ROAD SAFETY OBSERVATORY

UNDERSTANDING PEDESTRIAN USE OF CROSSING FACILITIES IN MAURITIUS

(PROJECT CODE K0532)

JULY 2021

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TMRSU
Safer Roads and Mobility

Research Report Documentation Page

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Abstract

With an average of approximately 145 road traffic fatalities over the past 5 years in Mauritius, the TMRSU has recognized the need for carrying out research on road safety issues to ensure evidence-based policy decisions. Pedestrians being categorised as vulnerable road users, this study aims at investigating pedestrian usage of crossing facilities in Mauritius through the use of data obtained from Statistics Mauritius and the IMAAP database and questionnaire surveys carried out on field and online to capture the reported perceptions and attitudes of people on the pedestrian facilities and environment.

Analysis of the data have yielded various findings showing that pedestrians comprise individuals with diverse needs and capabilities, who may act differently as the settings change. Therefore, a combination of measures is needed in order to comprehensively address the range of risks to pedestrians in different settings. Interventions that have been found effective from literature include reducing vehicle speeds, separating pedestrians from other traffic, increasing the visibility of pedestrians, changing pedestrian and motorist behaviour through public education and law enforcement, improving vehicle design and improving care for the injured

Based on the situational assessment for Mauritius, it is recommended to create a pedestrian safety action plan as the next step. This plan of action should set out a strategy for improving pedestrian safety in the setting under consideration while providing a framework to organize interventions in a strategic manner and facilitate evaluation of progress over time. This plan should have clearly set objectives, which are evidence-informed and SMART and allow for both short-term and medium- to long-term realistic targets to be set, with key performance indicators identified to measure progress being made.

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Pedestrian crossings, pedestrian attitudes and behaviour, Safe System approach Theory of Planned Behaviour, pedestrian perceptions, pedestrian environment.	Document available upon request from the TMRSU

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Executive Summary

In 2010, the United Nations General Assembly (resolution 64/255) proclaimed a Decade of Action for Road Safety. As part of the Sustainable Development Goals (SDGs), the goal of the Decade (2011-2020) is to stabilize and then reduce the forecast level of road traffic deaths around the world, while also making the transport system safer by 2030. These objectives fall under the SDG Goal 3 Target 3.6 – Halving the number of global deaths and injuries from road crashes and SDG Goal 11 Target 11.2 – Providing access to safe, accessible and sustainable transport systems for all.

Pedestrians account for around 20% of road deaths annually in Mauritius. This research has been carried out to gain a better understanding of pedestrian use of crossing facilities by investigating underlying factors such as community perception, attitudes and behaviour at crossings as well as personal, social and environmental factors influencing safe pedestrian behaviour. The project had three components: a literature review; analysis of available data from authorities and surveys with pedestrians.

The literature review identified that the occurrence of pedestrian crashes is influenced by age, gender with young males being over-represented in collisions both as pedestrians and drivers. The road environment has also been found to have a significant role with urban areas, night-time and crossing outside pedestrian facilities being important contributors to pedestrian crashes. The literature has also shown that although pedestrians are generally aware of the rules, they are willing to take risks if this allows them to save time and cover less distance. Finally, various countermeasures that have been found to effectively address pedestrian safety issues have been provided.

An assessment of the evolution of the pedestrian safety situation has been carried out using data obtained from Statistics Mauritius and the IMAAP database from the Traffic Management and Road Safety Unit (TMRSU). Statistics over the past decade show an average of 600 pedestrians involved in crashes annually with people above 45 years being particularly vulnerable to fatal collisions. Analysis of the IMAAP data has allowed the identification of crash clusters and critical road stretches in Mauritius.

To understand the pedestrian perception of crossing facilities and road environment as well as the factors that influence their attitudes and behaviour, a survey questionnaire has been devised and administered

both in the field and online. The surveys have attempted to gather information at identified blackspots while also capturing respondents from varying backgrounds in terms of age, gender, geographical location, educational level and physical ability. 1382 persons participated in the survey, with the main findings after analysis being regrouped under different themes:

Crossing facilities in high speed environment

- Irrespective of their age category or gender, respondents generally perceive road crossing facilities as slightly safe.
- Pedestrians generally prefer grade separated facilities for crossing dual carriageways and high speed roads. However, females, elderly persons and pedestrians with poor mobility or poor vision generally view footbridges as unsafe.
- Signalised pedestrian crossing across the motorway have the poorest safety perception level amongst the three facilities considered.

Crossing facilities in urban environment

- People with physical impairments find the zebra crossing in an urban environment unsafe although other pedestrians perceive it as safe.
- More than 8 out of 10 respondents found the pelican crossing as safe. However, the percentage of people above 45 years old who view this facility as unsafe is higher as compared to the younger age groups, indicating that older people may be having difficulties at signalised crossings due to inadequate green times.
- The speed table with pedestrian crossing is the facility that is viewed as safe by the largest number of respondents (88%). People with mobility or vision impairment also prefer this facility.

Pedestrians' travel motivations

- Most participants have rather positive travel motivations, with 3 out of 4 persons claiming to enjoy walking and 86% walking because of its health benefits.

- 70% of interviewees stated that they often/always walk for short trips. However, more than 50% of people do not walk to go to work, suggesting that there is a strong car dependency when it comes to travelling to work

Pedestrians' behaviour at/near crossing facilities

- Although the majority of respondents stated that they do not cross when the priority is for vehicles or when the pedestrian light is red, 25% of respondents have stated that they engage in non-compliant behaviour at signalised crossings. Almost 40% of interviewees have admitted that they cross outside pedestrian crossing when they are in a hurry or when they are in urban areas. Furthermore, 60% of persons indicated that they cross outside pedestrian crossings even if there is one less than 50m away. The findings suggest that time savings and convenience are determinant factors for pedestrians.
- Males are slightly more prone to take risks while age plays a more prominent role with people less than 30 reporting that they are more likely to engage into behaviour that put them at risk. People over 60 are less likely to take risks while crossing the road.

Pedestrians' behaviour when crossing the road

- Results indicate that trip purpose has a strong correlation with risk taking attitudes, with people regularly engaged in walking as leisure activities more likely to engage in risky behaviour compared with persons who walk mainly to go to work.
- Although results indicate that people are likely to use pedestrian crossing facilities correctly in general but when presented with some situations, pedestrians will engage in a non-compliant behaviour, with the scenarios being when people need to cross the road between vehicles during traffic jams and when people are walking with friends.
- Age seems to have a significant relevance with those aged between 18 and 30 years old being the group with the most self-reported non-compliant behaviour when crossing the road in certain scenarios.

- The survey results also suggest that people tend to engage in risky pedestrian behaviour or non-compliance with rules in certain districts more than in others, with Port Louis, Pamplemousses and Grand Port being the ones faring the poorest.

Pedestrians' attention to the road environment

- The majority of respondents (8 out of 10) stated that they were attentive/alert while crossing the road, whether they are alone or in groups.
- Among those who have reported having lapses in attention while crossing the road, young adults less than 30 years old are more prevalent.
- It is noted that when pedestrians are accompanied by others, they tend to forget the danger or take a greater risk, with only 4 out of 10 stating that they would walk in a single file.
- Pedestrians sometimes cross several streets and intersections without paying attention to traffic or even when in conversation with someone.

Pedestrians' perception on road crossing

- Results indicate that 50% of persons surveyed perceive crossing the road as a difficult task occasionally, with 29% of interviewees stating that this often/always presents a difficulty to them. These comprise largely of people who have reduced mobility levels.
- The survey also indicated that a high percentage of respondents view crossing the roads outside pedestrian crossing as wrong or as an act that increases the risk of accident. However, approximately 20% of respondents think that these acts do not constitute wrong or risky behaviour.
- Although pedestrians often know that crossing roads is difficult and is wrong outside pedestrian crossing, they sometimes cross outside crossings to save time but at a risk of a crash. Findings indicate that more that 50% of respondents think that crossing outside pedestrian crossings helps in saving time, with 29% stating that they are not likely to make a detour in order to find a protected crossing facility. 34% of persons interviewed also stated that they will take risks while walking if this allows them to save time.

- Although routes with signalised crosswalks are preferred by 75% of respondents, 25% do not prefer these types of facilities while walking and this may be due to the delay associated with signalised crossings.

Pedestrians' perception related to drivers

- According to respondents, car drivers are more likely to stop compared to other vehicle drivers, with motorcyclists and cyclists being the least likely to give way to pedestrians at crossings.
- Respondents also confirmed that car drivers are more likely to reduce their speed when approaching a crossing facility, with motorcyclists and cyclists being the least likely to do so.

Pedestrians' perception on sensitisation campaigns

- Approximately 60% of both male and female interviewees have acknowledged hearing or seeing sensitisation campaigns on road safety for pedestrians but 1 in 4 persons have stated that they have not been exposed to any.
- In terms of the effectiveness of the sensitisation campaigns, less than 20% of respondents have stated that these have had a positive impact on people's behaviour when crossing streets, with the large majority thinking that the campaigns are not effective.

The questionnaire also made provision to collect the views of persons on road safety for pedestrians. Comments made were varied but could be grouped into 3 main categories: pedestrian behaviour, pedestrian environment and the suggestions for improvement. Interviewees have identified poor behaviour of pedestrians and drivers as a major issue and have suggested greater enforcement of laws. Respondents have also requested for better infrastructure provision for pedestrians in terms of greater footpath width and better maintenance of facilities, lighting, safety barriers and video surveillance provision as well as crossings at appropriate locations. They have also requested for educational and sensitisation campaigns.

From the literature review and analysis of data, it is clear that pedestrians comprise individuals with diverse needs and capabilities, who may act differently as the settings change. Therefore, a combination of measures is needed in order to comprehensively address the range of risks to pedestrians in different settings. Interventions that have been found effective from literature include reducing vehicle speeds, separating pedestrians from other traffic, increasing the visibility of pedestrians, changing pedestrian and motorist behaviour through public education and law enforcement, improving vehicle design and improving care for the injured.

While the provision of specific recommended measures does not form part of the scope of this study, the following measures have been proposed for consideration and further investigation to improve the pedestrian safety situation in Mauritius:

- An integrated approach to pedestrian safety, in keeping with the principles of a safe system and incorporating educational, enforcement and engineering measures should be considered and adopted where possible in the planning and design phase of new or upgrading projects.
- Development of a Pedestrian Facility Audit and Selection Tool which will allow for carrying out road safety audits of pedestrian infrastructure and to select the most appropriate type of pedestrian safety measures based on walkability, safety and economic outcomes.
- Implementing an asset management framework for road infrastructure, which will allow identification of funding and maintenance needs to optimise the performance of the transportation system with respect to road safety.
- Adopt the eight strategic principles of the International Charter for Walking whenever new developments are being undertaken. Existing guidelines such as the PPG should be reviewed to make better provisions for walking, while engineering standards and guides should be developed for transport infrastructure in Mauritius to ensure that new constructions are more pedestrian friendly.

- With the implementation of the Metro Express, particular attention should also be given to pedestrians at rail-grade crossings as this presents an unfamiliar crossing environment. Adequate warning of approaching Light Rail Vehicles should be provided together with pedestrian-focused measures.
- Incorporate greater use of intelligent transportation systems (ITS) to create smarter roadways.

- Pedestrianisation of streets with high pedestrian flows.
- Improve the enforcement of good behaviour from all road users
- Implementation of targeted sensitisation campaigns for all age groups.
- Improve the safety of vehicles for pedestrian protection through regulations on new vehicles.

Areas for future research to gain a better understanding of pedestrian safety and countermeasures have also been proposed in the report.

This study has carried out a situational assessment of pedestrian safety in Mauritius and constitutes a first step in understanding the local pedestrian safety situation. The information gathered can be used to make decisions on priority focus areas, the best approaches to improve pedestrian safety, and whether to strengthen existing plans and programmes or develop new initiatives.

Based on the situational assessment for Mauritius and list of measures that have been implemented successfully in other countries, it is recommended to create a pedestrian safety action plan as the next step. This plan of action should set out a strategy for improving pedestrian safety in the setting under consideration while providing a framework to organize interventions in a strategic manner and facilitate evaluation of progress over time. This plan should have clearly set objectives, which are evidence-informed (i.e. derived from literature and local studies) and SMART (specific, measurable, achievable, relevant and time-bound) and allow for both short-term and medium- to long-term realistic targets to be set, with key performance indicators identified to measure progress being made.

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CHAPTER 1.0

INTRODUCTION

1.0 INTRODUCTION

1.1 Context of the Study

Currently estimated to be the eighth leading cause of death across all age groups globally, road traffic crashes result in the deaths of approximately 1.35 million people annually, while being also responsible for non-fatal injuries to as many as 50 million people (WHO, 2018). The study also reveals that the young are particularly vulnerable on the roads worldwide, with road traffic crashes being the main cause of death among people aged between 15 and 29 years while more than half of the people who die on the world's roads are pedestrians, cyclists and motorcyclists. These statistics make road safety not only a national priority but also a global challenge.

In 2010, the United Nations General Assembly (resolution 64/255) proclaimed a Decade of Action for Road Safety. As part of the Sustainable Development Goals (SDGs), the goal of the Decade (2011-2020) is to stabilize and then reduce the forecast level of road traffic deaths around the world, while also making the transport system safer by 2030. These objectives fall under the SDG Goal 3 and 11, as explained in figure 1 below.

Figure 1: Road Safety-related SDGs and targets

Despite the commitment of world leaders to the attainment of the Sustainable Development Goals, the figures worldwide from the WHO and other road safety agencies show that there is still a long way to reversing the current trend in road crashes. It is essential for road safety to become a top priority for the global community, with the aim to establish adequate legal frameworks, expanding safe public transport systems and formulating national road safety strategies and plans.

In line with the Sustainable Development Goals, Mauritius adopted the National Road Safety Strategy (NRSS) in May 2016 with the objective of reducing the number of fatalities by 50% by the year 2025. Among the ten strategies identified for the NRSS are the delivery of road safety education, improving safety standards of our road infrastructure and implementing a research and development programme. The key agency advocating for road safety is the Traffic Management and Road Safety Unit (TMRSU), which is under the aegis of the Ministry of Land Transport and Light Rail. The main responsibilities of the TMRSU related to road safety include:

- Ensuring road safety through engineering measures;
- Developing Education and Training programs (ETP) on road safety and conducting mass media sensitization campaigns;
- Building and maintaining a comprehensive injury road crash database with the Road Crash Data Management system and;
- Implementing and managing traffic control measures such as traffic lights, traffic signs, road markings and parking restrictions.

1.2 Aim and Objectives of Report

With an average of approximately 145 road traffic fatalities over the past 5 years in Mauritius, the TMRSU has recognized the need for carrying out research on road safety issues to ensure evidence-based policy decisions. The National Road Safety Observatory (NRSO) which is a collaboration between the Traffic Management and Road Safety Unit (TMRSU) and the University of Mauritius was launched on 5 March 2020. The NRSO will serve as a Centre of Excellence for road safety in Mauritius, engaging in research on various themes pertaining to issues being encountered by the TMRSU, road users and transport infrastructure users.

Pedestrians being categorised as vulnerable road users, this study aims at investigating pedestrian usage of crossing facilities in Mauritius. The document sets out the methods and findings in relation to each of the key project objectives:

1. Assessment of the pedestrian safety situation
2. Identification of pedestrian blackspots in Mauritius
3. Investigating pedestrian perception of crossing facilities
4. Identification of underlying factors that influence pedestrian informal behaviour on the pedestrian crossing facilities (age, gender, education, familiarity, size of groups, purpose of trip)
5. Exploring the general behaviour of pedestrians along roads and at crossing facilities
6. Investigating pedestrian perception on ease of crossing roads and attitudes of other road users at crossings.
7. Assessment of pedestrian perception on road safety campaigns.
8. Identifying areas for future research concerning pedestrians and related facilities.

1.3 Structure of Report

To address the objectives set, the report begins with a critical review of the literature in relation to pedestrian crossings, behaviour and perception. This is presented in Chapter 2, which provides the background to the problem of pedestrian safety at road crossings and an overview of factors that influence pedestrian behaviour and safe road use. Finally, countermeasures to improve pedestrian safety that have been trialled internationally and evidence of their effectiveness is discussed.

Objectives 1 and 2 were met by using available data for Mauritius, which was obtained from Statistics Mauritius, and the IMAAP software made available by the TMRSU. These have helped to assess the road safety situation in Mauritius and identify blackspot locations for pedestrian crashes. The findings are given in Chapter 3.

In order to meet Objectives 3, 4, 5, 6 and 7 for this project, two empirical studies were conducted: an intercept interview (in-person survey) and an online survey. The focus in the intercept interview was to gather data on pedestrians at or in the neighbourhood of blackspot locations identified from IMAAP as far as possible. The online survey was intended to obtain a larger sample of pedestrians drawn from a more diverse and broader population of pedestrians than was possible in the intercept interviews. A description of the rationale, approach and method is presented in Chapter 4.

The results and findings from these studies are presented in Chapter 5.

Lastly, objective 8 is addressed in the conclusions and recommendations in Chapter 6.

Chapter 1 Introduction	This chapter will provide a background to the issue of road safety before providing the aims of the report and its structure.
Chapter 2 Literature Review	The chapter consists of a critical review of the international literature in relation to pedestrian crossings, behaviour and perception.
Chapter 3 Pedestrian road safety situation in Mauritius	The road safety situation in Mauritius will be discussed using data available from Statistics Mauritius and IMAAP software from the TMRSU.
Chapter 4 Methodology	The rationale for adopting the methods used to carry out the study will be detailed in this chapter.
Chapter 5 Results and Findings	The chapter will provide details on the findings of the study on pedestrian use of pedestrian crossings.
Chapter 6 Conclusions and Recommendations	The recommendations and way forward will be set out in the concluding chapter.

CHAPTER 2.0

LITERATURE REVIEW

2.0 LITERATURE REVIEW

2.1 Road safety in the international context

Safe, efficient, low carbon, and affordable mobility for all is essential to sustainable human development. Transport is the engine of the economy with people all over the world depending on a variety of transport modes to earn their livelihood, access essential goods and services, attend educational institutions and ultimately, enhance equal opportunities to participation in society (SLoCaT, 2019). With economic growth and increased urbanisation, many countries are however experiencing transport-related problems as the infrastructure is unable to cope with increasing travel demand. These problems include an increased number of road crashes, which in addition to the grief and suffering they cause, constitute an important public health and development problem with significant socioeconomic costs (WHO, 2018). Several measures have been taken worldwide to curb the rise in road crashes, but the progress made varies significantly among regions and countries, with a strong association between the risk of death from road fatalities and income level of countries as shown in Figure 2 below.

Figure 2: Number of countries where a change in the number of road traffic deaths has been observed

The data indicate that while there has been progress in reducing the number of road traffic fatalities in some middle-income and high-income countries, an increase has still been noted in more than 100 countries for road deaths.

In November 2017, United Nations Member States reached consensus on a set of 12 Voluntary Global Performance Targets for Road Safety Risk Factors and Service Delivery Mechanisms (detailed in Figure 3). These voluntary targets provide a framework to guide and monitor the implementation of legislation, the establishment of standards and other interventions to prevent road crashes and related injuries, and deaths.

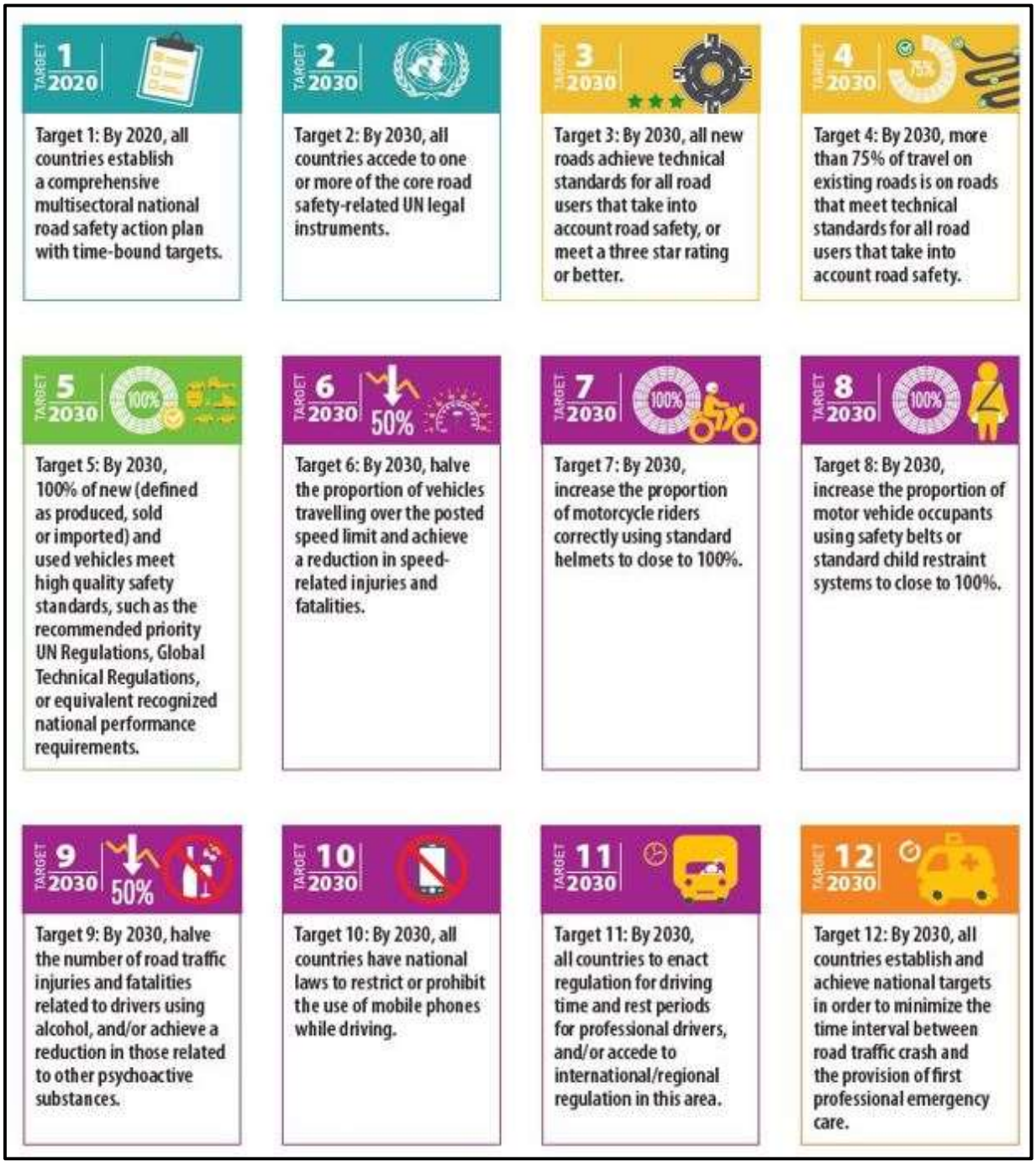


Figure 3: Global Voluntary Performance Targets for Road Safety Risk Factors and Service Delivery Mechanisms, 2017

The aim of setting the twelve targets is to ensure that measures to improve the road safety situation will be taken in a planned approach in order to achieve the desired outcomes and make the required impacts. This 3-stage logic, which is applicable to any area of road safety, is displayed in Figure 4 below – with speeding used as an example.

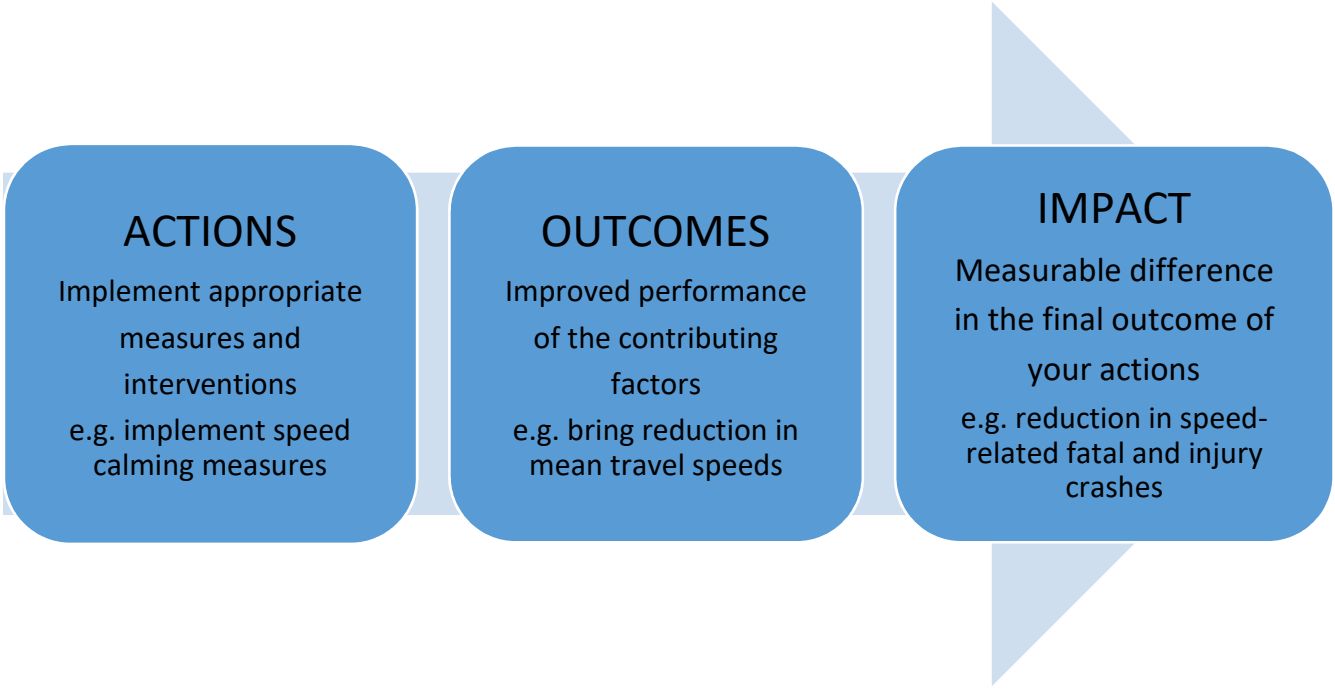


Figure 4: Three-state logic for road safety measures

2.2 Approaches to improving road safety

2.2.1 Vision Zero

Improving road safety will require action to address all areas covered by the 12 targets, not just one. Over the past two decades, two main approaches have been adopted by various countries around the world, namely the Vision Zero and the Safe System Approach.

