

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

Kariyawasam Tantrige Champaka Ariyawansa

(149380 V)

Degree of Master of Science in Occupational Safety and Health
Management

Department of Building Economics

University of Moratuwa

Sri Lanka

June 2019

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

Kariyawasam Tantrige Champaka Ariyawansa

(149380 V)

Dissertation submitted in partial fulfilment of the requirement for the Degree Master
of Science in Occupational Safety and Health Management

Department of Building Economics

University of Moratuwa

Sri Lanka

June 2019

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.

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

.....
K.T. Champaka Ariyawansa

.....
Date

I hereby acknowledge that K.T. Champaka Ariyawansa has followed the dissertation process for the Masters Dissertation set by the Department of Building Economics under my supervision.

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

.....
Date

DEDICATION

*I dedicate this dissertation
to my beloved **Amma** and **Thattha**,
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.

First and foremost, I express my deepest gratitude to my supervisor, Chartered Quantity Surveyor Professor (Mrs) Kanchana Perera for her utmost guidance, assistance and confidence towards me in successfully completing the research. I am indebted to my supervisor for steering me in the right the direction throughout the process.

I would also like to acknowledge the Co-ordinator of the M.Sc. degree program, Dr. (Mrs) Nayanthara De Silva and Dr.(Mrs) Yasangika Sandanayake, Head of the Department of Building economics, University of Moratuwa, for their immense assistance and guidance during the course.

My sincere gratitude is also extended towards Mrs Ayosha Udeni and all the non-academic staff members of the Department of Building Economics for their support.

I would like to appreciate the support given by the staff of the Library. I am grateful to my batch mates who helped me in numerous ways during the course.

I greatly appreciate the assistance received from the Director and the staff of Police Traffic Administration and Road Safety Division of Sri Lanka and the Road Development Authority

Last, but not least, I would like to thank my family and my friends for supporting me in countless ways throughout this dissertation.

.....

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.

TABLE OF CONTENTS

Declaration.....	i
Dedication.....	ii
Acknowledgements.....	iii
Abstract.....	iv
Table of Content.....	v
List of Figures.....	ix
List of Plates	xi
List of Abbreviations.....	xiii

CHAPTER 1

1.0 INTRODUCTION.....	1
1.1 Background.....	1
1.2 Problem Statement.....	4
1.3 Aim of the study.....	5
1.4 Objectives.....	5
1.5 Chapter breakdown.....	6

CHAPTER 2

2.0 LITERATURE REVIEW.....	7
2.1 Introduction.....	7
2.2 Conventions on Road Traffic.....	7
2.3 Highway codes.....	8
2.4 Highways in Sri Lanka	9
2.5 Rules and Regulations on Highways.....	9
2.5.1 Highway Code of Sri Lanka - Rules for pedestrians.....	10
2.6 Highway Code of The UK	12
2.6.1 General guidance.....	12
2.6.2 Rules for pedestrians - Crossing the road.....	13
2.6.3 Rules for pedestrians - Crossing.....	15
2.6.4 Signal controlled Crossings.....	19
2.6.5 Equestrian crossings / Pegasus crossings.....	20
2.6.6 “Staggered” Pelican or Puffin crossings.....	21

2.6.7	Crossings controlled by authorised personnel.....	22
2.7	Situations needing extra care.....	22
2.8	Overview of road traffic injuries.....	23
2.9	Effect of road traffic injuries on children.....	29
2.10	Importance of road network structure on pedestrian safety	30
2.11	Functions of traffic signs.....	31
2.12	Road safety in Sri Lanka.....	32
2.13	Pedestrian safety in Sri Lanka.....	33
2.14	Summary.....	35

CHAPTER 3

3.0 METHODOLOGY

3.1	Introduction	36
3.2	Research Approach	36
3.3	Research Methodology	33
3.3.1	A comprehensive literature survey.....	33
3.3.2	Desk study.....	36
3.3.3	Obtaining quantitative data.....	37
3.3.4	Local field observations.....	37
3.3.5	Overseas observations.....	38
3.3.5.1	The United Kingdom.....	39
3.3.5.2	Singapore.....	40
3.4	Research Process	41
3.5	Summary	41

CHAPTER 4

4.0 FINDINGS AND ANALYSIS

4.1	Introduction	42
4.2	Analysis of data obtained from the Police Traffic Administration and Road safety division	42
4.2.1	Major categories of road accidents.....	42

