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School of Transportation Sciences

Master of Transportation Sciences

Master's thesis

Road Safety and Accessibility : Facilitating the autonomous movement of people with physical disabilities in pedestrian environments

Ruvimbo Machingaidze

Thesis presented in fulfillment of the requirements for the degree of Master of Transportation Sciences, specialization Traffic Safety

SUPERVISOR :
Prof. dr. An NEVEN

CO-SUPERVISOR :
dr. Evelien POLDERS

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Preface

Being able to access opportunities is a basic need for everyone. Unfortunately, the journey, literally, is not always easy for people with decreased mobility. There are many barriers which limit the independent movement of people with decreased mobility, which ultimately limits the opportunities they are able to reach, affecting quality of life. With that in mind, this research set out to find out the specific accessibility challenges that certain road conditions pose for people who use assistive devices to walk. This is an important topic because involving everyone in society will help in achieving the Sustainable Development Goals.

The study took place in Harare and coincided with the approval and acceptance of the Zimbabwe National Disability Policy. In line with the stipulations of the policy, this study contributes to the inclusion of people with disability, more specifically, those with mobility impairments. The recommendations proposed advocate for Universal Design, where the road environment does not need to be altered but is already made to suit the needs of every road user despite their specific mobility needs. A lot of research in the country has focused on the inaccessibility of transport and buildings but little to do with the road infrastructure's accessibility and safety. That was the major reason for undertaking this study. One of the components of the Safe Systems approach is safe roads and this study contributes to this objective through advocating for the creation of forgiving roadsides.

The study was not without barriers of its own. As the study was conducted during pandemic times, many changes had to be made to the methodology in order to come up with workable solutions. The intended target organisation could not provide participants for interviews therefore, a compromise was made to do a survey instead, and to reach out to people outside of that organisation.

I am extremely grateful to have been able to reach this stage in my academic career, it has not been an easy road. From being far away from home, to dealing with mental battles, to losing my dad, I am still standing. I express gratitude to my supervisors, prof. dr. An Neven and dr. Evelien Polders. I have not been performing optimally but thank you for your patience and guidance. To my family and friends, I thank you all for the constant support, it has kept me going. Special mention also goes to Mr. Tapiwa Kuda Tsikai for helping me to reach out to participants for the study. Thank you all!

This master thesis was written during the COVID-19 crisis in 20-2021. This global health crisis has had an impact on the process, the research activities and the research results that are at the basis of this thesis because organisations were closed, and I was unable to reach the intended participants for data collection as planned. Only one, daytime Road Safety Inspection was conducted due to restrictions. Much of the methodology was also altered.

Abstract

Being able to reach opportunities in important for members of society however, this does not always come with ease for people with decreased mobility who are faced with many barriers – attitudinal, environmental, and institutional. This study focuses on the physical barriers and how they impact the independent movement of people with decreased mobility in pedestrian environments. The goal of the research was to highlight safety hazards and the accessibility barriers that ensue. A Road Safety Inspection was conducted in the surroundings leading up to a medical rehabilitation centre in Harare. Images were captured and presented to 33 adults with decreased mobility and use assistive devices through a photo-elicitation survey questionnaire. Respondents were asked to comment on how the road conditions would affect their independent movement and what their preferences were. Thematic content analysis was used to examine participants' responses. The study found that people with decreased mobility have a need to travel which is not always catered for by the road environment. Similar to prior studies, it was noted that the road poses physical barriers which compound the risk of falling and injury. Shared use roads, non-functional traffic lights, unmarked roads, discontinuous paths, and unsmooth surfaces were among some of the issues identified in the inspection and echoed by participants as barriers to their movement. The study recommends basic measures such as painting road markings, providing solar traffic lights and providing separate paths for the movement of pedestrians. By utilising Universal Design principles, the interventions do not only benefit people with decreased mobility, but all road users.

Key words: Autonomous movement, disability, decreased mobility, Road Safety Inspection, Universal Design

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LIST OF ACRONYMS

CDC	Centers for Disease Control and Prevention
CRPD	Convention on the Rights of Persons with Disabilities
ICF	International Classification of Functioning, Disability and Health
NDP	National Disablity Policy
OECD	Organisation for Economic Co-operation and Development
PWD	People with Disabilities
RSI	Road Safety Inspection
UN	United Nations

CHAPTER 1

INTRODUCTION

1.1 Background

The United Nations Convention on the Rights of Persons with Disabilities (CRPD) (UN, 2006) showcased a global recognition and effort to tackle the inclusion of people with disabilities (PWDs). The CRPD confirms a paradigm shift from viewing PWDs as recipients of charity to bearers of human rights and partners for achieving sustainable development. In this way, the CRPD plays a dual role: as a development and a human rights protection instrument. The human rights role of the CRPD underscores that PWDs must fully enjoy all human rights and fundamental freedoms on an equal basis with others (CRPD, 2006). The CRPD further defines 'disability' in a broad and inclusive manner, which indicates a model shift in approaches to disability. Ngwena et al. (2013) state that the CRPD "*constitutes a shift from traditional ways of looking at disability as individual impairment to focusing on State obligations to dismantle a disabling environment and, in its stead, create an enabling environment which is inclusive and accommodates all human beings in their diversity.*"

To date, there have been 177 ratifications to the CRPD worldwide (International Disability Alliance, 2021). On the African continent, Fernandez et al. (2017) report that 44 nations had ratified the CRPD and that, 35 nations had a national policy on disability. Zimbabwe ratified the CRPD and its Optional Protocol on 23 September 2013 (Mandipa and Manyatera, 2013). Under article 4(a), the CRPD directs the adoption of appropriate legislative measures for the implementation of the rights recognised in the CRPD. Article 33(1–2) calls for the establishment of independent national institutions to advance PWDs' issues. Considering this, Zimbabwe took steps to honour the requirements of the CRPD. Amongst other actions, the constitution incorporated provisions of the CRPD, the Zimbabwe Human Rights Commission (ZHRC) was formed, and a special advisor to the president and cabinet on disability was appointed. Most recently, the National Disability Policy (NDP) was approved by cabinet in June 2021. Like the CRPD, the NDP is grounded in a conceptual framework that includes the social model of disability, human rights, and intersectional models (Government of Zimbabwe, 2021). In line with the vision of the country, this research sets out to contribute to the inclusion of PWDs in the transport sector, specifically in terms of road safety, accessibility, and independent mobility. Other African nations have national disability policies with contents similar to those found in the Zimbabwean one. Examples are Zambia, Tanzania, Uganda, and South Africa. Many of these policies are general and state that they will ensure equal opportunities for People with Disabilities, in all social services and programs are promoted and that such services will enhance the independence of People with Disabilities and advance their integration into the mainstream of society. Common to all policies is the definition of terms, mandates for different authorities and, a situation analysis of disability in the country. South Africa's policy does not mention anything specific to roads and transport, but the policy mentions that the document is to be read in conjunction with other documents and legislation. Tanzania's policy mentions roads and road safety explicitly stating that disabled persons experience difficulties in the use of transport facilities, for example buses and roads. Their policy

(Aldersey & Turnbull, 2011) goes on to specify that, “The government in collaboration with stakeholders shall:

i) take measures to ensure that transport facilities are accessible to people with disabilities.

ii) ensure that roads have necessary facilities to allow for convenient use and passage by disabled persons.”

Zimbabwe’s policy also addresses road safety and accessibility, this is addressed later in this report.

Being able to travel is a basic need for all people and providing the conducive environment to do so, in terms of safety on the road, the variety of modes and the usability of roads; should be the goal of transport facility providers (Geurs & van Wee, 2004). Walking constitutes an essential part of human life and for persons with disability, this activity may not come at the same ease, since the design and construction of the physical environment may not meet their mobility needs (Danso, Ashigbi & Tunzi, 2014). PWDs face many challenges when travelling, regardless of mode selected. King and King (2014) mention that PWDs have significant challenges as they may have a greater need for a smooth and continuous path, may have less speed when crossing roads and may have sensory impairments that constrain their perception and prediction of emerging traffic situations. Yau et al. (2014) report challenges on a plane for wheelchair users and state that people may not stop traveling, but their overall enjoyment is diminished and their enthusiasm for future trips lessens. Many travellers who used wheelchairs reported on the perils of travel, as airlines require their chairs to be stowed under the plane for security and safety reasons. A few participants complained that their wheelchairs had been improperly reassembled, arrived with missing parts, or that the airlines had lost the batteries. Very often flight crews are not trained to handle wheelchairs properly. PWDs are often faced with limited choices or access problems, which can be frustrating. They are often forced to accept more expensive arrangements than the rest of the group. In addition, to have companions, they may have to make many compromises, in terms of destination, time, and date of traveling. Such impositions may decrease the propensity or frequency of travel (Yau et al., 2014).