The Vision Zero was established in the Swedish Law in 1997 and is the Swedish approach to road safety thinking (STA, 2012). It is based on the ethical standpoint that no one should be killed or seriously injured for life in road traffic, with the only acceptable figure for the number of fatalities and serious injuries resulting from road crashes being zero. Road safety in the spirit of Vision Zero means that roads,

streets and vehicles must be much more adapted to human capacity and tolerance. The responsibility for safety is shared between those who design and those who use the road transport system. The approach recognizes the fact that human beings are not infallible and that the road transport system must be designed so that any mistake will not cause serious or fatal injury (STA, 2012). The key differences with the traditional approach of designing infrastructure is illustrated in Figure 5.

Figure 5:Traditional v/s Vision Zero approaches to road safety

Since the adoption of Vision Zero, significant changes have been brought in the road infrastructure in Sweden geared towards reducing the risk of serious human injury (STA, 2012). This approach has also been gaining acceptance across Europe and is becoming popular in American cities.

2.2.2 Safe System Approach

The Safe System Approach has evolved from 'Vision Zero' and 'Sustainable Safety' and is sometimes termed 'Towards Zero'. It is based primarily on Vision Zero, recognising that human beings' lives and health should never be compromised by their need to travel. This is considered best practice in road safety according to the World Health Organisation and the Organisation of Economic Cooperation and Development (OECD, 2016). The key principles of the Safe System (Austroads, 2016a) are:

- People make mistakes that lead to road crashes - Human error is human nature and is to be expected. This is because human beings cannot be relied upon to repeatedly perform correctly in all traffic conditions at all times, even if they intend to behave safely on the roads.

- The human body has a limited physical ability to tolerate crash forces before harm occurs - The human body can only withstand a certain level of kinetic energy before a crash will result in death or serious injury.
- Road Safety and the reduction of crashes resulting in death or serious injury is a shared responsibility for those who design, build, manage and use roads and vehicles and those who provide post-crash care.
- All parts of the system must be strengthened in combination to multiply their effects, so that if one part of the system fails, all road users are still protected.

The Safe System vision proposes a holistic approach to achieve these objectives. This approach involves careful consideration of interactions between road infrastructure, travel speeds, road users and vehicles. The safe system approach has been adopted by several OECD countries, including Australia and New Zealand. Transport for London's (TfL) 'Safe Streets for London' plan was also based on the pillars of the Safe System approach with the aim of encouraging a common approach to road safety among the organisations involved in the management of the road transport system in London (TfL, 2013).

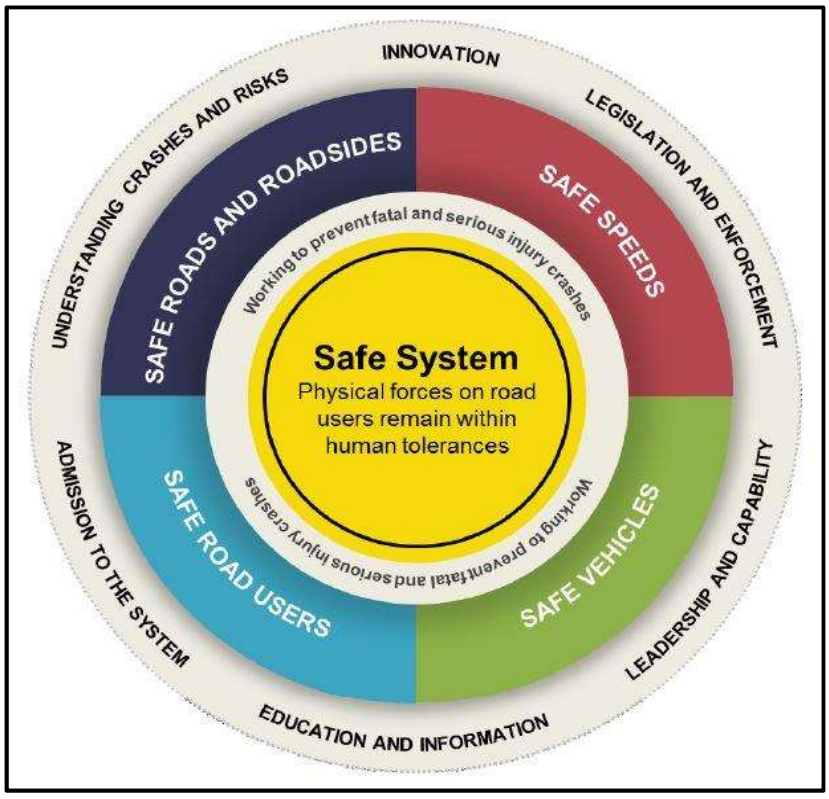


Figure 6: Safe system approach to road safety (Austroads, 2015)

2.2.3 International Road Assessment Programme

iRAP (the International Road Assessment Programme) is the umbrella programme for Road Assessment Programmes (RAPs) worldwide using an evidence-based approach to help in improving road infrastructure and reduce the number of deaths and injuries from road crashes. The programme involves calculation of Star Ratings for road infrastructure based on road inspection data and provides a simple and objective measure of the level of safety which is 'built-in' to the road for vehicle occupants, motorcyclists, bicyclists and pedestrians (irap.org, 2021). A 1-star rating is the least safe and a 5-star road is the safest. The fatal and serious injury crash rates are typically 30-50% lower for each incremental improvement in star rating (OECD, 2016).

Under the 'Vaccines for Roads' programme, iRAP has summarised a sample of road infrastructure assessments on 358,000 km of road from 54 countries worldwide where more than 700 billion km of vehicle travel occurs every year. Results show that there is scope for much improvement to make roads safer worldwide.

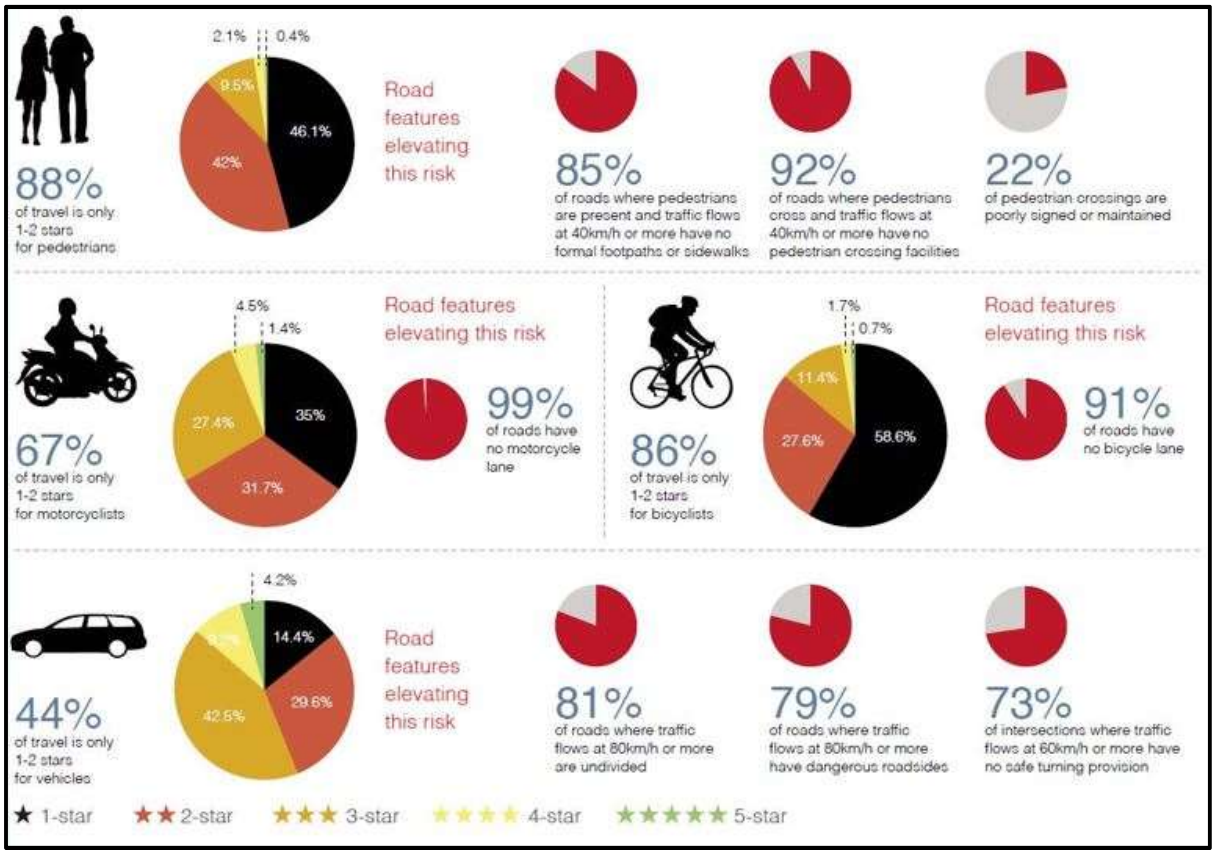


Figure 7: Vaccines for Roads Study based on 358,000km of roads across 54 countries

2.3 Pedestrians as road users

Most transport trips involve walking at the start and end of trips. As well as being a fundamental mode of travel and an essential part of any successful transport system, walking is increasingly acknowledged as providing a wide range of benefits in terms of health, social inclusion, environmental improvements, liveability of cities and economic opportunities (Walk21, 2016).

Box 1: Who is a pedestrian?

Various definitions have been provided for pedestrians and pedestrian movement:

A pedestrian is any person who is travelling by walking for at least part of his or her journey. In addition to the ordinary form of walking, a pedestrian may be using various modifications and aids to walking such as wheelchairs, motorized scooters, walkers, canes, skateboards, and roller blades. The person may carry items of varying quantities, held in hands, strapped on the back, placed on the head, balanced on shoulders, or pushed/pulled along (GRSP, 2013).

Pedestrians are people who walk, sit, stand in public spaces, or use a wheelchair, be they children, teens, adults, elderly, people with disabilities, workers, residents, shoppers or people watchers (SDRPA, 2002).

Pedestrian movement is the generally regular and predictable flow of pedestrian traffic in a public area, such as a shopping mall, plaza, or street intersection. Despite apparently random patterns of foot traffic, pedestrians usually follow the most direct route to a destination, which may or may not conform to the pathways planned and constructed for pedestrian movement (APA, 2021).

The EU funded Civitas FLOW project carried out in 2020 in different cities came up with the following findings on the effect of walking and walking spaces on traffic congestion (H2020-flow.eu., 2021):

- Pedestrianisation improves mobility and accommodates 700 more people during rush hour (Dublin, Ireland)
- Narrowing roads to reduce pedestrian crossing distances does not increase congestion (Lisbon, Portugal)
- Pedestrian improvements reduce bus travel times by 40% (Strasbourg, France)

- New pedestrian plazas reduce journey times for taxis and buses by 15% (New York, USA).

The findings illustrate the importance of walking in the improvement of mobility and making our transport system more sustainable. Yet, pedestrians are a vulnerable group of people and safety concerns are a significant barrier in one's decision to walk (Chen et al, 2014).

2.4 Pedestrians and road crashes

Unlike driving, where public activity is completely regulated and there are access restrictions (i.e. driver licensing), walking is a natural and largely unregulated activity undertaken from childhood onwards as an incidental part of everyday life. Crossing or walking along roads forms a minor part of total walking, but presents the highest risk because of the interaction with motor vehicles (Austroads, 2016*b*). Pedestrians are therefore classified as an important category of the vulnerable road user group. Globally, pedestrians and cyclists represent 26% of all deaths, with those using motorized two- or three-wheelers comprising another 28%. Africa has the highest proportion of pedestrian and cyclist mortalities with 44% of deaths (WHO, 2018).

In a vehicle-pedestrian collision, the probability of survival for the pedestrian decreases dramatically at impact speeds above about 30 km/h. Results from on-scene investigations of collisions involving pedestrians and cars show that about 90% of pedestrians survive when hit by a car at speeds of 30 km/h; whereas less than 20% survive at speeds over 50 km/h (OECD & ECMT 2006).

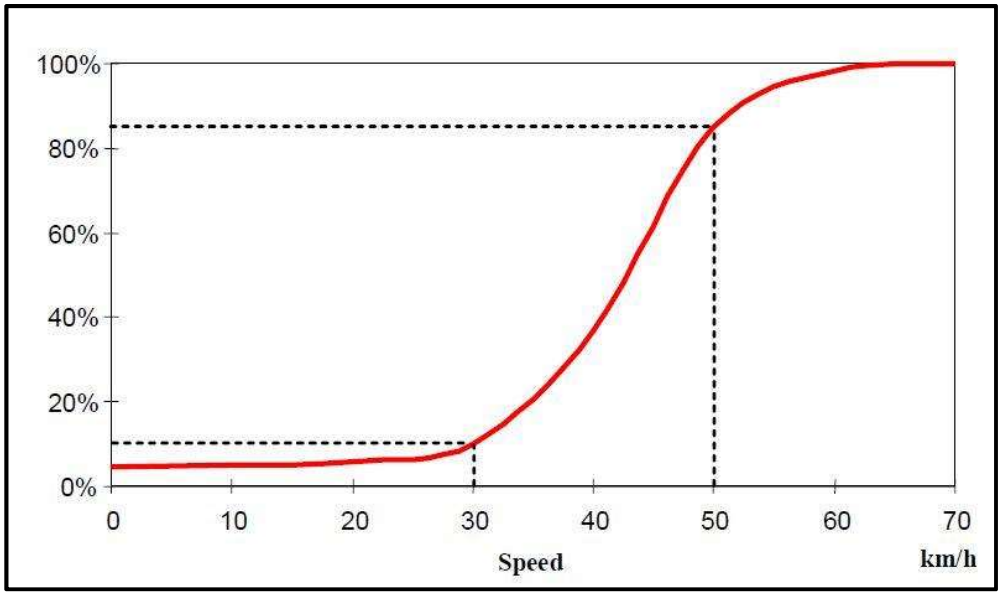


Figure 8:Probability of fatal injury for a pedestrian colliding with a vehicle (OECD & ECMT 2006)

Reduction or elimination of the risks faced by pedestrians is an important and achievable goal. Pedestrian collisions, like other road traffic crashes, should not be accepted as inevitable because they are, in fact, both predictable and preventable (WHO, 2018). There is a close association between the walking environment and pedestrian safety. Walking in an environment that lacks pedestrian infrastructure and that permits use of high-speed vehicles increases the risk of pedestrian injury. The risk of a motor vehicle colliding with a pedestrian increases in proportion to the number of motor vehicles interacting with pedestrians (Jacobsen, 2003).

Box 2: Who are killed and injured as pedestrians?

Pedestrians form a mixed group of people with respect to age, gender and socioeconomic status. Characteristics of killed or injured pedestrians vary widely across countries and regions. However, from previous studies, young males contribute significantly to pedestrian casualties.

Age

Pedestrian crashes affect people from different age groups, though some age groups may be represented more than others in certain settings.

Pedestrians aged between 10 and 19 account for the majority (21 per cent) of pedestrians killed or seriously injured (KSIs) in road crashes (DfT, 2015).

In New South Wales, Australia, in 2010, 20% of pedestrians killed were less than 21 years old, and 29% were aged between 21 and 40 years.

Sex

Male pedestrians, both children and adults, have been found to be over-represented in pedestrian collisions.

A study conducted in the United States found that males accounted for 70% of pedestrian deaths, with a fatality rate of 2.19 deaths per 100 000 population, compared to a female fatality rate of 0.91 per 100 000 (TRB, 2005).

Young male pedestrians between the ages of 10 and 19 are the most over-represented male group as pedestrian KSI. In 2013 they comprised of 22 per cent of male pedestrian KSIs. A similar pattern is evident for male pedestrians over the age of 70 (DfT, 2015).

2.5 Pedestrians Road crash environment

Overall, there is wide variation in different countries in the road environment in which pedestrian road crashes occur. While pedestrian collisions occur more in urban areas than rural settings in high-income countries, the opposite is true in some low- and middle-income countries.

A study on pedestrian crash locations in North Carolina using data from 2012 to 2016 showed that pedestrians overall are most often (62%) in a regular travel lane (i.e. outside intersections), not in a crosswalk area (17%), intersection (3%), or other type of location (driveway crossing, paved shoulder) when struck (HSRC, 2018). This was explained by the fact that pedestrians may be less anticipated by motorists when crossing at a location not associated with an intersection as there may be no crosswalk markings or lighting enhancements and motorists may not be slowing in anticipation of turns or stopping for traffic controls.

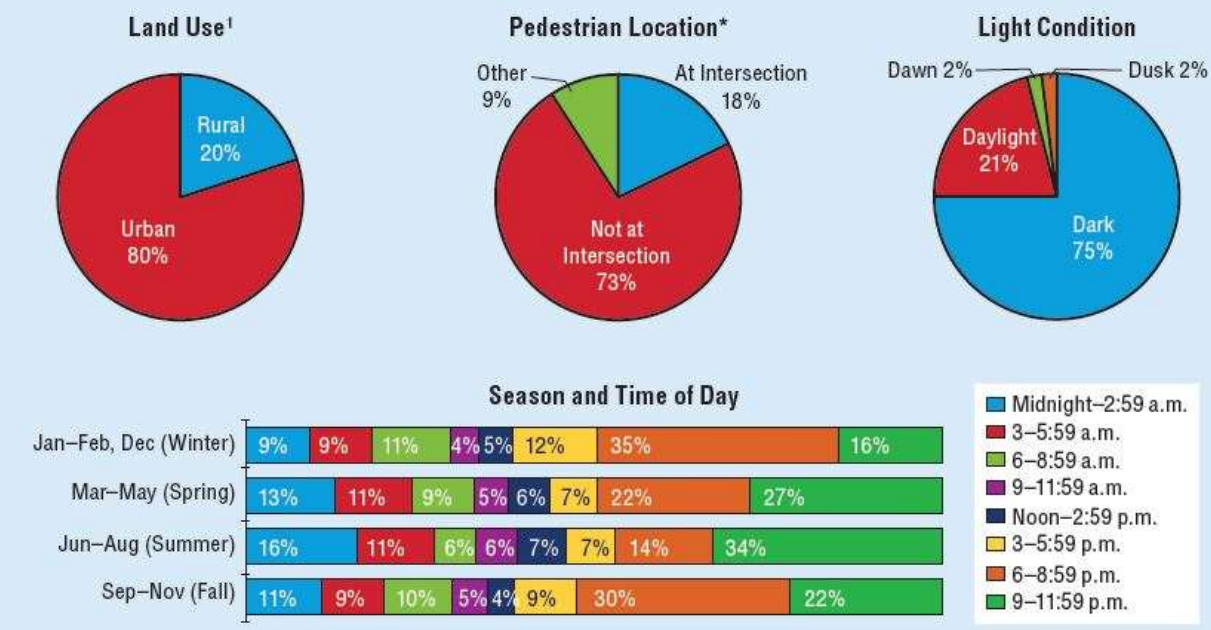
These relate to findings from a study carried out by the NHTSA in 2017, which indicated that most of the pedestrian fatalities did not occur at intersections (73%) as opposed to those that occurred at intersections (18%). The remaining 9% occurred at other locations such as roadsides/shoulders, parking lanes/zones, bicycle lanes, sidewalks, medians/crossing islands, driveway accesses, shared-use paths/trails, non-traffic way areas, and other sites.

In the United Kingdom, urban roads account for more than four fifths of pedestrian KSI casualties across all road types in 2013 (DfT, 2015), with 83 per cent of casualties occurring on urban roads, 16% on rural roads and only 1% on motorways. The report also indicated that over half of pedestrian KSI casualties are in accidents reported in areas away from pedestrian crossings (51%), with a further 14% occurring at pedestrian crossing points and 11% occurring within 50 metres of pedestrian crossings in 2013.

However, studies have also shown that in some countries pedestrians who commute in rural areas were more likely to suffer injuries than pedestrians who commuted in urban areas. For example, a study of university students in Cairo, Egypt, found that participants who resided in rural areas were significantly more likely to suffer pedestrian injuries than those who resided in urban areas (Ibrahim et al., 2012).

Night-time travel is one of the greatest risk factors for pedestrians (Kwan et al., 2009). According to a study carried out by Griswold et al. in 2011, twilight and the first hour of darkness typically see a high frequency of pedestrian collisions in the United States and in most other countries. The most plausible explanations for this situation are that: (1) dusk is a time when glare and associated reduced visibility occurs for both drivers and pedestrians westerly facing; (2) reduced visual contrast during the transition from daytime to darkness makes headlights less effective; (3) vision adapts more easily outside of a car, so that pedestrians are less aware of the reduced visibility of drivers; (4) pedestrians and/or drivers do not compensate appropriately for the reduced visibility and increased crash risk of pedestrians during these times (Grisword et al., 2011). Other studies have also concurred with this finding with night-time identified as an aggravating factor in crashes involving pedestrians (HSRC, 2018). The study carried out by the NHTSA in 2017 on pedestrian crashes also indicated that more pedestrian fatalities occurred in the dark (75%) than in daylight (21%), dusk (2%), and dawn (2%).

Box 3: Percentage of pedestrian fatalities in relation to road environment



Source: NHTSA, 2017. Traffic safety facts, 2017.

Pedestrian crashes also depend on the time of the year and day of the week. For example, during the month of December in the United States, collisions are concentrated around twilight and the first hour of darkness throughout the week whereas in June, collisions are concentrated around twilight and the

first hours of darkness on Friday and Saturday (Griswold et al., 2011). In Europe Union countries in 2016, the highest percentage of pedestrians killed in road crashes was recorded on Fridays and Saturdays, while the lowest was recorded on Sundays. Moreover, there is an increase in pedestrian fatalities during the winter months which is probably due to the duration of darkness/twilight being longer than in other seasons making pedestrians much less visible (ERSO, 2018).

2.6 Pedestrians crashes while crossing the road

Even though pedestrian exposure to traffic when crossing represents a small part of total walking activity, most serious injuries and deaths to pedestrians occur when they are hit by motor vehicles while crossing the road. For example, a study by the Department for Transport in 2015 in the UK found that pedestrians are more likely to be killed or seriously injured while crossing the road. Of the 5,396 pedestrian KSIs occurring in 2013, 62% of these occurred when the pedestrian was crossing the road without being masked by a stationary vehicle, and 15% where they were masked by a stationary vehicle while crossing. A further 17% were killed or injured in a carriageway but not crossing or on a footway or verge (DfT, 2015).

Pedestrians' crossing behaviour is strongly related to human and environmental factors which makes it complex, subjective and random. Pedestrians' decision making about where to cross or when to cross can be described as the process of perception-judgment-decision-action (Guo et al., 2014). Psychological processes such as detection, recognition, identification, and decision making are required as before crossing the street, the pedestrian needs to scan the road, perceive traffic and make judgments about the distance, speed and direction of vehicles. Based on this information, he or she makes a decision as to whether or not to cross the road at that moment. Moreover, there are various other factors that impact the pedestrian behaviour and safety - environment (road type, width, intersections, crosswalks, surfaces, lighting), traffic (volume, moving and stationary vehicles, communication), personal (physical, psychological, personal characteristics, motivation, experience, psychological state), and social (presence of others, purpose of journey, play). Thus, crossing the street can be more complex than one might think (CCMTA, 2013).

