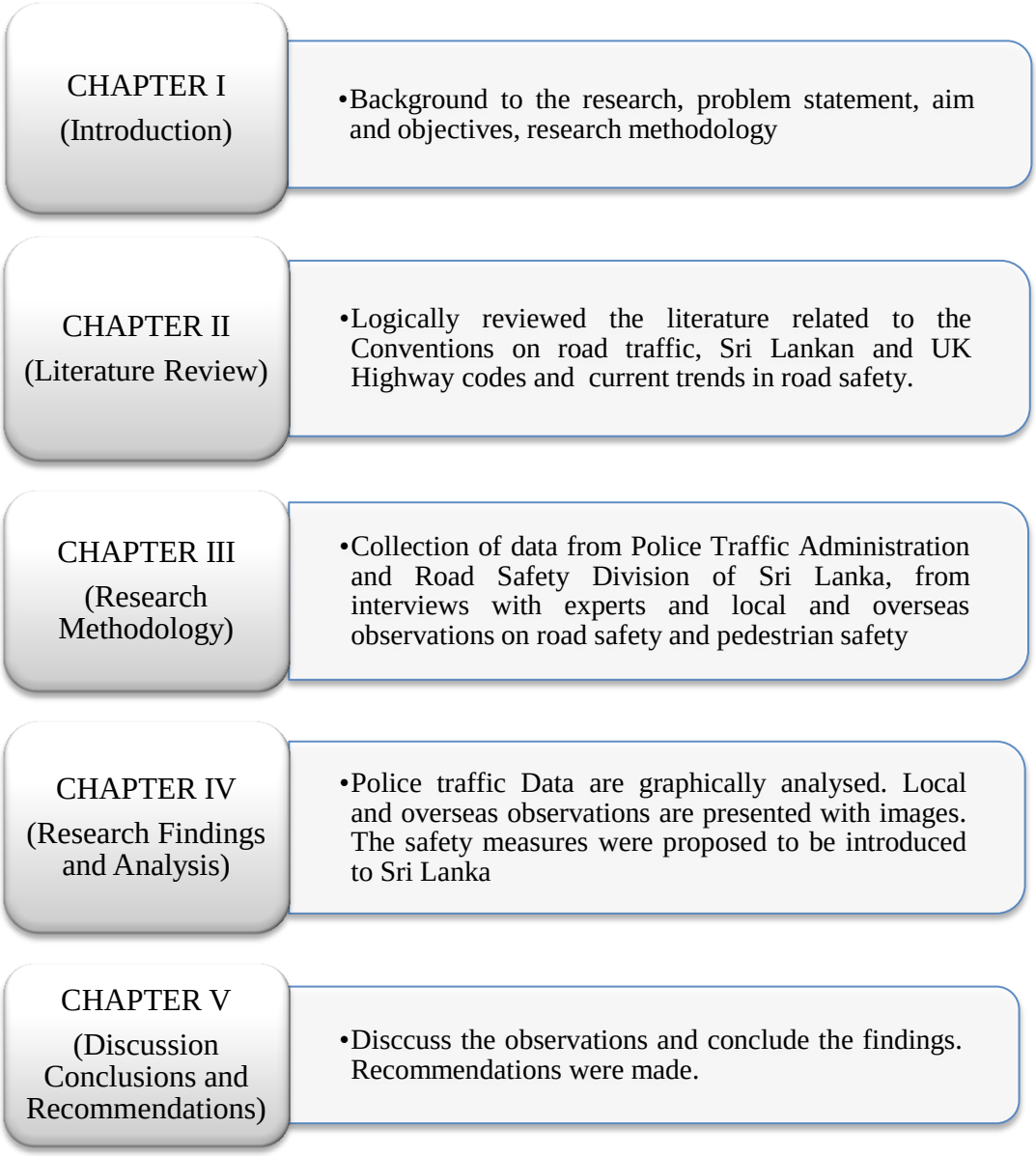
The aim of this study is to propose management strategies to have better safety conditions for pedestrians to reduce the damage caused by accidents.

### 1.4 Objectives of the Study

The above aims were achieved by following the research objectives listed below:

1. Identifying the current rules and regulations in Sri Lanka for road users, with special reference to pedestrians.
2. Analysing the available recorded data of road accidents in Sri Lanka to understand the main causes of pedestrian deaths and injuries
3. Identifying international road safety conditions, rules and regulations operated in the United Kingdom and Singapore.
4. Identifying the existing safety conditions for pedestrians in Sri Lankan roads.
5. Proposing appropriate Road Safety Measures which could be implemented to improve Pedestrian Safety in Sri Lanka

## 1.5 Chapter breakdown



# Chapter 2

# LITERATURE REVIEW

## 2.1 Introduction

This chapter explains the conventions on road traffic and general guidance of highway codes (with respect to pedestrians) operated in Sri Lanka and the UK. Research findings on global road safety conditions as well as in local conditions are discussed in this chapter. The traffic rules and regulations which are currently implemented in the UK and Sri Lanka are also explained.

## 2.2 Conventions on Road Traffic

The first convention on road traffic was signed in 1949 in Geneva. It was generally recognised as the Geneva Convention on Road Traffic. A total of 19 Asian countries, including Sri Lanka, signed the convention. Representing other continents, 15 American countries, 34 European countries and 32 Middle Eastern and African countries have also signed the Geneva Convention (UN Treaty collection-Road Traffic). In this agreement, general provisions, rules of the road, signs and signals and provisions applicable to motor vehicles were established. (Geneva Convention on Road Traffic 1949).

In 1968, the Vienna convention on road traffic was established. It was a UN worldwide treaty especially intended to facilitate global road traffic and increase road safety by launching uniform, regular traffic rules among the contracting parties (UN Treaty Collection-Road Traffic status as at 19-03-2019).

According to the Vienna Convention on Road Traffic 1968, one of the major benefits of conventions for motorists is the obligation of signatory countries to recognize the legality of vehicles from other signatory countries.

The Convention on Road Traffic (Vienna, 1968) replaces the Convention on Road Traffic (Geneva, 1949). However, it appears that fewer countries have ratified the 1968 convention than have originally ratified the 1949 convention, so there are perhaps some countries which are still technically parties to the 1949 convention.

Along with the Convention on Road Traffic, there was also a 1968 Vienna Convention on Road Signs and Signals, which replaced the 1949 Geneva Protocol on Road Signs and Signals, which in turn replaced the 1931 Geneva Convention Concerning the Unification of Road Signals, under the League of Nations.

In Sri Lanka, the regulations of motor traffic (Signs, Signals, Symbols and Road Markings) of No. 02 of 2015 is based on the accepted terms of the Vienna Convention.

The two conventions provide significant outlines enabling international road traffic through uniform traffic rules and coordinated road signs, signals, symbols and markings.

### 2.3 Highway codes

The Highway Code is a comprehensive guide that helps to understand traffic rules and regulations, signs and signals, the laws and road user safety (Highway Code, Singapore 2007).

It is a handbook for all road users including vehicle drivers, motorcyclists, cyclists and pedestrians. These regulations are devised to ensure that all road users observe a code of conduct that contributes to safety and maximises the use of very costly road space. Knowing and applying the rules included in the Highway Code could considerably decrease road accidents.

The first edition of the Highway Code of UK was published on 14 April 1931.

## 2.4 Highways in Sri Lanka

The Road Development Authority (RDA) was assigned with the responsibility of developing and maintaining all classified roads in the country rising up to around 28, 000 km of roads and bridges.

The National Road Network contains more than 12, 000 km of roads, nearly 170 km of Expressways and about 4,662 bridges as at January 2018 (RDA, 2018). The R.D.A. is responsible for the maintenance and expansion of the national road network and planning, designing and building of new highways, bridges and expressways.

## 2.5 Rules and regulations on Highways

The main legislative provisions regarding motor vehicles and their uses on highways and to regulate the provision of passenger carriage services are envisaged by the provisions of the Motor Traffic Act of 1951 (No 14). This act has been amended several times.

The Highway Code of Sri Lanka, published by the Department of Motor Traffic, is based on Motor Traffic (Highway Code) regulations, 1987. This was published in the extraordinary gazette 486/8- Tuesday, December 29, 1987.

These regulations made in 1987 could be considered as the only available legal document focussed on pedestrians. These regulations were not amended thereafter. Some legal aspects of pedestrian crossings are explained in the Motor Traffic (Signs, Signals, Symbols and Road Markings) Regulation No. 02 of 2015, appeared in extraordinary gazette no 1940/21 Thursday, November 12, 2015.

### 2.5.1 Highway Code of Sri Lanka - Rules for pedestrians

The Highway Code explains the following regulations for pedestrians:

2.5.1.1 Children are not allowed to play on the roadway. When walking with children, always keep them away from the traffic flow.

2.5.1.2. Always use the sidewalk or footpath if it is available. If not, walk on the right-hand side of the road facing the oncoming traffic.

2.5.1.3 Give vehicular traffic as much use of the roadway as possible and walk preferably in single file, but never more than two abreast. Except at pedestrian crossings and on sidewalks, pedestrians should give way to vehicular traffic.

2.5.1.4 At night, especially if there is no footpath, wear light coloured clothing or carry something white, so that drivers will be able to notice your presence.

2.5.1.5 When you want to cross the road, look for a pedestrian crossing, or an overhead or underground pedestrian way. You must cross the road at these points if you are within 50 m of one of them.

2.5.1.6 If there is no designated pedestrian crossing available, get a clear view of the traffic and wait for a safe gap in the traffic before you cross. Look right, left, then right again and, if it is safe to do so, walk briskly straight across the road. Do not cross just behind or in front of a stopped vehicle.

2.5.1.7 Take care when walking around a corner at a junction where the footpaths are narrow or absent.

2.5.1.8 Before you attempt to cross a road at a pedestrian crossing, give the driver a sufficient period of time to see you, slow down and stop before you cross the road.

2.5.1.9 At a pedestrian crossing where both traffic and pedestrians are controlled by traffic lights, do not cross the road if the red man signal is on. Press the operating button and wait for the green man to light up. Then cross.

2.5.2 If you wish to board an omnibus, go to the nearest halting place identified by a sign. Wait until the bus stops at the bus halt before you get into or alight from the bus.

## 2.6 Highway Code of The UK

The guidelines given for pedestrians in the Highway Code of the UK are written in detail and provide more information for pedestrians in each and every aspect of road rules. Those detailed instructions are relevant and applicable to Sri Lankan pedestrians as well.

The highway code of Singapore, Japanese Traffic Rules (Pedestrian and Cyclist's Edition) and Road Users' Handbooks of New South Wales and Australia were also studied, but considering the relevance and applicability of those rules in Sri Lankan roads, the UK Highway Code can be considered as the most comprehensive document to be explained here.

Following details were extracted from the Highway Code of the UK, with reference to pedestrians.

### 2.6.1 General guidance

2.6.1.1 Pavements should be used if provided.

2.6.1.2 If a pavement or walkway is not available, walk on the right-hand side of the road.

2.6.1.3 Take extra care on narrow roads or in low light.

2.6.1.4 Help other road users to see you by wearing or carrying something light-coloured, bright or fluorescent in low light situations.

2.6.1.5 Kids must go with an adult. Strap infants into push-chairs.

2.6.1.6 Organised walks. Use a pavement if large clusters of people are going together.

2.6.1.7 Pedestrians should not walk on motorways.

### 2.6.2 Rules for pedestrians - Crossing the road

2.6.2.1 **The Green Cross Code**. – This is for all pedestrians when crossing the road. Children should be educated with the Green Cross Code. Many children cannot judge the speed of the vehicles and the distance to a moving vehicle.

2.6.2.2 Cross the road through a safe place. Use a crossing point controlled by a police officer or a traffic warden. Avoid crossing diagonally and between parked cars or any covered places.

2.6.2.3 Stop before you reach the kerb, where any incoming vehicles are visible.

2.6.2.4 Look all around for traffic and listen. Vehicles can come from any direction. Traffic can often be heard before it is seen.

2.6.2.5 Let the incoming traffic pass. Wait for a safe gap in the moving vehicles. Make sure you have enough time.

2.6.2.6 When it is safe, walk straight across the road.

2.6.2.7 At a junction, look out for turning traffic. Use pedestrian safety barriers**.**

2.6.2.8 Tactile paving - provides caution and direction to blind or partially sighted people.

2.6.2.9 One-way streets. Check which direction the traffic is travelling in.

2.6.2.10 Take care when crossing bus and cycle lanes.

2.6.2.11 Routes shared with cyclists. Separated routes can be incorporated by short lengths of tactile paving to help visually impaired people stay on the correct side. This contains a series of flat-topped bars running across the direction of travel (in a horizontal ladder pattern) on the pedestrian side. On the cyclist side, the same bars are positioned vertically.

2.6.2.12 Parked vehicles. If you cross between parked vehicles, use the outside edges of the vehicles as if they were the kerb. Make sure there is a gap between any parked vehicles on the other side. Do not cross the road in front of, or behind, any vehicle with its engine running, especially a large vehicle, as the driver will not be able to see you.

2.6.2.13 Reversing vehicles**.** Do not cross behind a reversing vehicle.

2.6.2.14 During the night, wear reflective clothing to make you visible and make it easier for others to see you.

### 2.6.3 Rules for pedestrians – Crossings

#### 2.6.3.1 **At all crossings**.

- constantly check if the traffic has stopped before you start to cross
- always cross among the studs or on the zebra crossings.

Do not park on a crossing or in the area with zigzag lines.

Six (6) different types of pedestrian crossing can be seen:

- School crossing,
- Zebra,
- Pelican,
- Puffin,
- Toucan
- Pegasus (https://www.2pass.co.uk)

#### 2.6.3.2 **School crossings:**

In a school crossing (Figure 2.01), you must wait for the school crossing patrol officer (also known as the lollipop person) before you cross. Always cross in front of him/her (Figure 2.02). You must dismount from your bike before crossing, and must stop when they show a stop sign.


Figure 2.01: A school crossing
(Source: https://www.bbc.com)


Figure 2.02: School crossing patrol officer at the crossing
(Source: https://www.bbc.com)

2.6.3.3. Zebra crossings.

Upcoming Zebra crossing can be noticed by their black and white poles with blinking yellow beacons and zigzag road markings.

Before you cross, give the traffic ample time to notice you. (Figure 2.03 & 2.04).

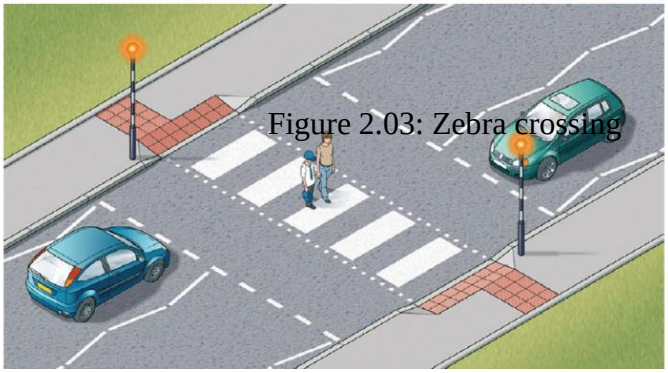


Figure 2.03: Zebra crossing

Figure 2.03: Zebra crossing
(Source: http://www.highwaycodeuk.co.uk/)

Figure 2.04: Pedestrians using a Zebra crossing
(Source: https://www.bbc.com)

If an island is in the middle of a zebra crossing, you must delay on that island and follow the rules before the second half of the road, as it is separated (Figure 2.05 & 2.06).