4.2.1.1	Identification of fatal accidents.....	43
4.2.1.2	Identification of major injury accidents.....	43
4.2.1.3	Identification of minor injury accidents.....	44
4.2.1.4	Identification of property damage accidents.....	45
4.2.1.5	Comparison of four categories of road accidents.....	45
4.2.2	Identification of deaths by road accidents.....	46
4.2.3	Identification of causes of death.....	47
4.2.4	Deaths according to the day of the week.....	50
4.2.5	Effect of the age of the driver on accidents.....	51
4.2.6	The age categories of people killed by road accidents.....	52
4.2.7	Effect of time on fatal accidents.....	53
4.3	Available Safety Conditions for Pedestrians – Local Field Observations....	55
4.3.1	Crossings.....	56
4.3.1.1	Pelican crossings.....	56
4.3.1.2	Toucan crossings.....	57
4.3.1.3	Zebra crossings.....	58
4.3.2	Sidewalks.....	60
4.3.3	Bus stops/ Bus bays.....	64
4.3.4	Signboards.....	65
4.4	Identification of the Suitable Pedestrian Safety Conditions in other Countries.....	66
4.4.1	Sidewalks.....	66
4.4.2	Facilities for Visually Impaired People.....	66
4.4.3	Sheltered sidewalks.....	67
4.4.4	Overpasses.....	68
4.4.5	Underpasses.....	68
4.4.6	Specially Designed Streets for Pedestrians.....	68
4.4.7	Special Public Areas with Facilities.....	69
4.4.8	Roadside Seating Facilities.....	70
4.4.9	Proper Signboards and Name Boards.....	71
4.4.10	Railing and Lifebuoys for Accident Prone Areas.....	72
4.4.11	Bus Bays and Bus Stops.....	73

4.4.12 Taxi stops.....	73
4.4.13 Bicycle Sharing Facilities	74
4.4.14 Cycle Parking Facilities.....	74
4.4.15 Proper Street Lighting.....	75
4.4.16 Speed Limits and Special Speed Limit Marked Roads	75
4.4.17 Traffic Calming Devices in Residential Areas	76
4.4.18 Trees for Shade	76
4.4.19 Regular Road Cleaning	77
4.4.20 Providing Safe Paths during Construction.....	77
4.5 Identified Safety Conditions in the UK and Singapore	78
4.6 Identified Causes for Road Traffic Accidents in Sri Lanka.....	78
4.7 Proposed Appropriate Road Safety Measures to Improve Pedestrian Safety in Sri Lanka.....	81
4.7.1 Reduce Vehicular Speed.....	81
4.7.2 Crossings.....	82
4.7.3 Sidewalks.....	84
4.7.4 Seating facilities.....	86
4.7.5 Safety Conditions for Schoolchildren.....	87
4.8 Summary	89

CHAPTER 5

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction	90
5.2 Overview of the Objectives	90
5.3 Recommendations	92
5.4 Limitations of the study.....	94
5.5 Further research.....	95
References.....	96
Appendix A	100

List of Figures

Figure	Page
Figure 2.01: A school crossing	15
Figure 2.02: School crossing patrol officer at the crossing	16
Figure 2.03: Zebra crossing	16
Figure 2.04: Pedestrians using a Zebra crossing	17
Figure 2.05: Zebra crossing with an island	17
Figure 2.06: Pedestrians on a Zebra crossing with an island	17
Figure 2.07 :Traffic lights at a Pelican crossing	18
Figure 2.08 : Pedestrians at a Puffin crossing	19
Figure 2.09: Toucan (Two-Can Cross) crossing	20
Figure 2.10 : Cyclists are riding across a Toucan crossing	20
Figure 2.11: Pegasus crossings	21
Figure 2.12 : Staggered crossings (with an island in the middle)	21
Figure 2.13: Trends in road traffic fatality rates in high income countries	24
Figure 2.14: Road traffic fatality rates in high, middle and low income countries	25
Figure 2.15 Death rates due to road traffic accidents	26
Figure 2.16: Percentage of pedestrian deaths as part of overall traffic fatalities	26
Figure 2.17: Road traffic crashes, injury and fatality trends in Sri Lanka	32
Figure 2.18 Road users killed in various modes of transport	33
Figure 3.1: Cities in western province where road safety conditions observed	38
Figure 3.2: Selected cities observed in the UK	39
Figure : 3.3 Selected areas observed in Singapore	40
Figure 4.1 : Deaths due to fatal accidents of vehicles (2001 – 2014)	43
Figure 4.2 : Major Injuries due to accidents of vehicles (2001 – 2014)	44
Figure 4.3 : Minor Injuries due to accidents of vehicles (2001 – 2014)	44
Figure 4.4 : Property damages due to accidents of vehicles (2001 – 2014)	45
Figure 4.5: Damages due to accidents (2001 - 2014)	46
Figure 4.6: Categories of deaths of road users (2001 - 2014)	46