Ndebele (2020) also gives an account of a man who was moving on the streets of Bulawayo, Zimbabwe, and vendors had to move their wares to create enough space for him to pass through. The man was headed to a commuter omnibus where he had to negotiate with the conductor to be accommodated on the vehicle. Ndebele reports of how the man was carried and endured some degree of indignity as the supposed simple action of boarding a bus drew so much attention on him. These are but some of the barriers that limit independent movement for PWDs.

This research contributes to the following Sustainable Development Goals (SDGs):

SDG 3: Good Health and Well-being – the focus being ensuring healthy lives and promoting the well-being for all, at all ages, which is essential for sustainable development.

SDG 9: Industry, Innovation and Infrastructure – where investments in infrastructure are crucial to achieving sustainable development, and

SDG 11: Sustainable Cities and Communities – which highlights the need for a future in which cities provide opportunities for all, with access to basic services, energy, housing, transportation and more.

It is in the context of these instruments that the current research is placed. The safety and accessibility barriers to the independent movement of PWDs in road environments in a developing context are explored. A road safety inspection was conducted in conjunction with a photo-elicitation survey to assess specific accessibility issues on researcher-identified unsafe spots within the road environment, with the aim of understanding the likely unique experiences and proposing appropriate solutions to facilitate the independent movement of PWDs. Because access and safety provide favourable conditions for movement (Mpafhudi, 2014; Danso et al, 2014), increasing them will facilitate the independent movement of PWDs in the road environment. Based on the findings, opportunities for improvement are recommended using both local and global best practices.

1.2 Operational definitions

For purposes of this study, the following definitions are adopted.

i) People with disabilities (PWDs)

This is defined in this study as all persons with physical impairments that affect the lower extremities, thereby limiting mobility. In this report, these individuals are also referred to as people with decreased mobility.

ii) *Road Safety Inspection*

This refers to the proactive approach that involves a systematic review of an existing road by driving and walking to identify hazardous conditions, faults and deficiencies in the road environment that may lead to road user injury (adopted from African Development Bank, 2014).

iii) Autonomous movement

Autonomy is defined as “having the freedom from the control, influence, support, aid, or the like, of others” (dictionary.com, 2021).

Movement is defined as “the act, process, or result of moving or, a particular manner or style of moving” (dictionary.com, 2021).

Considering the previous definitions, autonomous movement in this study refers to the moving of people from one place to another with (little to) no support or aid from others.

The words “autonomous” and “independent” are used interchangeably in the paper, and the term “personal mobility” is also sometimes used.

iv) Accessibility

This is defined as “the ability to reach relevant activities, individuals or opportunities”, which might require traveling to the place where those opportunities are located (Handy 2005).

1.3 Scope of the Research

The current scope of work focuses on the autonomous movement or personal mobility of PWDs within the urban road environment surrounding St. Giles Medical Rehabilitation Centre in the suburb of Milton Park in Harare, Zimbabwe. The mode emphasised is walking or movement in pedestrian spaces, as it is the most basic mode of transport, and requires no financial expenses. Walking is a pollution-free form of mobility that is fundamental to life. In African cities, many are dependent on it as their primary means of transport (ITDP & UN Habitat, 2018). For those who use public transport or personal motor vehicles, walking often becomes the dominant mode for short trips during the day. Physical, ambulatory disabilities are the type of disability under the spotlight. In essence, impairments concerned with the lower extremities. The study only focuses on physical barriers within the road although the barriers to independent movement go far beyond the physical alone. The focal point of the study is the physical road environment and not the socio-economic or any other influencing factors.

This research is limited to the inspection of a single road section (divided into 4 for reference purposes) leading to St. Giles Medical Rehabilitation Centre. The purpose of using this road section is because it is an area that is frequented by PWDs on their way to the rehabilitation centre thus, it would be beneficial to facilitate easier or independent movement there. The centre can be reached from two entry points, one in Drummond Chaplin Road, the other in Clayton Road.

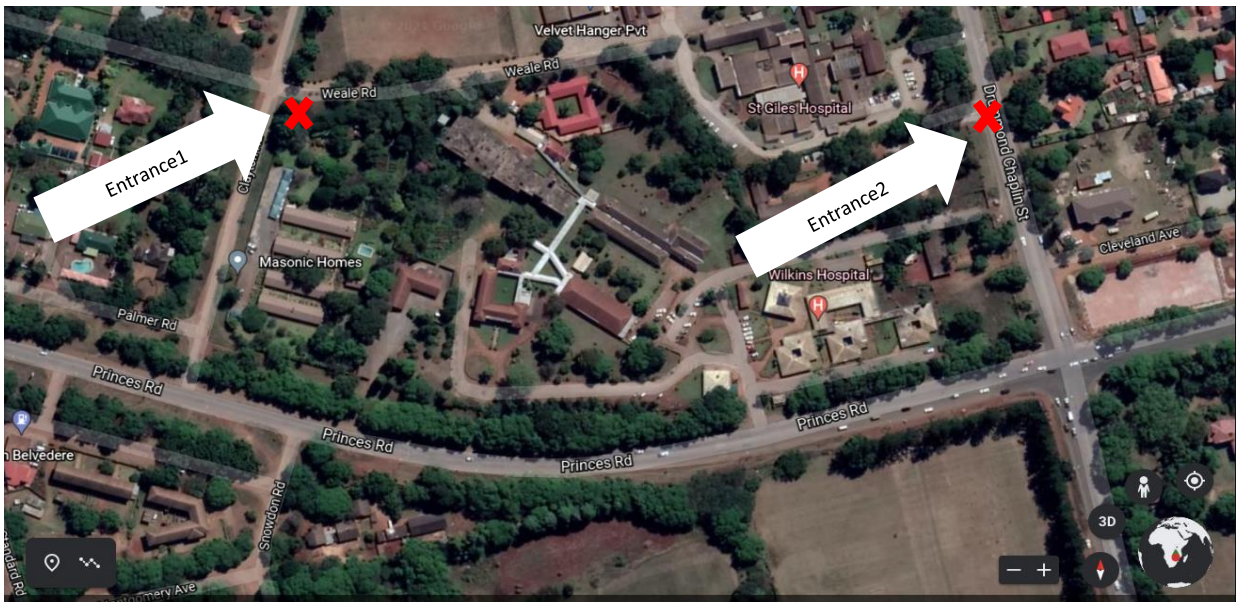

FIGURE 1 Map of St. Giles Rehabilitation Centre (Google Earth, 2021)