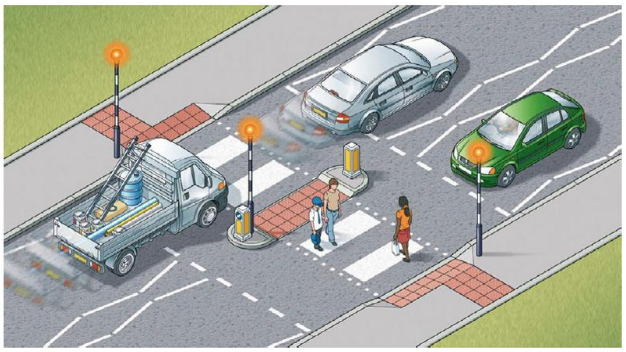


Figure 2.05: Zebra crossing with an island

(Source: http://www.highwaycodeuk.co.uk/)

Figure 2.06: Pedestrians on a Zebra crossing with an island (Source: https://metro.co.uk)

2.6.3.5 At traffic lights. These are special signals to direct pedestrians. You can start crossing the road when the green light/figure appears. In case the green figure disappears while you are crossing, you still have time to reach the other side.

2.6.3.6 **Pelican crossings**

Pelican (Pedestrian Light Controlled Crossing)

These are signal-controlled crossings activated by pedestrians by pushing the control button. Pedestrians should not cross while the red figure appears. When a steady green figure appears, check that the traffic has stopped before crossing the road with care. When the green figure blinks, do not start to cross.


*At pelican crossings only

Figure 2.07: Traffic lights at a Pelican crossing
(Source: http://www.highwaycodeuk.co.uk/)

At some pelican crossings, a beeping sound is used to alert blind or partially-sighted people of the appearance of a steady green figure.

### 2.6.4 Signal controlled crossings

2.6.4.1 **Puffin crossings (Pedestrian User-Friendly Intelligent Crossings)** These differ from pelican crossings, as the red and green figures are above the control box on your side of the road and there is no blinking green figure. Press the button, wait for the green figure and then cross the road (Figure 2.08).

Figure 2.08: Pedestrians at a Puffin crossing
(Source: https://www.trafficchoices.co.uk)

2.6.4.2 **Toucan (Two-Can Cross) crossings**

These are light-controlled crossings facilitating both cyclists and pedestrians to share the same crossing space and cross at the same time (Figure 2.09). These crossings are operated by a push-button. Cyclists are allowed to ride across the road (Figure 2.10).

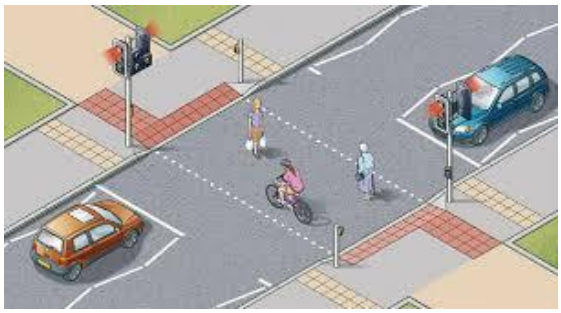


Figure 2.09: Toucan (Two-Can Cross) crossing

(Source: http://www.highwaycodeuk.co.uk/)


Figure 2.10: A cyclist riding across a Toucan crossing

(Source: https://www.trafficchoices.co.uk)

2.6.4.3. At certain crossings, the presence of a beeping sound or voice signal indicates to blind or visually impaired people when the steady green figure is showing, and there may be a tactile signal to help deaf and blind people.

### 2.6.5 Equestrian crossings / Pegasus crossings

The Pegasus crossing is usually used outside race courses. These are for horse riders (Figure 2.11).

Figure 2.11: Pegasus crossings
(Source: http://www.highwaycodeuk.co.uk/)

### 2.6.6 'Staggered' pelican or puffin crossings.

These are two separated crossings, on either side of the central island. Upon reaching the central island, press the button once more and wait for a green figure to be displayed. (Figure 2.12).

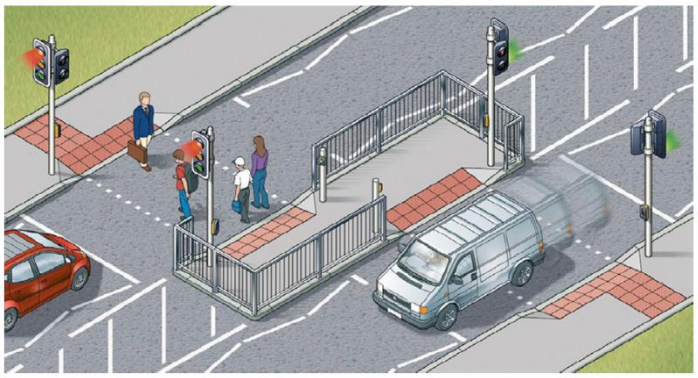


Figure 2.12: Staggered crossings
(Source: http://www.highwaycodeuk.co.uk/)

### 2.6.7 Crossings controlled by authorised personnel

Crossing signals are controlled by a police officer, traffic warden or school crossing patrol. The pedestrian is not to cross unless signalled to do so by the authorized persons. Always cross in front of them.

## 2.7 Situations needing extra care

2.7.1 If emergency vehicles (an ambulance, fire engine, police or other emergency vehicle) enter the road, move to the side.

2.7.2. Entering or exiting a bus can only be done once it has stopped. Whilst exiting, keep an eye out for cyclists. The road should never be crossed directly behind or in front of a bus. Wait until the road is clear of vehicles and both directions can clearly be seen.

2.7.3 Tramways. These may run through pedestrian areas.

2.7.4 Railway level crossings. Do not cross if lights are red, if an alarm is sounding or if the barriers are being lowered.

2.7.5 If a pavement has been closed temporarily, take extra care if you are directed to walk in or to cross the road.

The Highway Code of the UK indicates above instructions, especially for pedestrians. The Highway Code of Singapore has also been studied. It has not specifically addressed the rules and regulations for

pedestrian safety but mainly focused on obtaining a driving licence. Therefore the Highway Code of Singapore is not discussed here.

Comparing the instructions given in the Highway codes of Sri Lanka, UK and Singapore, the UK Highway code has given more detailed guidelines for pedestrians than the other two. Some of these instructions can be used when formulating guidelines for pedestrian safety in Sri Lanka.

## 2.8 Overview of road traffic injuries

Almost 400,000 pedestrians die by vehicle crashes annually around the world. (Naci et al., 2009). According to a world report on road traffic injury prevention (WHO, 2004), in higher-income countries, road traffic crashes are among the top ten leading causes of disease burden. Shoukrallah (2008) stated that in less developed countries, road accidents were the most prominent cause of losing a healthy life. The author confirmed that the lower rates of road deaths and road injuries can be found in the developed world while higher numbers can be found in India, China and other developing nations.

Most of the countries operate strategies to alleviate pedestrian crashes, but many low-income countries are deficient in pedestrian safety services (Zegeer & Bushell, 2012).

Shoukralla (2008) further analysed the death rate by road accidents and stated that close to half of all traffic deaths worldwide take place in the Asia Pacific region and it is estimated that one fatality occurs every 5 minutes in China.

In urban places, pedestrians are at risk as there is a high number of vehicles. Since people need to walk as a part of their journey, designing safe and widespread services for pedestrians are essential to lower pedestrian injuries. (Zegeer & Bushell, 2012).

According to the 2007 annual report of the World Health Organization, the high-income countries showed a declining rate of road traffic fatalities. (Fig. 2.13)

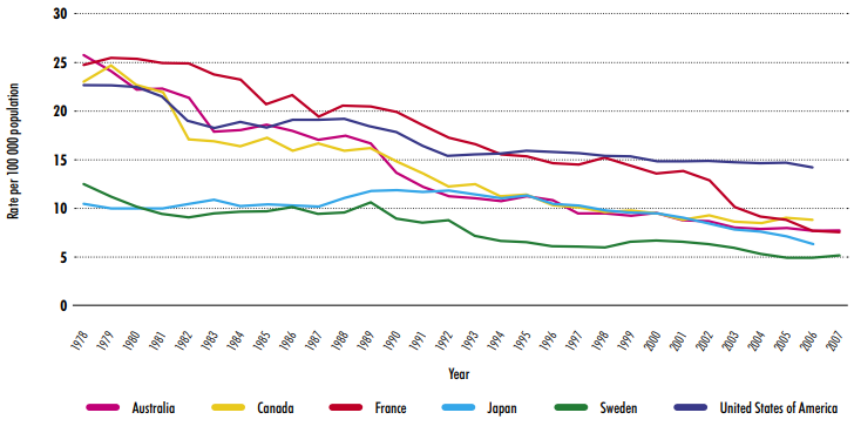



Figure 2.13: Trends in road traffic fatality rates in selected high-income countries (WHO 2007)

In developed countries, despite high levels of motorisation, decreasing trends in road traffic deaths have been seen. The 2012 annual report of the World Health Organization repeatedly explains this feature while emphasising the increasing trend in road traffic deaths in low-income countries despite the low

but increasing level of motorization (WHO 2012). Middle-income countries are balanced in the numbers of deaths. (Figure 2.14)

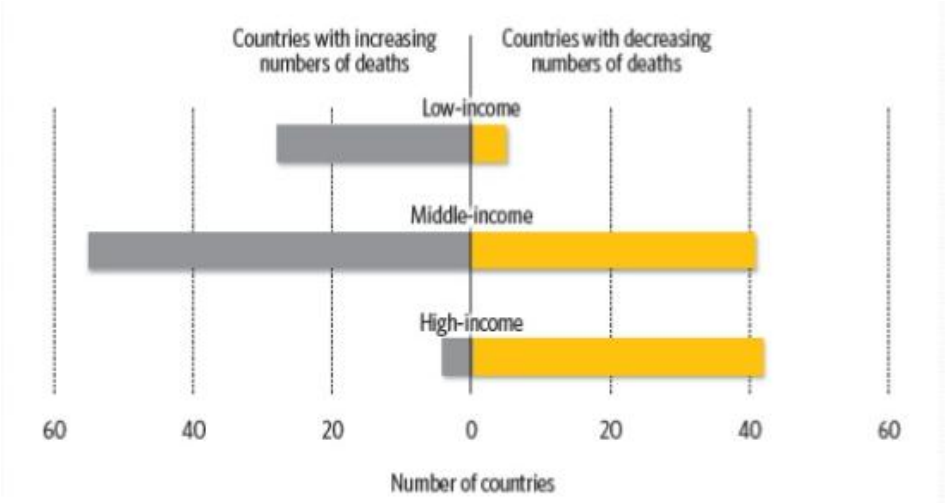



Figure 2.14: Road traffic fatality rates in high, middle and low-income countries (WHO 2012)

This information clearly indicates that traffic injuries and deaths represent a serious threat to the development of low- and middle-income countries.

International road death rates allow any country's road safety performance to be compared with others, considering the level of motorisation and distances travelled (Fig.2.15).

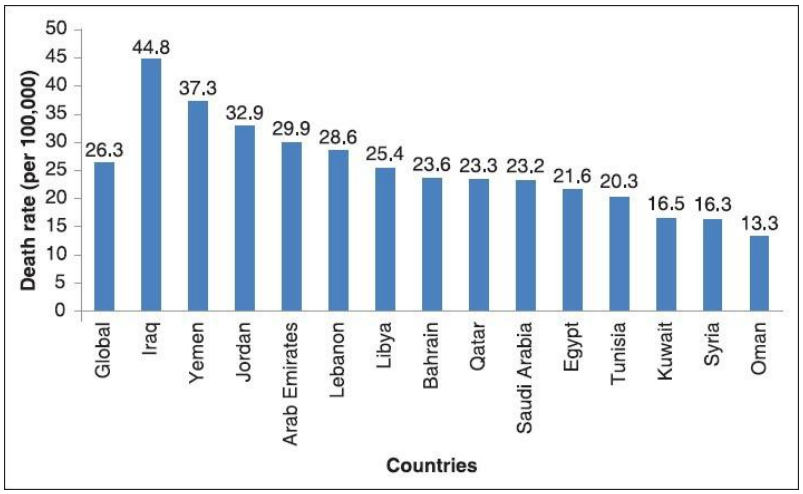



Figure 2.15: The death rates due to road traffic accidents per 100,000 populations in various Arab Middle Eastern Countries (Asim *et al*. 2014)

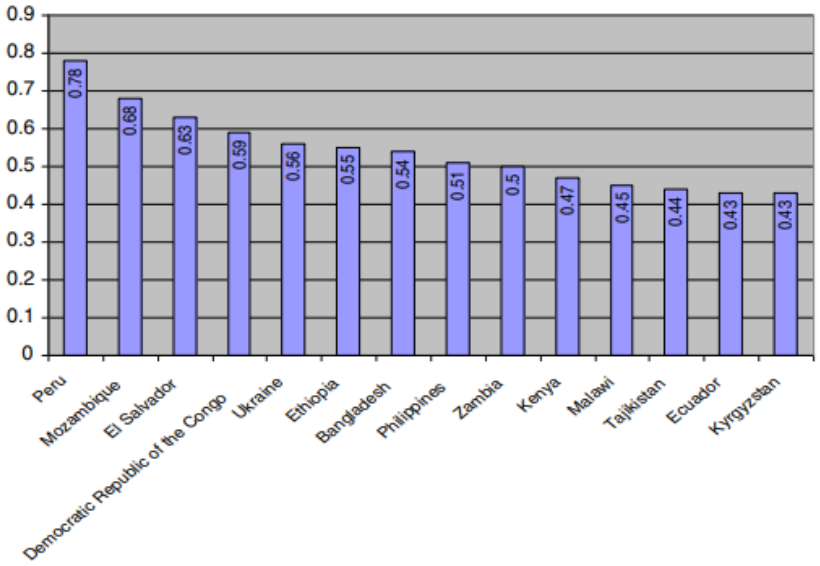



Figure 2.16: Percentage of pedestrian deaths as part of overall traffic facilities in selected low-income countries (WHO 2009)

The number of resources utilised for road traffic facilities is fairly lower in low- and middle-income countries. The percentage of pedestrian deaths depends on the overall traffic facilities of those countries as illustrated in Fig. 2.16.

Shoukrallah (2008) stated that efforts from many parts of the world recently succeeded to put road safety on the global political agenda. The UN General Assembly acknowledged that many low-income countries have limited capabilities to address road safety and highlighted the importance of international cooperation, financial and technical assistance in this context. The WHO, the World Bank and the European Union have all recently established complete traffic protection plans.