Pedestrians crossing the road using unsafe means are more exposed to the risk of crashes compared to those walking on footpaths. Furthermore, crossing at unmarked mid-block sections increases the chances of a crash compared to crossing on a marked or signalized crosswalk. In a marked crossing, (predictable

situation) pedestrians have a well-designated space to use for crossing, equipped with signs to alert drivers to be prepared and reduce their speed. At these crossings, most drivers will give way to pedestrians, minimizing the chances of a conflict. On the other hand, (ambiguous situation) while crossing at an undesignated mid-block section, the space for crossing is not known to the driver or the pedestrian. In many cases, the driver is not aware at all that a pedestrian will cross in that section. Even if a driver sights a pedestrian, the priority is not set; not knowing who will yield to the other creates a state of confusion (Shaaban et al., 2018).

There is little evidence that pedestrians lack knowledge of the rules for crossing roads (King et al., 2009). The reasons for unsafe road use are therefore more likely to lie with pedestrian motives, their general walking behaviours (given that road crossing is a small element of walking activity) and other activities or practices to which walking is incidental (Austroads, 2016b), with some examples being:

- engaging in a conversation while walking and not focusing on the road environment;
- listening to music through headphones thus decreasing the ability to hear vehicles;
- consuming alcohol and then walking with an impaired ability to make decisions about safe crossing;
- hurrying to meet a time-critical deadline (e.g. a bus departure) such that there is increased willingness to accept potential risks along the route.

2.7 Risk factors for pedestrian crashes while crossing the road

Data on pedestrian road crashes indicate that pedestrian crashes often occur when people are trying to cross the street outside pedestrian crossings or where no pedestrian crossings exist. However, records also show that crashes involving pedestrians occur frequently at facilities designed for pedestrians such as pedestrian crossings (OECD, 1998).

A study by the Transport Research Laboratory, UK (Martin A., 2006) on the behaviour of pedestrians while crossing the road identified five main factors leading to an increased risk of crashes:

- Choice of crossing place,
- Non-compliance at designated crossings,
- Crossing speed,
- Failure to attend to traffic and

- Pedestrian alcohol consumption

These five main factors are further dependent on various parameters such as:

Traffic volume - Crossing in light traffic is generally regarded by pedestrians as a safe action therefore they will not choose to cross at a designated crossing facility if they feel it is safe to cross where it is more convenient to them. American research has shown that commuters are more likely to risk crossing at non-designated crossing points than occasional users and did so because they perceived no risk in doing so (Sisiopiku and Akin, 2003). Such trends have mainly been observed in light traffic conditions.

Effects of pedestrian delay - Pedestrians will generally take the quickest route to their destination and hence delay is linked closely with pedestrians' propensity to take risks. Research has shown that pedestrians organise their crossing location and timing to minimise their walking distance and delay (Sisiopiku and Akin, 2003).

Effects of demographic variables - Choice of crossing place can be dependent on the type of pedestrian. Older pedestrians and females are more likely to choose to cross at signalised crossings (on green) than any other group (Martin A., 2006).

Effects of peer pressure - Many studies, particularly those focussing on the crossing behaviour of children, found that reaction to peer pressure has a significant influence on a pedestrian's propensity to cross at a designated crossing (Martin A., 2006).

Effects of waiting times - Studies have suggested that waiting time has an effect on pedestrian behaviour when attempting to cross a road. This is particularly important when pedestrians are waiting to cross at signalised crossings. As per the Highway Capacity Manual (HCM) when pedestrians experience more than a 30 s delay, they become intolerant and engage in risk-taking behaviour (HCM, 2000). Based on a survey of pedestrian behaviour at signalized intersections in Kolkata, India, it was found that time-saving is the primary motivation of the pedestrian signal violation in Kolkata, and nearly 40% of the pedestrians violate traffic signals to reduce their waiting time before crossing (Mukerjee & Mitra, 2019).

2.8 Pedestrian crossing facilities

Typically, crossing facilities are needed to provide continuous and connected routes for pedestrians. An important purpose behind creating crossing points is to concentrate the movements to selected locations where pedestrians are provided with a safe place to cross the road using treatments and devices that effectively manage conflicts between with motorised traffic and where all road users can readily identify the crossing as a point of crossing (Austroads, 2020). Crossing facilities can be categorised in three main groups (Philpotts, 2015):

- **Uncontrolled Crossing -** A facility provided to help people cross a carriageway, but where they have no legal priority over motorised traffic. The most basic form of crossing is a pedestrian island in the centre of the road, often at junctions.
- **Controlled Crossing -** A facility provided to help people cross a carriageway but where they have priority over motorised traffic.
- **Grade separated crossings -** A facility provided to separate in space and time pedestrians and vehicles.

The type of facilities required can depend on many, often linked, factors, and these can affect the choice of provision. Some of the factors that designers need to consider, according to the study in the UK by Philpotts in 2015 on safe pedestrian crossings, are:

- Numbers of people wishing to cross at any one time
- Speed and volume of traffic
- Crossing distance
- Confidence of person crossing
- Age of person crossing
- Physical or visual considerations of the person crossing
- Perception of danger
- Time of day

Box 4: Suitability of pedestrian crossings at different speeds (mph)

Crossing Type	Traffic Flow	Traffic Speed					Advantages	Disadvantages
		20	30	35	40	50 +		
CONTROLLED								
Zebra crossing	High						Pedestrians have priority over traffic. Almost immediate access to crossing priority	Less suitable on faster roads. Can impact on traffic flow where pedestrians stream
	Medium							
	Low							
Signal controlled (stand-alone)	High						Favoured by many older and disabled people. Signals give clear priority to pedestrians	Can be inflexible leading to delays for both pedestrians and traffic, although puffin detection reduces issues
	Medium							
	Low							
Signal controlled (junction)	High						Can be used on higher speed roads. All green, pedestrian phase allows diagonal crossing	When staggered for traffic flow, pedestrians experience longer walking routes and times
	Medium							
	Low							
GRADE SEPERATED								
Bridges	High						No crossing delays, good subjective safety. No delays to traffic. Can be used with high traffic speeds/flows	Poor layouts with tight turns, steep ramps, steps, and long detours will exclude some people
	Medium							
	Low							
Subways/underpasses/road bridges	High						When open and see through, can be direct, convenient and feel safe to use	When isolated and without clear views through, can feel unsafe and less likely to be used
	Medium							
	Low							

Generally Acceptable ■ Design With Caution ■ Generally Unacceptable ■

Source: Philpotts, 2015. Designing for walking, CIHT.

2.9 Considerations for selection of pedestrian crossing facilities

Although there are several general issues facing the designer when considering crossing type, it is essential to recognize that each site is different. It is therefore essential to visit the site at different times of day (and night) to observe desire lines and behaviour and also to ask people about what will benefit them. Another consideration is that traffic speed and flow can change with time, making what is acceptable today, inadequate for road users in the future (Philpotts, 2015).

There are several important issues for practitioners and decision-makers to consider when installing crossings (GRSP, 2013):

- Crossing locations should be convenient for pedestrians and accessible for pedestrians in wheelchairs. Pedestrian movements and desire lines (most direct/shortest path between two locations) can be analysed to identify optimum locations for crossings.
- There should be adequate visibility between vehicles and pedestrians. For example, night-time pedestrian crossings should be properly illuminated in order to help drivers to see pedestrians.
- The effectiveness of overpasses and underpasses depends largely on convenience, security, and walking distances compared with alternative crossing locations. Pedestrians generally do not use these facilities if a more direct route is available.
- Overpasses are suitable when the topography allows for a structure without ramps. Overpasses with multiple stairs are not user-friendly for the elderly or disabled pedestrians. Underpasses need to be designed in such a way as to offer a sense of being open and accessible.
- Underpasses can be affected by flooding and may quickly become dirty without regular maintenance. Underpasses are often dark, secluded places. They may be targeted by gangs or other perpetrators of interpersonal violence, and, for this reason, people who perceive a high risk of assault avoid them. Overpasses and underpasses should be well-lit and secure, to maximize personal security and therefore utilization.

2.10 Preferences of pedestrians for different crossing facilities

Roads are physical and psychological obstacles to the movement of pedestrians, with unfavourable effects on accessibility and social inclusion (Appleyard et al,1981; Anciaes et al, 2016). Urban and transport planners have improved the road environment, but they are constrained by the legacy of road networks that limit facilities for non-motorised modes of transport (Illich, 1974). It is important to note that the ease of crossing busy roads is not improved by the provision of crossing facilities. Research studies has in fact proven that pedestrians usually dislike certain types of amenities which ultimately lead to informal road crossing behaviour or simply crossing away from the facilities (Demiroz et al, 2015; Obeng-Atuah et al, 2017; Sinclair et al, 2016). Therefore, to overcome this hindrance, we should understand pedestrians' preferences for different types of crossing facility.

For example, footbridges are often viewed as a safe path for pedestrians (Gallegos, 2012; Mutto et al, 2002). However, it has been observed that pedestrians do not usually use footbridges due to infavourable location and proximity evaluated during the crossing situation (Cambon et al, 2009; Oviedo et al, 2017). Anciaes et al (2016) estimated pedestrians' preferences and willingness to access different types of crossing facilities in three busy roads in England notably London, Birmingham, and Southend-on-Sea, using a stated preference survey. One of the very first finding indicated that participants (especially women, older people, people with disabilities) rated footbridges and underpasses systematically below signalized crossings. On average, respondents choose underpass and footbridge only if these amenities are nearer than straight signalized crossings. However, there are significant variation according to age, gender and trip purpose.

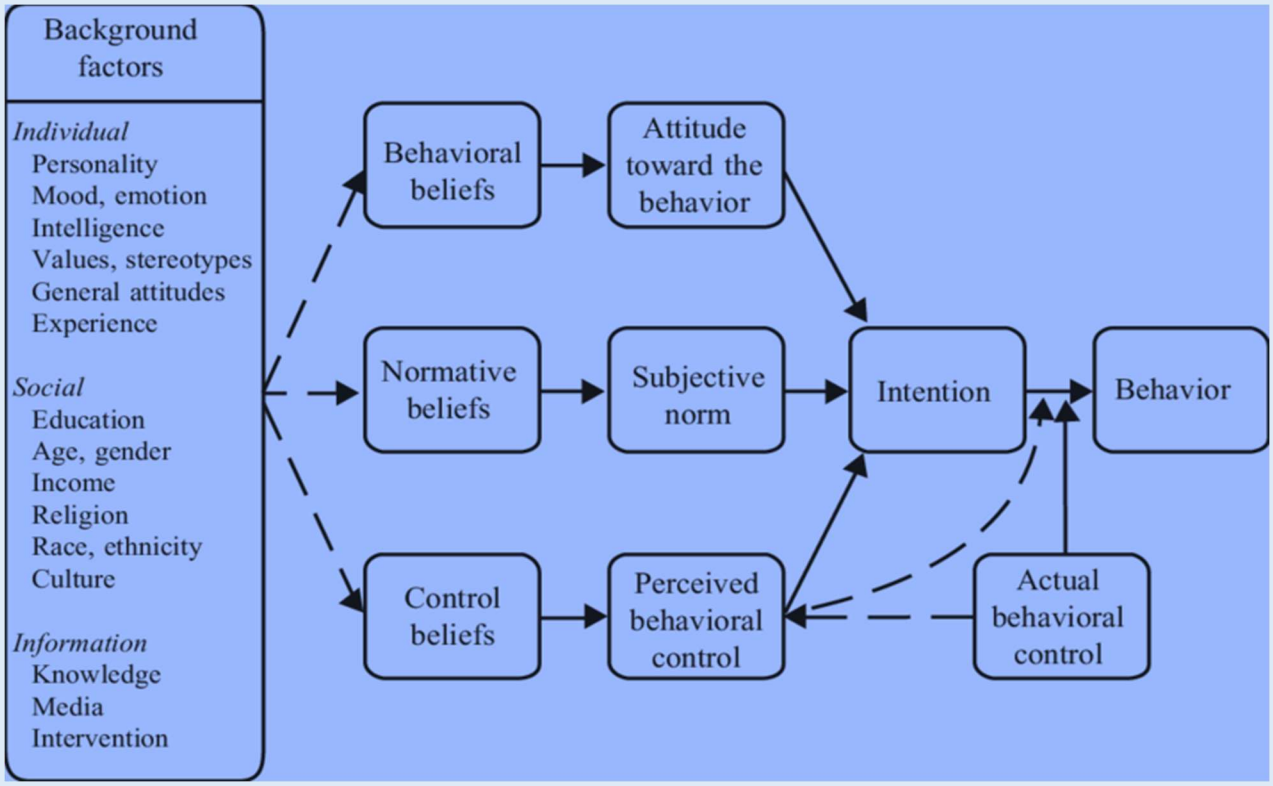
According to another study by Sisiopiku et al in 2003, it is claimed that the main factor influencing people to cross the road is the distance to the trip destination. Cantillo et al (2015) conducted research using all types of crossing facilities and found that individuals are less likely to walk to footbridges than to a signalized crossing. Nevertheless, they note that social demographic factors such as age, gender, level of education, and purpose of trip all play a key role in the choice made by pedestrians. On the other hand, Meltofte et al (2013) modelled the choice between using crossing facilities and crossing the roads informally, under diverse conditions such as multiple lanes, traffic volumes and speeds and different walking distances to the nearest crossing facility. They assert that people are more likely to cross the roads informally when the walking distance to the crossing facility is longer.

2.11 Pedestrian behaviour at crossing facilities

Several studies have shown that the decisions taken by pedestrians about where to cross the street consist of a trade-off between ease and safety (Sharples et al, 2001 and Rankavat et al,2016). Despite the fact that crossing away from assigned pedestrian crossing facilities scales the risk of pedestrian injury, this crossing method is often selected because it is the fastest and straightest way to reach the opposite side (Demiroz et al,2015). Tanaboriboon et al (1994) conducted a study in China where only 25% of respondents listed that they were agreeable to use signalized crossings while the majority (60%) stated that it was time lost as it included walking time to access the crossing and waiting for the green time to cross.

Box 5: Theory of planned behaviour

The Theory of Planned Behaviour (TPB) is an extension of the Theory of Reasoned Action (TRA) (Fishbein et al 1975, Ajzen et al 1980).The theory of planned behaviour (Ajzen, 1985) posits that there are 3 main factors which influences a person's decision to engage in a particular behaviour. Firstly, there is the person's attitude towards the behaviour, which reflects the extent to which he or she believes that the behaviour will lead to favourable or adverse outcomes. Secondly, there is the perceived social pressure to do or not to do the behaviour and thirdly there is the person's perception of control over doing the behaviour. Its application to road safety behaviour has been very limited but it has been observed that it is highly significant in understanding pedestrian perception and behaviour.



Source: Ajzen, I., & Fishbein, M. (2005). The influence of attitudes on behaviour

Papadimitriou et al (2016) conducted a field survey in which 75 youth and adult pedestrians were asked to take 8 short walking trips (each one corresponding to different crossing facilities scenario) in Greece.

This activity allowed the researcher to record their crossing behaviour at different road and traffic environments. In a subsequent comparative analysis of the participants' declared (questionnaire responses) and observed crossing behaviour, the results depict that pedestrian observed behaviour is in parallel with their declared behaviour. However, there were some pedestrians who claimed that they never cross at mid-block on major urban road but did so during the field survey. Therefore, it can be noted that although most follow the rule, but they may all deviate under certain conditions.

Pedestrian behaviour is very complicated and influenced by environmental designs and urban planning. Research studies carried out by Elvik et al (2013) and Shriver (1997) reported that a good design of facilities can promote walking without compromising safety and convenience. They noted that the waiting time and crossing distance are two key factors that would lead to unsafe crossing.

Research studies also confirm that young pedestrians are more likely to perform impatient behaviour on pedestrian crossing facilities. Therefore, the violation rates are higher among younger pedestrians compared to others (Brosseau et al, 2013; Wang et al, 2011 and Guo et al, 2011).

2.11 Pedestrian safety countermeasures

With pedestrians being a group with diverse needs and capabilities, a combination of measures is needed in order to comprehensively address the range of risks to pedestrians in different settings. Interventions that have been found effective include reducing vehicle speeds, separating pedestrians from other traffic, increasing the visibility of pedestrians, changing pedestrian and motorist behaviour through public education and law enforcement, improving vehicle design and improving care for the injured (WHO, 2013). Measures that have been implemented have been categorised into 3 areas by WHO (2013):

- Proven – Studies have shown measures to be effective to reduce pedestrian fatalities/injuries.
- Promising – Studies have shown some effectiveness but further evaluation is required.
- Insufficient evidence – Evaluation of measures have not provided firm evidence on their effectiveness.

A list of these measures is provided in the figure below.

Key measures	Examples of interventions	Effectiveness		
		Proven	Promising	Insufficient evidence
Reduce pedestrian exposure to vehicular traffic	Provide sidewalks	■		
	Install and/or upgrade traffic and pedestrian signals	■	■	■
	Construct pedestrian refuge islands and raised medians	■		
	Construct enhanced marked crossings		■	
	Provide vehicle restriction/diversion measures	■	■	
	Install overpasses/underpasses	■		
	Improve mass transit route design	■		
	Reduce traffic volumes by switching journeys from the car to public transport, walk and cycle for distances and purposes where these options work well	■		
Reduce vehicle speeds	Reduce speed limit	■		
	Implement area-wide lower speed limit programmes, for example, 30 km/h	■		
	Implement road-narrowing measures		■	
	Install speed management measures at road sections	■	■	
	Install speed management measures at intersections	■	■	
	Provide school route improvements		■	
Improve sight distance and/or visibility between motor vehicles and pedestrians	Provide crossing enhancements	■	■	
	Implement lighting/crossing illumination measures	■		
	Reduce or eliminate obstruction by physical objects including parked vehicles		■	
	Install signals to alert motorists that pedestrians are crossing		■	■
	Improve visibility of pedestrians		■	

Note: When the terms ‘proven’, ‘promising’ and ‘insufficient evidence’ appear highlighted in the same line, it shows that there are different measures in the same broad category at different stages of development as already explained above with respect to effectiveness

Key measures	Examples of Interventions	Effectiveness		
		Proven	Promising	Insufficient evidence
Improve pedestrian and motorist safety awareness and behaviour	Provide education, outreach and training	■		
	Develop and/or enforce traffic laws on speed, drinking and driving, pedestrian right-of-way, red light disobedience, commercial roadside activity and traffic control	■		
	Implement 'walking school bus' programmes		■	
Improve vehicle design for pedestrian protection	Develop vehicle safety standards and laws for pedestrian protection		■	■
Improve vehicle design for pedestrian protection	Enforce vehicle safety standards and laws for pedestrian protection			■
	Publicize consumer information on pedestrian safety by make and model of car, for example, results of New Car Assessment Programmes		■	
Improve care for the injured pedestrians	Organize pre-hospital trauma care systems	■		
	Establish inclusive trauma care systems	■		
	Offer early rehabilitation services	■		

Figure 9: List of pedestrian safety measures (WHO, 2013)

2.12 Conclusion

Pedestrian safety is a shared responsibility. All road users have a role to play in better protecting pedestrians and making the world safe for walking – even pedestrians themselves. Effective interventions exist to better protect pedestrians, and implementation of these should utilise a comprehensive approach that focuses on a combination of engineering, enforcement and education. Such actions will contribute to a culture of safety, make walking safe, and, ultimately, save pedestrian lives (WHO, 2013).

CHAPTER 3.0

PEDESTRIAN SAFETY SITUATION IN MAURITIUS

3.0 PEDESTRIAN SAFETY SITUATION IN MAURITIUS

3.1 Background

This chapter provides information on the evolution of the road safety situation for Mauritius with emphasis laid on pedestrians using secondary data obtained from publications made by Statistics Mauritius. Data from the IMAAP software, which was made available by the TMRSU to researchers from the University of Mauritius for this study were also used to identify and analyse possible causes and trends in pedestrian crashes.

3.1 Road Traffic Statistics

Data from the Digest of Road Transport and Road Accident Statistics published by Statistics Mauritius for the past years have been used in this section to provide an overview of the road safety situation in Mauritius. Records indicate that the stock of registered vehicles has increased substantially over the past decade from 400,919 in 2011 to 600,053 in 2020. For the year ending 2020, an increase of 3.3% was observed in the number of registered vehicles as compared to end of year 2019, which corresponds to an additional 19,424 vehicles on the roads. In contrast, the length of the road network has increased from approximately 2100 km in 2011 to only 2800 km in 2020. Key statistics for some years in the past decade are provided in Table 1 below, with some data missing for years 2019 and 2020.

Table 1: Key road transport statistics for Mauritius (Statistics Mauritius, 2020)

YEAR	2011	2014	2017	2019	2020
No. of registered vehicles	400,919	465,052	531,797	580,629	600,053
No. of accidents	22,387	26,400	29,627	29,644	28,611
Rate per 100,000 population	1,847	2,165	2,425	2,425	2,086
Rate per 1,000 registered vehicles	57	58	57	52	49
Total no. of casualties	3,422	3,592	4,209	3,484	n.a
Number of fatalities	152	137	157	144	131
Number of seriously injured	487	505	560	n.a	n.a
Fatality rate per 100,000 population	12.5	11.2	12.8	11.8	10.7
No. of fatalities per 100 casualties	4.4	3.8	3.7	3.9	n.a

As observed from the figures from Table 1, the increase in vehicular fleet has also been accompanied by a rise in the number of registered road accidents from 22,387 in 2011 to 29,644 and 28,611 in 2019 and 2020 respectively. Although a decrease in the number of crashes was noted for 2020, probably due to the lockdown period, the general trend over the past decade indicate an increase in the number of accidents. However, a general decrease in the rate of accidents per 1000 registered vehicles and in the fatality rate per 100,000 population can be observed, with the fatality index being less than 4.0 since 2013.

According to data from Statistics Mauritius for the past years, pedestrians suffer from road crashes with between 500 to 700 persons involved annually from 2009 to 2018 as shown in the figure below.

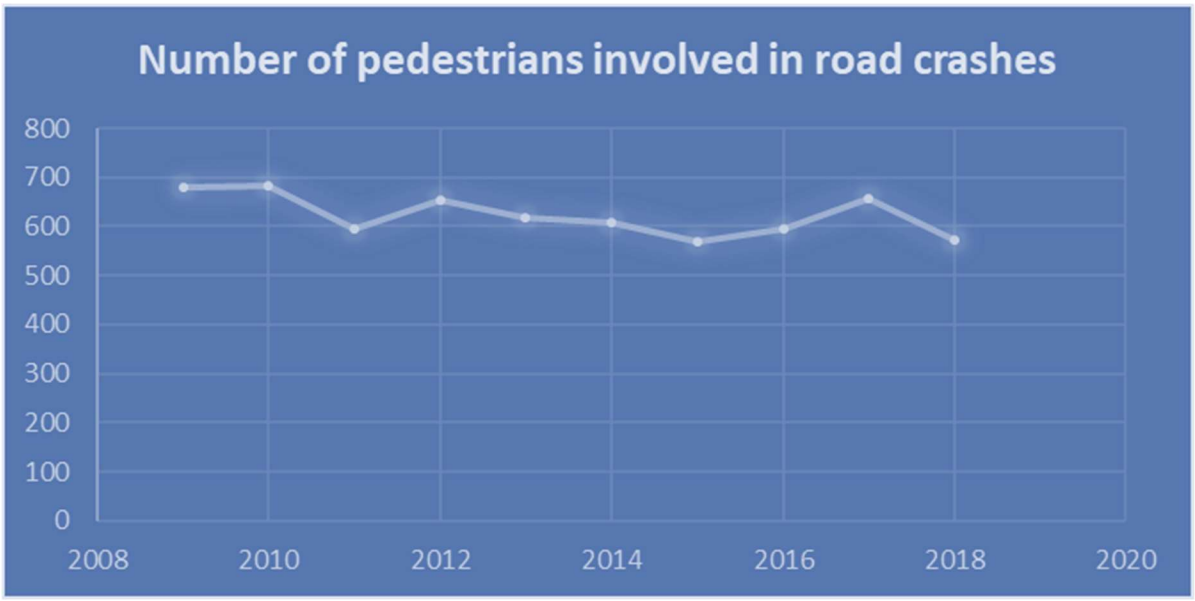


Figure 10:Pedestrian involvement in road crashes (Statistics Mauritius, 2020)

For the year 2019, 35 pedestrians died as a result of road accidents with 30 of the fatalities being aged 45 or above i.e., approximately 85%. A similar trend was noted for 2020, where 20 out of the 24 pedestrian fatalities were aged 45 and above.

The Digest of Road Transport and Road Accident Statistics do not however provide more information on other characteristics pertaining to pedestrians involved in road accidents such as location, time of the day, physical ability, and possible causes of the crashes. The IMAAP software was therefore used to obtain further information on the pedestrian crashes that have occurred in Mauritius over the past decade.

3.2 IMAAP Road Crash Data

IMAAP data allowed the identification of pedestrian blackspot locations (crash clusters) around Mauritius and this was used to determine possible locations for carrying out pedestrian surveys later in the project. Figure 10 below gives an indication of some roads and blackspot locations in Mauritius.