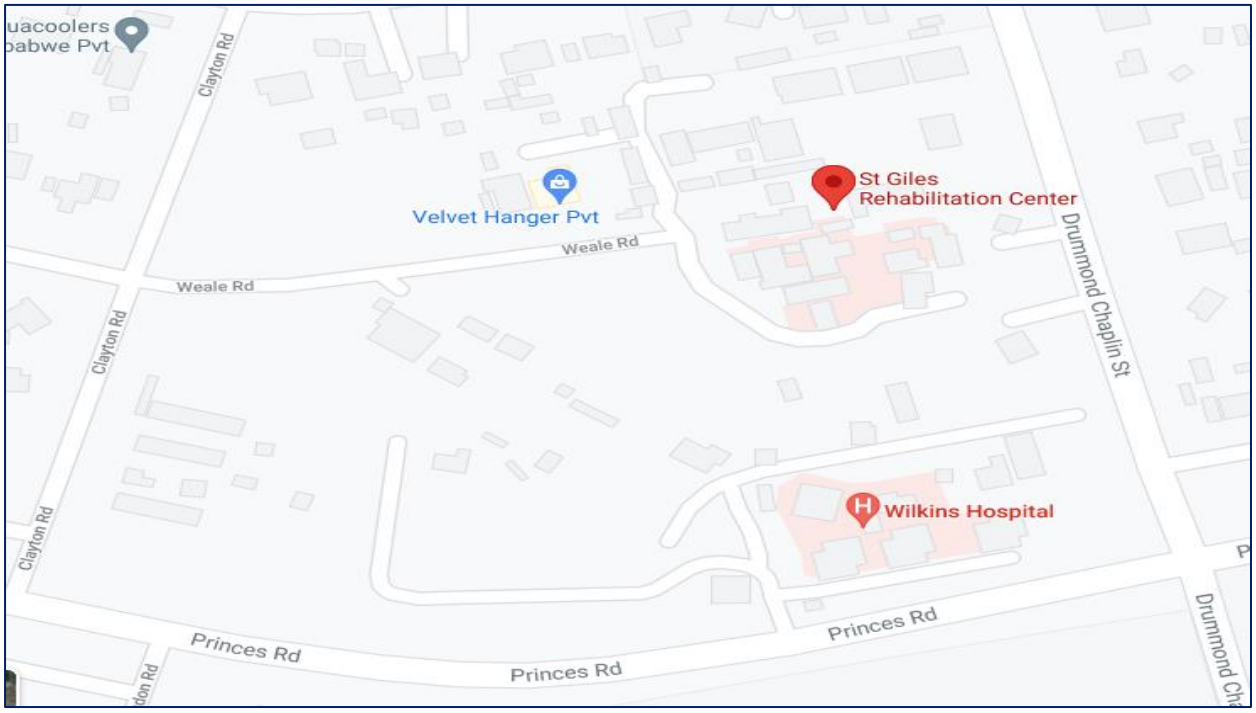

FIGURE 2 Map of St. Giles Rehabilitation Centre (Google Earth, 2021).

As part of the aim to improve the road facilities, this study presents an inspection report and responses from PWDs which will be presented to stakeholders such as the PWDs themselves, organisations working with PWDs, the rehabilitation centre in the study area, academia, and relevant government ministries. The findings from this study will illuminate the needs of PWDs in road environments and inform countermeasures. The study does not only benefit PWDs, but the Universal Design approach proposed allows for the collective usage of the road by all people.

The study relies on a single, day-time inspection conducted in the summer and on foot, and this is because of restrictions posed by the Covid-19 pandemic. The standard of operation for road safety inspections is usually conducting day and night-time inspections, and in different weather conditions.

1.4 Research Goals and Questions

The purpose of the study was to explore the way in which safety and accessibility affect independent movement of people with decreased mobility in the road environment surrounding St. Giles Medical Rehabilitation Centre.

It aims to:

- Identify potential hazards in the road environment through a Road Safety Inspection (RSI).
- Explore and highlight the specific accessibility barriers to pedestrian movement in unsafe road environments for people with decreased mobility from the user's perspective.

- Recommend appropriate countermeasures in the level of personal mobility and safety for pedestrians with mobility limitations.

1.5 Research Questions

In what way do safety and accessibility of the road environment affect the autonomous movement of people with decreased mobility?

- What accessibility barriers and challenges do pedestrians with decreased mobility face in unsafe spots in the road environment?
- How can the autonomous movement of people with decreased mobility be facilitated in street environments?

1.6 Structure of the report

This report is divided into six chapters. Chapter one introduces the study topic and gives a contextual background as well as operational definitions. The second section provides a theoretical background, looking at related literature regarding disability, mobility, and safety. Section three presents the methodology and data collection adopted for the study. Section four provides the results from the inspection and the interviews. Chapter five is a discussion of the results and gives recommendations whilst chapters six is the conclusion of the research.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The current chapter looks at relevant and related literature. Concepts that are central to the study are explored further. These include accessibility and the need for it, Road Safety Inspections (RSIs) and how they are conducted, disability and other sub-topical issues. Similar studies and the approaches they used are also alluded to.

2.2 Disability

A disability is any condition of the body or mind that makes it more difficult for the person with the condition to do certain activities and interact with the world around them (CDC, 2020). There are many types of disabilities, such as those that affect a person's vision, movement, thinking, remembering, learning, communicating, hearing, mental health, and social relationships. Although "people with disabilities" (PWDs) sometimes refers to a single population, this is actually a diverse group of people with a wide range of needs. Two people with the same type of disability can be affected in very different ways. Some disabilities may be hidden or not easy to see.

According to the World Health Organization's International Classification of Functioning, Disability and Health (ICF) (2001), disability has three dimensions:

1. **Impairment** in a person's body structure or function, or mental functioning; examples of impairments include loss of a limb, loss of vision or memory loss.
2. **Activity limitation**, such as difficulty seeing, hearing, walking, or problem solving.
3. **Participation restrictions** in normal daily activities, such as working, engaging in social and recreational activities, and obtaining health care and preventive services.

2.2.1 Travel Challenges Encountered by People with Decreased Mobility

Research has shown that people with decreased mobility regularly encounter transportation difficulties and structural obstacles (World Bank, 2009) such as topographical features when navigating, accessing, and utilizing socio-economic spaces. They are therefore largely confined to their ''niche occupations'' in their neighbourhoods and so are unable to access socioeconomic opportunities to achieve their full potential and live independent lifestyles. Addressing spatial needs entails not only engaging key stakeholders but also drawing on the perspectives of the mobility impaired. In this regard, Worth (2008) and Kitchin (2001) insist that research based on their own personal experiences provides valuable insights into policy formulation and implementation processes.

Some studies in Sweden pointed out that barriers to older people's mobility, for example, are connected to traffic and infrastructure characteristics and older people often point out the importance of enforcing vehicle speeds as well as the design of barrier-free pedestrian environments and public

transport. There are several barriers to good access in outdoor environments due to poor design and maintenance of pedestrian facilities. Such barriers include narrow pavements, poor crossing facilities, high kerbs, uneven or slippery surfaces, stairs without handrails, lack of benches, poor lighting, amongst others (Carlsson 2004; I'DGO n.d.; Ståhl *et al.* 2008; Wennberg, Ståhl and Hydén 2009).

People often need to travel to access health services, employment, education, shops, and social contact. However, the physical environment and traffic present significant barriers and risks. Traffic environment encompasses the external surroundings that lead people to their destination: whether it is to a public building, market, residential colony, or transit system, and is a key element in maintaining continuity in the mobility chain (Agarwal et al., 2008). These barriers are even more pronounced for people with decreased mobility in Low- and Middle-Income Countries (LMICS), due to the generally lower levels of road safety (Global Status Report on Road Safety, 2018). Some of these barriers and risks include mixed traffic on the road, discontinuous pathways, unsuitable surfaces for wheelchairs, parked vehicles obstructing the road, and visibility to approaching vehicles, amongst others (King, 2018)

Manatsa (2012) echoes the CRPD in stating that disability is an inter-play between various impairments on one hand and socio-attitudinal and environmental barriers on the other hand. This highlights that impairments on their own cannot be an impediment to the enjoyment of one's rights on an equal footing with others. On the contrary, it is the nature of the built-up environment and social attitudes that inhibit people with decreased mobility from enjoying their rights at par with their non-impaired counterparts.

The barriers to the enjoyment of these rights can be broadly divided into three main areas (Kett et al., 2020):

- *institutional* (legislation, political will, policy, etc.)
- *environmental* (infrastructure, information); and
- *attitudinal* (transport staff, other passengers, lack of accessible information, etc)

For this study however, the focus is placed on physical/infrastructural barriers because the purpose of the study is to highlight deficiencies with the aim of proposing solutions for them. It is very important to improve the conditions in communities by providing accommodations that decrease or eliminate activity limitations and participation restrictions for people with disabilities, so they can participate in the roles and activities of everyday life (WHO, 2001).

2.3 Accessibility

Accessibility is a complex concept due to its multifactor nature. Consequently, the assessment and quantification of accessibility is a challenging process (Litman, 2011). Accessibility refers to the potential—or ease—of reaching desired opportunities (or activity sites). *Opportunities* in this context refer to any desired destinations or sites providing employment, goods, and/or services. Thus, accessibility depends

on both the transportation network (or mobility) and the distribution and quantity of opportunities, which can be reflected in the land use patterns.

Geurs and van Wee (2004) identify four basic components of accessibility: land use, transportation, temporal, and individual. The land use component is associated with the spatial distribution of opportunities, as well as the quantity and quality of them. The transportation component reflects the travel impedance in terms of time, cost, and personal effort that a trip to and from an opportunity is related with. The temporal component pertains to the temporal variation of the constraints imposed on the access to opportunities, such as service times of modes and opportunities throughout the day. Finally, the individual component refers to the unique needs, abilities, and opportunities of individuals and population groups based on their socioeconomic, demographic, and physical characteristics.