Yu & Zhu (2016) showed that more sidewalks and a higher amount of local roads reduce pedestrian accidents around schools and it has been proposed that it is required to localise schools in areas with more local roads and low highways.

Clifton, Burnier & Akar (2009) confirmed that female pedestrians face accidents less often than their males, children are at high risk of getting injured and older people are getting fatally injured. They further stated that pedestrians who violate traffic signals and who are not in a crosswalk are at high risk.

In the U.S., males of all ages are responsible for 70% of pedestrian deaths relative to females, assuming that males may walk more than females (Clifton and Livi, 2005).

Traditional "neighbourhood schools" are often located in the neighbourhood, allowing lower home-to-school travel, walkable

surroundings, and low-speed traffic that safeguard pedestrian security (Ewing and Greene 2003).

The uneven pattern of road networks has proved to be the safest in terms of pedestrian accidents (Guo & Yao, 2017).

Zegeer & Bushell (2012) stated that bicyclists, pedestrians, and motorcyclists were also known as vulnerable road users and liable to accidents in countries with poor traffic laws. Authors further stated that many countries are engaging in pioneering methodologies to ensure safety in urban areas.

World health statistics (2013) says those road traffic injuries are the eighth leading reason for death worldwide, and the foremost reason of death for the young of fifteen to twenty-nine years old. World health statistics (2013) suggests that by 2030 road accident deaths shall be the fifth leading cause of death if critical action is not taken.

Crandall *et. al* (2002) reported that compared to injured vehicle occupants, pedestrians have more multisystem injuries and mortality. According to the author, pedestrian casualties cause a large societal cost in industrialised nations, even though an excessive amount of crashes occur in developing and transitional countries.

Accidents between vehicles and pedestrians along highways with transit routes are related to high rates of injury and death of pedestrians and cause a significant societal problem (Hess *et al,* 2004)

## 2.9 Effect of road traffic injuries on children

Pedestrian injuries pose a great threat to children in terms of both morbidity and mortality.

Road accidents are the second reason for the death of young children (Peden 2004) and are the foremost reason for disability worldwide (Peden *et al.* 2008).

Rothman et al. (2017) reported that the use of vehicles for all travel has reduced child road accidents in Canada. Persuading people to walk may reduce the traffic injuries, but potential risk factors related to walking to school need to be examined (Rothman *et al.* 2017). The high rate of accidents was associated with frequent traffic lights and traffic calming in school surroundings (Rothman *et al*., 2014). More than 1/3 of accidents were recorded within 300 m of a school, with the highest children crashes within 150 m of a school (Warsh *et al*., 2009)

McComas *et al.* (2002) stated that children are at certain risk as pedestrians since their skills and decision-making abilities have not been satisfactorily established. They further stated that other factors also had an effect on accidents in children including not paying attention, the inability to judge the speed of vehicles, thoughtlessness and excited behaviour. Students need to learn the four main lessons for child road safety: staying on the sidewalk, stopping at the curb, looking L-R-L, and being watchful while crossing the road. According to McComas *et al,* (2002) one-third of the children stated that they had had at least one accident in their lifetime. Accidents reported by

boys were of expressively high severity than that of girls. If children have a fair knowledge of safety, they were subjected to low negligence.

## 2.10 Importance of road network structure on pedestrian safety

Road network structures have been accepted as tremendously significant in determining traffic safety, especially for pedestrians (Zhang et al., 2015).

The structure of road networks has an influence on pedestrian safety over both its effects on the traffic volumes and driving patterns (Zhang et al., 2015).

In his book, *Towards Better Roads*, Weerasekara (2008) has proposed a road safety plan to reduce all serious road casualties. This should target three vital areas *i.e.* road user behaviour, the standards of vehicles, and road conditions. The author has proposed an informal training to all private bus drivers, stressing the importance of the responsibility that they are entrusted with. Safety measures such as seatbelts, wearing helmets etc. were considered. According to the author, the standard of vehicles deals with vehicle roadworthiness. The road conditions imply a specific speed limit for each road and that limit should be displayed clearly at regular intervals.

Weerasekera (2008) has described pedestrian-vehicle accidents as the most important safety issue at signalized connections in towns. Unexpected behaviour like sudden speed changes cannot be foreseen by drivers, which can lead to safety threats.

Furthermore, in long crosswalks, a short green time makes pedestrians hurry and unexpectedly change their speed without paying attention to the surrounding conditions (Iryo-Asano et al., 2014)

## 2.11 Functions of Traffic Signs

Incorporation of traffic signs was agreed upon at the UN conference on Road Traffic held in Vienna on the 8$^{th}$ of November 1968. Sri Lanka is a signatory to the convention for the adoption of international traffic signs.

The main function of traffic signs is to guide the road user and thereby improve the safety and efficiency of roads. Traffic signs are used to warn, regulate and direct the vehicle drivers and enhance the safety of pedestrians.

According to the extraordinary gazette no. 1940 / 21 of 12.11.2015 of Motor Traffic Act, the traffic signs are in several categories:

### 2.11.1 Danger warning signs

These are mostly rectangular and notify the public of any incoming changes in road condition.

### 2.11.2 Regulatory signs

#### 2.11.2.1 Prohibitory signs

#### 2.11.2.2 Restrictive signs

#### 2.11.2.3 Mandatory signs

#### 2.11.2.4 Priority signs

## 2.12 Road Safety in Sri Lanka

In the past few years, there was a heavy increase in mobility and motorisation in Sri Lanka. This has created a rapid introduction of different ways of travel which are not safe on our roads which contain high pedestrian movements. Statistical data collected by the Police Traffic express that Sri Lankan roads are becoming more dangerous annually.

Sri Lanka has a considerable problem of road traffic injuries and mortalities. Coordinated government road safety policies and road safety research need to be increased to address this situation in the country.

In Sri Lanka, an absence of road safety investigations and the inadequate data accessibility on road traffic accidents make it problematic for policy-makers to propose solutions to prevent road traffic accidents (Dharmaratne et al., 2015).

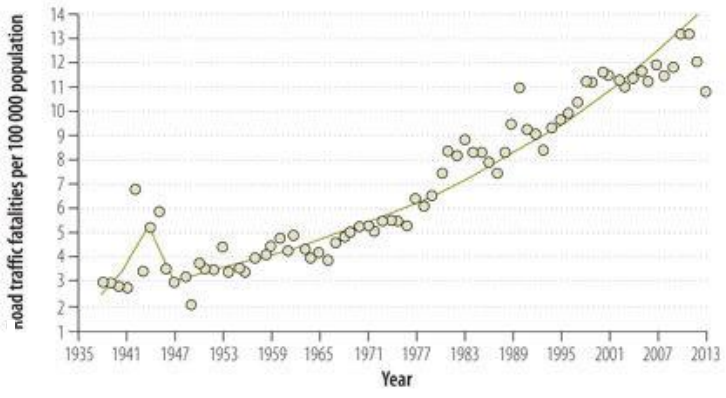



Fig. 2.17: Road traffic crashes, injury and fatality trends in Sri Lanka: 1938–2013, (Dharmaratne *et al*., 2015).

As shown in Fig. 2.17, the steady growth in traffic mortalities has been related to the increase in number of vehicles, poor traffic law enforcement and underdeveloped road infrastructure (Dharmaratne et al., 2015).

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## 2.13 Pedestrian Safety in Sri Lanka

The Sri Lankan Traffic Police has shown that one person is killed in a road accident every 3 ½ hours and two people are critically injured. This explains the increasing danger of road travel.

Considering all road users died in different ways of transportation as a proportion of all road traffic injury deaths, pedestrian fatalities in Sri Lanka account for 40% of all road deaths (Fig. 2.18). Among the victims of road crashes, pedestrians accounted for 39% deaths. The majority of those victims are at the age of 20 to 35 years. (Police Accident Report, 1996).

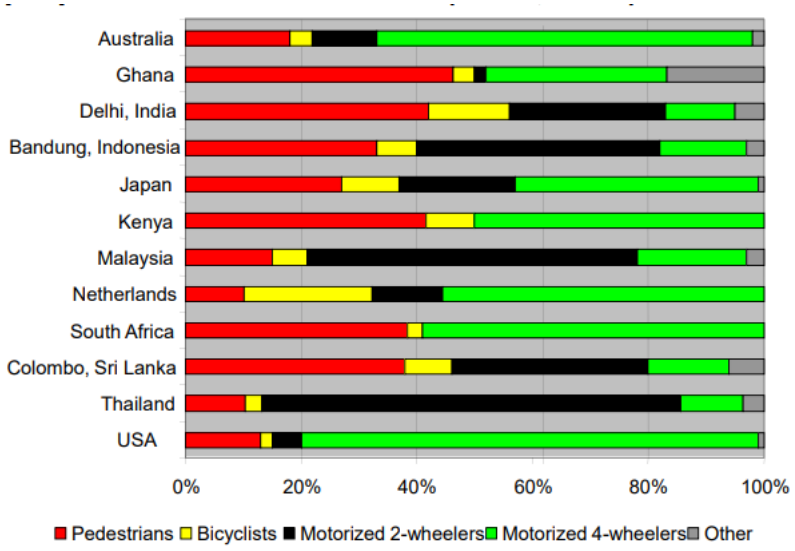



Fig. 2.18 Road users killed in various modes of transport as a proportion of all road traffic injury deaths (WHO 2009)

Pedestrian appears to be the most vulnerable road user type. Most of these pedestrians have had to pay with their life, not due to their own fault but very often due to the fault of motorists. According to 2002 data, a total of 94% of motorists are responsible for pedestrian accidents while 95% of motorists are responsible for pedestrian deaths.

Although motorcycles are frequently involved in pedestrian accidents it was ranked in fourth place for fatal accidents. Hence it can be seen that pedestrian accidents involving larger vehicles result in the death of the pedestrian more often than when they are hit by a smaller vehicle type.

Considering the above data, it is clear that pedestrian safety in Sri Lanka is minimum and is a clear indication that road travel is becoming increasingly dangerous and hazardous. This factor has been discussed in detail in Chapter 04 under findings and analysis.

The capacity of the existing road network seems incapable of accommodating the varying demands and volumes of road usage. Pedestrian safety is not guaranteed in most of our roads due to inadequate sidewalks, pedestrian crossings and other signs. The existing pedestrian safety conditions in some selected roads are explained in detail under Findings and Analysis of Chapter 04.

## 2.14 Summary

The Rules and regulations of Highway Code of Sri Lanka and the UK with reference to the pedestrians are explained in detail in this chapter in order to make the readers aware. The current trends in road safety conditions are explained with relevant literature covering road accidents in a global context and its impacts on pedestrians. Child accidents and their impacts are also discussed. Finally, road safety and pedestrian safety conditions are discussed in order to highlight the drawbacks in existing conditions.

# Chapter 03

# Research Methodology

## 3.1 Introduction

This chapter describes the research methodology involved in this study to fulfil the objectives. Quantitative data as well as qualitative information were collected during this process.

## 3.2 Research approach

Mixed research methodology was used in this research involving collecting, analysing and integrating both quantitative and qualitative data within a single investigation. This method is used when the incorporation of both provide a better understanding of the research problem than either of each alone.

## 3.3 Research method

### 3.3.1 A comprehensive literature survey

A comprehensive literature survey was conducted by referring to international and local research articles and books related to road traffic conditions and pedestrian safety.

### 3.3.2 Desk study

Desk study was conducted on rules and regulations on road safety with reference to pedestrians in global context. The following documents were studied with reference to road traffic rules and pedestrian safety.

1. Conventions on road traffic
2. The highway code of Sri Lanka (Extracted from the Motor Traffic Act No 486/8- 1987.12.29)
3. The highway code of UK
4. The highway code of Singapore
5. Japanese Traffic Rules
6. Motor Traffic Act (Chapter 203) and amendments
7. Manual on Traffic Control Devices, Part I

### 3.3.3 Obtaining quantitative data

Quantitative / statistical data on major categories of road accidents, pedestrian deaths and causes of accidents, deaths as per the time of the day, day of the week, age of the driver etc. were obtained from the Police Traffic Administration and Road safety division , operated under Police Headquarters, Colombo, Sri Lanka (Appendix 1). Further information and clarifications of quantitative data were obtained by expert interviews.

### 3.3.4 Local Field Observations

Field Observations on road safety were done by visual observations and capturing images of those conditions. The observations were done in some selected urban areas in Bambalapitiya, Kollupitiya in Colombo and Kottawa, Piliyandala and Moratuwa in western province of Sri Lanka as indicated in Figure 3.1.

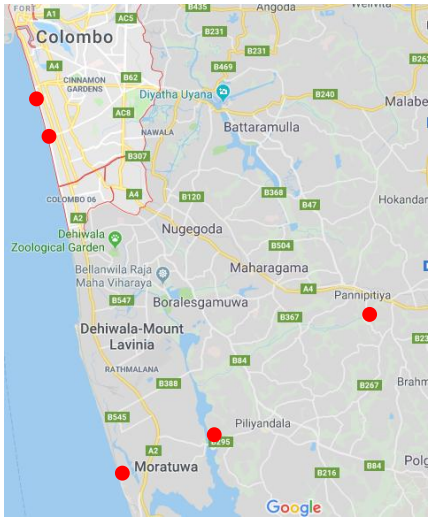



Figure 3.1: Cities in western province where road safety conditions were observed (marked in red).

The safety conditions of crossings, sidewalks and bus bays were observed and are explained with relevant images under results. The availability of road signs / signboards was also observed.

Duration observed:

Observations were made during the period of May 2017 – November 2018. Weekends (Saturday and Sunday) were mainly used for these observations. School hours of weekdays were also used for the observations of crossings.

### 3.3.5 Overseas observations

Pedestrian road safety conditions were observed and studied in selected cities of two countries. Observations were explained using images.

### 3.3.5.1 The United Kingdom


Figure 3.2: Selected cities observed in the UK (marked in red)

Study areas: Selected cities - Aberdeen and Glasgow in Scotland and London in England as indicated in Figure 3.2

These highly populated main western cities maintain good safety conditions for road users and use modern traffic controlling measures to provide efficient road system for the citizens and visitors.

Duration observed:

Week days and weekends during the period of November 2016 – February 2017.

The observations were made on walkways, overpasses and underpasses, signboards, taxi and cycle parking, bus stops/ bus bays, traffic calming etc.