DISTRICT	ROAD NAME
Pamplemousses	A2 - Port Louis - Central Flacq Road; A4 - Terre Rouge – Triolet – Grand Baie Road & B11 - Plaine des Papayes Road
Riviere du Rempart	B16 - Poudre d'Or Road; A5 - Mapou - Goodlands Road & B42 - Forbach Road
Port Louis	M1 - Port Louis Plaisance Dual Carriageway; M2 – Port Louis Sottise Dual Carriageway; A1 – Port Louis St Jean Road; A3 – Riviere Noire Road B93 – Old Moka Road & B141 - St François Xavier Road
Plaines Wilhems	A1 - Port Louis St Jean Road; A8 – St Jean Road B3 – Candos Vacoas Road; B63 – Swami Sivananda Avenue B64 – Vacoas La Marie Road
Moka	A7 - Moka - Camp de Masque - Flacq Road at Verdun, near Quartier Militaire Bus Station & near junction with St Pierre Bypass
Flacq	A7 - Moka - Camp de Masque - Flacq Road B23 - Brisée Verdière - Saint Julien - Constance Road B27 - Montagne Blanche - Bel Air Road B28 - Flacq - Mahebourg Road
Grand Port	M1 - Port Louis Plaisance Dual Carriageway A10 - Phoenix - Plaisance Road A12 - Plaine Magnien – Mahebourg Road B82 – New Grove Road
Savanne	B8 - La Baraque Road B10 – Chemin Grenier Road
Black River	A3 – Riviere Noire Road B2 – Palma Road & B34 – Flic en Flac Road

Figure 11:Roads with pedestrian blackspot locations/stretches

The following figures give graphic representations of the location of fatal and serious accidents for the five districts which have the highest incidence of pedestrians injured or killed in road crashes during the past years with red spots indicating fatal crashes and orange spots serious crashes

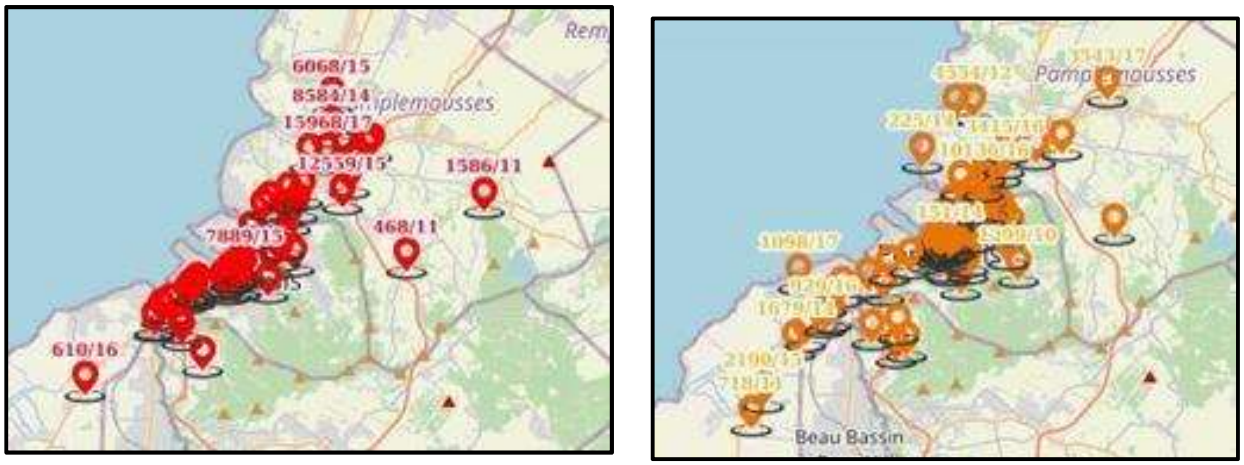


Figure 12: Port Louis Fatal and Serious Crashes (Source : iMAAP)

Figure 13: Plaines Wilhems Fatal and Serious Crashes (Source : iMAAP)

Figure 14: Pamplemousses Fatal and Serious Crashes (Source : iMAAP)

Figure 15: Riviere du Rempart Fatal and Serious Crashes (Source : iMAAP)

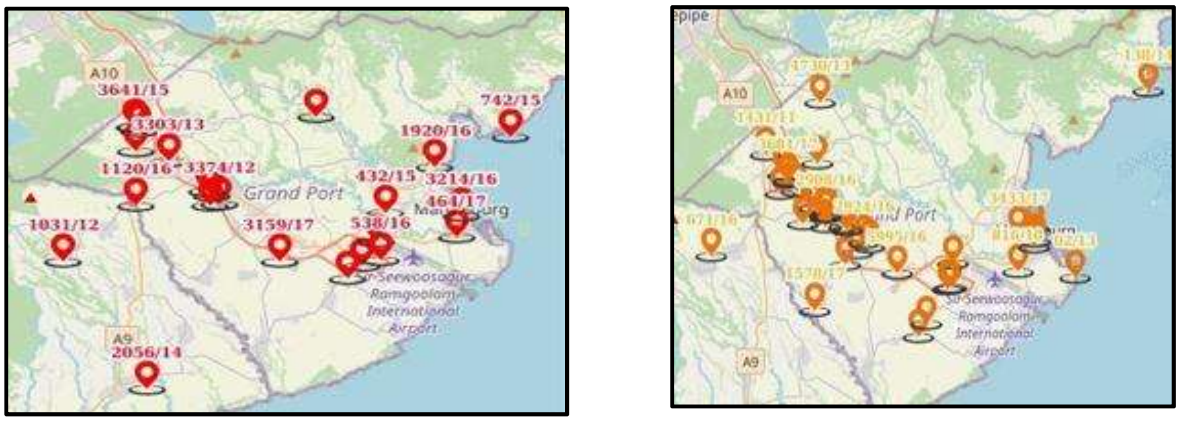


Figure 16: Grand Port Fatal and Serious Crashes (Source : iMAAP)

A cluster analysis was also carried out to identify sites with the highest pedestrian collision frequency (at least three casualty crashes over the period 2007 – 2018). The findings are shown in figures below.

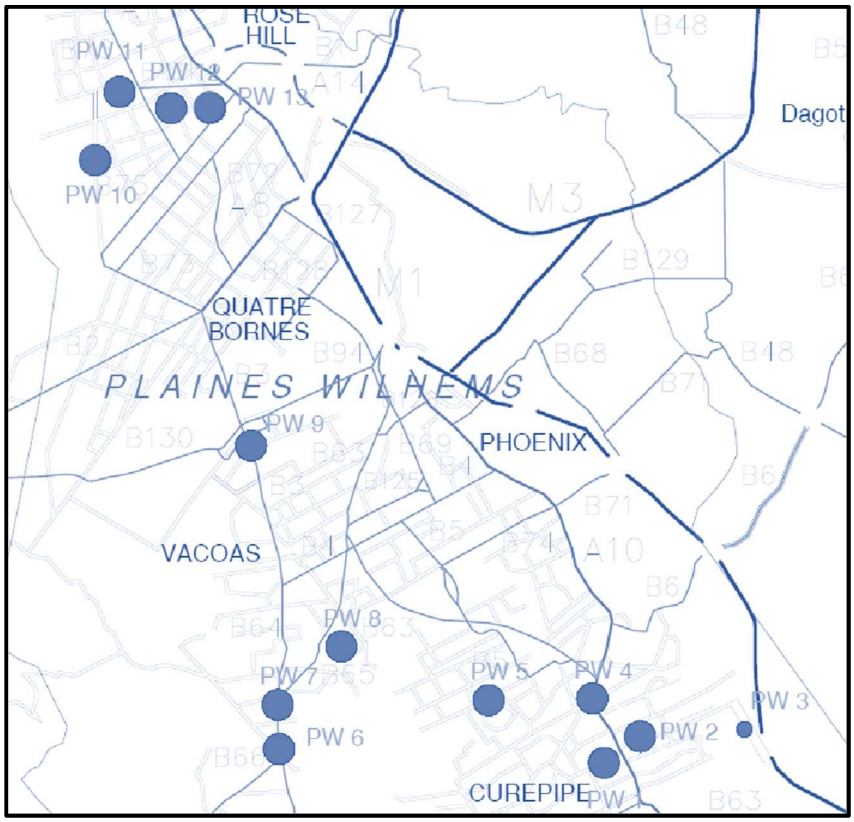


Figure 17:Clusters with high pedestrian crash occurrence – Plaines Wilhems (Source: IMAAP)

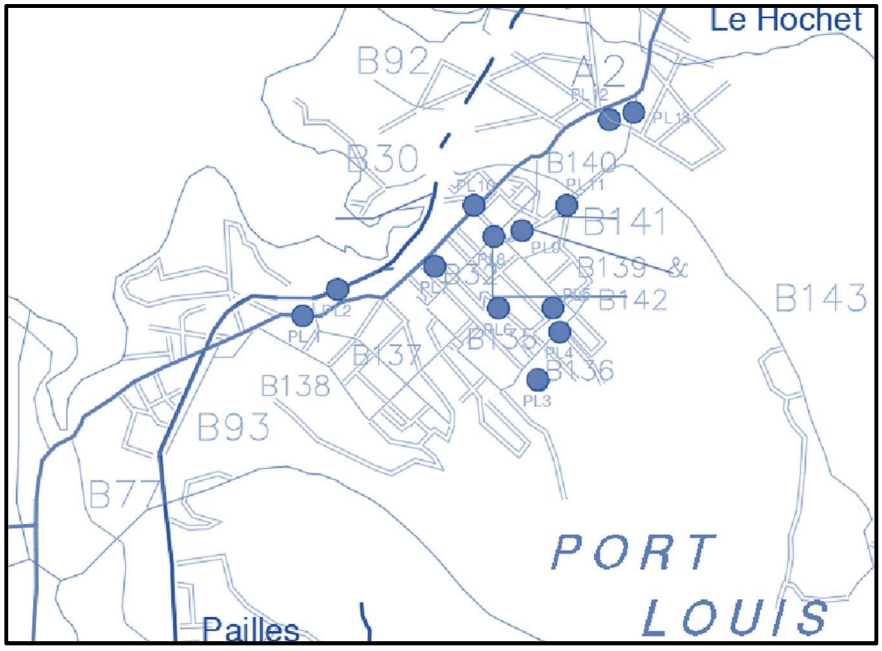


Figure 18: Clusters with high pedestrian crash occurrence – Port Louis (Source: IMAAP)

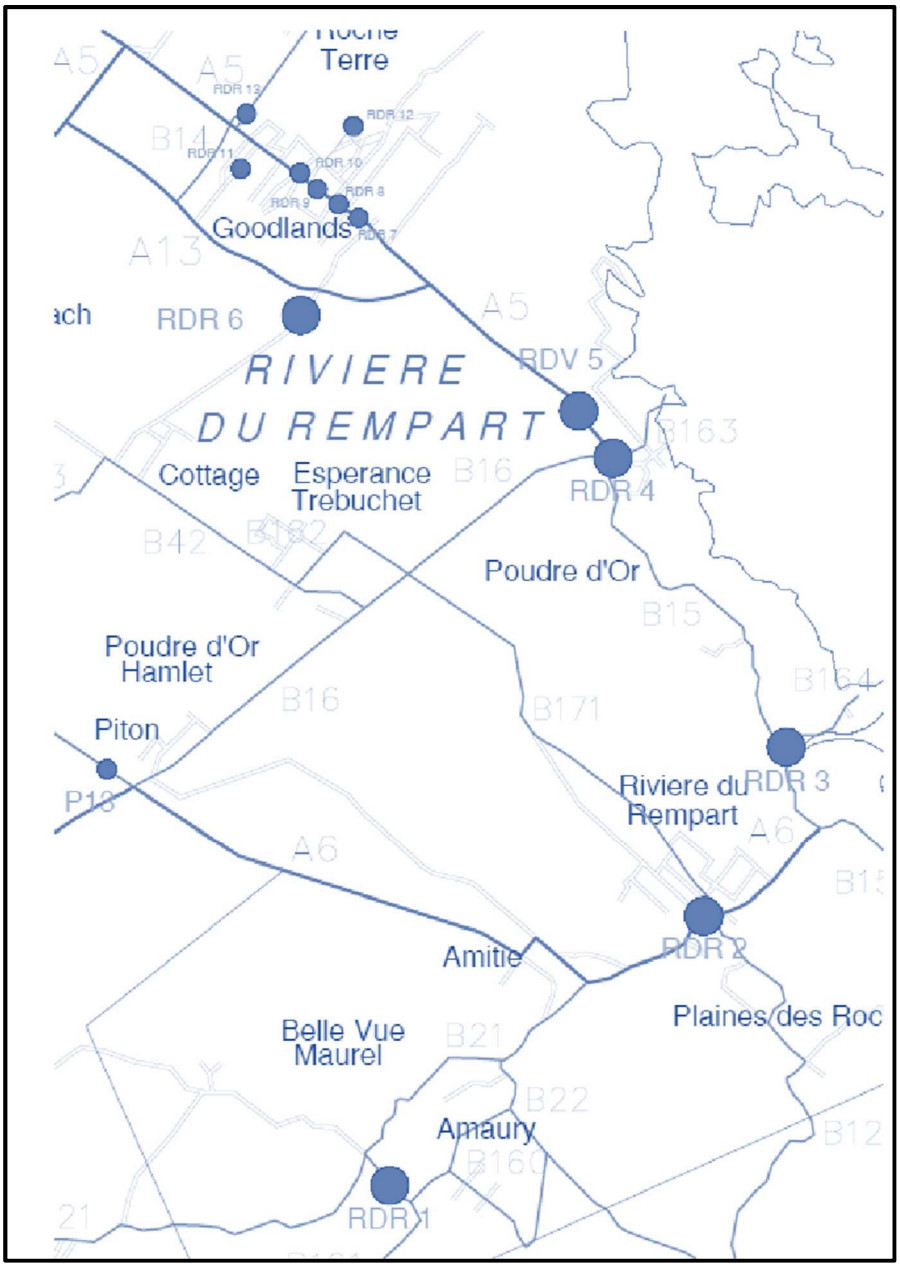


Figure 19: Clusters with high pedestrian crash occurrence – Riviere du Rempart (Source: IMAAP)

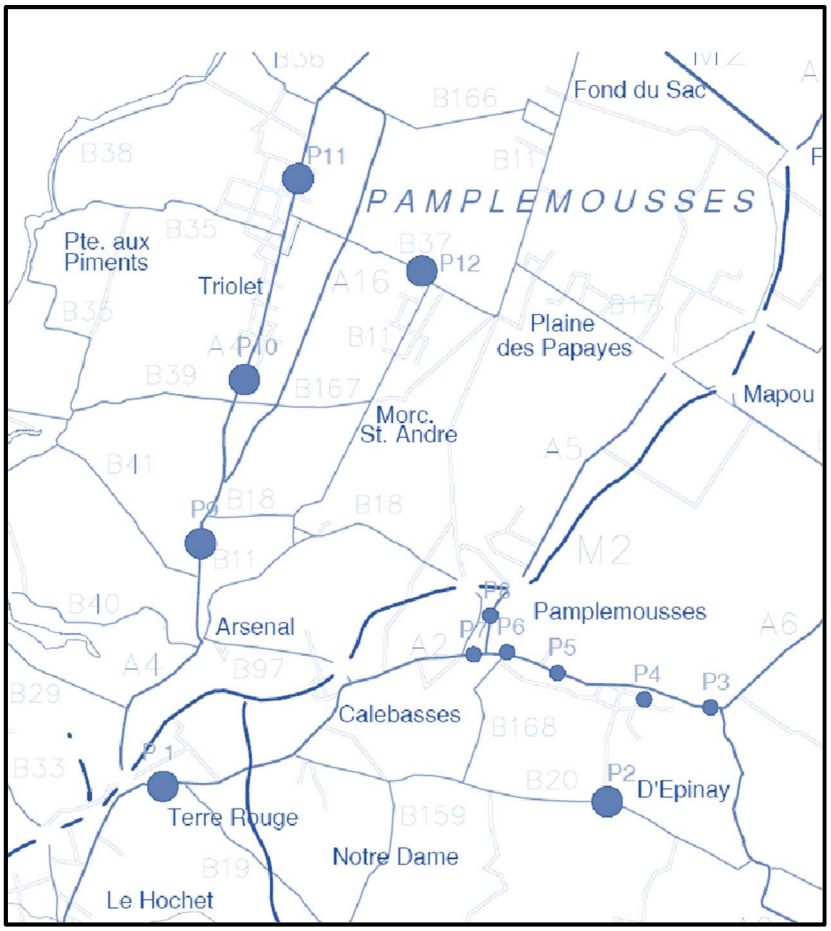


Figure 20: Clusters with high pedestrian crash occurrence - Pamplemousses (Source: IMAAP)

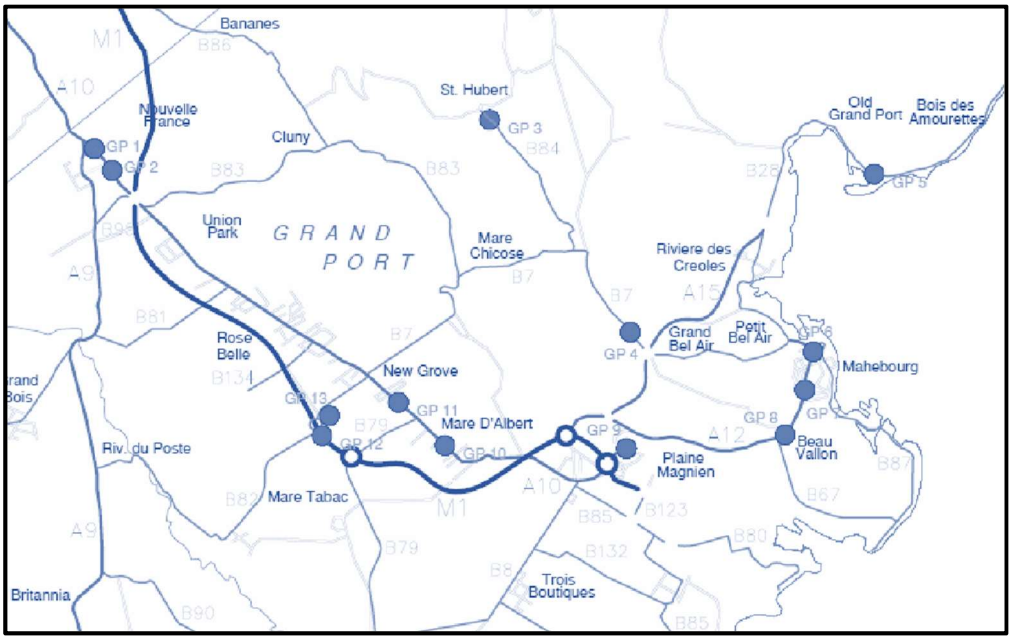


Figure 21: Clusters with high pedestrian crash occurrence - Grand Port (Source: IMAAP)

3.3 Other Findings from IMAAP Road Crash Data

A sample of 1881 fatal and serious crashes involving pedestrians in the IMAAP database over a 15-year period (2002 – 2017) were used to identify other characteristics pertaining to the crashes and comprised 1250 males (66%) and 631 females (34%). On a comparative basis, statistics for UK indicate that out of 5,326 pedestrian killed or seriously injured casualties in 2013, 60 per cent were male and 40 per cent were female (DfT, 2013).

Pedestrians involved in crashes comprised 15% aged below 18 years, 9% aged between 18 and 25 years, 17% aged between 26 and 39 years, 34% aged between 30 and 60 years and 25% being 60 years or more. This corroborates with literature, which has shown that people from all age groups are involved in pedestrian crashes although some age groups are more represented than others in certain settings (GRSP, 2013).

It was observed that 64% of the crashes involved pedestrians crossing the road (1207 crashes) whereas the rest consisted of pedestrians walking along the road edge (25%) and standing near the road (11%). While this corroborates with other studies, which show that the greatest percentage of pedestrian crashes involve pedestrians crossing the road (GRSP, 2013), there is still a non-negligible number of pedestrians who are being hit while walking along the road edge. This may indicate that provision for pedestrians along roads is not adequate and needs to be reviewed.

For the 1207 pedestrians involved in collision while crossing the road, 181 were hit on a pedestrian crossing (15%), 87 were hit within 50m of a pedestrian crossing (7%) and the rest were hit outside of these locations.

Most of the pedestrian collisions occurred outside junctions (80%), along straight flat road sections. 8% of pedestrian crashes occurred on motorways, 6% along one-way streets while the rest occurred on other classes of two way streets. This corroborates with previous research which has found that the highest proportion of pedestrian casualties occur on distributor roads which were A or B roads with speed limits of 70 km/hr or less while one-way streets constitute a low-risk environment and may be considered as a low-cost countermeasure to improve pedestrian safety (Martin, 2006).

It was also observed that the frequency of pedestrian crashes was slightly higher during the weekend (average of 297) as compared to weekdays (average of 254). Most of the pedestrian collisions (91%) were found to occur in fair weather conditions. 58% of fatal and serious pedestrian crashes occurred during the day, with 7% occurring at dawn/dusk and the rest (35%) occurring during the night. Out of the 654 crashes occurring during night-time, 500 took place at locations where street lighting was present i.e. more than 75%, with only 24% occurring in conditions with poor/no lighting. These findings concur with previous research that have explained that although risks for pedestrian collision are higher in poor weather and lighting conditions, people are less likely to go out in bad weather or walk in places with no lighting. This therefore reduces the likelihood of having pedestrian collisions in these settings (Martin, 2004).

For vehicles involved in pedestrian collisions, it was observed that 43% were cars, 10% motorcycles, 10% buses, 18% light and heavy goods vehicles, 4% minibuses and the rest comprises autocycles and other vehicles. The majority of the vehicles (79%) involved were moving ahead at the time of collision with a pedestrian.

Drivers involved in pedestrian collisions comprised 13% aged between 18 and 25 years, 36% aged between 26 and 39 years, 34% aged between 40 and 60 years and the rest being 60 years or more. This corroborates with research that shows that young drivers were most likely to be involved in pedestrian collisions as they are less likely to take pedestrians into consideration while driving (Martin, 2004).

CHAPTER 4.0
RESEARCH METHODOLOGY

4.0 RESEARCH METHODOLOGY

4.1 Introduction

The aim of this research is to provide authorities with research-based evidence on the suitability and effectiveness of different types of road crossings for implementation purposes. This chapter elaborates on the methodology used to achieve the objectives.

4.2 Research Plan

This study uses a deductive research approach. The 2 key steps of the research plan completed so far are:

1. Conduct an in-depth literature review to establish key theories and concepts pertaining the effectiveness, behaviour, and perceptions of road crossings. The findings and critical appraisal of related research works are described in Chapter 2.
2. Understand the pedestrian safety situation in Mauritius. To further understand the problem statement and narrow the scope of study, secondary data has been collected for Mauritius and an in-depth analysis was carried out. The study carried out in Chapter 3 has been used to develop the instrumentation plan that will serve as a road map for this research.

The remaining steps of the research plan as listed below, will be further described in the forthcoming sections.

1. Define Research Questions.
2. Choice of survey mode
3. Establishing the sampling approach
4. Designing the Questionnaire
5. Strategies for Conducting the Survey
6. Analysis of survey and presentation of findings
7. Ethical Clearance and Limitations for this study.

4.3 Research Questions

Based on the findings from the findings from the literature review (chapter 2) and secondary data collected for the local context (chapter 3) the following research questions were formulated:

- What are the perception of pedestrians on the pedestrian facilities available, the pedestrian environment and road safety campaigns?
- What underlying factors (age, gender, education, familiarity, size of groups, purpose of trip) influence pedestrian informal behaviour on the pedestrian crossing facilities?
- In what way/s do the studied factors influence pedestrian behaviour particularly with reference to pedestrian safety? (What are the impacts on attentiveness, adherence to rules and signs, attitudes to safety?)

4.4 Choice of survey mode

Previous research studies on pedestrian crossing behaviour have used a multitude of research methods such as self-completed questionnaires, video surveys (Sisiopiku et al, 2003), personal interviews, GIS analysis, pedestrian tracking (Papadimitriou, 2012) and experiments. Most of these studies have revealed that long waiting times and accessibility influence road crossing behaviour. To answer the abovementioned research questions, a quantitative-based cross-sectional survey method has been adopted. This involves the use of questionnaires to collect data from a defined number of participants over 4 months and will give us an idea about the perceptions of pedestrians regarding road safety and pedestrian crossing behaviours. This approach is cost-effective, generalisable, reliable and versatile. Hence, a single survey questionnaire was designed for the following survey strategies:

- Online survey - online questionnaire using google forms
- In-person survey - appointed surveyors interviewed passers-by at specific locations.

4.5 Sampling Approach

To ensure the validity of this survey, the determined size should be optimum and must be obtained by the scientific method. The target population of pedestrians in Mauritius (above 1 million pedestrians) being significant, and given the small timeframe earmarked for the data collection, a mixed non-probability sampling approach consisting of quota and convenience sampling was selected. In order to ensure a fair representation of the population, a targeted sample size for specific locations was established as shown in the table below. The estimated sample size is 1250 respondents. With the help of the IMAAP tool, blackspots in terms of pedestrian crashes were identified for in-person surveys in all districts.