Geurs and van Wee (2004) discuss that an accessibility-based measure should account for all four components of accessibility; nevertheless, that is rarely the case because accessibility is a complex construct to measure. The authors identify four types of measures that have emerged from the literature and can be associated with all or some of the four components of accessibility:

- Infrastructure-based measures assess the efficiency, effectiveness, and performance of transportation networks and services; examples are travel speeds and peak-hour periods.
- Location-based measures focus on assessing the opportunities and the opportunities' characteristics within reach from a location; examples are travel time/cost between locations and amount of a specific opportunity type (e.g., schools) within a specific distance (e.g., 30 min travel time).
- Person-based measures are concerned with the individuals' capability of reaching an opportunity; examples can be travel time/cost between locations and individuals' temporal constraints.
- Utility-based measures focus on the economic aspect of accessibility, and specifically on the benefits from accessing opportunities; examples can be transport users' benefits and travel time and cost variations throughout a day.

Infrastructure-based measures alone account for the mobility aspect of accessibility and thus are directly related to the mobility-based measures, as one can infer from the description and examples. On the other hand, person-based measures frequently capture the observed travel patterns of individuals as a means to evaluate the ease of reaching opportunities and thus are closer to outcome-based measures.

Maart and Jelsma (2014) state that accessibility is the ease with which an individual can access services and facilities that he or she needs or desires. It reflects the ability of individuals to reach and use transport services and infrastructure as well as life enhancing facilities and services. Accessibility also describes the catchment characteristics of a given location. A range of factors impact upon accessibility. These include travel time, cost of travel, location of facilities and services, method and timing of service delivery, safe routes of travel, fear of crime, knowledge of available travel and service choices, travel horizons, and characteristics, needs and perceptions of the individual (ibid). Accessibility indicators are used to quantify accessibility and assess the ease with which a given population, population segment or

community can access one or more services from a residential or other location using one or more modes of transport. In relation to disability, Danso et al (2019) define accessibility as the absence of barriers which prevent a person with any form of disability from fully participating in all aspects of society.

2.3.1 Universal Accessibility

Universal access to transport services requires a change in environments where the public walk, would like to walk, or should walk. Whilst there are factors in transport environments that directly affect the accommodation of people with disabilities, universal access means that their accommodation must be made together with the rest of the population without disabilities (PIARC/Gibberd, 2019). The safety of the road environment becomes an important consideration, if public transport is to be used by everyone, and if walking is to become a means of transport in its own right.

Universal accessibility means appropriate access for all users to all services. These services include housing, roads, transport, public spaces, buildings, information, communication, and facilities available to the public. By users, it is necessary to consider all those who wish to use or who use these services, including people with disabilities and anyone with reduced mobility (e.g., older people, pregnant women, children, people carrying heavy loads, etc.). The notion of accessibility must be based on the concept of the unbroken chain of movement and human safety. The links between accessibility and road safety then seem obvious, inseparable, and indispensable. Universal accessibility provides standards and/or adaptations for urban development in terms of road safety (Austroads, 2009).

2.3.2 Instruments for accessibility and inclusion

There have been steps to make opportunities accessible, not only for PWDs, but for all. This section talks about the UN's SDGs, the Convention on the Rights of Persons with Disabilities (CRPD), Zimbabwe's National Disability Policy and Universal Design standards, and how these relate to transport and accessibility for all.

Sustainable Development Goals

The SDGs represent a set of political commitments and targets enshrined in seventeen Goals that guide the current development agenda until 2030. Within the targets of the Goals, safety in mobility and transportation infrastructure for all persons is addressed, with an explicit mention of persons with disabilities and older persons as target groups. In Goal 3, *Ensure Healthy Lives and Promote Well Being of All Ages*, safe and inclusive mobility is linked to improved safety of transport infrastructure. Arguably, to achieve this target, mobility and transportation infrastructure must be improved through policies that address safety and accessibility as a priority indicator in implementation (Humanity and Inclusion, 2018).

Inclusion is a lifestyle in which a person is an active participant in their own life, rather than a passive observer and the recipient of decisions someone else has made. To this end, inclusion promotes quality of life by:

- Empowering individuals to have control over their own lives

- Providing individuals with the opportunity to select the lives of their choosing, and
- Conferring individuals with the socio-political power to defend their choices.

The Convention on the Rights of People with Disabilities

The CRPD emphasises that PWDs must fully enjoy all human rights and fundamental freedoms on an equal basis with others. It also defines 'universal design', which refers to the design of products, environments, programs, and services to be usable by all people, to the greatest extent possible, without the need for adaptation or specialised design. Universal design does not exclude assistive devices for particular groups of people with disability where this is needed.

Several articles in the CRPD (The United Nations, 2006) address universal design and, road and transport infrastructure. Articles 3 and 9 are some examples. Article 9 requires all signatories to provide equitable access to the physical environment, transportation and information, communication, and other services, as well as to public areas, urban and rural. The contents of these articles are as follows.

Article 3 – General principles

The principles of the present Convention shall be:

(a) Respect for inherent dignity, individual autonomy including the freedom to make one's own choices, and independence of persons;

(b) Non-discrimination

(c) Full and effective participation and inclusion in society;

(d) Respect for difference and acceptance of persons with disabilities as part of human diversity and humanity;

(e) Equality of opportunity

(f) Accessibility

(g) Equality between men and women

(h) Respect for the evolving capacities of children with disabilities and respect for the right of children with disabilities to preserve their identities.

Article 9 – Accessibility

1. To enable persons with disabilities to live independently and participate fully in all aspects of life. States Parties shall take appropriate measures to ensure to persons with disabilities access, on an equal basis with others, to the physical environment, to transportation, to information and communications, including information and communications technologies and systems, and to other facilities and services open or

provided to the public, both in urban and in rural areas. These measures, which shall include the identification and elimination of obstacles and barriers to accessibility, shall apply to, inter alia:

(a) Buildings, roads, transportation, and other indoor and outdoor facilities, including schools, housing, medical facilities and workplaces;

(b) Information, communications, and other services, including electronic services and emergency services.

Universal Design

While the concept of universal design emerged primarily with people with disability in mind, universal design helps everyone with support and assistance needs including the elderly, pregnant women, children and people with a temporary illness or injury. Thus, the benefits of implementing universal design are wide. When working in developing countries, it is important to also consider cultural, economic, engineering, environmental, gender and social contexts (AusAID, 2013).

Universal design principles to consider include:

Principle 1: Equitable use - Design that is useful and marketable to persons with diverse abilities.

Principle 2: Flexibility in use - Design that accommodates a wide range of individual preferences and abilities.

Principle 3: Simple and intuitive use - Design that is easy to understand, regardless of the user's experience, knowledge, language skills, or concentration level.

Principle 4: Perceptible information - Design that communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.

Principle 5: Tolerance for error - Design that minimises hazards and the adverse consequences of accidental or unintended actions.

Principle 6: Low physical effort - Design that can be used efficiently and comfortably and with a minimum of fatigue.

Principle 7: Size and space for approach and use - Design that provides appropriate size and space—for approach, reach, manipulation, and use, regardless of the user's body size, posture, or mobility.

It is important to note that the right to personal mobility can only be exercised in an accessible environment (CRPD, 2006) and assistive technologies and mobility aids are not holistic solutions to the challenges of inaccessible infrastructure. Accessibility is an essential pre-condition to realise full inclusion and participation of persons with disabilities in society. Therefore, urban mobility planning and initiatives must systematically assess accessibility and incorporate the principles of universal design, as defined within the CRPD, into the built and digital environment.

National Disability Policy

In line with the CRPD, Zimbabwe also has a newly adopted NDP. In terms of transport and accessibility, the NDP has the following articles:

3.8.1 Measures must be put in place to ensure that persons with disabilities attain maximum independence, full physical, mental, social, and vocational ability, as well as full inclusion and participation in all aspects of life.

3.11.3 Eliminate barriers to access in relation to indoor and outdoor facilities, including personal mobility of older persons in ways of their choice.

3.11.6 Community services and facilities must be accessible to older persons with disabilities.

3.14.1 Buildings, transportation, and other indoor and outdoor facilities, including schools, housing, medical facilities, and workplaces must be accessible to persons with disabilities.