### 3.3.5.2 Singapore

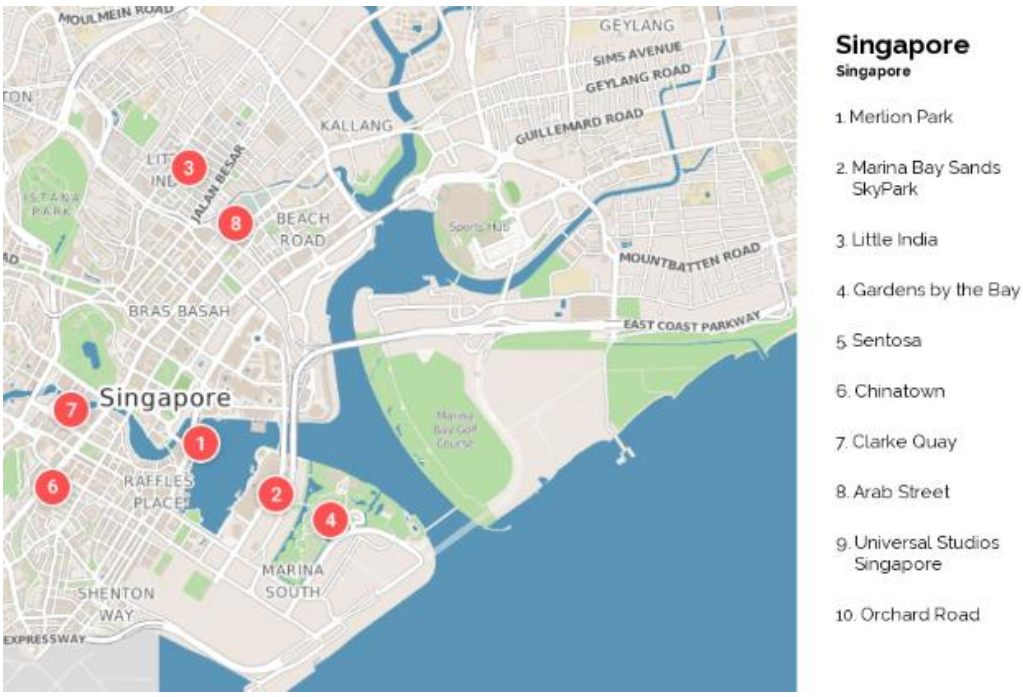



Figure: 3.3 Selected areas observed in Singapore

Study areas: Selected localities – Merlion Park, Marina Bay, Little India and Gardens by the Bay (1-4) and surrounding areas as indicated in Figure 3.3.

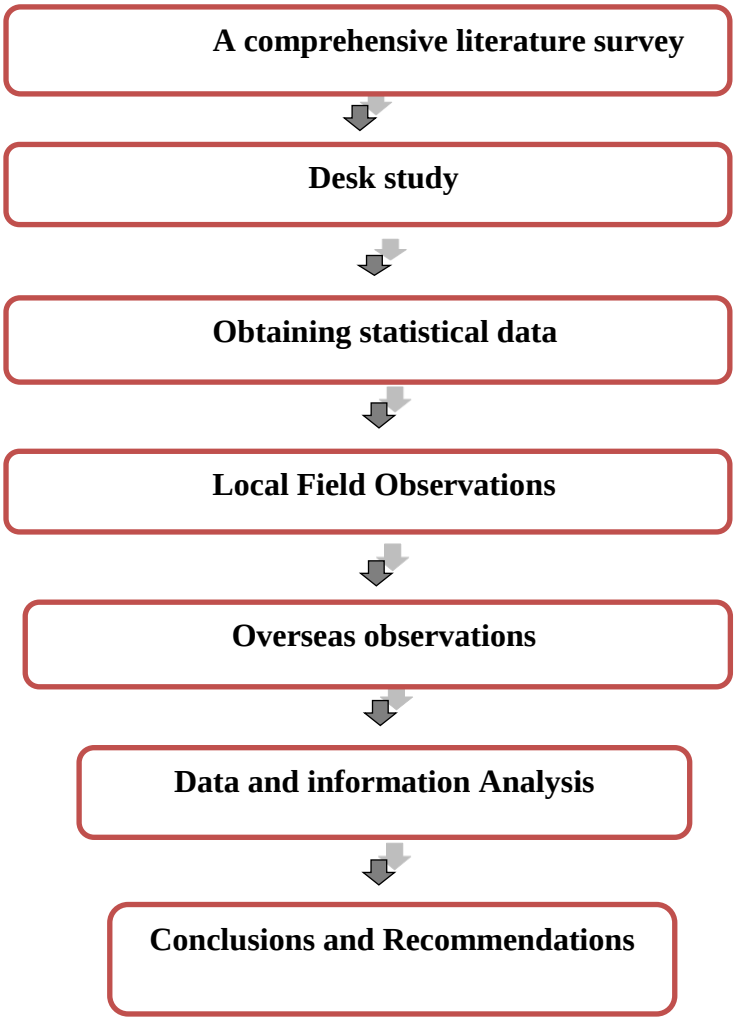
The selected areas are busy Eastern commercial cities, recently developed, and facilitating mainly for tourists.

Duration: 17$^{th}$ July 2018 – 23$^{rd}$ July 2018.

The observations were made on walkways, overpasses and underpasses, signboards, bus stops/ bus bays etc.

These two countries were selected as they are developed, high-income countries with diverse modes of modern public transportation and motorization. The pedestrian safety measures which are well formulated in those countries can be implemented in countries such as Sri Lanka as well.

### 3.4 Research process




### 3.5 Summary

This chapter discusses the overall research methodology adapted in order to achieve the research aim successfully. The methodology covers a vast area of study in pedestrian safety.

# Chapter 04

# FINDINGS AND ANALYSIS

## 4.1 Introduction

Third chapter elaborated on the methodology adhered to achieve the ultimate research aim. Fourth chapter focuses on presenting the analysis of research findings. The data obtained from the Police Traffic Administration and Road safety division has graphically analysed in the first part of this chapter. The observations on pedestrian safety conditions from selected local areas and two selected countries are explained using images.

## 4.2 Analysis of data obtained from the Police Traffic Administration and Road Safety Division

### 4.2.1 Major categories of road accidents

According to the data obtained from the Police Traffic Administration and Road safety division operated under Police Headquarters, Colombo, Sri Lanka, the road accidents can be divided into four major categories i.e.

- Fatal accidents
- Major injury accidents
- Minor injury accidents
- Property damage accidents

#### 4.2.1.1 Identification of Fatal accidents

Analysing the fatal accident data within last 10 years from 2004 - 2014, it can be observed that the highest number of fatalities occurred due to motorcycle crashes, which cause nearly 900 deaths in 2014. Lorries and dual-purpose vehicles accounted for the deaths following motorcycles. Land vehicles contributed for the lowest number of deaths (Figure 4.1).

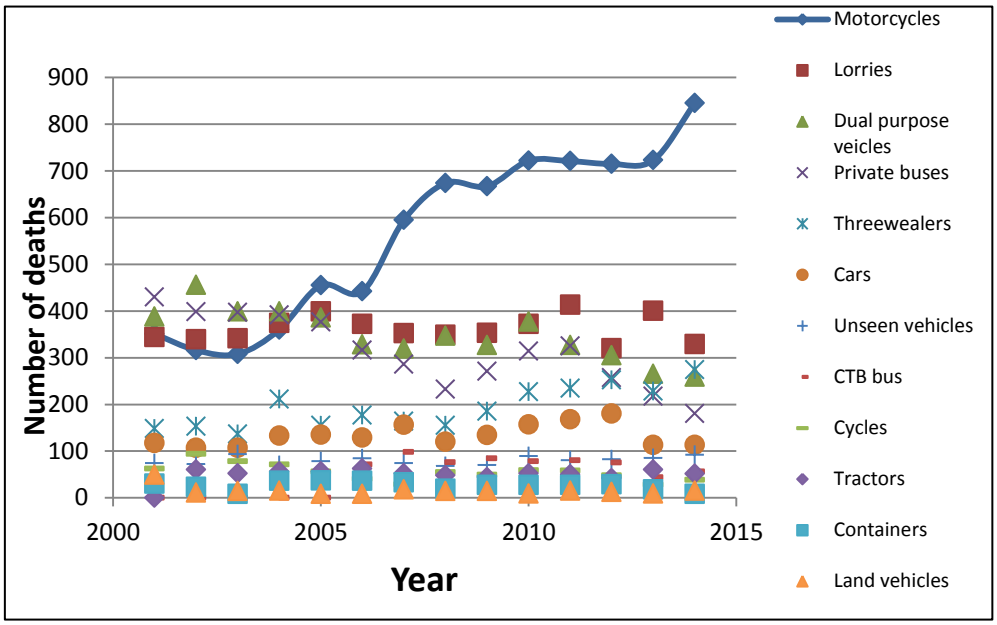



Figure 4.1: Deaths due to fatal accidents of vehicles (2001 – 2014) in Sri Lanka

#### 4.2.1.2 Identification of Major Injury accidents

Major injuries within last 14 years from 2001 - 2014 have occurred mainly due to motorcycle accidents (Figure 4.2). Dual purpose vehicles were secondly responsible for major damages.

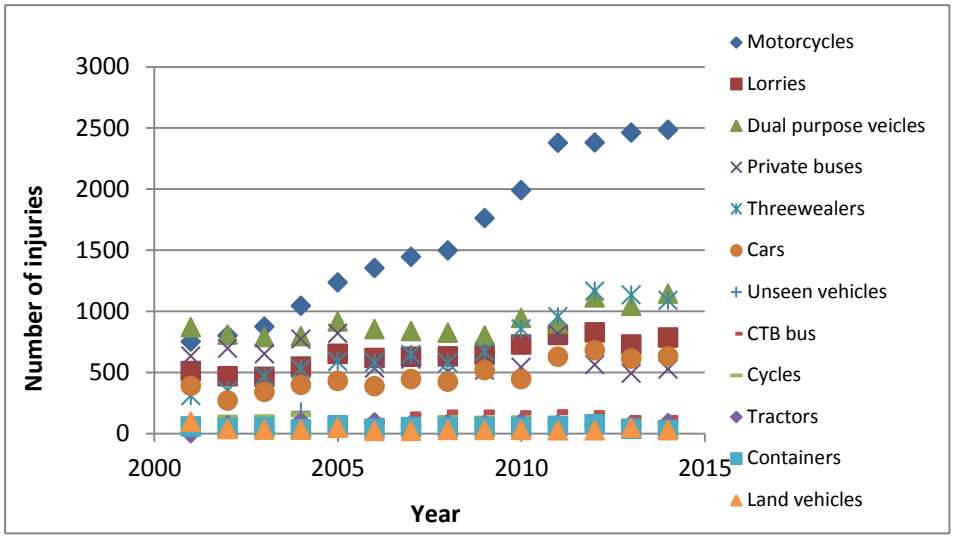



Figure 4.2: Major Injuries due to accidents of vehicles (2001 – 2014) in Sri Lanka

#### 4.2.1.3 Identification of Minor Injury accidents

As observed in fatalities and major injuries from 2001 – 2014, the main cause for minor injuries was also due to motorcycle crashes (Figure 4.3). Motorcycle crashes were increased from 2010, causing the highest damage at the 2012 peak. The incident became lower thereafter; however it has caused more than 4000 minor damages in 2014.

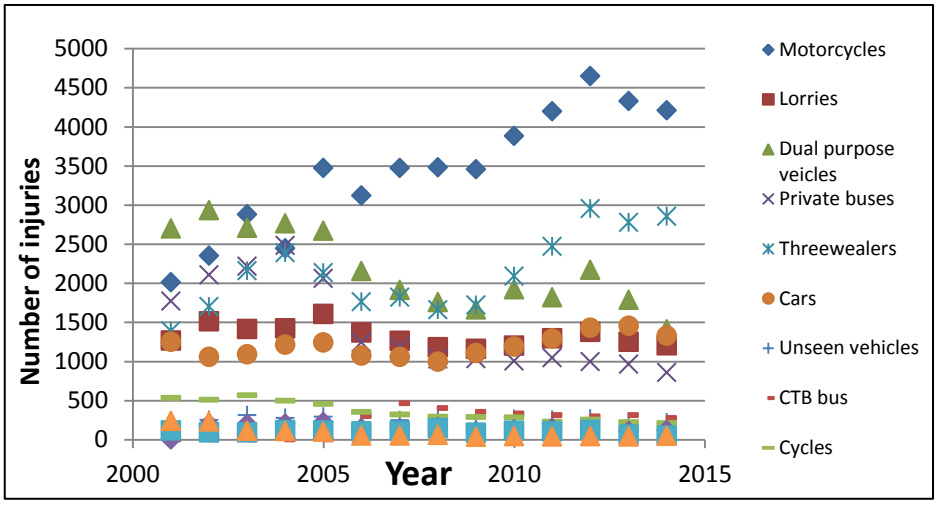



Figure 4.3: Minor Injuries due to accidents of vehicles (2000 – 2014) in Sri Lanka

#### 4.2.1.4 Identification of Property Damage accidents

Property damages occurred by road accidents reduced drastically after 2006.

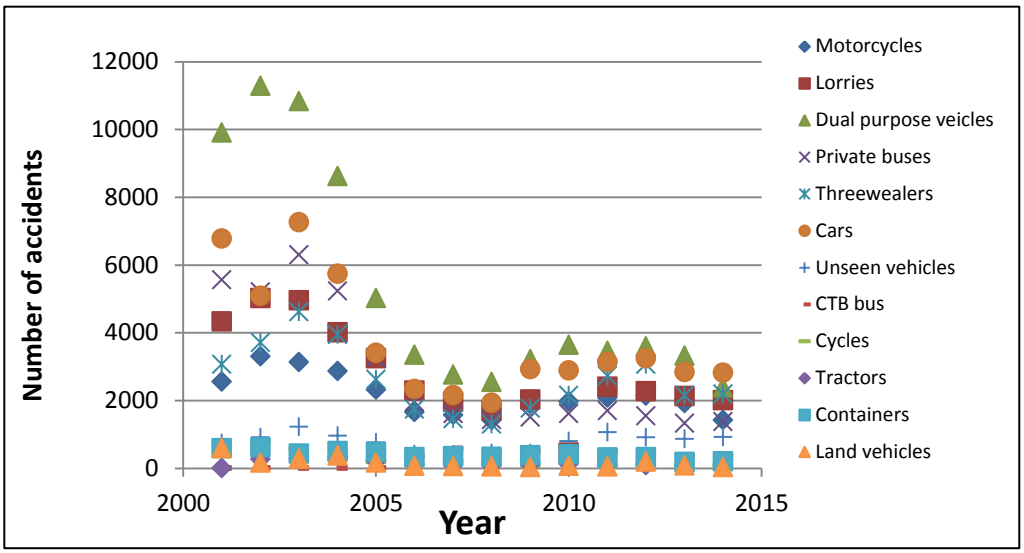



Figure 4.4: Property damages due to accidents of vehicles (2000 – 2014) in Sri Lanka

#### 4.2.1.5 Comparison of four categories of road accidents

Analysing data obtained from the Police Traffic Administration and Road safety division of Sri Lanka, from 2001 to 2014 throughout the island, it was clear that the motorcycles accounted for highest fatalities, major and minor injuries. This was mainly due to the nature of the vehicle where the rider is directly exposed outside and there is no hard barrier to absorb the pressure of an accident. Due to lack of balance after a collision, a motorcyclist could be fallen on the road and can be damaged by the incoming traffic.