Table 2: Resident population and sample size per district

DISTRICT	ESTIMATED RESIDENT POPULATION BY GEOGRAPHICAL DISTRICT REPUBLIC OF MAURITIUS 2018	SAMPLE SIZE
Port Louis	118,604	119
Pamplemousses	141,442	141
Riviere du Rempart	107,993	108
Flacq	138,700	139
Grand Port	112,808	113
Savanne	68,338	68
Plaines Wilhems	367,269	367
Moka	83,659	84
Black River	83,395	83
TOTAL	1,222,208	1,222

It was aimed to carry out at least 1250 surveys, with a quota allocated to capture data from each district according to the size of their resident population. The district of Plaines Wilhems was further divided in terms of the different municipal councils to conduct the surveys.

4.6 Questionnaire Design

A semi-structured questionnaire has been designed with the aim to understanding pedestrian use of crossing facilities in Mauritius. Different types of closed ended questions were used such behavioural questions, attitudinal questions, and classification questions. The questionnaire was designed both for the online survey and in-person survey. A copy of the questionnaire is included in the appendices to this report. The questionnaire consists of the following sections:

- Section A: Demographic Information
    - The demographic questions such as respondents' age, gender, qualifications and their involvement in any accident will enable the cross-tabulation and comparison of subgroups to see how responses vary between these groups.
- Section B: Pedestrian Perception about crossing facilities.
    - Section B has been designed to fathom respondents' perception of how safe some crossing facilities are.
- Section C Pedestrian Behaviour near/on crossing facilities
    - In this section, we aim to understand why respondents choose to walk as well as establish their behaviours before and while using crossing facilities.
- Section D Perception of pedestrian on drivers
    - Section D relates to questions pertaining to the respondents' challenges and benefits of using crossings and their perceptions of drivers' behaviours when crossing the road.
- Section E: Reflection on sensitisation campaigns
    - In Section E, respondents disclose the effectiveness of road safety campaigns.
- Section F: Further comments on road safety of pedestrians
    - In the section, respondents subjectively describe any feedback of suggestions pertaining to road safety of pedestrians.

4.7 Strategies for conducting the survey

A pilot study was carried out at University of Mauritius among 15 individuals including students, administrative staff, and other members. Subsequently, questions were reviewed based on responses received during the pilot study.

The finalised questionnaire was then used to conduct in-person surveys at locations identified as explained previously. An attempt has been made to include both sexes according to their representation in the overall population as well as people from all age groups in the in-person surveys. The surveys in the field were carried out by two research assistants during weekdays from 9.00 a.m to 4.00 p.m from start of December 2020 to end of February 2021.

The online survey was carried out through a Google Form, which was sent to a pool of respondents working in the Civil Service in mid-February 2021, with responses accepted upto mid-March 2021. This was a self-selection survey as people had the choice to participate in the survey and it attracted a fair number of respondents.

Combining both surveys allowed to achieve the minimum required number of respondents in the limited time and resources that were available to implement the work.

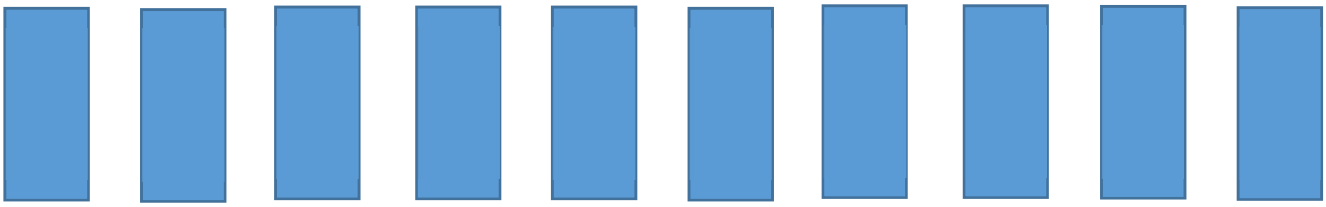
4.8 Analysis of survey and presentation of findings

The crash datasets from the IMAAP software were used to primarily assess the road safety situation in Mauritius as well as identifying blackspot locations for pedestrian crashes.

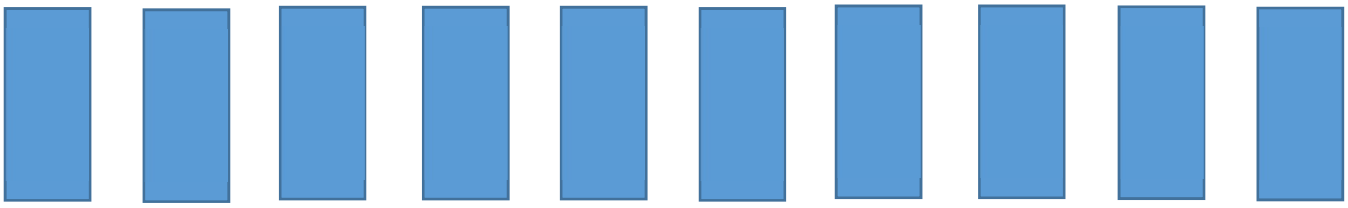
The questionnaire was analysed using statistical analysis techniques. Using SPSS, we were able to conduct both descriptive and inferential analysis. First, the collected data was converted from the Google Form dataset into a CSV. Secondly, the data was then imported in SPSS. Finally, the collected data was cleaned, and useless data were omitted, before performing analysis. The findings were presented using visual aids such as charts and other diagrams.

4.9 Ethical clearance and limitations of the study

Police clearance was sought before undertaking the research study**.** Due to time and budget constraints, it was decided to collect a sample of data sufficiently large enough to conduct meaningful analysis. The research therefore was narrowed down to cover only 4 main types of crossing facilities, namely zebra crossings, overhead footbridges, signalised crossings, and crossings with speed calming treatment.



CHAPTER 5.0
RESULTS & DISCUSSION



5.0 RESULTS AND DISCUSSION

5.1 Introduction

The results of the surveys carried out are presented and discussed in this chapter. These have been used to formulate recommendations on potential measures that can help to improve pedestrian use of crossing facilities in Mauritius.

5.2 Demographics

A total of 1382 persons responded to the survey, out of which 57% were female and 43% males. The distribution for the different age groups is 23% for persons aged from 18 to 25 years old, 38% for persons aged from 25 to 40 years, 32% for persons aged from 40 to 60 years and 7% for persons aged above 60 years old.

57% of the respondents were married or living with a partner, 38% were single while the remaining 5% were either divorced or did not specify the type of relationship they were in.

The survey has attempted to capture participants throughout the island as already explained in the previous chapter. The distribution of the respondents place of residence district-wise is given in the table below.

Table 3: Geographical location of survey respondents

DISTRICT	NUMBER OF RESPONDENTS
Plaines Wilhems	456
Grand Port	210
Flacq	155
Moka	140
Pamplemousses	135
Savanne	93
Riviere du Rempart	83
Port Louis	78
Black river	26

The district of Plaines Wilhems has the largest number of respondents as surveys were carried out to include participants in each town, whereas the districts of Port Louis and Black River had the smallest number of participants as the survey was interrupted due to the national confinement.

The participants were asked to state their level of education and most of the respondents have stated that they had done studies up to a certain level. The details are given in the figure below.

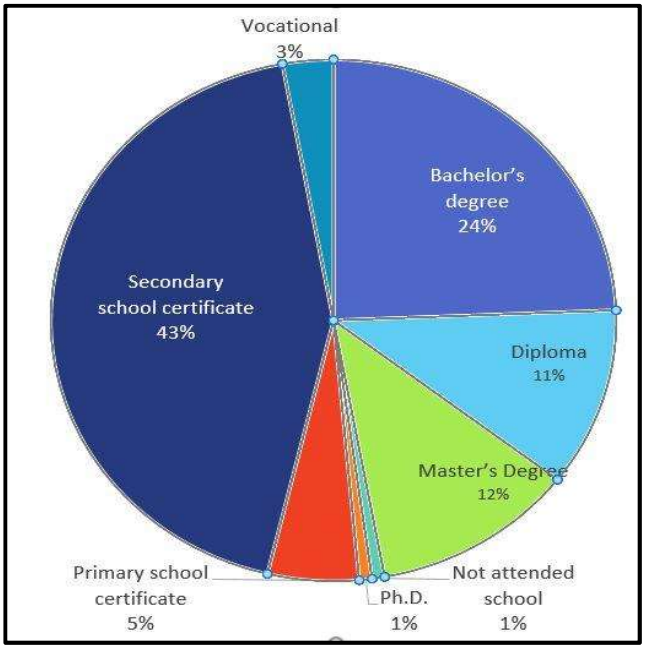


Figure 22: Level of Education

The majority of people surveyed have studied at least up to secondary level while more than one third of respondents have at least a bachelor's degree. This high level of literacy of respondents may be explained by the fact that the survey included an online questionnaire which was distributed to persons in the civil service and who possess at least a secondary school certificate.

Respondents were also queried on their levels of physical ability, which is important for walking and crossing roads. Most participants claimed to have adequate eyesight and mobility levels as shown in the figures below.

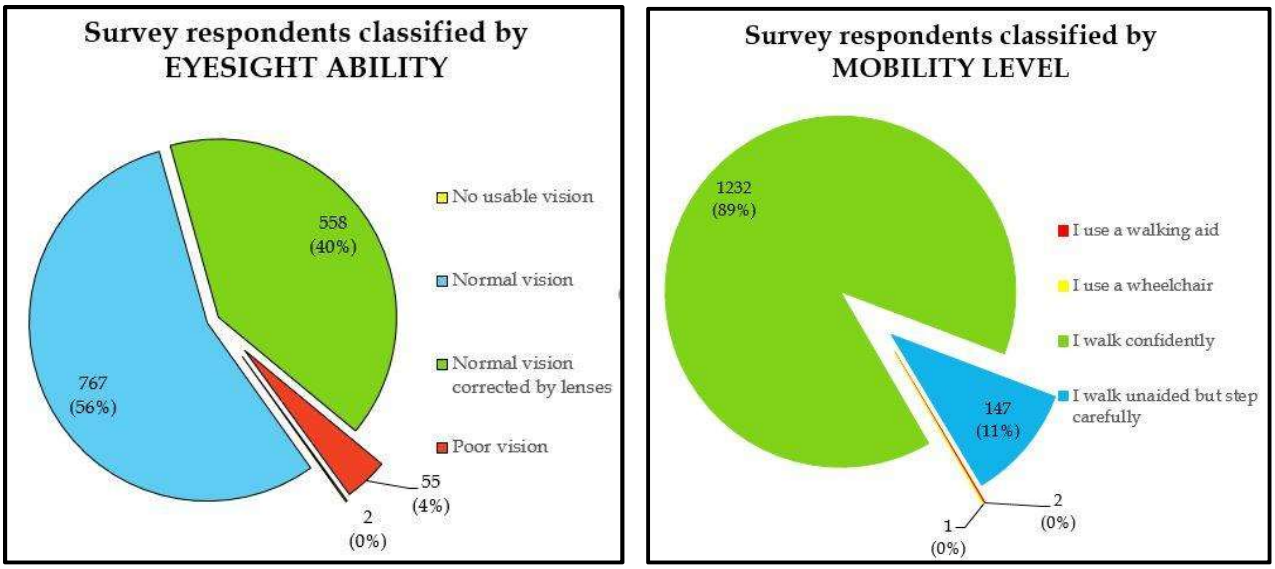


Figure 23: Respondents self-reported vision and mobility levels

Out of the 1382 persons who participated in the survey, only 87 (6%) reported that they had previously been involved in a traffic crash as a pedestrian, with 53% being females and 47% males. 19% of respondents claimed that the crash severity was serious (they had to be admitted to the hospital for more than 24 hours) while the rest required no medical treatment or only a check-up.

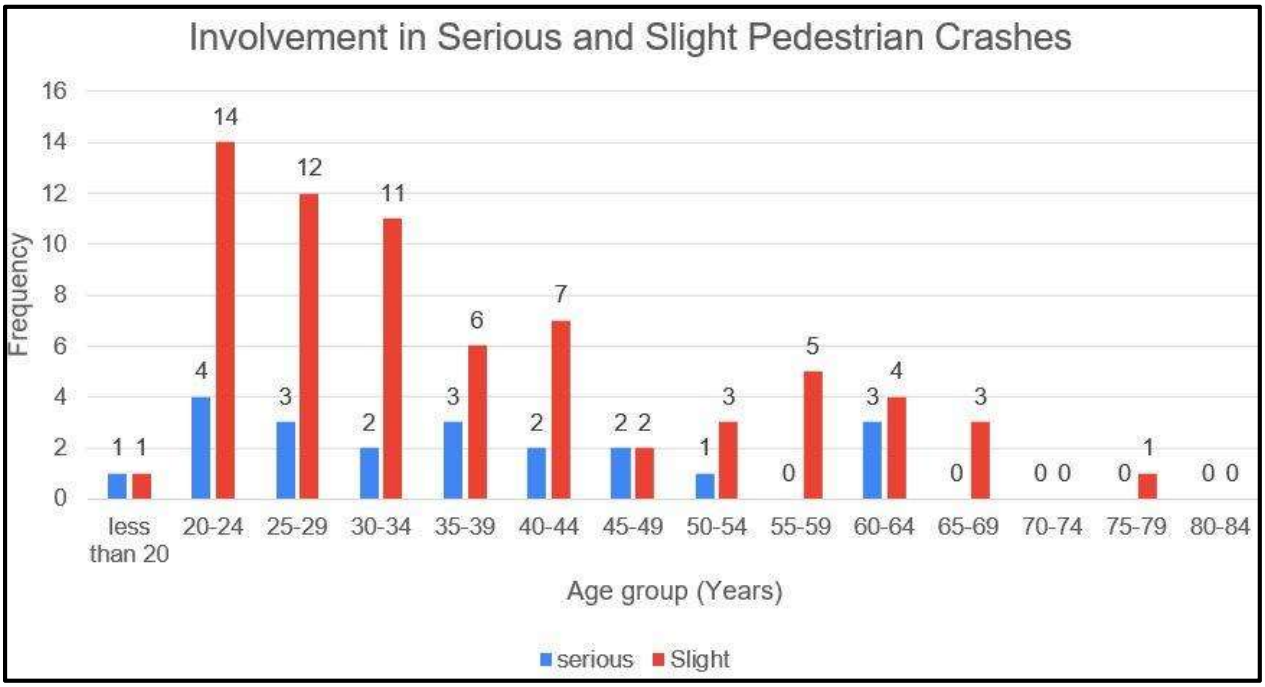


Figure 24: Respondents involvement in pedestrian collision according to age groups

The results indicate a higher proportion in the 20 to 34 age group. However, it can also be observed that the 55 to 69 age group is also vulnerable to pedestrian crashes. Amongst those surveyed, it is observed that young males between 18 and 24 years are more likely to be involved in serious crashes whereas for females, all age groups are involved in this type of collision.

5.3 Pedestrian perception of crossing facilities

The perception of pedestrians on common pedestrian facilities used in Mauritius was sought, with different types of environment in terms of type of road, number of lanes and operating speed considered. The findings from the questionnaire surveys are detailed hereunder:

5.3.1 Overhead footbridge on Motorway

49% of people surveyed have stated that they consider this type of crossing facility as safe with 29% reporting it as unsafe and 22% finding it slightly safe. It is to be noted that the percentage of males and females for the whole survey who found this type of crossing unsafe did not differ largely with 26% males and 30% females. Among the females interviewed, one out of every three females aged between 25 and 60 years old stated that the facility was unsafe while 4 out of 10 females aged over 65 years old considered the facility as unsafe.

25% of respondents who did not have any mobility impairment, found this facility unsafe while 50% of persons who had difficulty in walking (walk unaided but step carefully, use of walking aid and wheelchair) stated that this facility was not safe. Moreover, 30 out of 55 persons who had poor vision reported this facility as unsafe.

The above findings corroborate with research studies which have found that footbridges are often viewed as a safe path for pedestrians (Gallegos, 2012, Mutto et al, 2002). However, several studies (James et al, 2005 in the UK; Rasanen et al, 2007 in Turkey; Mfinanga, 2014 in Tanzania; Tao et al, 2010 in China; Rankavat et al, 2016 in India and Villaveces et al, 2012 in Colombia) have also revealed that footbridges are disliked due to personal security issues as well as the time and effort required to use them. Moreover,

it has been reported that older adults and women are less likely to use grade separated crossing facilities especially at night (Rankavat et al, 2016 and Tanaboriboon et al, 1994).

5.3.2 Pelican Crossing on Motorway

31% of people surveyed have stated that they consider this type of crossing facility as safe with 42% reporting it as unsafe and 27% slightly safe. Of the 577 persons who found this facility unsafe, it is to be noted that the percentage of males and females for the whole survey who found this type of crossing unsafe did not differ largely with 19% males and 22% females. Among the persons interviewed, it is noted that the age of the respondents did not have any major impact on the perception of safety of this facility.

40% of respondents who did not have any mobility impairment, found this facility unsafe while 70% of persons who had difficulty in walking (walk unaided but step carefully, use of walking aid and wheelchair) stated that this facility was not safe. This may be due to inadequate time being provided to these road users for crossing the total width of the road. Moreover, 30 out of 55 persons who had poor vision reported this facility as unsafe.

5.3.3 Zebra Crossing with Median Treatment on Dual Carriageway

43% of people surveyed have stated that they consider this type of crossing facility as safe with 24% reporting it as unsafe and 33% slightly safe. Persons who found this facility unsafe were evenly distributed in terms of gender. Based on the survey, the age of the respondents also did not have any major impact on the perception of safety of this facility.

20% of respondents who did not have any mobility impairment, found this facility unsafe while 50% of persons who had difficulty in walking (walk unaided

but step carefully, use of walking aid and wheelchair) stated that this facility was not safe. This may be due to inadequate provision being made to cater for people who have difficulty walking or are in wheelchairs such as having to cope with difference in levels between the road and the footpath/median treatment, which may lead to trips and falls for pedestrians. Moreover, 19 out of 55 persons who had poor vision reported this facility as unsafe.

5.3.4 Zebra Crossing on Single Carriageway

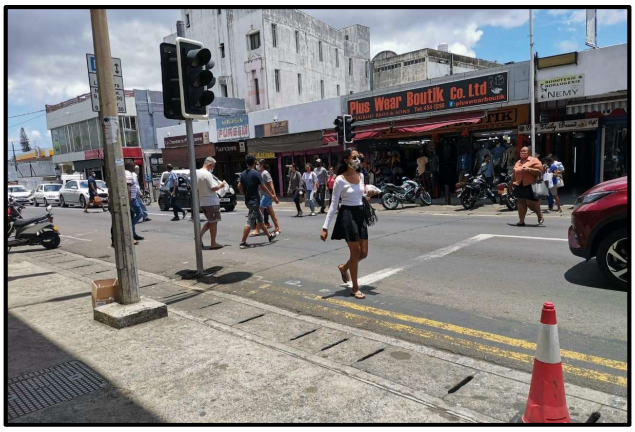
45% of people surveyed have stated that they consider this type of crossing facility in an urban environment as safe with 22% reporting it as unsafe and 33% slightly safe. Persons who found this facility unsafe were evenly distributed in terms of gender. Based on the survey, the age of the respondents also did not have any major impact on the perception of safety of this facility.

18% of respondents who did not have any mobility impairment, found this facility unsafe while 55% of persons who had difficulty in walking (walk unaided but step carefully, use of walking aid and wheelchair) stated that this facility was not safe. Moreover, 25 persons out of 55 who reported they suffered from poor vision found this facility unsafe. This may be due to inadequate provision being made to cater for people suffering from mobility or vision impairments such as having to cope with difference in levels between the road and the footpath/median treatment, which may lead to trips and falls for pedestrians.

5.3.5 Pelican Crossing on Single Carriageway

56% of people surveyed have stated that they consider this type of crossing facility in an urban environment as safe with 17% reporting it as unsafe and 27% slightly safe. Persons who found this facility unsafe were evenly distributed in terms of gender. Among the interviewees, one out of every four persons aged between 18 and 45 years old stated that the facility was unsafe while 1 out of 3 respondents aged over 45 years old considered the facility as unsafe, indicating that age has an impact on how people perceive this facility. This may be due to the walking speed of pedestrians which is generally less for older persons, who therefore need to be provided with more time to safely use this

facility. This corresponds to research studies carried out in the UK which have suggested that extra time should be provided at this type of crossing to cater for people with a lower walking speed (less than 1.2 m/s) due to age, infirmity or being overloaded (Martin, 2004).



17% of respondents who did not have any mobility impairment, found this facility unsafe while only 20% of persons who had difficulty in walking (walk unaided but step carefully, use of walking aid and wheelchair) stated that this facility was not safe. Moreover, 11 persons out of 57 who reported they suffered from poor vision found this facility unsafe. The figures suggest that this type of crossing is considered more user friendly by persons who suffer from either mobility or vision impairment.

5.3.6 Speed Table on One-Way Single Carriageway

54% of people surveyed have stated that they consider this type of crossing facility in an urban environment as safe with 14% reporting it as unsafe and 32% slightly safe. Persons who found this facility unsafe were evenly distributed in terms of gender. Among the interviewees, one out of every four persons aged between 18 and 60 years old stated that the facility was unsafe while 1 out of 2 respondents aged over 60 years old considered the facility as unsafe, indicating that age has an impact on how people perceive this facility. This may be because older persons are not yet familiar with this type of facility or encounter difficulties when using it and this needs to be further investigated.

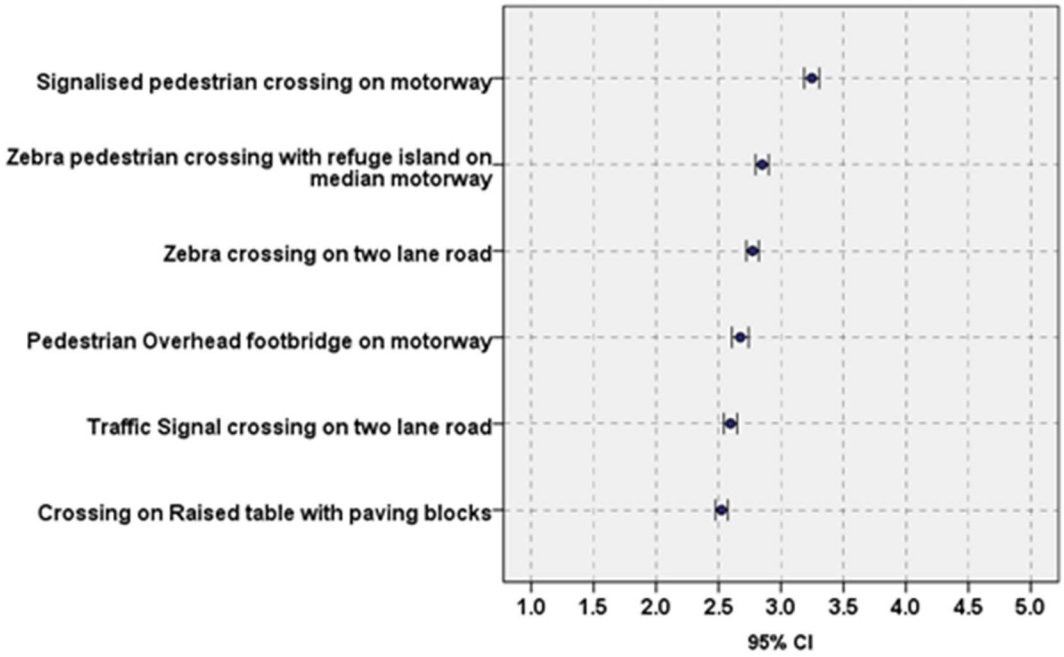
15% of respondents who did not have any mobility impairment, found this facility unsafe while only 10% of persons who had difficulty in walking (walk unaided but step carefully, use of walking aid and wheelchair) stated that this facility was not safe. Moreover, 8 persons out of 57 who reported they

suffered from poor vision found this facility unsafe. The figures suggest that this type of crossing is considered more user friendly by persons who suffer from either mobility or vision impairment.