3.15.1 All Road Authorities must ensure that minor and major roads, sidewalks, pathways, curbs, and associated facilities are accessible to persons with disabilities.

2.3.3 Universal Design and Road Safety

Universal design features are critical throughout the transportation network, making it possible for any street user to comfortably and conveniently reach every transit stop. Universal street design facilitates station access, system equity, and ease of movement for all users, especially people using wheelchairs or mobility devices, the elderly, people with children and strollers, and people carrying groceries or packages (Khan, 2012). Employing tactile, visual, and audible design elements together, guides people of all abilities through the street environment. Consistently using detectable surfaces, colour contrast, and audible warnings assists all users, enhancing safety and accessibility (ITDP & UN Habitat, 2018).

2.4 Road Safety

Road safety has been known to impact accessibility. Many of the barriers to access have safety implications, and concerns for safety inhibit access (King, 2018; Maart and Jelsma, 2014). traffic safety refers to methods and measures for reducing the risk of a person using the road network being killed or seriously injured. As a measure to maintain road safety, the infrastructure needs to be checked for potential hazards resulting from deterioration or poor road design. This is done through several procedures, one of which is a Road Safety Inspection (RSI). An RSI is a systematic, on-site review, conducted by road safety expert(s), of an existing road or section of road to identify hazardous conditions, faults and deficiencies that may lead to serious accidents (World Road Association, 2012). RSIs are a safety management tool that can be implemented by road authorities as part of an overall safety process. RSIs claim to identify potential problems so countermeasures can be applied to remove or minimise the chance of an accident occurring. This is turn will lead to reduced costs associated with crashes to individuals, families, and society.

Some countries use the term “audit” for their audits on existing roads. There are however concerns expressed from certain authorities worldwide on the use of the term “audit” on these existing roads (South African Road Safety Audit Manual, 2010). In light of this, the term “Road Safety Appraisal” is recommended for use when road safety auditing is conducted on existing roads in South Africa, for example, but many other countries have used the term “inspection”.

2.4.1 Road Safety Inspection

RSI is a proactive safety management tool. It comprises a routine, programmed and systematic field survey which is undertaken proactively on existing roads to identify risk factors and to achieve enhanced safety. RSI results in a formal report detailing road hazards and safety issues supported with videos and photographs. An RSI is a standardised survey undertaken to collect prescribed data relating to road characteristics (highway and environmental features) of existing roads. This allows the identification of sections of road that warrant further road safety investigation (Africa Development Bank, 2014).

The survey is not restricted to the consideration of highway features (e.g., road markings, signage, drainage, road restraint systems, etc.). Rather, during an RSI, information on the context of the road and surrounding development will also be collected (e.g. road alignment, adjacent development etc.). The RSI also records information relating to how an individual might perceive and use the road. RSIs should ideally be undertaken for each road section every three to five years. Five years should be the maximum permissible number of years between inspections. Ideally all roads would be covered by an RSI, though if budget and resources are limited, a road authority may wish to prioritise the inspection of higher volume roads, roads of strategic importance or roads that are known to be higher risk (African Development Bank, 2014).

The objective of a Road Safety Inspection (RSI) is to identify foreseeable hazards for all road users. The RSI process provides a reasonable, but not absolute, hazard identification method for all road users with a focus on the reduction in fatal and serious injuries (Austroads, 2009). Inspections can lead to reductions in the likelihood of crashes, in the crash severity and, potentially, the need for costly remedial infrastructure work. To be effective, treatments must be identified and implemented as a result of the RSI (African Development Bank, 2014).

Although in practice most RSIs require consideration of all road user groups, increasingly what are called ‘thematic road safety audits’ are being commissioned which involve a focus on one or more, typically vulnerable, road user groups e.g., pedestrians, cyclists, and on-road public transport users. Thematic audits are an element of road safety audits (and inspections) that were introduced in Australia to focus on a particular aspect or use of a facility (the 'theme') in the road environment. The purpose of thematic audits is to focus on specific recurrent problematic issues to make the road safer in the future (Brisbane and Yee, 2002). Thematic audits not only address individual areas of concern in the network, but over time knowledge gained from these audits will provide the opportunity to improve guidelines, improve training and change practices, thereby promoting continuous improvement.

Worldwide, RSIs:

- are completed by independent and qualified audit teams (these are road safety specialists for example, traffic engineers, human factors scientists, traffic manager etc) (African Development Bank, 2019).
- are completed by applying Safe System principles while seeking to ensure that roads will operate as safely as practicable by eliminating fatal and serious injury crash potential
- consider the safety of **all** road users (unless specified within the audit brief)
- are conducted on existing roads.

Depending on the complexity of the work, an inspection may be done by a single inspector or by a group of inspectors (PIARC, 2012). Where possible, and under the supervision of an experienced and qualified Team Leader, the inclusion of local road safety practitioners in the RSI team is encouraged. On smaller projects, a single inspector may be adequate and a more practical option.

2.4.2 The Road Safety Inspection process

This section highlights the general process to prepare and conduct an RSI. The first decision is to determine the extent of the inspection by defining the start and end points of the inspection. This is usually agreed upon by the parties involved in the inspection, usually he road authority and the inspection team. The agreement describes what to inspect, who pays for what, timelines and deadlines, what the local agency should contribute and so on. The RSI process involves four steps, namely:

1. Preparatory work in the office

Background information about the road, the road function, road standard and the traffic volumes should be obtained. Information can be sought from local residents through face-to-face discussions or a questionnaire.

2. On-site field study

Inspectors need to look out for their safety first and this is done through wearing high-visibility vests and having flashing lights on their vehicles. For a reliable inspection report, the inspection should be made by both car and on foot where needed and incorporate both sides of the road and roadsides.

During the inspection, checklists need to be used and completed. The checklists are quite detailed and consequently there should be a systematic collection of the deficiencies that were found (African Development Bank, 2014). The general structure of the checklists is shown in table 1. The completed checklists themselves are not added to the inspection reports but a summary of the results is contained in an investigation form. In this form, the deficiencies are collated under the broad headings from the

checklist with locations provided (PIARC, 2003). This document is a way of gathering all the information onto one form, and that form should comprise part of the RSI report.

TABLE 1 Structure of the Checklists (PIARC, 2003).

General data of the road	
Length	About ..... Km, percentage of inside and outside towns and villages
Max speed	.... km/h outside, ... km/h inside towns and villages
Traffic Data	Recent and predicted traffic volume
Accident Data	If available
Road characteristics for active safety avoiding human errors ad accidents	
Geometric Design Characteristics	
1. Function	Is the road suitable for therole it plays, does it have mixed functions, are vulnerable road users separated, are speed limits appropriate, are there any impacts from land development?
2. Cross-section	Is the road wide enough for the traffic using it, what are the surface conditions, are the shoulders adequate but not too wide, is the road designed so water does not pool on the surface, is drainage from the road adequate?
3. Alignment	Is the alignment consistent, make sure none commence just over a hill, are the horizontal and vertical alignment coordinated, are sight distances adequate?
4. Intersections 4.1 Geometry 4.2 Signalisation 4.3 Railway crossings	Are the intersections appropriate for the traffic volumes and road characteristics, are they fully visible and recognisable, are they perpendicular, are weaving lanes long enough, are there traffic signals and are they sufficient? Also look at local accesses and railway crossings?
5. Services 5.1 Service and rest areas 5.2 Access control, city halls, hospitals, churches and cemeteries, supermarkets, cinemas etc 5.3 Public transport	Is there sufficient space and acceleration/deceleration lanes into the rest area, what amenities are provided (including petrol stations, public services such as schools, hospitals, restaurants and parking places)? Should also look at parking and loading facilities and public transport facilities such as bus stops, their position relative to traffic lights, are they adequately protected including the needs of their passengers
6. Needs of vulnerable road users	Have the needs of pedestrians, cyclists and scooter/moped or motorbike riders been taken in to account?
Road equipment	
7. Traffic signing, marking and lighting	Is the signing and marking appropriate and clear, is lighting adequate or is it needed?
8. Roadside features and passive safety installations 8.1 Forgiving roadsides 8.2 Engineering structure 8.3 Plantings 8.4 Other obstacles 8.5 Passive safety measures	What structures, steep slopes and embankments, plantings, trees and other obstacles are near the roadside that could pose a problem? Are there open windows in the passive safety and/or is it an obstacle itself?