Considering all categories of accidents, property damages were greater than any other category. Those damages were highest in 2003 and then it was decreased to lowest in 2008.

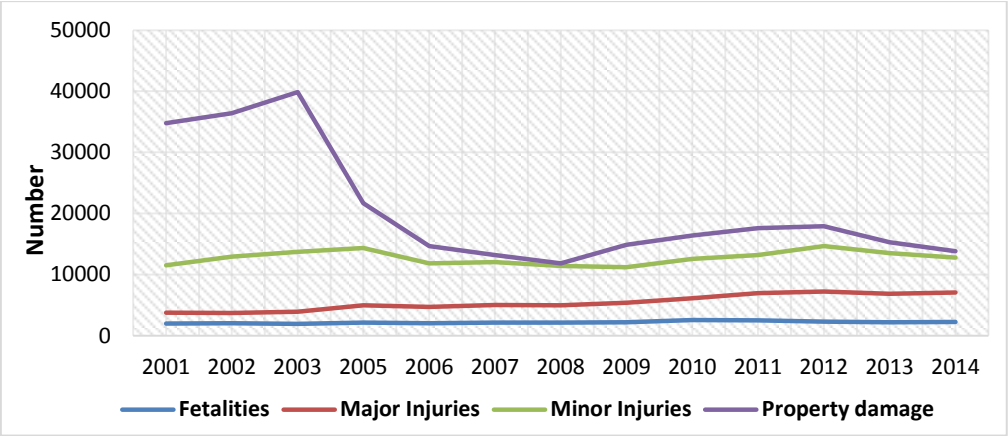



Figure 4.5: Damages due to accidents (2001 - 2014) in Sri Lanka

Fatalities, major and minor injuries were fairly constant and in parallel with each other for the last three years from 2012. Property damages also show a decreasing trend in that period (Figure 4.5).

### 4.2.2 Identification of deaths by road accidents

Detailed analysis of deaths of road users showed that pedestrians were the most vulnerable group for death. During the last 14 years' period (2001 - 2014), pedestrian deaths were the highest in 2010 and then continued fluctuating between 600 and 900 (Figure 4.6).

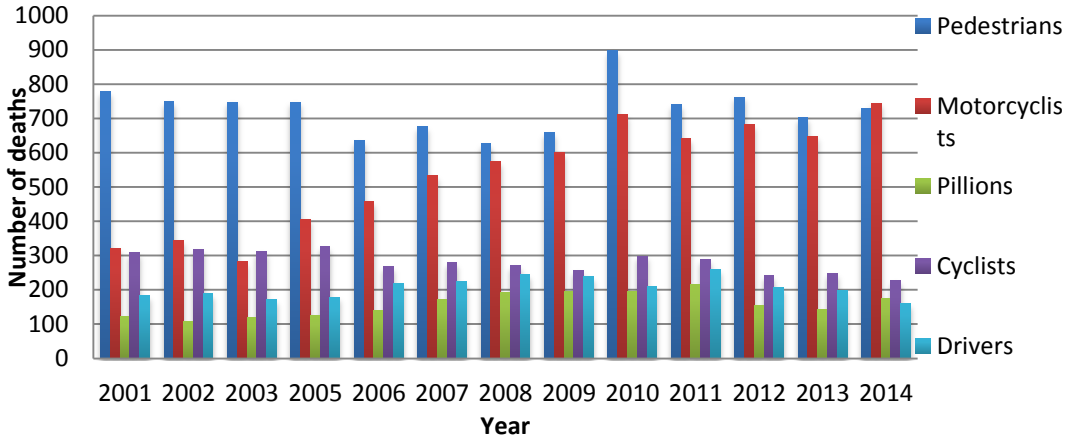



Figure 4.6: Categories of deaths of road users (2001 - 2014) in Sri Lanka

Deaths of motorcyclists gradually increased from 2000. In 2014, motorcyclists' deaths exceeded the deaths of pedestrians. Pillion passengers (passenger behind a motorcyclist) and motorcyclists together were the group mostly killed by road accidents (Figure 4.7).

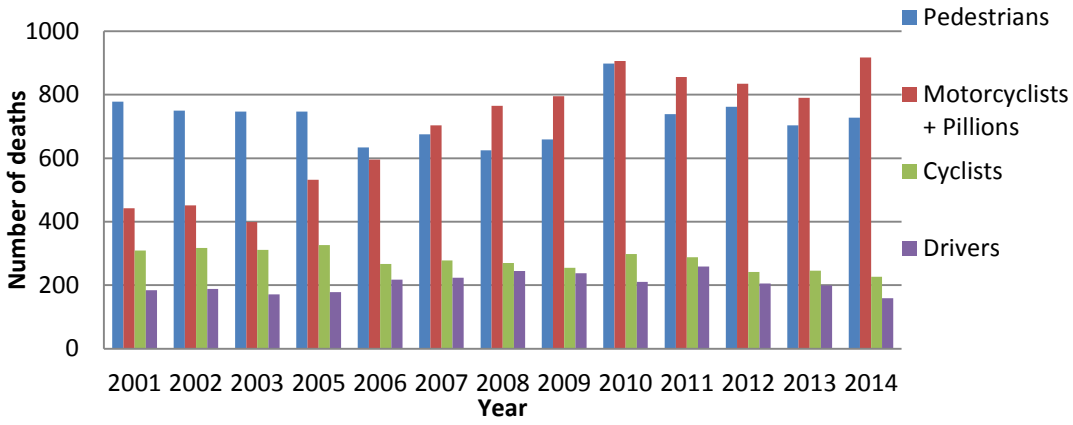



Figure 4.7: Deaths by road accidents (2001 - 2014) showing the highest death rate of motorcyclists and pillion passengers.

### 4.2.3 Identification of Causes of death

The Police Traffic Administration and Road safety division of Sri Lanka has identified several causes of death in road accidents. Those are

- Speed driving
- Overtaking
- Turning of vehicles
- Intoxication (Alcohol intake) of drivers
- Mechanical errors of vehicles
- Carelessness of pedestrians
- Accidents on the crossing

Analysing the above data, it was observed that the main causes of deaths occurred were due to human errors. Among them speed driving was the major cause of death of road accidents (Figure 4.8)

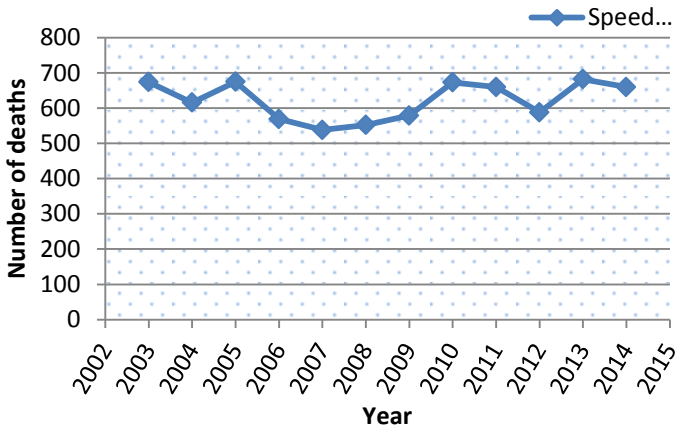



Figure 4.8: Deaths due to speed driving in Sri Lanka

Each year from 2002 onwards, more than 500 people died due to speed driving where it reached its highest point in 2013. When the road conditions facilitate driving fast, the number of deaths will show an increase.

The next highest reason for pedestrian deaths was overtaking. The number of deaths due to overtaking lied within the range of 300 – 500, from 2002-2014 (Figure 4.9)

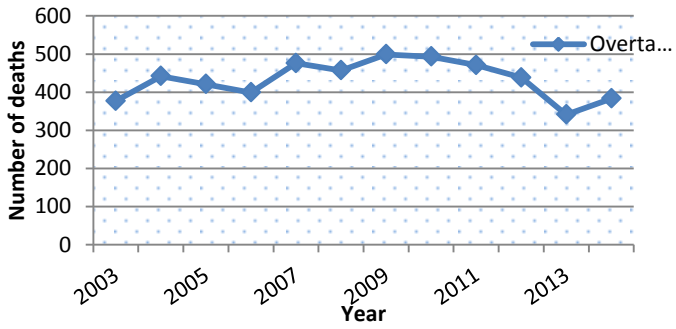



Figure 4.9: Deaths due to overtaking

Deaths due to turning of vehicles, intoxication of drivers and carelessness of pedestrians can be considered as minor causes of deaths of road users.

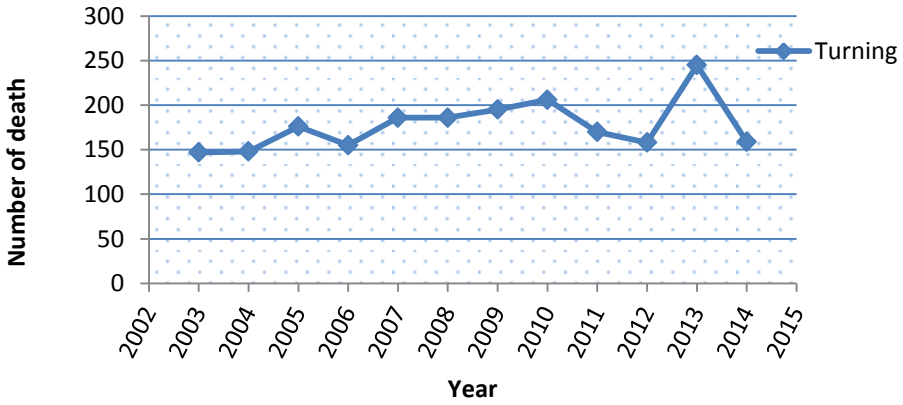



Figure 4.10: Deaths due to turning vehicles

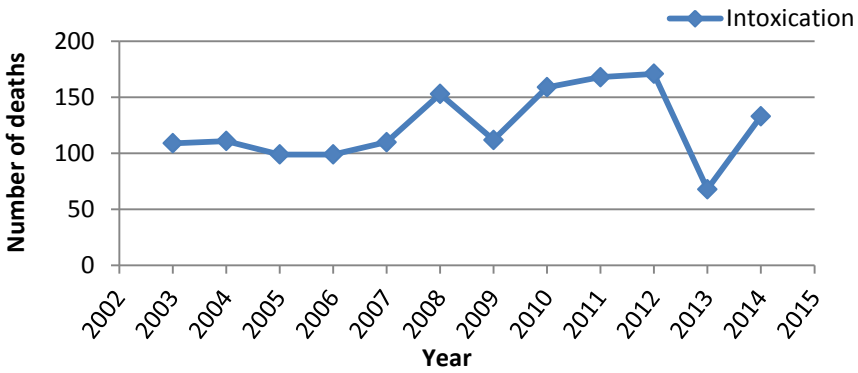



Figure 4.11: Deaths due to intoxication

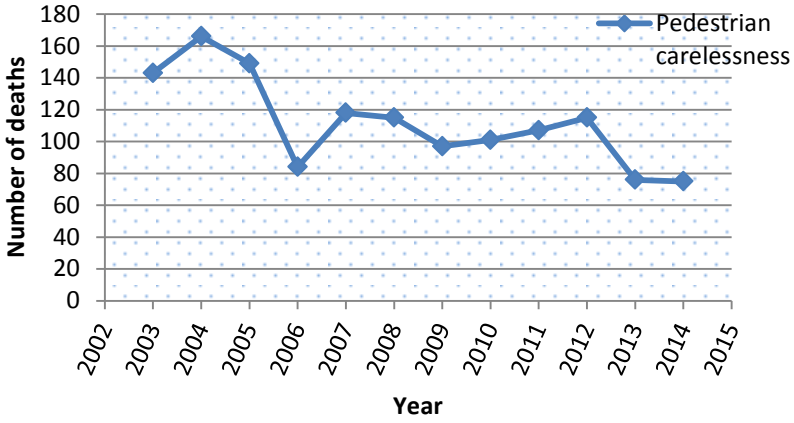



Figure 4.12: Deaths due to pedestrians' carelessness

Accidents occurred on the crossing also has an influence on deaths in a lower scale.

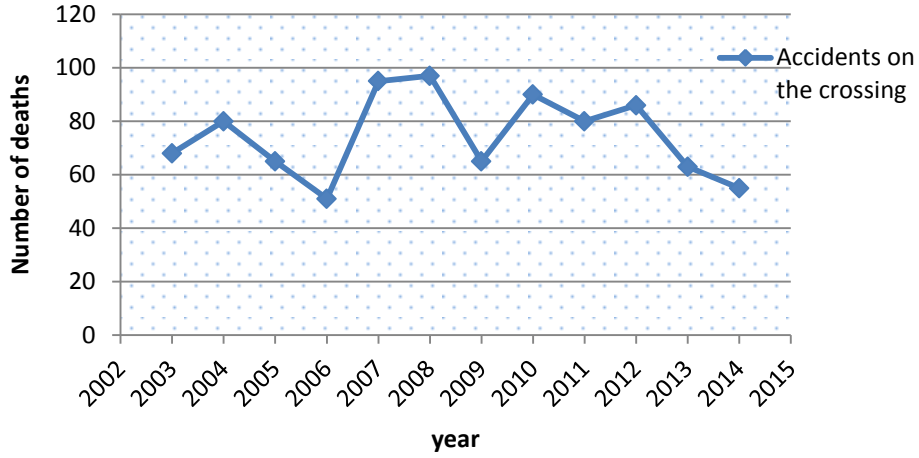



Figure 4.13: Deaths due to accidents on the crossings

### 4.2.4 Deaths according to the day of the week

Fatal accidents occurred during the last 14 years from 2001 onwards showed that the highest number of accidents was reached in 2010 and 2011. Number of deaths was indicated according to the day of the week in Figure 4.14.

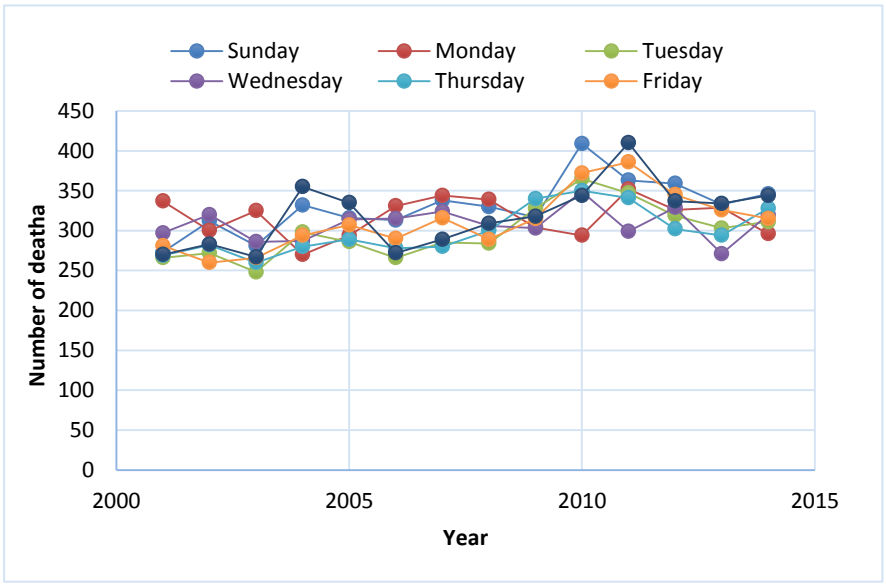



Figure 4.14: Fatal accidents according to the day of the week.