5.3.7 Summary of Pedestrian Perceptions on Crossing Facilities

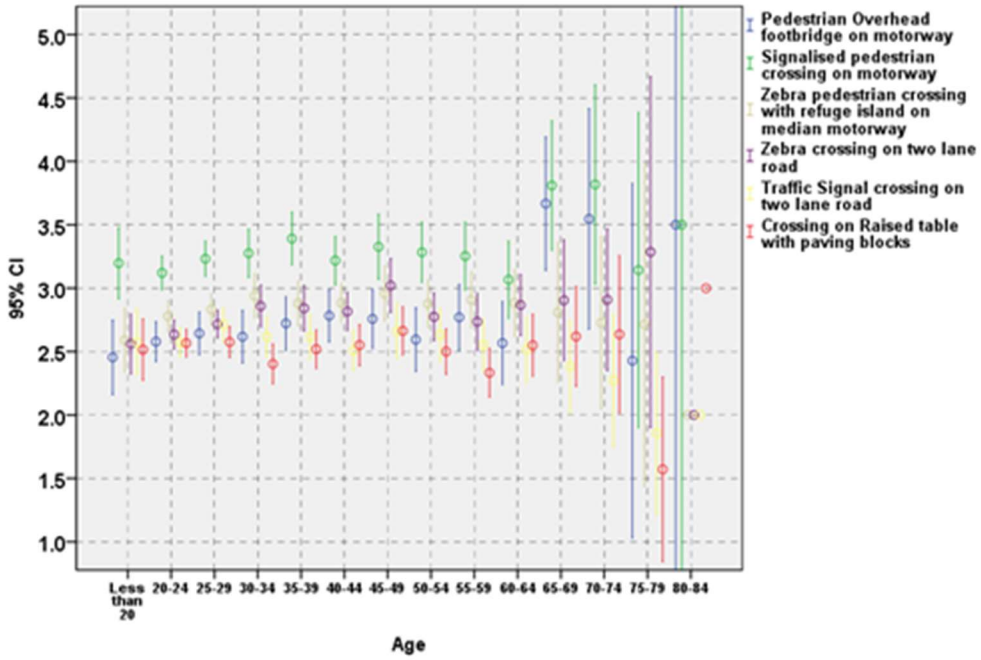
A summary of the pedestrian perception of the six crossing facilities studied in terms of their safety is provided below.

- Figures 25 and 26 shows the 95% confidence interval plots of the safety levels and on average respondents reported that all these crossing facilities are slightly safe in general but with the signalised pedestrian crossing on motorway to have the significant tendency to be unsafe compared to the others. Crossing on raised table with paving blocks is perceived to be between safe and slightly safe. Hence, in general none of these crossing facilities are considered to be safe and very safe on average. Similar tendency is observed for each age category but as from the age of 65 years, we observe a less consistent response with a wider variability.



(1: Very Safe, 5: Very Unsafe)

Figure 25: 95% Confidence interval plot for crossing facilities



(1: Very Safe, 5: Very Unsafe)

Figure 26: 95% Confidence interval plot for crossing facilities by Age

- For dual carriageways and high-speed environment, results suggest that people prefer grade separated facilities, with the pelican crossing being the least favoured one.
- For roads in urban environment, speed tables and pelican crossings are regarded as the safest with only 14% and 17% of respondents finding these unsafe. People with mobility or vision impairment also favour these facilities.
- While there was no apparent link between gender and the safety perceptions for 5 out of the 6 facilities, a clear correlation was noted for footbridges where one out of every three females aged between 25 and 60 years old stated that the facility was unsafe while 4 out of 10 females aged over 65 years old considered the facility as unsafe.
- In terms of age, it was noted that 1 out of 3 respondents aged over 45 years old considered the pelican crossing facilities as unsafe, suggesting that age has an impact on how people perceive this facility.

5.4 Pedestrian behaviour

Interviewers were required to report on their behaviour near or on crossing facilities in this section of the questionnaire and the findings are detailed hereunder:

5.4.1 Pedestrian Travel Motivations

The travel motivations of respondents are shown in the table below.

Table 4: Travel Motivations

	Never	Rarely	Sometimes	Often	Always
I walk for the pleasure of it	8%	18%	35%	21%	18%
I walk because it is healthy	5%	9%	29%	29%	28%
In short trips, I prefer to walk	4%	7%	18%	29%	41%
I walk to go to work	53%	12%	10%	8%	17%
I walk because I have no other choice	26%	25%	24%	10%	16%
I walk to take another mode of transport	13%	18%	22%	18%	29%

From responses obtained, most participants have rather positive travel motivations, with 3 out of 4 persons claiming to enjoy walking and 86% walking because of its health benefits. Moreover, 70% of interviewees stated that they often/always walk for short trips. However, it can be seen that more than 50% of people do not walk to go to work, suggesting that there is a strong car dependency when it comes to travelling to work, with only 25% using this mode of transport as a regular mode of travel. This can be explained by the fact that most people do not work in their neighbourhoods. Moreover, it was observed that age and level of education was not a determinant factor in whether people use walking as a mode of travel to go to work.

1 out of 4 persons have stated that they walk because they do not have a choice, with respondents evenly distributed among all age groups. Finally, it was noted that almost 50% of interviewees walk regularly in order to take another mode of transport whereas 13% have stated that they do not need to walk to access another mode of transport.

5.4.2 Pedestrian behaviour at/near crossing facilities

Questions were asked to participants in order to assess how they would behave in different scenarios when at/near crossings. The findings from the survey are summarised in the figure below.

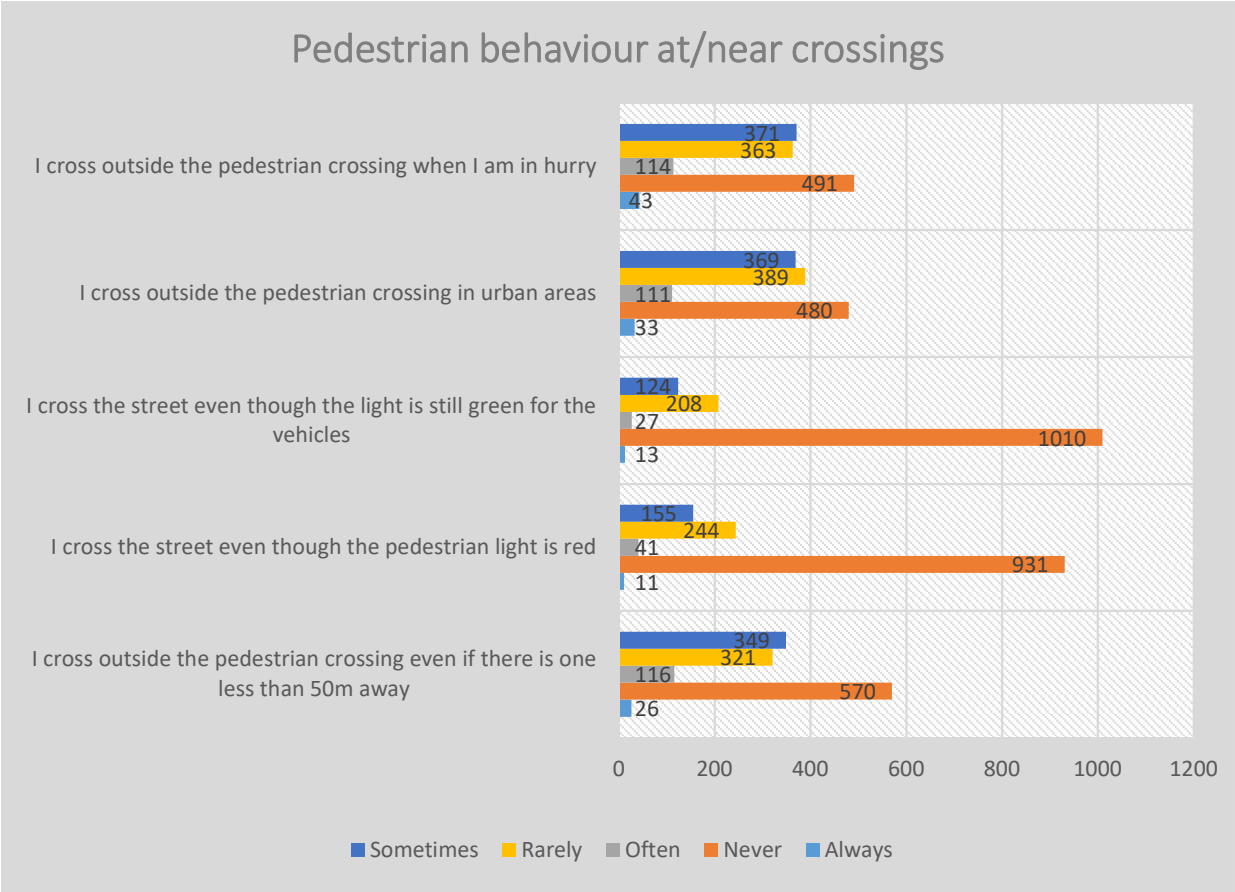


Figure 27: Pedestrian behaviour at/near crossings

The majority of respondents have stated that they do not cross when the priority is for vehicles or when the pedestrian light is red. However, 25% of respondents have stated that they do engage in non-compliant behaviour at signalised crossings. A previous study by Onelcin and Alver (2016) identified that time saving, and low traffic volume were the main reasons for this behaviour.

Almost 40% of interviewees have admitted that they cross outside pedestrian crossing when they are in a hurry or when they are in urban areas. 60% of persons have accepted that they cross outside pedestrian crossings even if there is one less than 50m away.

Further analysis shows that males are slightly more prone to take risks while age plays a more prominent role as shown in the table below. The highest percentage for each age group has been highlighted in red.

Table 5: Pedestrian behaviour according to age groups

I cross diagonally to save time				I cross outside the pedestrian crossing even if there is one less than 50 m away			
Age group	Occurrence			Age group	Occurrence		
	Never	Rarely/Often/ Sometimes	Always		Never	Rarely/Often/ Sometimes	Always
18 – 29	27.0	69.8	3.3	18 – 29	33.3	63.8	2.9
30 – 60	44.3	54.4	1.4	30 – 60	45.2	53.7	1.1
>60	64.4	33.7	2.0	>60	55.4	42.6	2.0
I cross the street even though the pedestrian light is red				I cross even though the light is still green for vehicles			
Age group	Occurrence			Age group	Occurrence		
	Never	Rarely/Often/ Sometimes	Always		Never	Rarely/Often/ Sometimes	Always
18 – 29	58.5	40.4	1.1	18 – 29	65.9	33.0	1.1
30 – 60	71.7	27.7	0.5	30 – 60	77.0	22.1	0.8
>60	84.2	14.9	1.0	>60	83.2	15.8	1.0
I cross outside pedestrian crossing in urban areas				I cross outside pedestrian crossing when I am in a hurry			
Age group	Occurrence			Age group	Occurrence		
	Never	Rarely/Often/ Sometimes	Always		Never	Rarely/Often/ Sometimes	Always
18 – 29	31.5	65.0	3.5	18 – 29	26.6	68.1	5.3
30 – 60	35.0	63.3	1.8	30 – 60	39.9	58.5	1.6
>60	50.5	48.5	1.0	>60	52.5	45.5	2.0

People less than 30 reported that they are more likely to engage into behaviour that put them at risk whereas pedestrians over 60 are less likely to take risks while crossing the road according to the survey

carried out. This is in line with previous studies (Wang et al., 2011; Guo et al., 2011; Brosseau et al., 2013) that found young pedestrians (19-29) violate the red light rule more compared to their older counterparts while older pedestrians seem to be more cautious when they are crossing. However, almost 50% of people who are more than 60 years old have admitted that they take risks by not using crossing facilities when they are in a hurry or in an urban environment while 45% have reported that they would cross outside a pedestrian crossing even if there was one less than 50m away. Lastly, it is noted that people in the 30 – 60 age group are also prone to taking risks when crossing the road although at a slightly lesser extent that the 18 – 30 age group.

These findings corroborate with a research study on pedestrians risky crossing behaviour (Soathong et al, 2021) which stated that often pedestrians cross the road at random points or where it is most convenient for them despite a crossing facility nearby because they perceive it as being a necessary risk worth taking (benefits outweigh any disbenefits). While this risk-taking behaviour by pedestrians may not result in crashes, it leads to increased crash exposure and creates a higher risk of collisions. Therefore, roads with a high volume of pedestrians should be carefully re-evaluated or designed to create safe-crossing facilities that provide the shortest path to the desired destination, if possible.

Soathong et al (2021) also discussed that pedestrians often perceive risky crossing behaviour at mid-block sections as an acceptable act by society. This is noted in the responses obtained in the survey carried out for Mauritius and therefore, increasing road safety awareness and knowledge of associated risks could potentially be required to change this perception. Pedestrians need to understand that this behaviour is not a low-risk activity and be aware of their vulnerability. Designing and implementing programs should also be tailored to suit the different target groups as it has been observed that all age groups tend to take risks in certain situations.

5.4.3 Pedestrian behaviour when crossing the road

In this section of the questionnaire, respondents were provided with five scenarios, in which they would not be complying with rules when crossing the road and were required to report how likely they were to perform these actions. Results are given in the table below.

Table 6: Pedestrian behaviour when crossing the road

	Never	Rarely	Sometimes	Often	Always
I start to cross on a pedestrian crossing and I finish crossing diagonally to save time	45%	30%	21%	4%	1%
I cross between vehicles stopped on the roadway in traffic jams	35%	26%	26%	10%	3%
I do not follow the traffic signs when crossing the road in groups	57%	25%	13%	4%	2%
I walk on the roadway to be next to my friends on the sidewalk or to overtake someone who is walking slower than I am	33%	25%	30%	9%	2%
I cross the street between cars rather than using a pedestrian crossing	44%	25%	23%	5%	3%

The findings from the survey indicate that approximately 7 out of 10 people are likely to use a pedestrian crossing instead of crossing between cars and will do so correctly instead of crossing diagonally. However, responses indicate that presented with some situations, pedestrians will engage in a non-compliant behaviour, with the scenarios being when people need to cross the road between vehicles during traffic jams and when people are walking with friends.

The survey does not indicate any significant correlation between gender and the behaviour adopted in the various scenarios given with both males and females equally likely to engage in the non-compliant behaviour amongst those who have reported that they would do so. However, age seems to have a significant relevance with those aged between 18 and 30 years old again being the group with the most reported non-compliant behaviour when crossing the road in certain scenarios. This corroborates with findings from previous studies (Martin, 2004), which have shown that younger pedestrians are more likely to exhibit non-compliant behaviour because they perceived more social pressure to cross (subjective norms) and thought they have greater control over the performance of their behaviour than older pedestrians.

An analysis of risky pedestrian behaviour and non-compliance was also carried out based on their location/place of residence. A chloropleth map was used to represent the districts in terms of the percentage of respondents reporting to exhibit a risky behaviour and is shown in the figure below.

The survey results indicate that people tend to engage in risky pedestrian behaviour or non-compliance with rules in certain districts more than in others, with Port Louis, Pamplemousses and Grand Port being the ones faring the poorest. This indicates that these districts may need to be given priority when trying to tackle the issue of pedestrian safety.

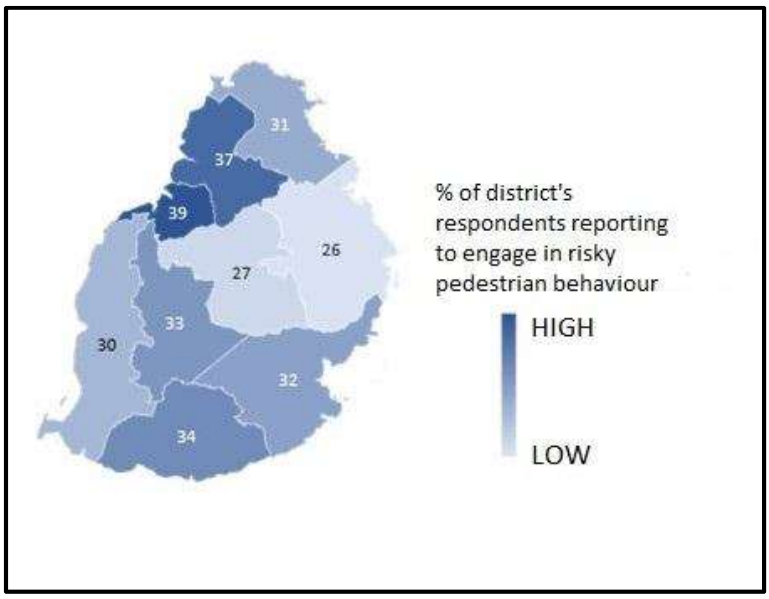


Figure 28: Chloropleth map showing risky pedestrian behaviour

A further analysis showed that trip purpose has a strong correlation with risk taking attitudes and non-compliance for pedestrians near/at crossings as well as while crossing the road. A comparison between pedestrians who walk mainly for pleasure and those walking to work is shown in the table below.

Table 7: Trip purposes and pedestrian behaviour

I WALK TO GO TO WORK	Never/Rarely	Sometimes	Often/Always
Cross diagonally to save time	60%	8%	32%
I cross outside the pedestrian crossing even if there is one less than 50m away	58%	9%	32%
I cross the street even though the pedestrian light is red	58%	10%	33%
I cross even though the light is still green for vehicles	48%	8%	45%
I cross outside pedestrian crossing in urban areas	66%	8%	26%
I cross outside pedestrian crossing when I am in a hurry	62%	8%	29%
I start to cross on a pedestrian crossing and I finish crossing diagonally to save time	67%	10%	24%
I cross between vehicles stopped on the roadway in traffic jams	64%	9%	27%
I do not follow the traffic signs when crossing the road in groups	59%	11%	30%
I walk on the roadway to be next to my friends on the sidewalk or to overtake someone who is walking slower than I am	64%	6%	30%
I cross the street between cars rather than using a pedestrian crossing	63%	5%	32%

I WALK FOR THE PLEASURE OF IT	Never/Rarely	Sometimes	Often/Always
Cross diagonally to save time	21%	33%	46%
I cross outside the pedestrian crossing even if there is one less than 50m away	23%	27%	51%
I cross the street even though the pedestrian light is red	21%	27%	52%
I cross even though the light is still green for vehicles	30%	23%	48%
I cross outside pedestrian crossing in urban areas	32%	25%	43%
I cross outside pedestrian crossing when I am in a hurry	27%	29%	45%
I start to cross on a pedestrian crossing and I finish crossing diagonally to save time	25%	31%	43%
I cross between vehicles stopped on the roadway in traffic jams	32%	31%	37%
I do not follow the traffic signs when crossing the road in groups	29%	30%	41%
I walk on the roadway to be next to my friends on the sidewalk or to overtake someone who is walking slower than I am	26%	31%	43%
I cross the street between cars rather than using a pedestrian crossing	23%	29%	48%

The results show that people regularly engaged in walking as leisure activities are more likely to engage into risky behaviour compared with persons who walk mainly to go to work. This corroborates with literature which has identified walking motivations as being an underlying factor which influences pedestrian behaviour on roads (Papadimitriou et al, 2016) and that higher pedestrian collision risk is often associated with shopping land use (Martin, 2004).

The above analyses indicate that current provision for pedestrians needs to be reviewed as people are being encouraged to take up walking as a transport mode. Previous research by Elvik et al (2013) and Shriver (1997) report that a good design of facilities can promote walking without compromising safety and convenience, with waiting time and crossing distance being two key factors which lead to unsafe crossing. Necessary infrastructure should therefore be provided in terms of footpath width, with the current provision of 1.2m wide footpath likely to be inadequate to cater for people walking in groups. Moreover, appropriate facilities should be provided to access places where people engage into walking for leisure purposes, such as continuity of footpath to residential zones/parking facilities and provision of crossing facilities at appropriate locations.

5.4.4 Pedestrian attention to the road environment

In this section of the questionnaire, respondents were asked to report on the degree of attention they pay to the road environment when they are walking. From responses obtained, the majority of interviewees (8 out of 10) stated that they were attentive/alert while crossing the road, whether they are alone or in groups. This shows that people are aware of the danger/risk that they are exposed to while crossing the road. However, it is again found that when pedestrians are accompanied by others, they tend to forget this danger or take a greater risk, with only 4 out of 10 stating that they would walk in a single file. Results are given in the table below.

Table 8: Pedestrian reported attention paid to the walking environment

	Never	Rarely	Sometimes	Often	Always
I forget to look before crossing because I am thinking about something else	82%	12%	4%	1%	0%
I forget to look before crossing because I want to join someone on the sidewalk on the other side	84%	10%	5%	1%	1%
I cross without looking because I am talking with someone	86%	8%	4%	1%	1%
I realize that I have crossed several streets and intersections without paying attention to traffic	83%	9%	6%	1%	1%
When I am accompanied by other pedestrians, I walk in single file on narrow sidewalks so as not to bother the pedestrians I meet	23%	19%	23%	23%	12%

It is further noted that those who have reported having lapses in attention while crossing the road consist mostly of young adults less than 30 years old.

It is also noted with concern from the 95% confidence interval plot that on average, pedestrians sometimes cross several streets and intersections without paying attention to traffic or even when in conversation with someone.

Figure 29: 95% Confidence interval plot for attention to road environment (1: Never, 2: Rarely, 3: Sometimes, 4: Often, 5: Always)

5.6 Pedestrian perception of road environment

Interviewers were required to report on their perception of crossing facilities as well as on their interaction with road users making use of other transport modes in this section of the questionnaire. The findings are detailed hereunder:

5.6.1 Pedestrian perception on road crossing

During the survey, respondents were required to report on how they perceived different aspects associated with crossing the road. The results are shown in the Table below.

Table 9: Pedestrian perception on road crossing

	Never	Rarely	Sometimes	Often	Always
Crossing roads is difficult	12%	9%	50%	14%	15%
Crossing roads outside pedestrian crossing increases the risk of accident	2%	3%	13%	26%	57%
Crossing roads outside pedestrian crossing is wrong	5%	3%	12%	13%	67%
Crossing roads outside pedestrian crossing saves time	33%	10%	35%	14%	8%
I prefer routes with signalised crosswalks	4%	4%	17%	20%	56%
I am willing to make a detour to find a protected crossing	10%	19%	33%	18%	20%
I am willing to take risk as a pedestrian to save time	44%	22%	23%	7%	4%

Results indicate that 50% of persons surveyed perceive crossing the road as a difficult task occasionally, with 29% of interviewees stating that this often/always presents a difficulty to them. These comprise largely of people who have reduced mobility levels.

The survey also indicated that a high percentage of respondents view crossing the roads outside pedestrian crossing as wrong or as an act that increases the risk of accident. However, approximately 20% of respondents think that these acts do not constitute wrong or risky behaviour. This may explain the reasons for people adopting risky or non-compliant behaviour at crossings as they are unaware of the fact that risk of collision is much higher away from crossing facilities compared with on a crossing (Martin, 2004).

It can also be observed that more that 50% of respondents think that crossing outside pedestrian crossings helps in saving time, with 29% stating that they are not likely to make a detour in order to find a protected crossing facility. 34% of persons interviewed also stated that they will take risks while walking if this allows them to save time.

From the 95% confidence plot, despite pedestrians often know that crossing roads is difficult and is wrong outside pedestrian crossing, they sometimes cross outside crossings to save time but at a risk of a crash.

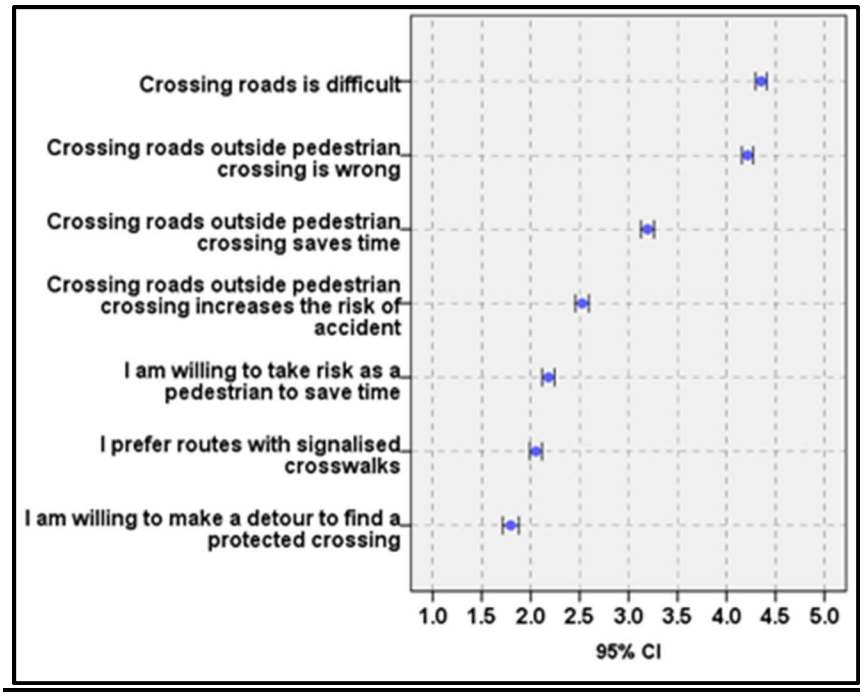


Figure 30: 95% Confidence interval plot for perception related to road crossing (1: Never, 2: Rarely, 3: Sometimes, 4: Often, 5: Always)

These findings corroborate with previous studies, which have found that pedestrians generally take the quickest route to their destination and they will generally try to shorten distances and reduce waiting times by taking risks to minimise delays (Martin, 2004). Sisiopiku and Atkin (2003) also reported that pedestrians tend to organise their crossing location and timing to minimise walking distance and delay.

Routes with signalised crosswalks are preferred by 75% of respondents. However, the remaining 25% do not prefer these types of facilities while walking and this may be due to the delay associated with signalised crossings. A previous study by Ren at al (2011) has identified time savings and convenience as the main reasons for people not complying with red lights at signalised crossing. Guo et al (2011) further reported that pedestrians have an endurance of 50s for waiting at traffic lights, with 50% likely to violate the red light after 50s have elapsed.