The equipment required for an inspection includes:

- A vehicle (with appropriate high visibility markings)
- Video camera (ideally GPS linked system)
- GPS (can be achieved using a satellite navigation system or smart phone)
- Notepads
- Inspection forms/checklists
- Pens
- Personal Protective Equipment (e.g. high visibility clothing and protective footwear)
- Dictaphone (optional)

3. RSI report

The RSI report should consist of an introduction, three parts and appendices with maps and illustrations as necessary. The introduction should include details of the road or section of road being inspected and the composition of the inspection team, date, times, and conditions at the same time of the inspection. Part A should outline the background data obtained during the preparatory work in the office and a description of the activities undertaken. Part B describes the shortcomings or deficiencies which were found and an assessment of these deficiencies. It should contain the completed investigation form and the documentation with pictures. Part C contains proposals for countermeasures, from short to long-term, and a brief cost estimate if possible.

4. Remedial measures and follow-up

Remedial measures do not form part of the formal inspection process, but they are important steps. Implementation depends on available funds and other factors such as the need for land acquisition.

*2.4.3 Thematic Audits (**audit here refers to inspections)*

Thematic audits provide specific and relevant input material to the stakeholders involved to facilitate corrective action and thereby minimise the exposure of road users to potentially unsafe elements of the road and the road environment (Winning and Park, 2007). It is also possible to conduct a road safety audit assessing only certain aspects. Examples include:

- Land-use development project audit
- Monitoring Stage Audit
- Interim road safety audit

- Specialist audits for specific user groups

Specialist audits for specific user groups

All road safety audits are conducted in a way that addresses the needs of all road users. Conditions may occur where specialist audits need to be conducted to assess the exposure to risk for specific road user groups. The audit process may be used on existing roads, streets, bicycle paths, etc. to identify potential safety problems for such a road user group or groups. The results may then be used as input into other road or traffic safety programs like *Safe Routes to Schools* or safety awareness programmes (South African Road Safety Audit Manual, 2010).

These specialist audits can include audits like the following:

- *Safety audit for passenger coaches on major highways;*
- *Audits of roads for cyclist or pedestrian safety;*
- *Pedestrian safety audits of shopping centres and car parks;*
- *Audits of safe access for people with limited mobility like the elderly, or people with disabilities.*

It is necessary that in an audit of this kind, the audit team uses the mode of travel in question or include an elderly team member or a person with the disability being assessed. One such study was conducted in Cambodia and PWDs together with research assistants travelled on an entire journey together, with the PWDs identifying and describing their access challenges to the assistants (King, 2018). The audit looked at barriers to movement in critical points of the journey, such as on the way to the bus stop, at the bus stop, boarding the bus, de-boarding, and making way to the destination.

In some contexts, it is not enough to do an RSI alone in order to identify and address the deficiencies or challenges encountered by road users, receiving their specific views and opinions is also necessary to inform the action to be taken. One study carried out in Spain highlights the efficacy of the combination of these methods. The RSI was carried out in a school setting, and it was noted to be a very effective tool for checking safety conditions around schools in general. However, for that methodology to optimise the results obtained, it was deemed essential to have the municipal and school support by distributing surveys to parents, teachers and students and conducting personal interviews with the heads of the centres (Miralles-Olivar, 2012). The surveys collected and revealed information on the safety and accessibility problems encountered in the school area. In that way, the most benefits of that study were realised.

2.5 Walking as a mode of transport

Walking is an important connector between different travel modes. While some trips are made entirely by walking, others may involve walking as only one component of a trip, such as walking to catch a bus to school or walking from home to the car on the way to work. Walking trips to transit or between modes are typically not counted as walking trips but are included in part of trips made by other modes (Galanis

and Eliou, 2010). Consequently, there is a need to accommodate pedestrians safely, providing access and mobility at all types of transportation facilities.

2.5.1 The need for safe and conducive environments for walking

As the elderly, the disabled are more at risk of a collision in difficult traffic situations or on parts of the infrastructure that are not adapted to their abilities, and they may also in some cases present a lower faculty of recovery from injuries. If disabled people suffer from a handicap in traffic, this handicap results from the conjunction of their disability and of the kind of environment they have to move in (OECD, 1998). Research on older people's perception of the outdoor environment contributes to the development of age-friendly communities and cities as well as to the design of public spaces promoting the mobility and wellbeing of older people (Wennberg et al., 2018). Adapting outdoor environments to the needs and preferences of older people is also a critical safety factor in terms of preventing falls (Li et al., 2006; Ståhl and Berntman, 2007).

Walking is an important transport mode for older people, for example, as well as an essential way of getting out and about, for exercise, recreation, and joy (Iwarsson, Ståhl and Löfqvist 2013). Providing transportation options for non-drivers in the community, such as walkable neighbourhoods and user-friendly public transport, are therefore preconditions for many people to stay mobile and independent in old age (Wennberg et al, 2018). Living in a neighbourhood with good community facilities and services, including transport, contributes to quality of life in PWDs (Banister and Bowling 2004). The design and maintenance of the outdoor environment facilitate people's ability to get out and about (Mollenkopf *et al.* 2004). Effective access to local shopping and services, attractive outdoor environments, the possibility to rest during a walk, good pedestrian facilities and access to public transport contribute to an independent active lifestyle. In addition, design of pavements, seating and smooth pavements, walkways and other pedestrian facilities can support independence and increase social interaction and community engagement (Hallgrimsdottir, Svensson and Ståhl, 2015).

Frye (2013) reiterates the need for a safe and conducive walking environment that offers equal opportunities for all users irrespective of ones' demographic or physical characteristics. By this, the presence of sidewalks does not only offer an exclusive right of passage for persons with disability across the globe but also protects pedestrians from road crashes.

The call to modify the physical environment can be traced to the proponent of the social model of disability who argues that unnecessary barriers in the physical environment and society's poor understanding of varying functional ability are rather the factors that limit activity participation and excludes PWDs from enjoying mainstream activities (Anastasiou & Kauffman, 2013; Haegele & Hodge, 2016).

2.6 Safety and accessibility as deterrents of independent movement

To adequately plan for vulnerable road users, it is very important to precisely identify their mobility patterns. In other words, it is important to know both their actual travel activities and their wishes for travel in the future. People's transport needs are not always equal to their actual travel activities. It is

therefore important to know of any factors that may prevent people from fulfilling their transport wishes, for instance, their possible fear of getting involved in an accident or their feelings of insecurity (OECD, 1998). For example, in some countries, there are indications that children are less and less often left to make trips on their own. Elderly people seem particularly prone to trade-off between mobility and safety or security (at night, for instance). Lack of "friendliness" of the road infrastructure towards pedestrians and cyclists is a deterrent, as it makes walking or cycling both difficult, even strenuous, and dangerous. (ibid).

2.7 Increasing Autonomous Movement through Good Street Design

The design and maintenance of the physical external environment facilitate people's ability to get out and about. Effective design of the neighbourhood street can support older people's independence (such as being able to go shopping) and increase social interaction and community engagement, reducing reliance on care in the home (Newton et al, 2010). To facilitate good street design, the UK came up with a specific guidance on designing physical environments for disabled people such as British Standard 8300 (BSI, 2009), inclusive mobility, and the incorporation of disabled people's needs into mainstream guidance such as Manual for Streets (2007). These strategies suggest that neighbourhoods should be safe, inclusive, and well-planned places that respond to everyone's needs and enable effective engagement with the community at local level.

While designs for disabled people will have some positive impact on the experience of accessing and using their local neighbourhood, a more rigorous evidence base is needed to support implementation of design decisions for them (Newton et al., 2010). Previous research illustrates the importance of involving older or disabled people themselves in research and planning to get a complete insight into the issues of pedestrians with decreased mobility (Wennberg et al, 2018). Thus, their preferences need to be recorded.