Number of fatal accidents was not the same on each day of the week. The mean number of deaths on each day showed that the highest occurrence of fatal accidents was on Sunday followed by Saturday. Of week days Monday had the highest number of fatal accidents and Tuesday showed the lowest (Figure 4.15).

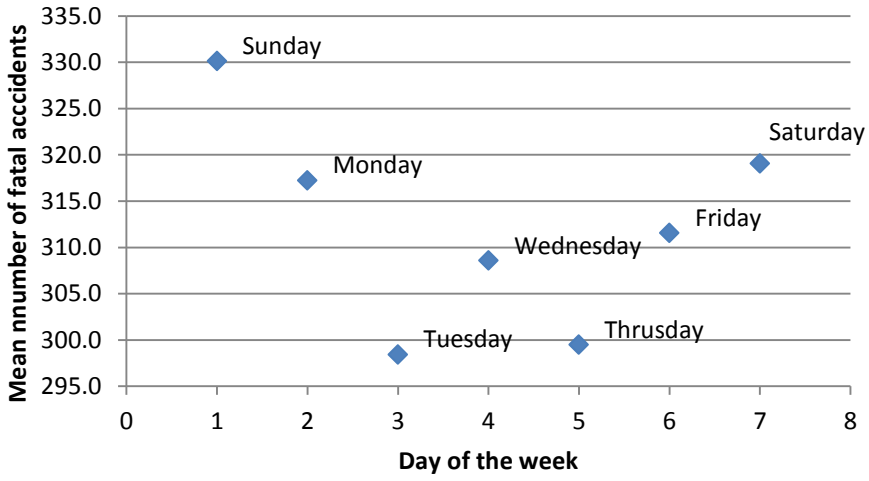



Figure 4.15: Mean number of deaths according to the day of the week.

### 4.2.5 Effect of the age of the driver on accidents

Analysis of data showed that the age group of the driver has a great effect on accidents.

It was observed that within the range of 16 -70 years, the number of accidents occurred increased with the driver's age from 16 to 35 and then decreased from 36 to 70. Drivers within the age groups of 26 - 30 and 31 - 35 were accounted for the highest number of accidents (Figure 4.16).

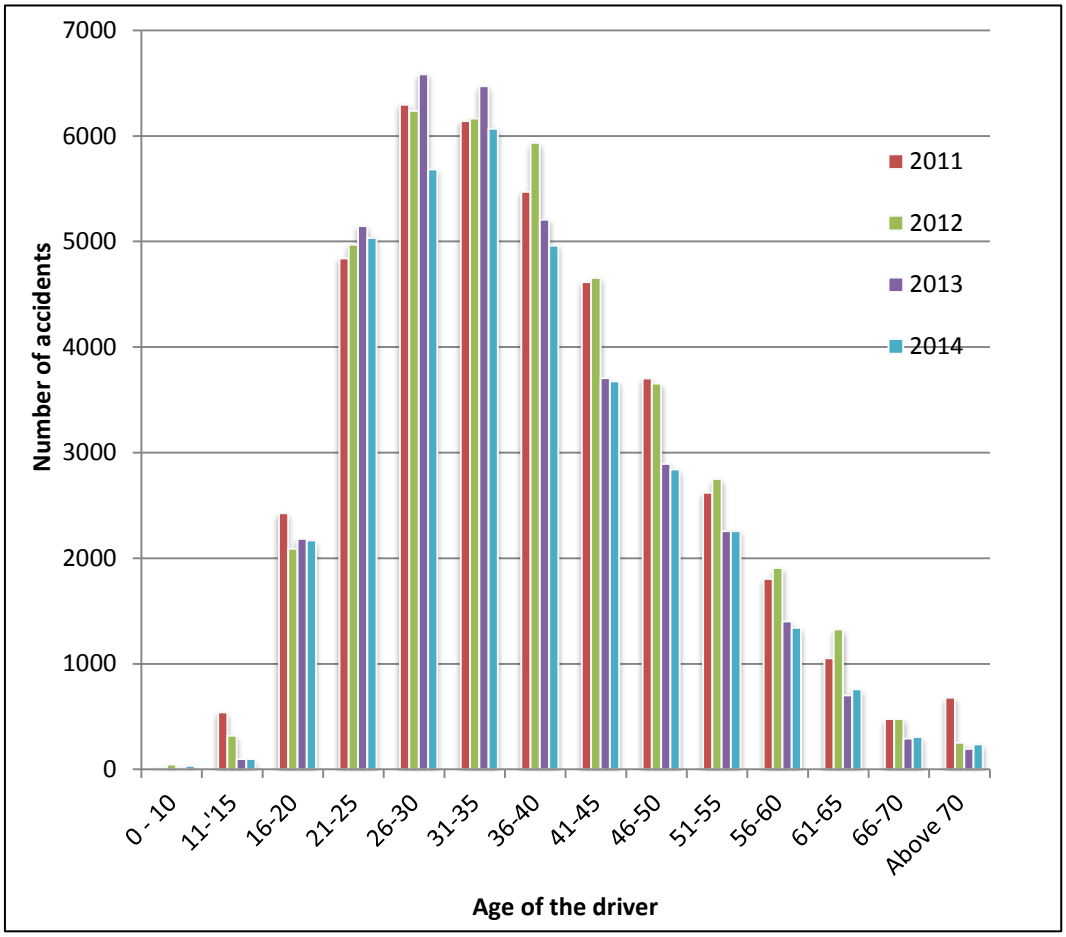



Figure 4.16: Deaths according to the age group of the driver.

### 4.2.6 The age categories of people killed by road accidents

The age categories of dead people were within the range from 0 – above 70. Dead counts were really low (below 50) among the children up to 15 years. It was increasing thereafter showing two peaks. Age groups 21- 25 and 26-30 produced one peak and the above 71 age group produced the other peak (Figure 4.17).

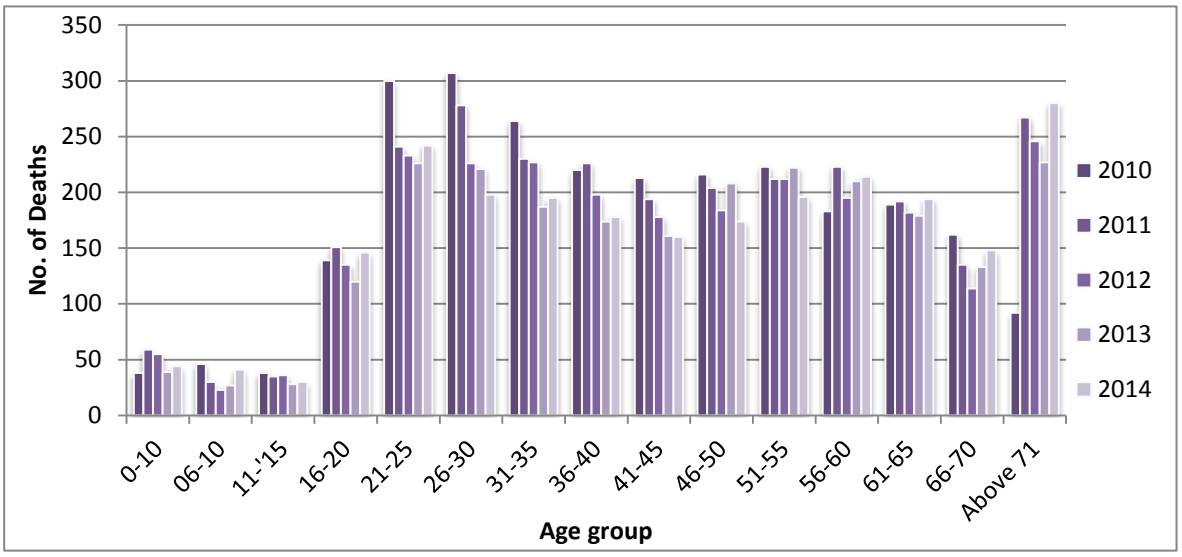



Figure 4.17: The age groups of the dead victims.

### 4.2.7 Effect of time on fatal accidents

The time of the day also has a great effect on the fatal accidents. Analysing the fatal accidents occurred during five years from 2010, it was noticed that fatal accidents were minimum at early morning between 0200 am – 0400 am. It was increasing with the time and reaching the highest between 1800 pm – 2000 pm at night. The number of fatal accidents is getting lowered around midnight (Figure 4.18).

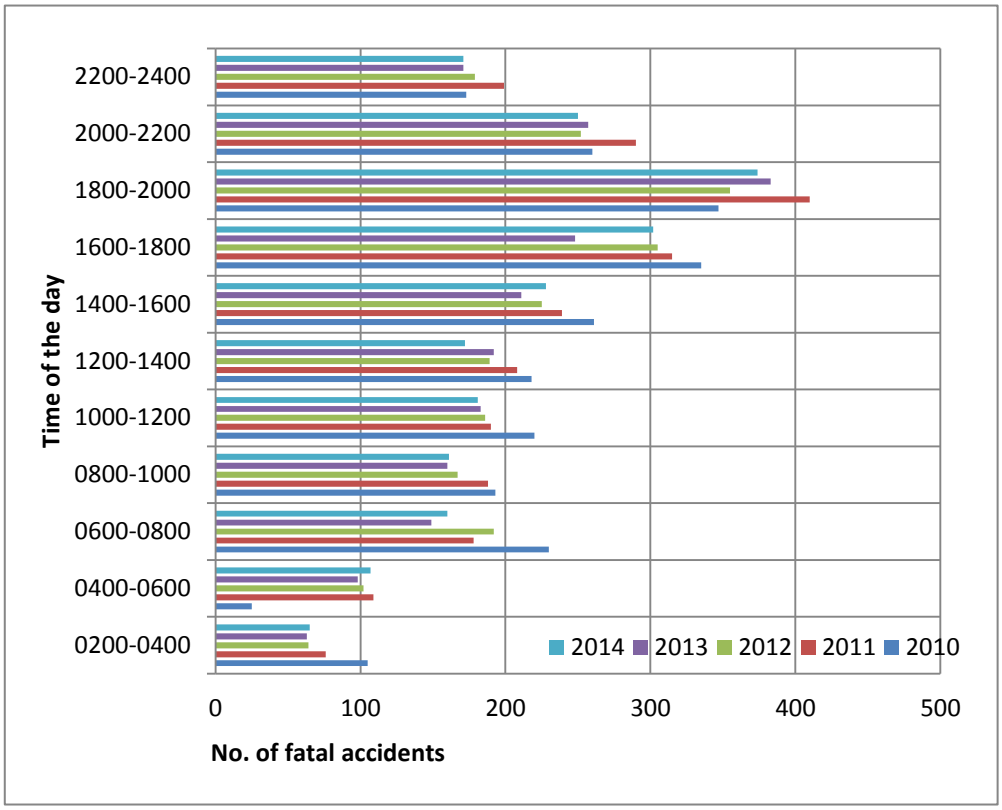



Figure 4.18: The occurrence of fatal accidents according to the time of the day.

## 4.3 Available safety conditions for pedestrians -Local field observations

Local field observations were done in three (03) selected roads as case studies where different safety conditions for pedestrians are available. Each road has definite criteria for selection as explained below:

**Selected Roads:**

1. Galle Road: From Colombo Galle face to Panadura (Bus route 100 )

   The main road with two lanes in each direction. It is a major road in the road network which comprises of all necessary road signs and various types of crossings. Proper lighting and sidewalks are established to facilitate vehicles as well as pedestrians.

2. Kottawa – Piliyandala Road (Bus route 255)

   A busy two-lane road with no sidewalks or cycle lanes. The road is much narrower and poor in safety conditions and signboards.

3. Piliyandala – Katubedda Road (Bus route 255)

   A newly renovated and expanded road with proper road signs and many types of crossings. Cycle lanes are present. Proper sidewalks are not available.

The road safety conditions for pedestrians of above roads are explained under the following categories.

1. Crossings
2. Sidewalks
3. Bus stops/Bus bays
4. Signboards

### 4.3.1 Crossings

Crossings are the most important points in the road where pedestrians interact with the moving vehicles. Several types of pedestrian crossings were observed as explained below.

#### 4.3.1.1 **Pelican crossings**

Plate 4.3.1.1 A pelican crossing at Piliyandala - Katubedda Road (left) and Galle road (right).

Pelican crossings, indicated above, can be considered as a safe and consumer-friendly method of crossing due to its many features of it. Those can be explained as given below:

i. The path is indicated between two separate lines.

ii. A pedestrian can push the button and wait at either side until a green man sign appears.

iii. All vehicles stop completely and allow the pedestrians to cross safely so that the chance of an accident is minimised.

iv. The time allocated for crossing is displayed allowing the pedestrian to reach the other side within that time.

v. The pedestrian can make his own judgement according to the time indicated.

vi. The crossing path is lit up at night by the overhead lights to facilitate the visibility

Considering the three selected roads, pelican crossings are available in the Galle Road and Piliyandala – Katubedda Road. But in Kottawa – Piliyandala Road those are not available.It was observed that most of the vehicle drivers follow the light signals at pelican crossings.

#### 4.3.1.2 **Toucan (Two-Can Cross) crossings**

Plate 4.3.1.2 A Toucan crossing at Piliyandala – Katubedda Road

Plate 4.3.1.3 Vehicles at the Toucan crossing at Piliyandala Katubedda Road

A Toucan (Two-Can Cross) crossing is indicated in the Plate 4.2.1.2 and 3 were also located at Piliyandala – Katubedda road and were not available in other two selected roads. This differs from the pelican crossing by having two separate lines for pedestrians and cyclists. Cyclists can ride across the road without dismounting the cycle.

4.3.1.3. **Zebra crossings**

This is the most common type of crossing observed in all three selected roads and in most of the urban areas where a comparatively low number of pedestrians is present. Compared to the other crossings, Zebra crossing may not visible to the vehicle drivers from the distance. Therefore newly built roads are provided with beacons. Beacon is a light, mounted on a striped post on the pavement at each end of a zebra crossing.

Plate 4.3.1.3 a: A Zebra crossing at Galle Road, Moratuwa with beacon lights

The middle area between two roads of the Galle Road is used as an island to

separate the Zebra crossing into two parts. Pedestrians can cross the first road and wait safely in the middle until the other road get free.

Plate 4.3.1.3 b: A Zebra crossing with an island at Galle Road, Moratuwa

School crossings are usually assisted with school traffic wardens, who are school children trained by the traffic police. When they wear the traffic warden jacket, they have the legal authority to stop the vehicles. They help the children in the morning and afternoon at the end of the school.