Figure 4.7: Deaths by road accidents (2001 - 2014) showing the highest deaths	47
Figure 4.8 : Deaths due to speed driving	48
Figure 4.9: Deaths due to overtaking	48
Figure 4.10 : Deaths due to turning vehicles	49
Figure 4.11 : Deaths due to intoxication	49
Figure 4.12 : Deaths due to pedestrians' carelessness	49
Figure 4.13 : Deaths due to accidents on crossings	50
Figure 4.14 : Fatal accidents according to the day of the week	50
Figure 4.15 : Mean number of deaths according to the day of the week	51
Figure 4.16 : Deaths according to the age group of the driver	52
Figure 4.17 : The age groups of the dead victims	53
Figure 4.18 : The occurrence of fatal accidents according to the time of the day	54

List of Plates

Plate	Page
Plate 4.3.1.1 A pelican crossing at Piliyanda - Katubedda road and Galle road	56
Plate 4.3.1.2 A Toucan crossing	57
Plate 4.3.1.3 Vehicles at the Toucan crossing	57
Plate 4.3.1.3 a :A Zebra crossing at Galle Road , Moratuwa	58
Plate 4.3.1.3 b : A Zebra crossing with an island	59
Plate 4.3.1.4 A school crossing and a traffic warden at work	59
Plate 4.3.1.5 : Rumble lines	60
Plate 4.3.1.6 : Pedestrian Overpasses	60
Plate 4.3.2.1 Paved sidewalks at Piliyandala bypass road and Galle road	60
Plate 4.3.2.2a. :Properly designed sidewalks	61
Plate 4.3.2.2b: Tactile paving in sidewalks at Bambalapitiya	61
Plate 4.3.2.3: Sidewalk blocked by display boards and lamp posts	62
Plate 4.3.2.4: Sidewalk blocked by parking of vehicles	62
Plate 4.3.2.5 : Some areas of Piliyandala – Kottawa road with no sidewalks	63
Plate 4.3.3.1. Bus bays at Moratuwa and Kollupitiya at Galle road	64
Plate 4.3.3.2 : Marked bus stops at Piliyandala – Katubedda road	64
Plate 4.3.4.1: Signboards displayed at the Galle road	65
Plate 4.3.4.2: Road markings at the Galle road	65
Plate 4.4.1.1 : Wide sidewalks	66
Plate 4.4.2.1 : Tactile pavings	67
Plate 4.4.3.1 : Sheltered walkways in Singapore city	67
Plate 4.4.4.1 : Overpasses at Singapore city	68
Plate 4.4.5.1: Underpasses	68
Plate 4.4.6.1 : Streets for pedestrians in Tokyo, Japan and Glasgow, UK	69
Plate 4.4.7.1 : Public area at Glasgow, UK	69
Plate 4.4.7.2 : Public area at Westminster, London, UK	70
Plate 4.4.8.1 : Roadside seating at Tokyo, Japan and Aberdeen, UK	70
Plate 4.4.9.1 : Instructions given at a crossing, Aberdeen, UK	71
Plate 4.4.9.2: Signboards at Aberdeenshire and London, UK	71

Plate 4.4.10.1 : Lifebuoy at Greenwich, UK	72
Plate 4.4.11.1 : Bus stops at Aberdeen and Singapore	73
Plate 4.4.12.1 : Taxi stops at Singapore and Aberdeen, UK	73
Plate 4.4.13.1 : Bicycle sharing facilities	74
Plate 4.4.14.1 : Bicycle parking and riding lanes at Union Street, Aberdeen, UK	74
Plate 4.4.15.1 Street lights operated at Great Southern Street, Aberdeen, UK	75
Plate 4.4.16.1: Roads with marked speed limits at Glasgow	75
Plate 4.4.17.1: Traffic calming humps at Aberdeen, UK	76
Plate 4.4.18 .1 : Trees planted at roadsides in Aberdeen and Tokyo	76
Plate 4.4.19.1 Daily cleaning of roads at Aberdeen, UK	77
Plate 4.4.20.1: Barricaded construction in Singapore	77
Plate 4.7.2.1: An exclusive pedestrian phase of a junction	83

List of Abbreviations

UK - United Kingdom

RDA - Road Development Authority

Km - Kilo meters

USDOT - United States Department of Traffic