5.6.2 Pedestrian perception related to drivers

During the survey, respondents were required to report on how they perceived different aspects associated with crossing the road. Interviewees were asked to identify which type of vehicle is more likely to stop when someone is waiting at a pedestrian crossing. The results are shown in the figure below.

According to respondents, car drivers are more likely to stop compared to other vehicle drivers, with motorcyclists and cyclists being the least likely to give way to pedestrians at crossings.

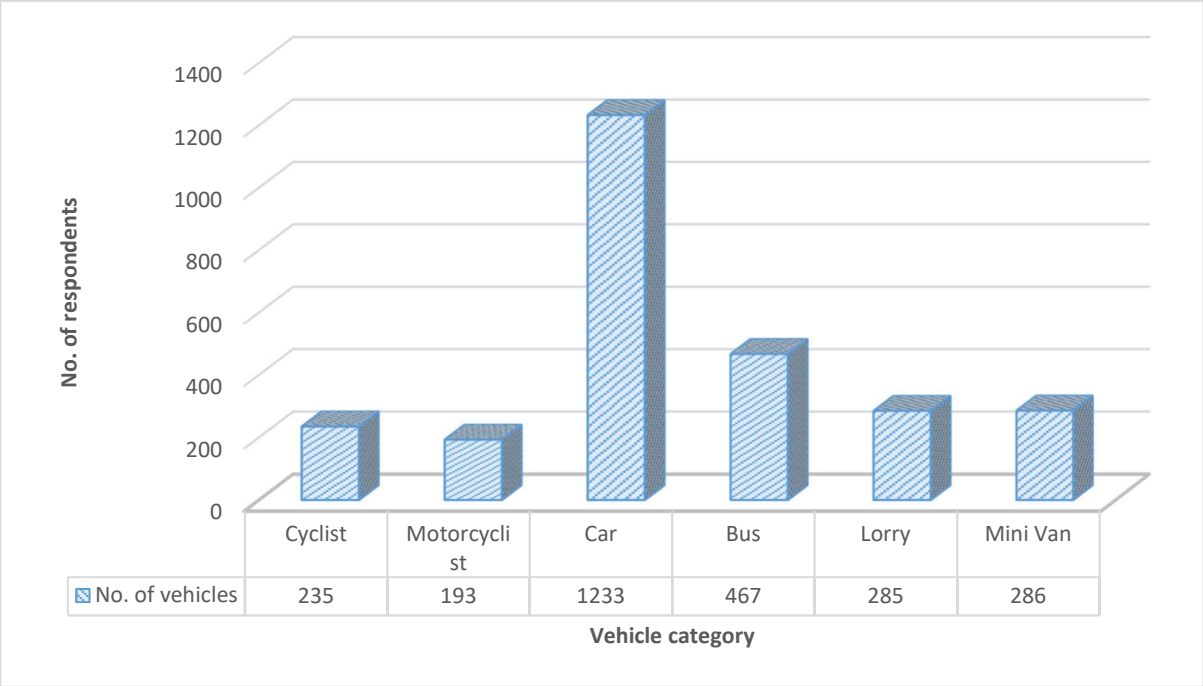


Figure 31: Perception of pedestrians on vehicles likely to stop at crossing facilities

Interviewees were also asked to give their perception on which vehicles reduce their speed when approaching pedestrian crossings. Responses summarised in the figure below confirm that car drivers are more likely to reduce their speed when coming near a crossing facility, with motorcyclists and cyclists being the least likely to do so.

Table 10: Respondents perception of vehicles reducing their speed when approaching pedestrian crossings

	Never	Rarely	Sometimes	Often	Always
Cyclist	37%	29%	19%	10%	6%
Motorcyclist	35%	32%	20%	8%	4%
Car	3%	7%	32%	41%	17%
Bus	12%	18%	31%	28%	12%
Lorry	18%	20%	31%	21%	10%
Mini Van	17%	21%	33%	20%	9%

From the 95% confidence interval plot, we observe that it is indeed significantly not a common practice (often or always) for drivers to reduce their speed when approaching a crossing.

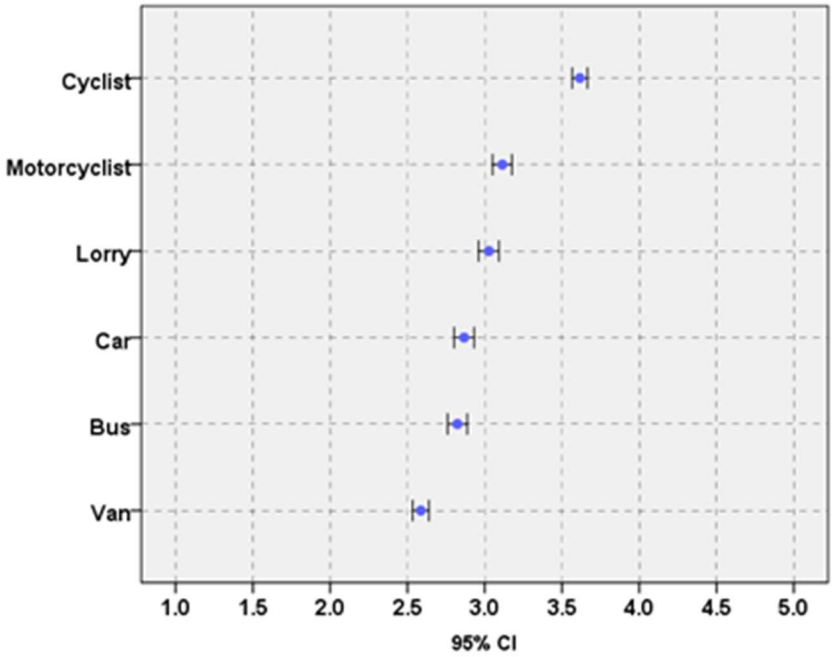


Figure 32: 95% Confidence interval plot for type of driver reducing speed when approaching a crossing

A study by Schroeder at al (2010) identified two main factors that influenced the reduction of the probability of driver yielding to pedestrians: vehicle dynamics (high speeds, deceleration rates) and vehicles travelling in a platoon. This may explain why car drivers are more likely to reduce speeds when approaching a crossing facility as compared to two-wheelers.

5.7 Pedestrian reflections on sensitisation campaigns

People participating in the survey were asked on how often they have seen or heard any television, radio or billboard messages about road safety for pedestrians. Results are shown in the figure below.

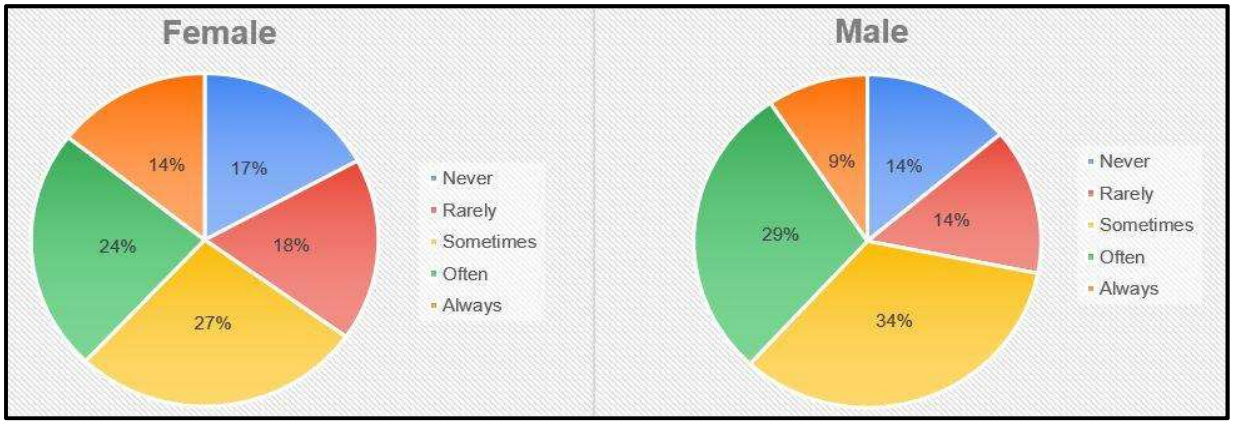


Figure 33: Pedestrians seeing/hearing sensitisation campaigns on road safety for pedestrians

Approximately 60% of both male and female interviewees have acknowledged hearing or seeing sensitisation campaigns on road safety for pedestrians but 1 in 4 persons have stated that they have not been exposed to any.

In terms of the effectiveness of the sensitisation campaigns, less than 20% of respondents have stated that these have had a positive impact on people's behaviour when crossing streets, with the large majority thinking that the campaigns are not effective.

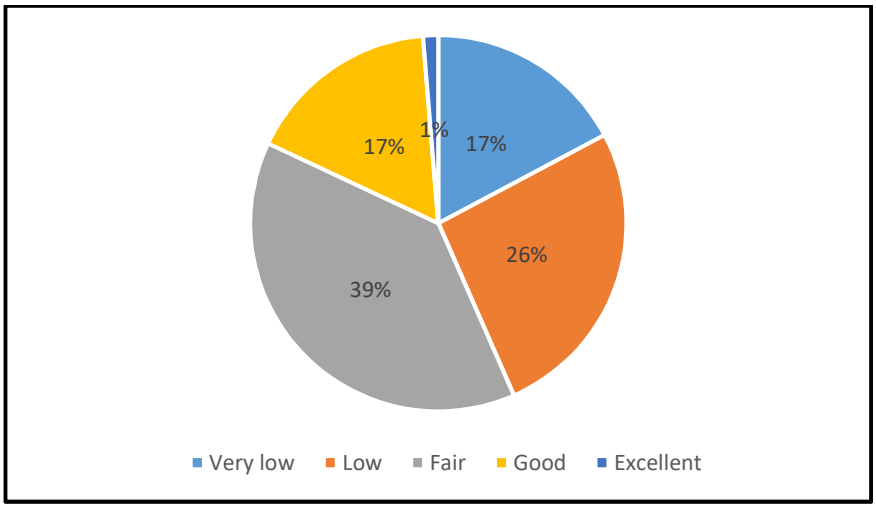


Figure 34: Perception of respondents on effectiveness of safety campaigns on pedestrians behaviour

In general, as per the confidence interval plot, pedestrians are sometimes exposed to sensitising campaigns and judge that these have a fair effectiveness or influence in their behaviour when crossing streets.

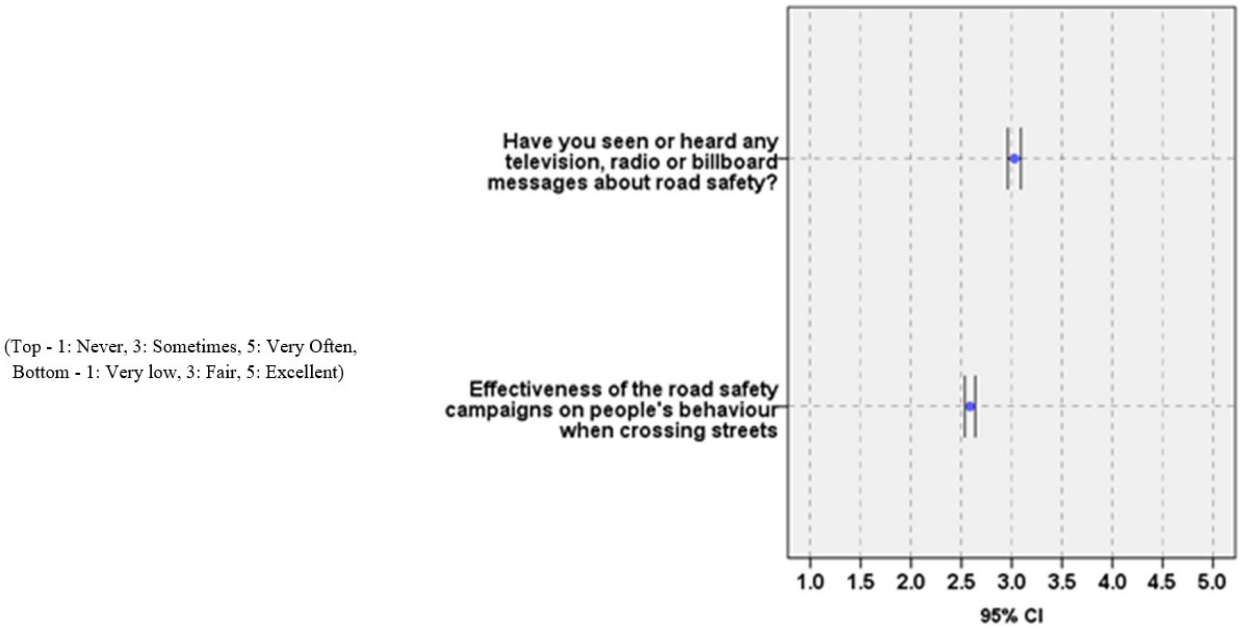


Figure 35: 95% Confidence interval plot for reflection on sensitizing campaigns

5.8 Respondents suggestions for improvement

The last section of the questionnaire included an open-ended question where interviewees were asked to comment on the aspect of road safety for pedestrians. Comments made were varied but could be grouped into 3 main categories: pedestrian behaviour, pedestrian environment and the suggestions for improvement as detailed below.

5.8.1 Comments on pedestrian behaviour

The following comments were made with respect to behaviour of pedestrians, showing that there is a lot of work to do on this aspect in order to improve compliance with rules while at the same time reducing the events which lead to pedestrians adopting risky behaviour such as long waiting times.

- Some pedestrians are not cautious enough on roads and do not respect road safety rules.
    - Pedestrians are often on their phones or listening to music while crossing busy roads.
    - Some pedestrians do not bother checking both sides of the road before using a zebra crossing, believing they are privileged.
    - Pedestrians do not wear clothes that make them more visible at night.
- Some pedestrians tend to minimize travel distances by crossing the road in a risky way.
    - They cross the road in between cars that are blocked in heavy traffic, risking being run over by motorcycles.
    - Some pedestrians cross diagonally to save time.
- Pedestrians are impatient. They do not wait for cars to stop before crossing the road. They do not ensure the driver has noticed them, thus endangering themselves.
    - At controlled crossings, some of them do not wait to have priority to cross the roads as it takes too much time and they are impatient.
    - Sometimes, if policemen are provided, they tend to prioritise vehicles more so as to diminish traffic. Hence, certain impatient pedestrians cross road as they please, endangering themselves.

5.8.2 Comments on pedestrian environment

The following comments were made with respect to the road environment for pedestrians. Many respondents believe that laws are not sufficiently enforced for drivers who do not comply with them and that the provision of infrastructure for pedestrian is lacking. Some of the comments made are given below:

- Drivers do not always comply with rules on the road.
    - Some drivers are impatient and not courteous, especially towards the elderly. They would rather speed up than stop and allow them to cross the road before them.
    - On a two road, vehicles on the other side of the roads sometimes do not stop causing the pedestrian to have to wait in the middle of the road, which is dangerous.
    - Some drivers stop on crossings, forcing pedestrians to cross roads recklessly between cars.

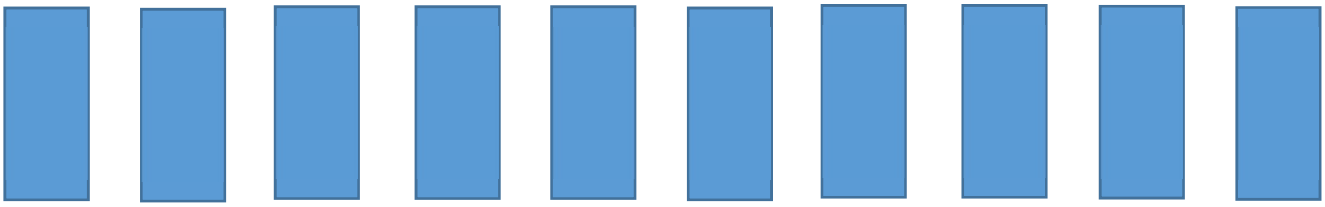
    - Some drivers park their vehicles just before the crossings, making the pedestrians less visible to other coming vehicles.
    - Motorcyclists ride at high speeds and tend to zigzag between vehicles, not paying attention to pedestrians, which may lead to accidents.
- Visibility of crossings is poor at night and drivers are less likely to stop due to this.
- At several locations, footpaths and pedestrian crossings are either limited or not found, causing pedestrians to walk on the side of the road and cross abruptly.
- Some crossings are located in risky areas such as pelican crossings after bends or roundabouts for instance.
- Road markings have faded on some roads. Crossings are no longer visible, putting pedestrians at risks.
- Traffic signals do not work at all times and the time allocated on crossings for pedestrians are too short.
- In certain regions, road pavements are in bad state. Roads having potholes or are too slippery increases risk of accidents.
- Footpaths for pedestrians often have several issues.
    - Pathways are blocked by vehicles and hawkers, forcing pedestrians to walk on road sides.
    - Pathways are at times in a pitiful state. Pedestrians are not willing to use them.
    - RC drain cover on walkways have settled from vehicles, making them uneven to walk on.
- Relocation or removal of crosswalks during or after constructions tend to affect pedestrians as they have to divert from their usual path to a riskier one, with additional walking distance.

5.8.3 Comments on suggestions for improvement

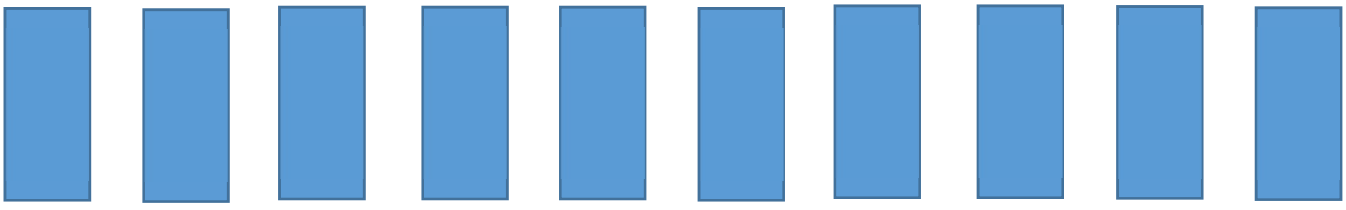
The following comments were made with respect to suggestions on possible measures to improve the safety of pedestrians. Improvements covered three main themes: educational campaigns, engineering and enforcement. Some of the comments made are given below:

- Educating the public on road safety rules and codes, and the risks that comes with a lack of caution.
    - Campaigns in educational institutions to be carried out.

  - More sustained communication campaigns, to further raise awareness and sensitise both drivers and pedestrians on road safety and risks associated with risky behaviour on roads.
- Infrastructure improvement to be carried out to cater for pedestrians.
  - Provide for wider footpaths.
  - Review traffic signals to cater more for pedestrians by reducing waiting times and increasing time allocated for crossing the road.
  - Proper maintenance of crossing facilities in terms of traffic signs and road markings.
  - Provision of speed reducing devices or safety cameras near pedestrian crossings.
  - Provide illuminated crosswalks at all places with high traffic volumes and street lighting in areas where pedestrian crossings are not clearly visible.
  - Provide pedestrian footbridge or underground crossings where it is difficult for pedestrians to cross roads.
  - Relocate crossings found at risky places or provide more where required.
  - Provide pedestrian fences in order to deter persons stepping outside the crossing or to compel them to exclusively use crossing facilities.
  - Place retractable barriers on both sides of the crossing like in Singapore in order to force vehicles to stop and allow pedestrians to cross the road safely.
- Greater enforcement of penalties for both drivers and pedestrians if they break any law.
- Provision of more police officers to help pedestrians cross roads, especially at peak hours.



CHAPTER 6.0 CONCLUSION & RECOMMENDATIONS



6.0 CONCLUSIONS AND RECOMMENDATIONS

This study was commissioned by the Traffic Management and Road Safety Unit to investigate the pedestrian use of crossing facilities in Mauritius.

The review of literature indicated that pedestrians form part of the vulnerable road users category and are particularly exposed to crashes. Previous research also concluded that pedestrian safety is influenced by multiple factors, including demographics such as gender and age, type of environment (urban or rural), time of the day and weather conditions. A range of factors can influence the decisions of pedestrians about when and where to cross with the preference of pedestrians for different crossing facilities and making use of them also influenced by age, gender, trip purpose, waiting time and travel distance (Anciaes et al, 2016 & Sisiopiku et al, 2003).

Pedestrians are also often involved in crashes while crossing the road, with a report by CCMTA (2013) identifying the main reasons as being the walking behaviour and motives. These are influenced by several factors including the road environment (road type, width, intersections, crosswalks, surfaces, lighting), traffic (volume, moving and stationary vehicles), personal (physical, psychological, personal characteristics, motivation, experience, psychological state), and social (presence of others, purpose of journey, play).

Based on the literature review, several behavioural patterns and risk attitudes as well as pedestrian perceptions of the crossing facilities and road environment have been examined and the findings are detailed in the section below.

6.1 Key research findings

The project specified a number of questions to which answers were sought. These are addressed below, with the main findings stated.

6.1.1 Pedestrian perception of crossing facilities

Crossing facilities in high speed environment

- Irrespective of their age category or gender, respondents generally perceive road crossing facilities as slightly safe.
- Pedestrians prefer grade separated facilities for crossing dual carriageways and high speed roads.
- 1 out of every 3 females aged between 25 and 60 years old stated that the overhead footbridge was unsafe while 4 out of 10 females aged over 65 years old considered the facility as unsafe, indicating that females as well as the elderly have difficulties using these facilities
- Persons with poor mobility or poor vision largely stated that they did not consider overhead footbridges as safe.
- For signalised pedestrian crossing across the motorway, more than 40% of respondents found it unsafe, especially those who had difficulty in walking (70%) and had poor vision (55%).
- While 3 out of 4 persons viewed the zebra crossing with median treatment as a safe facility, it was still viewed as unsafe by 50% of persons with mobility impairment and 35% of persons with poor vision.

Crossing facilities in urban environment

- The same trend was also noted for zebra crossing in an urban environment, suggesting that people with physical impairments have trouble at these types of facilities.
- More than 8 out of 10 respondents found the pelican crossing as safe. However, the percentage of people above 45 years old who view this facility as unsafe is higher as compared to the younger age groups, indicating that older people may be having difficulties at signalised crossings due to inadequate green times.
- The speed table with pedestrian crossing is the facility that is viewed as safe by the largest number of respondents (88%).
- People with mobility or vision impairment tend to view speed tables and pelican crossings as safe crossing facilities.

6.1.2 Pedestrian behaviour on/near crossing facilities

Pedestrians travel motivations

- Most participants have rather positive travel motivations, with 3 out of 4 persons claiming to enjoy walking and 86% walking because of its health benefits.
- 70% of interviewees stated that they often/always walk for short trips.
- However, more than 50% of people do not walk to go to work, suggesting that there is a strong car dependency when it comes to travelling to work

Pedestrians behaviour at/near crossing facilities

- Although the majority of respondents stated that they do not cross when the priority is for vehicles or when the pedestrian light is red, 25% of respondents have stated that they engage in non-compliant behaviour at signalised crossings. Almost 40% of interviewees have admitted that they cross outside pedestrian crossing when they are in a hurry or when they are in urban areas. Furthermore, 60% of persons indicated that they cross outside pedestrian crossings even if there is one less than 50m away. The findings suggest that time savings and convenience are determinant factors for pedestrians.
- Males are slightly more prone to take risks while age plays a more prominent role with people less than 30 reporting that they are more likely to engage into behaviour that put them at risk.
- People over 60 are less likely to take risks while crossing the road according to the survey carried out.

Pedestrians behaviour when crossing the road

- Results indicate that trip purpose has a strong correlation with risk taking attitudes, with people regularly engaged in walking as leisure activities more likely to engage into risky behaviour compared with persons who walk mainly to go to work.
- Although results indicate that people are likely to use pedestrian crossing facilities correctly in general but when presented with some situations, pedestrians will engage in a non-compliant behaviour, with the scenarios being when people need to cross the road between vehicles during traffic jams and when people are walking with friends.

- Age seems to have a significant relevance with those aged between 18 and 30 years old being the group with the most self-reported non-compliant behaviour when crossing the road in certain scenarios.
- The survey results also suggest that people tend to engage in risky pedestrian behaviour or non-compliance with rules in certain districts more than in others, with Port Louis, Pamplemousses and Grand Port being the ones faring the poorest.

Pedestrians attention to the road environment

- The majority of respondents (8 out of 10) stated that they were attentive/alert while crossing the road, whether they are alone or in groups.
- Among those who have reported having lapses in attention while crossing the road, young adults less than 30 years old are more prevalent.
- It is noted that when pedestrians are accompanied by others, they tend to forget this danger or take a greater risk, with only 4 out of 10 stating that they would walk in a single file.
- Pedestrians sometimes cross several streets and intersections without paying attention to traffic or even when in conversation with someone.