Plate 4.3.1.4 A school crossing and a traffic warden at work at Padukka

Another type of crossing called Puffin crossing can be seen in other countries, but it is not widely used in Sri Lankan roads. Due to the movement of

pedestrians, these crossings are activated and can be problematic with the vehicles.

In some roads, the speed of the vehicles is controlled by having a series of rumble lines in the equal distance (Plate 4.3.1.5). But that rumble lines were not observed in the three selected roads. If pedestrians are provided with overpasses (Plate 4.3.1.6) that is a better way of crossing the road without getting disturbed by the traffic flow.

Plate 4.3.1.5: Rumble lines at Meepe

Plate 4.3.1.6: Pedestrian overpass at Pannipitiya

### 4.3.2. Sidewalks

Plate 4.3.2.1 Paved sidewalks at Galle road

The sidewalk is a paved or constructed area for pedestrians where they can walk without getting disturbed from roads. It was observed that in many

newly built roads, the sidewalk was raised, paved and margined with striped curbs. These sidewalks provide a safe environment for pedestrians, even in dark hours. The striped curb directs the vehicles as well by the difference in the ground level which is easily felt by the driver even in a sleepy mood.

Plate 4.3.2.2a. : Properly designed sidewalks at Kumaratunga Munidasa Mawatha, Bambalapitiya

Sidewalks need to be supportive to visually impaired pedestrians as well. Special tactile paved areas can be seen in Galle road around Bambalapitiya, where visually impaired pedestrians can follow and get the direction (Plate 4.3.2.2b)

Plate 4.3.2.2b: Tactile paving in sidewalks at Bambalapitiya

The sidewalk is very easily blocked by many other activities. Name board are displayed in the sidewalk (Plate 4.3.2.3) completely blocking it. Roads when they were expanded, the lamp posts can be situated in the sidewalk, disturbing the pedestrians.

Plate 4.3.2.3: Sidewalk blocked by display boards (left) and lamp posts (right) at Piliyandala – Katubedda Road

Plate 4.3.2.4: Sidewalk blocked by parking of vehicles at Piliyandala – Katubedda Road

Vehicles parked at the road sides may block the sidewalk completely so the pedestrian shall take the risk of walking closer to moving vehicles.

Plate 4.3.2.5: Some areas of Piliyandala – Kottawa road with no sidewalks

During the construction of Piliyandala – Kottawa road, the area for a sidewalk is not considered due to lack of space. In that road, pedestrians walk at the sides of the road together with the movement of vehicles. The side drains at either side of the road create an unsafe and risky environment to pedestrians (Plate 4.3.2.5).

**S**idewalks found in the Galle road were in a satisfactory level. Although there was not an establish sidewalk on the Piliyandala - Katubedda road, alongside the cycle lane, space had been provided for pedestrians to safely walk. However in the Piliyandala - Kottawa road, no such space had been provided alongside the road for pedestrians. When comparing these roads, the Galle road provides the most safety for pedestrians.

### 4.3.3. Bus stops/Bus bays


Figure 4.3.3.1. Bus bays at Moratuwa (left) and Kollupitiya (right) at Galle road

Some roads have a separate outer space to stop buses, called bus bay. When the bus stops at a bus bay it does not block the traffic flow of the road. At the same time, passengers have a safe area to alight or get down from the bus. In the Galle road, most of the bus stops are provided with bus bays. But it is commonly seen that buses stop at the end of the road without moving into the bus bay. In Piliyandala – Katubedda road, the bus stops are marked as yellow squares informing other vehicles not to park or block that space (Plate 4.3.3.2).

Figure 4.3.3.2: Marked bus stop at Piliyandala – Katubedda road

In Piliyandala – Kottawa road, either yellow squares or bus bays were not available. Comparing the three selected roads, above facility was available only in the Galle road.

### 4.3.4. Signboards

Signboards always give directions and indications to the road users to follow. Both the Galle road and the Piliyandala – Katubedda road provided adequate signboards to the road users (Plate 4.3.4.1and 2), however the Piliyandala – Kottawa road did not provide sign boards adequately to the users and other instructions to vehicle drivers.


Plate 4.3.4.1: Signboards displayed at the Galle road


Plate 4.3.4.2: Road Markings at the Galle road

## 4.4 Identification of the Suitable Pedestrian Safety Conditions in Other Countries

Suitable pedestrian safety conditions were observed in the UK and Singapore as discussed below.

### 4.4.1 Sidewalks

Plate 4.4.1.1: Wide sidewalks in London, UK

In busy cities like London where pedestrians, mainly visitors or tourists are found in large numbers, they tend to walk from place to place since the vehicle / underground trains do not travel across. In such areas, comparatively wide sidewalks can be seen to facilitate the pedestrians. These sidewalks consist of seating areas, communication facilities and travel information as well.

### 4.4.2 Facilities for Visually Impaired People

People who are blind, deaf blind or partially sighted or have a severe vision loss are considered as visually impaired people. Those are facilitated with tactile paving, a profiled paving surface with outgrowths

of metal / concrete blisters providing guidance or warning to visually impaired people.

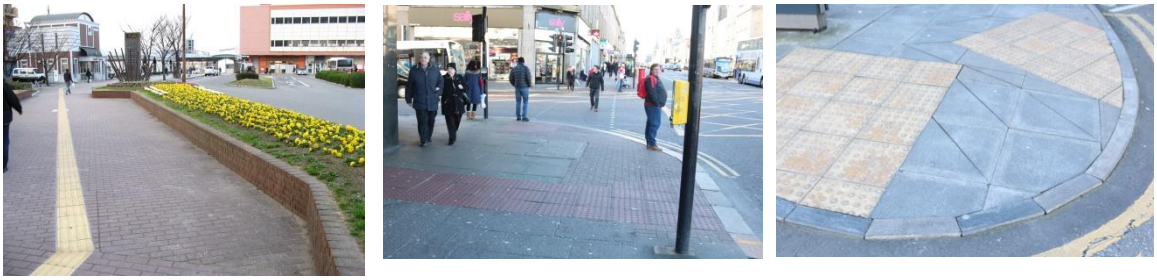


Plate 4.4.2.1: Tactile pavings observed in Kyushu (left), Japan and Aberdeen, UK (middle and right).

### 4.4.3 Sheltered sidewalks

Plate 4.4.3.1: Sheltered sidewalks in Singapore city

Some sidewalks in urban areas of Singapore are provided with railings and roofing so that the pedestrians are facilitated to walk safely in it. Special railing structures at either side of the sheltered walkway avoid unwanted entering of pedestrians into the road

### 4.4.4 Overpasses

Overpasses provide a safe way to cross a main road without get disturbed / damaged by the traffic flow (Plate 4.4.4.1).


Plate 4.4.4.1: Overpasses at Singapore city

### 4.4.5. Underpasses


Plate 4.4.5.1: The underpasses leads to tube ways in London, UK

Underpasses are common in urban areas of UK. These facilitate the public with a safe walkway without getting disturbed by the traffic flow.

### 4.4.6. Specially Designed Streets for Pedestrians

These roads are devoid of vehicles and only for the use of pedestrians. They connect the main train station, bus stands and the city centre. The pedestrians can find the way in a safe and easy way to their destinations.

Plate 4.4.6.1: Streets for pedestrians in Tokyo, Japan and Glasgow, UK

### 4.4.7: Special Public Areas with Facilities

Plate 4.4.7.1: Public area at Glasgow, UK

Public areas specially designed for pedestrians can be seen in some areas of the city. Seating allows the pedestrians to rest, read or wait for a bus / train. (Glasgow city areas)

Plate 4.4.7.2: Public area at Westminster, London, UK

In some visitor attractive places, tourists are facilitated with open common areas where they can gather, observe and take photos /videos, without getting disturbed by the moving traffic flow.

### 4.4.8. Roadside Seating Facilities

Roads of sub urban areas have seating facilities at the roadside. Pedestrians are free to use them to rest, read or eat. Those are located away from the margin of the road and keep privacy of the user from other road users.

Plate 4.4.8.1: Roadside seating at Tokyo, Japan (left) and Aberdeen, UK (right).

### 4.4.9 Proper Sign Boards and Name Boards


Plate 4.4.9.1: Instructions given at a crossing, Aberdeen, UK

The signs are displayed with some written instructions so the pedestrians very easily can follow them.

Other name boards, speed limits and the details of a roundabout are displayed at a higher level. (Plate 4.4.9.2)


Plate 4.4.9.2: Signboards at Aberdeenshire and London, UK

### 4.4.10 Railing and lifebuoys for accident prone areas

Plate 4.4.10.1: Lifebuoy at Greenwich, UK

Railing and lifebuoy located at the banks of river Thames in London and river Clyde in Glasgow.

A river flowing through the city can be considered as a hazard prone area. Both sides of the bridge should be covered with proper railing to prevent the pedestrians falling into the river. A lifebuoy has been provided in close vicinity of those areas. It is a lifesaving buoy designed to be thrown to a person in the water, to provide buoyancy and prevent drowning. Some roads are provided with railings to prevent the sudden intrusion of pedestrians into the road.

### 4.4.11 Bus Bays and Bus Stops

Those are located at marked places of the road, as an outward part. A stopped bus does not create a traffic block at this bay. Pedestrians have a safe environment to wait, alight and get off from the bus.

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Plate 4.4.11.1: Bus stops at Aberdeen (left) and Singapore (right)

### 4.4.12: Taxi stops


Plate 4.4.12.1: Taxi stops at Singapore (left) and Aberdeen (right)

Taxies are stopped in a special bay and meet the users queue in a sheltered area. (Plate 4.3.12.1) The passengers from a train also wait in a queue to get a taxi.

### 4.4.13 Bicycle Sharing Facilities

Plate 4.4.13.1: Bicycle sharing facility at Glasgow –UK (left) and Singapore (Right)

Bicycle-sharing facilities are available in cities in which bicycles are made available for shared use to individuals on a short term basis for a price or free.

These systems allow people to borrow a bike and return it at another place belonging to the same system.

### 4.4.14 Cycle Parking Facilities

Plate 4.4.14.1: Bicycle parking at Union Street, Aberdeen, UK

Special parking areas are assigned for bicycles. Two bicycles can park at either side of the rack and they should be locked properly.

### 4.4.15 Proper Street Lighting

Plate 4.4.15.1 Street lights operated at Great Southern Street, Aberdeen.

### 4.4.16. Speed Limits and Special Speed Limit Marked Roads



Plate 4.4.16.1: Roads with marked speed limits in Glasgow

Vehicle drivers have to strictly follow the speed limits indicated in the road. Most crowded streets with public places or schools are included in this category.

### 4.4.17 Traffic Calming Devices in Residential Areas

Plate 4.4.17.1: Traffic calming humps at residential areas in Aberdeen, UK

These speed bumps force the vehicle drivers to reduce the speed.

### 4.4.18 Trees for Shade


Plate 4.4.18 .1: Trees planted at roadsides in Aberdeen (right) and Tokyo (left).

These properly planted trees provide shaded environment for pedestrians and they act as berries for vehicles to reach the sidewalk.

### 4.4.19 Regular Road Cleaning


Plate 4.4.19.1 Cleaning of roads in Aberdeen

This cleaning provides a clean and safe environment from dust and any other material which can cause damage.

### 4.4.20 Providing Safe Paths during Construction

Plate 4.4.20.1: Barricaded construction areas in Singapore.

Any constructions activities carry out in the road should be separated from the path while providing an alternative way for the pedestrians.

## 4.5 Identified Safety Conditions in The UK and Singapore

4.5.1 Appropriate crossings mostly pelican, toucan or puffin crossings in urban areas

4.5.2 Zebra crossings in front of the schools direct by a traffic warden

4.5.3 Speed limits/ traffic calming devices around schools

4.5.4 Properly indicated traffic signs and instructions

4.5.5 Properly maintained street lighting

4.5.6 Well maintained road network

4.5.7 Sidewalks wide and facilitate the movement of pedestrians. Sheltered walkways can be identified as the best option in a city centre.

4.5.8 Sidewalks facilitated with visually impaired pedestrians

4.5.9 Pedestrians walk through overpasses / underpasses

4.5.10 Seating facilities at the shaded areas of roadside / public areas as resting places

4.5.11 Special streets only for pedestrians across a city

4.5.12 Properly designed bus stops, bus bays and taxi stops for passengers

4.5.13 Regular road cleaning

4.5.14 Constructions in barricaded areas to avoid unwanted entering

4.5.15 Parking facilities for cyclists

## 4.6 Identified Causes for Road Traffic Accidents in Sri Lanka

*Road safety* is most important for all the road users as it describes measures to prevent *road* users from being seriously injured or even killed. By observing the data collected from The Police Traffic Administration and Road safety

division of Sri Lanka, it is clear that existing road safety conditions in Sri Lanka are not in a satisfactory level.

Motorcyclists accounted the highest number of fatal accidents occurred in last ten years. Amongst the reasons for those fatalities, inadequate safety conditions may have also affected. Indicating the highest number of fatalities, major and minor injury accidents for last 15 years, it is clear that motorcycles were the most affected vehicle in Sri Lankan roads. But motorcycles accounted for a fairly low amount of property damage.

Considering the deaths of road users, pedestrians accounted for the maximum number of deaths during the last twelve years - from 2001 to 2013. Even though the relevant causes of those deaths of pedestrians were classified, a considerable number of pedestrians have been the victims of accidents throughout the country. Since pedestrians may directly expose to the moving vehicle, the damage is maximum compared to other road users. Speed driving and overtaking were the major causes of death of road accidents for the last 15 years and were seriously accounted for deaths of road users, especially pedestrians. Accidents by turning of vehicles and the intoxication of the vehicle driver were also considerably affected the road users.

Weekends were affected adversely to road users since these two days have encountered for highest deaths. Speed driving might have affected for the deaths occurred in weekends mostly due to less traffic in roads. Most of the people who live in urban areas tend to travel into remote places or long distances at weekends which are not familiar to them. Because of this,

accidents were recorded mainly in remote areas during weekends. Possibilities of accidents were also high due to speed driving during their way back to home, especially at night hours.

If vehicle drivers were in the age of 26 - 35, they have contributed highest for road accidents. With maturity they tend to drive carefully so the adult drivers will be safe at work. Even the road users at above age group were vulnerable to more road accidents.

The occurrence of road accidents was highest in the evening from 1800 to 2000 at night when the road traffic was also highest. Majority of road users were busy going back to their homes and less attention may be paid on road rules. The decrease in visibility might have affected on pedestrians at night if the lighting conditions of the roads were not in a satisfactory level.

With the increase in vehicle fleet, pedestrian deaths can be increased even further due to high opportunity of above discussed causes of accidents. Therefore the high risk of pedestrians getting injured or dying due to other road users needs to be minimised or controlled.

Most of the pedestrian injuries and deaths could be occurred due to human errors.

## 4.7 Proposed Appropriate Road Safety Measures to Improve Pedestrian Safety in Sri Lanka

Pedestrians walk along the road for a short time until they find a crossing, a bus stop or a turning point. If pedestrians are not informed about the road signs and any other markings of the road, they are not properly guided. If pedestrians were provided with supplementary information very effectively, they may follow them.