2.8 Methodological approaches to road environment studies for PWDs in literature

TABLE 2 Prior studies

Author & year	Description and Methodology	Adopted for current study
Sawyer et al. (2018)	Used photo-elicitation qualitative interviews to explore environmental facilitators and barriers to neighbourhood-based, outdoor physical activity in 23 adults living in two income-deprived neighbourhoods in Glasgow, UK. Data were explored using thematic analysis. The access section of the survey was designed to document patterns of self-reported need for services and problems with obtaining access to them. The aim of the qualitative component of the study was to provide an in-depth description and analysis of the problems experienced by	• Photo-elicitation to explore environmental barriers for outdoor physical activity • Thematic analysis

Author & year	Description and Methodology	Adopted for current study
	consumers with disabilities in getting access to needed (healthcare) services.	
Owusu-Ansah et al. (2019)	Captured the experiences of the mobility impaired with daily transport as well as physical access to the CBD and to the hospitals through questionnaire survey. The purpose of the questionnaire was to gain an initial understanding of mobility issues. This was then followed up with face to-face interviews with 10 mobility impaired persons to further explore their current circumstances.	• Gaining initial understanding of mobility issues • Questionnaire survey to capture travel experiences of PWDs
Odame and Amoako-Sakyi (2019)	This study adopted an exploratory research design, since it afforded the opportunity to acquire new insights, discover new ideas, as well as expand knowledge on new and existing phenomena including the mobility needs and constraints of students with physical disability in the University of Cape Coast, Ghana. An auditing scheme was developed to examine the presence, conditions and dimension of sidewalks which also included the inspection of walking facilities like curb, curb cuts, tactile signage, width of sidewalk as well as crossing aids for students with disability. To execute this, principal walkways on campus were segmented into 100-meter stretches. In addition to the use of the auditing scheme, the study also relied on an in-depth interview based on the lived experiences of 30 PWDs who were reached through snowballing. The interview was deemed necessary because it provided the opportunity to capture the voice of the population of interest and add both human and social perspective to the measure of an accessible walking environment.	• Snowballing • Sectioning the inspection site
Mphafudi (2014)	This study aimed to assess walkability in Johannesburg, South Africa, based on the Complete Streets Design Guidelines. It adopted a qualitative approach and the methods used included a case study (the street section selected), discourse analysis, photo analysis and one-on-one interviews. The interviews used unstructured and generally open-ended questions draw views and opinions from the participants.	• Selecting a road section to use as a case study • Photo analysis • Open-ended questions to draw views and opinions from participants

Author & year	Description and Methodology	Adopted for current study
	Six street users (pedestrians) were interviewed, and they were selected randomly while on site. All participants were over the age of 18. Four City of Johannesburg Metropolitan Municipality officials in the City Transport Unit were interviewed according to different hierarchical roles of involvement in the Complete Street Design Guidelines Manual.	
King et al. (2018)	In order to identify barriers to transport on journeys taken by PWDs in developing countries, this study utilised a Journey Access Tool (JAT), a tool which was developed iteratively from 3 pilot studies and stakeholder consultations in Cambodia. This tool was a combination of an access audit and a road safety audit. Access audits are intended to provide governments, organisations, and communities with a clear understanding of the accessibility of facilities, areas that require attention and recommendations for improvement (Austroads, 2009). Audit findings are incorporated into a structured plan of action, with highlighted priorities and achievable, realistic timeframes. Road safety audits of existing roads (RSIs) involve examination of a road section or intersection by a qualified and independent team, who compile a report on the road section's safety, deficiencies, crash potential and potential resolutions. It involved observations from an entire journey, from home to bus stop to transport ride to destination, where researchers and PWDs travelled together whilst recording facilitators and barriers to movement in the road environment. Several groups were used, conducting daytime and night-time trips. Additionally, participants were provided with cameras to personally capture what they perceived to be barriers to access. A focus group was also conducted.	• Road safety audit on existing road • Observation of journey route – barriers to movement in the road environment • Daytime trips • Participants identifying the access deficiencies
Newton et al. (2010)	Interviews were conducted with 200 people aged 65+ to assess their preferences for a range of street attributes. A structured questionnaire was used, in conjunction with photo elicitation. The analysis identified the components of a street that make a person feel safe and influence their	• Photo-elicitation • Questionnaire

Author & year	Description and Methodology	Adopted for current study
	decision to go out. The results found that if these components are absent, some older people limit outdoor activity for a range of reasons.	
Stahl et al. (2008)	In a study to identify and prioritise accessibility and safety for the elderly in a residential area in Sweden, Stahl et al (2008) adopted a mixed-methods approach. The study targeted improvements to outdoor pedestrian environments based on the problems identified by elderly people. The project involved people aged 65 years or more, representatives from regional authorities, municipal political groups and administrations, landlords, and tenant associations, i.e., public actors and stakeholders engaged in the physical planning of outdoor environments. It took place over a four-year period. The first sub-study was a postal questionnaire. Sub-study two were participant observations to register the environmental barriers and risk factors along pedestrian walkways. The critical incident technique was used. Participants were recruited through a purposeful sample. A short time after the first observed walk and in order to register environmental barriers and risk factors in the outdoor environment from an objective perspective, a researcher independently went the same route as the participants had. An objective mapping of environmental barriers was made, implying a professional, objective evaluation of the pedestrian walkways in accordance with their developed methodology. The last sub-study involved research circles which were developed as a means to engage practitioners and researchers in a joint effort to develop or collect knowledge that has not previously been recognised.	• Questionnaire • Observation to register environmental barriers and risk factors along pedestrian walkways
Blyth (2019)	Using the concept of 'Age-Friendly Cities', this research examined the links between specific elements and broader feelings of belonging or wellbeing that can arise from access to inclusive public spaces. Participants from two contrasting neighbourhoods were recruited to partake in a mental mapping and photo elicitation study of	• Photo-elicitation • Thematic analysis

Author & year	Description and Methodology	Adopted for current study
	their surrounding areas. These visual materials were used to assess the age-friendliness of the two areas. Findings were analysed according to themes.	
IDGO (n.d)	During the first phase of Inclusive Design for Getting Outdoors, the SURFACE Inclusive Design Research Centre audited the local neighbourhoods of 200 older participants (who were also interviewed for the project) using a detailed design checklist. The surveys were conducted within a 300m radius of each participant's home and only included the area the participant would be able to walk in from home without driving, so that areas not accessible to pedestrians due to physical barriers, such as rivers and railway lines, were excluded. All surveys were done between 10am and 3pm weekdays or during daylight hours at weekends. These studies also used diaries, lab simulations, focus groups, surveys and interviews, mapping and auditing tools, and literature review.	• Safety audits • Day-time audits • Survey • Literature review
Saha et al. (2019)	In this study, "Project Sidewalk" was used, and this is a web-based tool that enables online crowd-workers to remotely label pedestrian-related accessibility problems by virtually walking through city streets in Google Street View. The study also received findings from semi-structured interviews with three stakeholder groups soliciting reactions to Project Sidewalk and identifying key concerns and design suggestions.	• Walk-about audit • Semi-structured questions

2.9 Conclusion

This chapter has explored related literature. Similar research studies done elsewhere have been alluded to. Many studies that used photo-elicitation, used images taken by participants. These studies were also long-term studies with huge budgets to fund the study so as to provide cameras for participants and for them to capture images over a long period of time. Interviews and surveys were used to derive participants' experiences and opinions, showing that PWDs' input is essential in identifying barriers and coming up with appropriate and acceptable solutions. It has also been highlighted that road safety and accessibility are mutually reinforcing elements and essential components of a broader strategy to ensure equal opportunities and achieve sustainable, inclusive development.

CHAPTER 3

METHODOLOGY

3.1 Introduction

In this section, the overall research design, instruments, and data collection methods are underscored. The chapter also presents the data analysis tools used for the present study. The chapter also presents ethical considerations that were observed in the study. This chapter concludes, paving way to the section on the results' presentation and interpretation.

3.2 Research design

The study took the stance of a qualitative and phenomenological research as it explored the personal and perceived experiences of PWDs in road environments. The responsiveness of the road environment around St. Giles according to the users, and the personal experiences of people with decreased mobility were recorded. Participants were shown images of areas within the study area, and they were asked what they would likely encounter at such points within their journeys. Participants were asked to report on how certain road conditions would affect their independent movement. This road section was selected as it is an area frequented by PWDs on their way to the rehabilitation centre and the users of the road would greatly benefit from this study. Images were used to elicit tacit knowledge. In this way, the lived experiences could be shared in order to illuminate and illustrate the issues arising regarding the phenomena which were being explored. Observation was also used, and this took the form of an RSI. This was done systematically with the help of a standardised prompt from PIARC (2009).