6.1.3 Pedestrian perception of road environment

Pedestrians perception on road crossing

- Results indicate that 50% of persons surveyed perceive crossing the road as a difficult task occasionally, with 29% of interviewees stating that this often/always presents a difficulty to them. These comprise largely of people who have reduced mobility levels.
- The survey also indicated that a high percentage of respondents view crossing the roads outside pedestrian crossing as wrong or as an act that increases the risk of accident. However, approximately 20% of respondents think that these acts do not constitute wrong or risky behaviour.
- Although pedestrians often know that crossing roads is difficult and is wrong outside pedestrian crossing, they sometimes cross outside crossings to save time but at a risk of a crash. Findings indicate that more that 50% of respondents think that crossing outside pedestrian crossings helps in saving time, with 29% stating that they are not likely to make a detour in order to find a protected

crossing facility. 34% of persons interviewed also stated that they will take risks while walking if this allows them to save time.

- Although routes with signalised crosswalks are preferred by 75% of respondents, 25% do not prefer these types of facilities while walking and this may be due to the delay associated with signalised crossings.

Pedestrians perception related to drivers

- According to respondents, car drivers are more likely to stop compared to other vehicle drivers, with motorcyclists and cyclists being the least likely to give way to pedestrians at crossings.
- Respondents also confirmed that car drivers are more likely to reduce their speed when approaching a crossing facility, with motorcyclists and cyclists being the least likely to do so.

6.1.4 Pedestrian reflection on sensitisation campaigns

- Approximately 60% of both male and female interviewees have acknowledged hearing or seeing sensitisation campaigns on road safety for pedestrians but 1 in 4 persons have stated that they have not been exposed to any.
- In terms of the effectiveness of the sensitisation campaigns, less than 20% of respondents have stated that these have had a positive impact on people's behaviour when crossing streets, with the large majority thinking that the campaigns are not effective.

6.2 Recommended measures to address pedestrian road safety issues

Institutions and people working in pedestrian safety may tend to favour either engineering measures or behaviour-change measures but significant improvement to pedestrian safety requires a balanced approach that includes both perspectives (Lonero et al, 2006). Several engineering and behavioural interventions have been evaluated and it has been found that their effectiveness in improving pedestrian safety largely depends on the settings. Hence, it is important to recognise the fact that solutions which have been effective in other countries or even at specific locations in Mauritius may not necessarily be

effective for every location. Effective interventions depend on the dynamics relevant to the local situation, and understanding this local situation is important for planning appropriate solutions.

This study has carried out a situational assessment of pedestrian safety in Mauritius and constitutes a first step in understanding the local pedestrian safety situation. The information gathered can be used to make decisions on priority focus areas, the best approaches to improve pedestrian safety, and whether to strengthen existing plans and programmes or develop new initiatives.

Based on the situational assessment for Mauritius and list of measures that have been implemented successfully in other countries, it is recommended to create a pedestrian safety action plan as the next step. This plan of action should set out a strategy for improving pedestrian safety in the setting under consideration while providing a framework to organize interventions in a strategic manner and facilitate evaluation of progress over time. This plan should have clearly set objectives, which are evidence-informed (i.e. derived from literature and local studies) and SMART (specific, measurable, achievable, relevant and time-bound) and allow for both short-term and medium- to long-term realistic targets to be set, with key performance indicators identified to measure progress being made.

Measures for improving pedestrian safety are provided in various documents such as Countermeasures That Work: A Highway Safety Countermeasure Guide For State Highway Safety Office (NHTSA, 2017) and Countermeasures to improve pedestrian safety in Canada (CCMTA, 2013). While the provision of specific recommended measures does not form part of the scope of this study, the following measures are proposed for consideration and further investigation to improve the pedestrian safety situation:

- An integrated approach to pedestrian safety, in keeping with the principles of a safe system and incorporating educational, enforcement and engineering measures should be considered and adopted where possible in the planning and design phase of new or upgrading projects. A Safe by Design approach should be favoured by engineers involved in road infrastructure design and construction to ensure that the infrastructure and operating speeds accommodate for the safety of pedestrians.

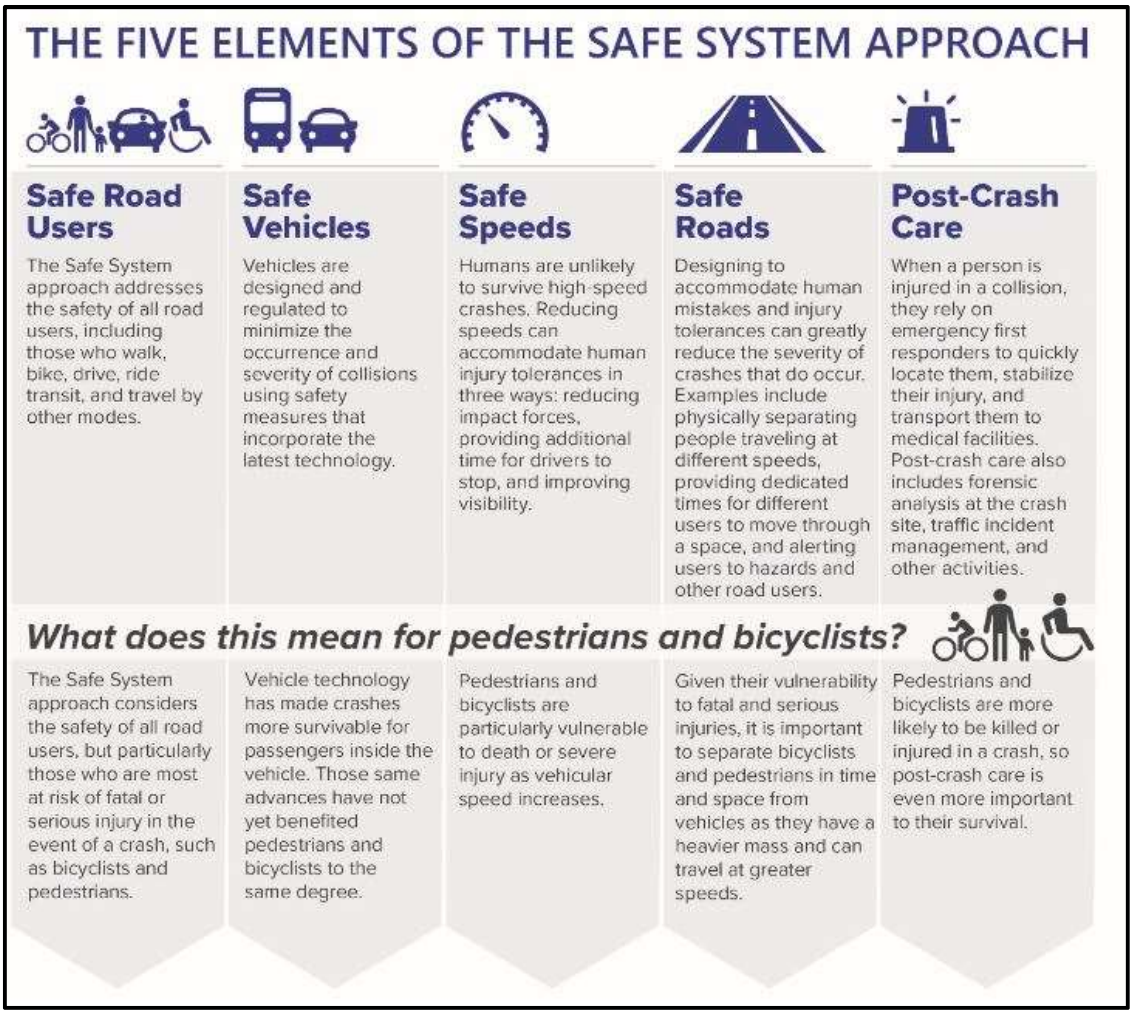


Figure 36: Safe system approach to pedestrian safety (FHWA, 2020a)

- Development of a Pedestrian Facility Audit and Selection Tool which will allow for carrying out road safety audits of pedestrian infrastructure and to select the most appropriate type of pedestrian safety measures based on walkability, safety and economic outcomes.

- Implementing an asset management framework for road infrastructure, which will allow identification of funding and maintenance needs to optimise the performance of the transportation system with respect to road safety. This will ensure that the TMRSU is aware of locations that require infrastructure provision for pedestrians as well as places where the existing infrastructure needs upgrading.

- Adopt the eight strategic principles of the International Charter for Walking whenever new developments are being undertaken. Existing guidelines such as the PPG should be reviewed to make better provisions for walking, while engineering standards and guides should be developed for transport infrastructure in Mauritius to ensure that new constructions are more pedestrian friendly.

Figure 37: Strategic principles of International Charter for Walking

- With the implementation of the Metro Express, particular attention should also be given to pedestrians at rail-grade crossings as this presents an unfamiliar crossing environment. Adequate warning of approaching Light Rail Vehicles should be provided with some pedestrian-focused solutions including:

- Signs prompting pedestrians to take a particular action (look both ways for trains or do not cross here) and barrier treatments such as fencing which encourage pedestrians to be cautious.
- Pavement markings that delineate the pathway up to and across the crossing and to indicate the desirable location to stop while waiting for approaching train/s.
- Install active systems that activate auditory/visual signals when a train is approaching or crossing.
- Reduce risky pedestrian behaviour at crossings through enforcement of trespassing laws and warning signal/sign violations.
- Educate pedestrians concerning the dangers of crossing railway tracks without paying attention to train traffic. Young people in particular need to be made aware of the need to pay attention at crossings when they are using entertainment and communication devices.

- Incorporate greater use of intelligent transportation systems (ITS) to create smarter roadways. These intelligent transport and technology-based methods can be used not only to collect and analyse data but also to assist in warning pedestrians of proximity to crossings or prevent inattentiveness of road users near crossings should be explored. Various measures exist such as:
  - Detectors - Used to detect pedestrians in the crosswalk, thus identifying the presence of individuals requiring additional time to cross and, accordingly, extend the clearance interval and provide more time to cross the road.

Figure 38: Smart Artificial Intelligence zebra crossing, (Source: CNN, n.d.)

- Accessible signals - Accessible pedestrian signals are products that supplement the visual signals and cues used by sighted pedestrians and enable visually impaired pedestrians to safely and independently negotiate intersections.

Figure 39: PB/5 press button Australian design to assist vision and sound impaired persons

- Illuminated push buttons and countdown timers at signalised crossings.
- In-pavement lighting - used at crosswalks to alert motorists to the presence of a pedestrian crossing or preparing to cross the street.

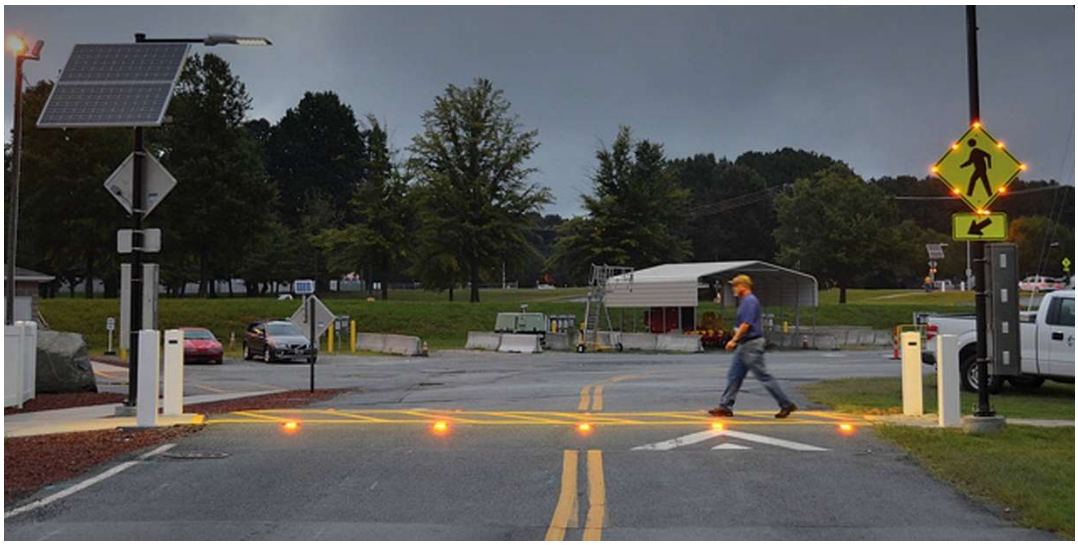


Figure 40: In-pavement lighting at pedestrian crossing (Source: https://www.tapconet.com/product/in-road-warning-light-system)

- Implementation of crossing types/footpaths which will alert pedestrians who are inattentive.

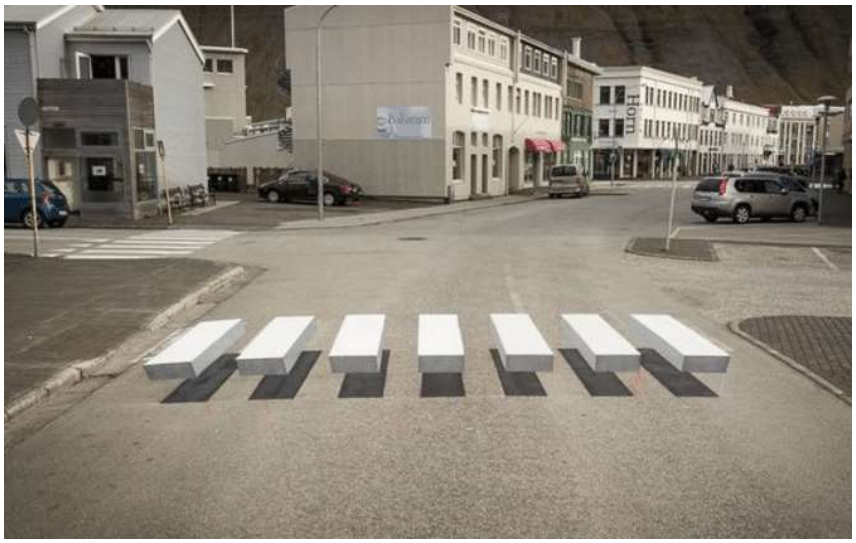


Figure 41: 3D-pedestrian crossing (https://www.researchgate.net/figure/Example-of-real-3D-crosswalk_fig1_325961246)

Figure 42: Footpath graphic design (Austroads, 2016)

- Pedestrianisation of streets with high pedestrian flows - Cities worldwide have been reclaiming their streets with a shift in urban planning, away from the dominance of cars and towards pedestrianization and more human scaled city development. The principle can be investigated for implementation along strategic pedestrian routes in Mauritius.

- Improve the enforcement of good behaviour from all road users

  - Implementation of policies to prevent jaywalking and ensure a stricter enforcement of these – Several countries regulate crossing of roads by preventing pedestrians to cross outside a pedestrian crossing if they are within a certain distance of one. Some countries also regulate how people should act on a crossing such as having to cross at right angles to the road axis.
  - Consider automated enforcement (speed and intersection safety cameras) in areas with high pedestrian flows or at crash clusters.

- Implementation of targeted sensitisation campaigns for all age groups.

  - Public education and awareness initiatives on vehicle speeds and the impact to safety for pedestrians.
  - Selective Traffic Enforcement Programs (STEP) that combine intensive enforcement of a specific traffic safety law with extensive communication, education, and outreach informing the public about the enforcement activity.
  - Use of innovative means to make people more aware of the risks they are putting themselves in - studies having highlighted the effectiveness of pedestrian safety education when virtual road environments are delivered as these can project graphical representation of the consequences of jaywalking and other risky behaviour while crossing the road.
  - Educate drivers about the difficulty in detecting pedestrians at night, stopping distances and the limitations of headlights.

- Improve the safety of vehicles for pedestrian protection through regulations on new vehicles to include:

  - Passive pedestrian protection.
  - Advanced braking systems including the Brake Assist System and other available systems that assist the driver in the event of a panic or emergency braking situation.
  - Adaptive headlights that orient light in the direction the vehicle is turning rather than simply straight ahead.

- Radar-brake pedestrian detection systems that would detect the presence of a pedestrian and automatically apply the vehicle's brakes in order to prevent the vehicle from striking a pedestrian.

6.3 Recommended areas for future research

The study has provided with an insight on pedestrians perception of the road environment and their behaviour while walking. Future research could include:

- Investigate pedestrian and drivers behaviour at/near crossing facilities using other methods such as video cameras or drone.
- Implementation of pilot sites to investigate the technical feasibility, user acceptance and effectiveness of engineering countermeasures to improve pedestrian safety such as speed reduction in residential areas, provision of higher visibility crossing facilities and wider footpaths, barriers to prevent jaywalking and pedestrian precincts.
- Investigate the feasibility and effectiveness of intelligent transportation system measures at pedestrian crossings.
- Identification and development of countermeasures specifically targeting the important young pedestrian group who are more likely to engage in risky pedestrian behaviour.
- Undertaking before and after studies at locations where the TMRSU or highway authorities are implementing measures to improve road safety and where improvements are being made to improve the existing infrastructure (footbridges and crossings)
- Investigation of countermeasures to improve safety for mobility and vision impaired pedestrians.
- Investigate the user acceptance and effectiveness of enforcement measures.
- Investigate the use of video surveillance to determine compliance of road users at crossing facilities
- Investigate the feasibility (including assessing the level of community acceptance) of introducing and enforcing legislation governing jaywalking.

- Investigate the desire lines of pedestrians in various environments and for various trip purposes.
- Investigate the effectiveness of targeted sensitization campaigns.

6.4 Conclusion

This study has helped to gain an insight on the pedestrian use of crossing facilities in Mauritius, with useful data collected on how people behave at/near crossings and how they perceive their environment. As already stated, measures to improve pedestrian safety depends on various factors and solutions to this problem cannot be generalised. Therefore, methods incorporating educational, enforcement and engineering measures should be considered and adopted where possible to improve pedestrian safety and help to achieve the road safety targets set for Mauritius.

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APPENDICES

RESEARCH PROJECT: UNDERSTANDING PEDESTRIAN USE OF CROSSING FACILITIES IN MAURITIUS

Questionnaire for Pedestrians

Dear Participant,

The University of Mauritius, in collaboration with the Traffic Management & Road Safety Unit (TMRSU) is carrying out a research project on "Understanding pedestrian use of crossing facilities in Mauritius". The project will collect information on the use of pedestrian crossings. We would be grateful if you spare some minutes to answer our questionnaire.

The information gathered will be used purely for research work and will be treated with utmost confidentiality and anonymity.

Section A: Demographic Information

i. **What is your gender?**

Female	☐
Male	☐
Other	☐

ii. **Which category below includes your age? (please tick)**

Less than 20	☐	55-59	☐
20-24	☐	60-64	☐
25-29	☐	65-69	☐
30-34	☐	70-74	☐
35-39	☐	75-79	☐
40-44	☐	80-84	☐
45-49	☐	85+	☐
50-54	☐		

iii. **What is your marital status?**

Single	☐
Married/Living with partner	☐
Divorced/ Separated Widowed	☐
Other (Please specify)	.....

iv. **Where do you live?** .....

v. **What is the highest degree or level of education you have completed?**

Not attended school	☐
Primary school certificate	☐
Secondary school certificate	☐
Vocational	☐
Diploma	☐
Bachelor's degree	☐
Master's Degree	☐
Ph.D	☐

vi. **Physical Ability?**

EYESIGHT		MOBILITY LEVEL	
Normal vision	☐	I walk confidently	☐
Normal vision corrected by lenses	☐	I walk unaided but step carefully	☐
Poor vision	☐	I use a wheelchair	☐
No usable vision	☐	I use a walking aid	☐

viii. **Any past involvement in traffic accident as a pedestrian?**

Yes	☐
No	☐

viii. **If yes, what was the severity of the accident?**

Serious (Admitted to the hospital more than 24 hours)	☐
Slight (Just a check up /No admission)	☐
Not applicable	☐

Section B: Pedestrian Perception about crossing facilities

i. How safe are the following facilities for pedestrians crossing the road?

Very Safe ☐
Safe ☐
Slightly safe ☐
Unsafe ☐
Very unsafe ☐

Very Safe ☐
Safe ☐
Slightly safe ☐
Unsafe ☐
Very unsafe ☐

Very Safe ☐
Safe ☐
Slightly safe ☐
Unsafe ☐
Very unsafe ☐

ii. How safe are the following facilities for pedestrians crossing the road?

Very Safe ☐
Safe ☐
Slightly safe ☐
Unsafe ☐
Very unsafe ☐

Very Safe ☐
Safe ☐
Slightly safe ☐
Unsafe ☐
Very unsafe ☐

Very safe ☐
Safe ☐
Slightly safe ☐
Unsafe ☐
Very unsafe ☐

Section C Pedestrian Behaviour near/on crossing facilities

Part A: Travel Motivations

As a pedestrian, how much would you agree with each one of the following statements:

	Never	Rarely	Some-times	Often	Always
I walk for the pleasure of it	☐	☐	☐	☐	☐
I walk because it is healthy	☐	☐	☐	☐	☐
In short trips, I prefer to walk	☐	☐	☐	☐	☐
I walk to go to work	☐	☐	☐	☐	☐
I walk because I have no other choice	☐	☐	☐	☐	☐
I walk to take another mode of transport	☐	☐	☐	☐	☐

Part B : Pedestrian behaviour at crossings

As a pedestrian, how much would you agree with each one of the following statements

	Never	Rarely	Some-times	Often	Always
I cross diagonally to save time	☐	☐	☐	☐	☐
I cross outside the pedestrian crossing even if there is one less than 50m away	☐	☐	☐	☐	☐
I cross the street even though the pedestrian light is red	☐	☐	☐	☐	☐
I cross even though the light is still green for vehicles	☐	☐	☐	☐	☐
I cross outside pedestrian crossing in urban areas	☐	☐	☐	☐	☐
I cross outside pedestrian crossing when I am in a hurry	☐	☐	☐	☐	☐

Part C : Pedestrian behaviour when crossing roads

As a pedestrian, how much would you agree with each one of the following statements:

	Never	Rarely	Some-times	Often	Always
I start to cross on a pedestrian crossing and I finish crossing diagonally to save time	☐	☐	☐	☐	☐
I cross between vehicles stopped on the roadway in traffic jams	☐	☐	☐	☐	☐
I do not follow the traffic signs when crossing the road in groups	☐	☐	☐	☐	☐
I walk on the roadway to be next to my friends on the sidewalk or to overtake someone who is walking slower than I am	☐	☐	☐	☐	☐
I cross the street between cars rather than using a pedestrian crossing	☐	☐	☐	☐	☐

Part D: Pedestrian behaviour – Attention to road environment

As a pedestrian, how much would you agree with each one of the following statements:

	Never	Rarely	Some-times	Often	Always
I forget to look before crossing because I am thinking about something else	☐	☐	☐	☐	☐
I forget to look before crossing because I want to join someone on the sidewalk on the other side	☐	☐	☐	☐	☐
I cross without looking because I am talking with someone	☐	☐	☐	☐	☐
I realize that I have crossed several streets and intersections without paying attention to traffic	☐	☐	☐	☐	☐
When I am accompanied by other pedestrians, I walk in single file on narrow sidewalks so as not to bother the pedestrians I meet	☐	☐	☐	☐	☐

Section D Perception of Pedestrian

Part A : Perception related to road crossing

As a pedestrian, how much would you agree with each one of the following statements:

	Never	Rarely	Some-times	Often	Always
Crossing roads is difficult	☐	☐	☐	☐	☐
Crossing roads outside pedestrian crossing increases the risk of accident	☐	☐	☐	☐	☐
Crossing roads outside pedestrian crossing is wrong	☐	☐	☐	☐	☐
Crossing roads outside pedestrian crossing saves time	☐	☐	☐	☐	☐
I prefer routes with signalised crosswalks	☐	☐	☐	☐	☐
I am willing to make a detour to find a protected crossing	☐	☐	☐	☐	☐
I am willing to take risk as a pedestrian to save time	☐	☐	☐	☐	☐

Part B : Perception related to drivers

i. Which type of driver is more likely to stop when you are waiting at a pedestrian crossing?

- Cyclist ☐
- Motorcyclist ☐
- Car ☐
- Bus ☐
- Lorry ☐
- Mini Van ☐

ii. How far do you agree that the following drivers reduce their speed when approaching pedestrian crossings?

	Never	Rarely	Sometimes	Often	Always
Cyclist	☐	☐	☐	☐	☐
Motorcyclist	☐	☐	☐	☐	☐
Car	☐	☐	☐	☐	☐
Bus	☐	☐	☐	☐	☐
Lorry	☐	☐	☐	☐	☐
Mini Van	☐	☐	☐	☐	☐

Section E: Reflection on sensitising campaigns

In the last year, have you seen or heard any television, radio or billboard messages about road safety?

Never	Rarely	Sometimes	Often	Very Often
☐	☐	☐	☐	☐

How would you rate the effectiveness of the road safety campaigns on people's behaviour when crossing streets?

Very low	Low	Fair	Good	Excellent
☐	☐	☐	☐	☐

Section F: Further Comments on Road Safety of Pedestrians

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Thank you for your participation in the survey.