Pedestrians are at risk whenever they cross the road ways. The degree of risk depends mainly on complexity of vehicular traffic and crossing locations. The direction and the duration of crossing are also important for a safe movement.

### 4.7.1 Reduce Vehicular Speed

In a street intersection turning vehicles and the speed at which they turn can be a great threat to a pedestrian because a vehicle driver always keeps the attention on other vehicles and less on the pedestrians. If pedestrians are not clearly seen, it will be a dangerous situation.

Traffic calming devices such as raised crosswalks, speed bumps can be introduced to reduce the speed of vehicles. Speed bumps are raised sections placed across the road to force vehicle drivers to travel at reduced speed. Traffic calming devises has proven to reduce traffic speeds and consequently reduce the number of pedestrian deaths.

Speed limits can be formulated near schools and residential areas. It is accepted that 20 miles / 30 Km per hour is a safe speed of driving in those areas. This speed limit can be displayed around school areas, in week days during opening and closing hours of the school. In the UK this limit has imposed as a law and displayed in the road.

### 4.7.2 Crossings

During crossing, if it is a long crossing distance and a short signal time is given, the pedestrian is at high risk. Any unseen vehicles at the distance can reach closer due to its high speed and can hit the pedestrians.

Any crossing without proper curb ramps is also not safe. If there is a curb extension, it will decrease the crossing distance while increasing the pedestrian's visibility. The crossing area if it is not indicated by beacons / lights at the corner of the crossing or by overhead lights, a vehicle driver may not noticed it properly at a distance. Therefore pedestrian crossing areas need to be visually distinguished by establishing raised crosswalks with any kind of detectable warnings installed at both ends like illuminated yellow and white plastic bollards with an arrow to remind motorists to keep left. Light controlled crossings provide safer environment for pedestrians even in dark hours. Due to overhead lights focused to the crossing, vehicle drivers can detect the red lights and also the pedestrians who cross the road.

Pedestrian activated signal devices are controlled by the pedestrian by pushing a button. If crossings are provided with sounds alert which generate a

beeping noise throughout the crossing time (audible pedestrian signal), pedestrians including those with vision impairments can follow the sound alert and cross the road without a danger. When choosing an accessible pedestrian signal that uses touch, it is important to choose sounds that will not be easily masked by wind and rain or confused with other sounds such as birds.

If crossings are located in the busiest places in a city where the pedestrian density and the traffic flow are high, the risk of crossing the road is also high. In such places, there should be a mechanism to create an exclusive pedestrian phase where all vehicles from all directions will stop so that pedestrians can cross the road even diagonally.

Plate 4.7.2.1 - an exclusive pedestrian phase of a junction

If crossings are located slightly away from a busy junction, this will encourage people to cross where there are fewer conflicts between pedestrians and vehicle drivers. Raised crossing is another suggestion for a

high traffic road. This is a raised surface marked as a pedestrian crossing. Combined with gently stopped ramps, those permit vehicle drivers to control the speed.

Areas with high pedestrian count, it is important to apply a method of crossing which would decrease the vehicle-pedestrian collision and at the same time cause minimum disturbance to the traffic flow. Overpasses / underpasses can be applied for those areas. Few overpasses / underpasses can be seen around Colombo and in few other main cities like Kandy. If those are constructed in busy junctions of main cities; this will reduce the accidents and increase pedestrian safety.

Specially designed roads for pedestrians can be introduced in crowded areas which would connect two main streets of a city. These streets are exclusively for pedestrians where the entrance and exit is blocked for vehicles.

Introducing sheltered sidewalks for pedestrians is another solution for pedestrian safety. Sheltered walkways are covered passages connecting two places of a city *i.e.* from a bus stop to a railway station, so that pedestrians can walk without interacting with moving vehicles. Also provide protection from weather conditions.

### 4.7.3. Sidewalks

Properly designed sidewalks at either side of the road improve safety conditions of pedestrians. If it is difficult for a pedestrian to identify the boundary between the sidewalk and the street, they may intrude the street

with a great risk. The sidewalks and cycle lanes should be demarcated clearly with white lines. Raised sidewalks lined with curbs provide better safety conditions for pedestrians.

Some areas of Kottawa – Piliyandala road are not provided with well-designed sidewalks. Both pedestrians and vehicles need to share the area between two white lines at either side of the road and pedestrians are forced to travel uncomfortably closer to the automobile traffic. This narrower space does not provide enough clear space for wheelchair users / people with walking aids.

According to the Guide for Local Highway and Street Maintenance Personnel, August 2008, a proper sidewalk is 3.1m (10 feet) in length and consists of four zones:

1. Curb zone
2. Planter/Furniture zone
3. Pedestrian zone
4. Frontage zone

The curb zone which is adjacent to the roadway prevents motor vehicles from driving onto the sidewalks. The plant zone lies between the curb and the pedestrian zone intended to house utilities, pedestrian amenities such as benches, shelters and trees and grasses and ensure that it is free of obstacles. This area may or may not be paved and serve as a buffer between pedestrian zone and the roadway. Pedestrian zone is the area of sidewalk that is especially reserved for pedestrian travel. This provides sufficient space for

two pedestrians to travel side by side without passing other pedestrians. Frontage zone is the area between pedestrian zone and the property line. Pedestrians trend to avoid walking close to the barriers at the property line.

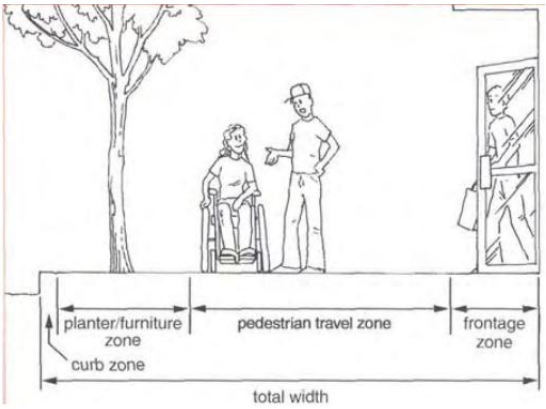


Figure 5.1: Zones of a sidewalk

Source: A Guide for Local Highway and Street Maintenance Personnel, 2008.

In some urban areas, side drains of the road are covered properly. Any open side drains at either side of the road are hazardous prone areas and an accident can occur by a pedestrian falling into the drain. However if drains are covered properly with cement slabs, that would become a usable space for pedestrians which can be a part of a raised sidewalk.

### 4.7.4 Seating Facilities

Among the pedestrians, there may be some disabled people, pregnant mothers or children who need the comfort of sitting. In order to facilitate them some seating arrangements would be really important and helpful.

### 4.7.5 Safety Conditions for School children

4.7.5.1. Visible clothing

School children leave the school in late evening may not be visible very clearly in a crossing due to their clothing (sport kits etc.). If any highly visible colours are included in their cloths, bags etc. this may help the vehicle drivers to recognise them at a distance.

4.7.5.2 Front gathering sheltered areas for school children and parents

In the morning at the starting time of schools, most of the parents and guardians gather at the entrance of the school to drop their children. When schools close in the afternoon, a gathering of parents and children can be seen again at the entrance where enough space is not available. Most of these stay at the road side causing an unsafe condition for children. If the entrance may closer to a main road, traffic congestion can also occur. This situation can be avoided if the entrance of schools is provided with a sheltered area. In a sheltered area, parents and children are protected with rain or sunlight and children can wait safely until they are picked up.

4.7.5.3 School traffic wardens

School traffic wardens are students who stay at the middle of the road during school opening and closing hours and facilitate crossing for other children. A student wearing a traffic warden jacket is considered as an authorised person to control traffic at the crossing in front of the school. They can be exposed to a highly polluted environment with vehicular emissions so this situation can

cause health problems among children. In urban areas, school children and parents can be facilitated by introducing a Pelican crossing **(Pedestrian Light Controlled Crossing).** Since this crossing is operated after pressing the switch by a pedestrian, moving vehicles will not be disturbed when pedestrians are not available.

4.7.5.4 Awareness on road traffic rules

Basic road traffic rules are already included in the primary school syllabus of Grade 3, 4 and 5 and again in Grade 8. In these classes, children are given a basic understanding on traffic signs and road rules. When children grow up they need to understand more about traffic signs and motor traffic regulations. Therefore it is necessary to introduce those in the school syllabus of upper grades like Grade 9 and 10.

The awareness of road rules can be increased among school children by having competitions of essays, posters, quiz programs or even dramas which explain the importance of motor traffic regulations. School walls can be decorated with traffic signs etc. by the children. The Education Department can also organize awareness workshops for school children with the help of the traffic police and share their experience.

Media can make a great influence to general public by having interesting programs on road safety and traffic rules. Safety messages can be displayed on exercise books and stationery items (pencils, pens, highlighters) which are widely used by school children.

In case of an emergency / accident which could occur in school hours, a preparedness plan for schools needs to be prepared. This plan shall explain the steps to follow in an emergency situation like first aids, admitting the victims to the hospital etc.

Currently school children are not much aware of the first aids and other immediate actions need to be taken in an accident. School children should aware about the first aids while each school is having a trained group of first aiders. This group should have a wide knowledge on first aid. Schools are also provided with necessary medicine and other first aid facilities.

## 4.8 Summary

The quantitative data has been analysed and graphically represented in this chapter. The suitable safety conditions for pedestrians were identified locally as well as in selected two other countries and those were explained with relevant images. After considering the overseas observations, the safety conditions operated in those countries were listed.

The Sri Lankan road safety conditions were discussed and the causes for road traffic accidents were identified. Accordingly appropriate road safety measures were proposed to improve the pedestrian safety conditions of Sri Lanka.

# Chapter 5

# CONCLUSIONS AND RECOMMENDATIONS

## 5.1 Introduction

The aim of the research is to propose strategies to manage better safety conditions of pedestrians to reduce the damage caused by accidents. A mixed research approach was used in this research where quantitative data and qualitative information were analysed and suitable safety measures are proposed to minimize or prevent pedestrian deaths and injuries. Chapter thus concludes how the research aim is achieved by fulfilling each objective and make recommendations while listing the limitations associated and further research options.

## 5.2 Overview of the Objectives

**Objective 1**: The current rules and regulations in Sri Lanka for road users, with special reference to pedestrians were identified by studying literature and referring to the Motor Traffic (Highway Code) Regulations, 1987. The provisions of these regulations are specified in the Highway Code of Sri Lanka. By referring the Highway Code those rules and regulations were identified and described in findings and analysis.

**Objective 2**: The available recorded data of road accidents in Sri Lanka were analysed to understand the main causes of pedestrian deaths and injuries. The

quantitative data obtained from the Police Traffic Administration and Road Safety Division of Sri Lanka were analysed and represented graphically in findings and analysis. Among the Sri Lankan road users, motorcyclists are the most vulnerable group for fatal accidents, major and minor injuries indicating that motorcycles are the most affected vehicle in Sri Lankan roads. Speed driving is the major reason for road accidents for the last 15 years. Overtaking, turning of vehicles and intoxication (Alcohol intake) of drivers were among the other reasons for pedestrian deaths. Following important facts were identified:

- Pedestrian accounted for the 2nd highest death count after 2007.
- Highest death rates of road users occur in weekends
- Vehicle drivers in the age of 26 -35 contributed for highest road accidents
- The occurrence of road accidents was highest in evening hours (1800-2000 hrs.)

**Objective 3**: International road safety conditions operated in the United Kingdom and Singapore were identified. The Highway Code of UK and Singapore were studied and those road safety measures were observed in selected major cities of those countries. Observations done in those countries were explained and included in findings and analysis part as images.

**Objective 4**: The existing safety conditions for pedestrians in Sri Lankan roads were identified. Local observations were made on existing safety

conditions for pedestrians in selected urban areas of the country and those were explained with images in findings and analysis.

**Objective 5**: Appropriate Road Safety Measures which could be implemented to Improve Pedestrian Safety in Sri Lanka were proposed.

By controlling the vehicular speed, creating safe crossings and sidewalks for pedestrians and improving the safety measures for school children, the safety conditions of can be improved. Any other safety conditions which could be implemented in the country are discussed in findings and analysis.

Finally the aim of this study was to propose strategies to manage better safety conditions of pedestrians to reduce the damage caused by accidents. The ultimate research aim was achieved by incorporating the literature, analysis of data, local and overseas observations on road safety conditions. Ideas and views on road safety from some selected personnel *i.e.* engineers involve in road construction, safety managers, teachers, students and traffic police officers were also obtained in proposing suitable safety conditions to be implemented in Sri Lanka.

### 5.3 Recommendations

Recommendations were basically focused on suggestions to improve the existing road safety conditions to increase road safety for road users,

especially for pedestrians. These recommendations were based on the local and overseas field observations.

While constructing new roads or during widening and rehabilitation work, it is important to keep provisions for sidewalks, bus bays, cycle lanes and space for utilities (water, electricity, telecommunication) tree planting and seating etc..

The road infrastructure can be improved by displaying traffic signs and other instructions adequately for pedestrians and other road users. Pelican crossings with sound alerts shall be constructed in front of the schools and other urban areas. Designing an exclusive pedestrian phase for crossings at highly populated junctions, construction of overpasses or underpasses in busy towns and introducing traffic calming devices/ speed bumps in front of schools, training institutes, universities and highly residential areas are some suggestions to control the interaction between moving vehicles and pedestrians. Speed limits can be formulated around schools. Properly built raised sidewalks with curbs and safely covered side drains provide a usable space for pedestrians.

Traffic signs and road rules shall be incorporated in to the school syllabus even in higher grades (Grade 9- 10). A colourful pictorial guide of Highway Code can be made available to school children for their reference. Extra activities need to be conducted among school children to increase the awareness.

In case of emergency/ accidents, schools should have a preparedness plan indicating important steps to follow with identified responsible personnel. Providing schools with first aiders and necessary first aid facilities is also important to reduce the damage from accidents.

Driving schools under government inspection and separately built areas for training can be implemented. Special training and exams should be conducted for the drivers of public transport systems.

Enforcement of relevant laws for misconducting traffic rules and strict supervision of vehicle drivers will also help to improve safety conditions of pedestrians.

### 5.4 Limitations

The data obtained from the Police Traffic Administration and Road safety division was broadly categorised in to different road traffic accident types, but were not specific on background causes. Due to this limitation precise details on pedestrian deaths were not available to the researchers.

Some authorised institutes are collecting detailed road traffic data. Those were not organized in to an easily accessible database to which researchers can log on to get information.

The three road conditions selected in this research does not represent the actual road conditions of the urban areas due to small sample size.

## 5.5 Further Research

Design the most effective way of introducing road safety into the school curriculum for higher grades through research.

Collection of road accident data in detail and make available them to general public.

Monitor the road accidents in different road conditions and make comparisons between them to reduce traffic injuries.

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# Appendix A

Bulletin Data obtained from the Police Traffic Administration and Road safety division