3.3 Participants

The inclusion criteria for participants were:

- Being 18 years of age or older
- Living in an urban area in Zimbabwe and
- Having a mobility impairment or ambulatory disability (affecting the lower limbs), and/or using an assistive device for movement

Participants were selected through convenience sampling. A snowballing approach was also utilised. Two organisations working with PWDs in Harare and Mutare were approached to help in the recruitment of participants and these organisations helped with facilitating the data collection process.

3.3.1 Ethical Considerations

In line with the General Data Protection Regulation (2018), anonymity and privacy of the respondents was maintained. This was achieved using intermediary organisations who reached out to respondents. Where surveys were filled in on paper, the organisations would enter that data online and the researcher would then be unable to identify the individuals. No personally identifying information was requested by the

survey. The participants were provided with information about the research and gave informed consent to participate in the study. Their participation was voluntary. The privacy policy was availed, and a contact person was also given. Because the study was carried out under the conditions of restricted travel, an exemption was sought from the Zimbabwe Republic Police.

3.4 Data collection

Data was collected from primary sources in January 2021 and July 2021. Both objective and subjective methods of data collection were employed to make sure that the information was not biased. The objective method was the RSI which was done to explore potential hazards within the selected road section. It was conducted according to set standards, as it is a systematic, formal, and professional procedure (PIARC, 2009). The subjective method was the survey which was used in seeking the experiential encounters of PWDs in certain conditions of the road environment.

3.4.1 Road Safety Inspection Procedure

The researcher adopted the RSI checklist for urban roads from the PIARC manual for RSIs. The RSI was conducted solely by the researcher. The first preparations were office work where the researcher gathered all the available and necessary equipment for the site inspection. A map of the selected area was downloaded from Google Earth for referencing by the researcher. The researcher used a checklist to ensure that they had all the required equipment before leaving for the site. The equipment carried included a high-visibility vest, a clipboard with the prompts and map, a mobile phone for capturing video and images, pencils, a backpack, and a permission letter from the authorities.

Initially the researcher had been driven around the inspection site and assessed the general condition of the road some days before. On the day of the field work, the researcher did not use a vehicle but carried out the inspection on foot. The inspection was conducted in the summer, in January 2021 under sunny conditions, after it had previously rained that morning. Traffic was minimal. The inspection commenced at 14:15pm, beginning from the bus stop along Princes Road, and assuming the position of a person who had just deboarded public transport now making their way to St. Giles on foot (figure 3). The researcher used the Mapillary application on their smartphone to capture images of the areas under inspection. This application was used because it would help in geo-locating the site.

FIGURE 3 Path followed for inspection

The section leading to the entrance mostly used by commuters to the centre (along Clayton Road) was inspected first. Both sides of the road were captured. The researcher walked from the stop to the entrance whilst recording video/images. The camera was paused at the entrance and the checklist for that section was completed. Because the researcher worked alone, the best way to capture the essence of the environment whilst minimising personal risk by being on the road was to record a video. The checklists for the remaining 3 sections were not completed on the street but upon returning to the office and revisiting the recorded video to make notes.

At the traffic-light controlled intersection of Princes Road and Drummond Chaplin, overt observations of people crossing the road were made. That was done to see how people were crossing the road as the traffic lights were not functional at the time. Pedestrian traffic was limited so the only two pedestrians who went across the road are the only ones who were observed to note potential challenges. This observation was done from a distance to ensure personal safety. The process of walking and recording images took 45 minutes to an hour. Upon reaching the office, the researcher revisited the video and images in order to fill in the checklists for the remaining three sections. This was done systematically as the images were sequential and progressed the same way a person walking on the road would.

After filling in the checklists, images showing areas of highest concern were highlighted so that they could be presented in the inspection report. These areas were selected based on their representativeness of the road section. Critical points within the road, such as crossings, intersections etc, were selected. An investigation form was then completed, indicating the potential hazards within the road sections and it was included in the inspection report.

3.4.2 Importance of user perspective

It is necessary to hear the opinions of vulnerable road users, including the disabled, as they can bring information or ideas that may not have been initially familiar to professionals or decision-makers (OECD, 1998; Cyril et al., 2015). Using community engagement approaches can lead to perceived improvements in the physical and social environment resulting in increased street use, which may lead to increases in walking for transport in the longer-term (Adams and Shirer, 2018). Community engagement can be defined as the "direct or indirect process of involving communities in decision making and/or in the planning, design, governance, and delivery of services using methods of consultation, collaboration, and/or community control" (O'Mara et al, 2013). Using community engagement approaches to deliver interventions can help improve health and well-being and reduce health inequalities. They can also lead to increases in social capital, community capacity building and empowerment of community members (Cyril et al, 2015). The current study made use of user perspective in assessing accessibility of the road environment from the PWDs perspective. The participants were able to comment on how certain road conditions impact their independent movement, thereby informing the intervention process. Hearing from the participants would also mean that the countermeasures presented would be their preferred ones, making acceptability easier.

3.4.3 Photo-elicitation survey

Photo-elicitation is the insertion of a photograph by the researcher into a research interview to evoke information, feelings, and memories due to the photograph's particular form of representation (Shaw, 2020). It is a qualitative technique where researchers solicit responses, reactions, and insights from participants by using photographs or other images as stimuli. Images can be researcher-generated or participant-generated and each has particular benefits and challenges (Copes et al, 2018). Whether the researchers supply those photos or participants are asked to bring their own, in either case, the participants are supplied "guiding questions" which help them talk about the photo (Harper, 2002). Similar studies have previously used photo elicitation (Newton et al., 2010; Blyth, 2019; Sawyer et al., 2018), with participants receiving cameras to capture their own images. Most of these studies were, however, long term studies and had the funding capacity to engage participants this way. The current study used researcher-generated images because of time and money limitations. Participants could not be equipped with cameras to capture personal images of the roadside as that would have required a significant amount of funds. The researcher presented images that they captured and asked for participant perception regarding the likely experiences in the shown images. Because the situations shown in the images were not necessarily unique to the study site, participants could comment based on prior experience in such situations. That is how photo -elicitation works to evoke tacit knowledge, which informs responses. As this study could not utilize interviews because of reported limitations in internet access from participants, a survey questionnaire was opted for instead. The survey could be availed in offline formats, making it more readily accessible.

Photo-elicitation does not replace studies based on conventional interviews and can be viewed as an adjunct to such methods, providing additional validity and depth, and offering new viewpoints and opportunities. Samuels (2004) found that photo-elicited interviews were richer and deeper when

compared to verbal interviews. Photo-elicitation stimulates the informants' ability to express their practical knowledge through the attribution and association of meanings (Bignante, 2010). In these activities, the informants do not only provide information, but they are also asked to describe their perceptions of specific phenomena and the values they attribute to them. Photo-elicitation can be a useful technique for breaching the communication impasse between interviewee and interviewer, for bridging geographical and cultural gaps between interviewee and interviewer, and for collecting more quantitatively and qualitatively complete data compared to that obtained by using "words" only (El Guindi, 1998; Dodman, 2003). Photo-elicitation can help to promote more relaxed and more aware participation in the research.

A semi-structured interview guide was developed to elicit detailed information about the barriers to movement in the roadside that confront people with disabilities. The researcher developed the tool based on images collected from the RSI. Representative images of key areas/aspects of the road were selected for photo elicitation because the researcher could not do a walk-about with participants because of the COVID travel restrictions. Images of key points in a journey were inserted in the interview to elicit participants to talk about what they were likely to experience at such a point in the road environment. These key areas included a bus stop, an intersection, crossings, pathways/sidewalks, and the road surface. The interview could not be done in person because of distance and internet access barriers so it was conducted as an online survey. A Microsoft Word version was also available for those who did not have internet access. That same version could be printed and filled in on paper. One question had a short video from an intersection observation. That video could be shared on WhatsApp for those who did not have capacity to stream it.

The pre-survey page gave participants information on the research, the survey, the privacy policy, and data regulations, and sought informed consent to participate. Upon agreeing the participants would then fill in their demographic information in the first part of the survey (items 2 - 11) which was closed-ended. The information included sex, age, occupation, type of mobility aid used, frequency of lone travel, amount of human assistance required, mode of transport used the most and, to where they travel. The second part of the survey (items 12 - 22) presented images from the inspected site and representations of best practice, then asked respondents what experiences they might encounter whilst using the road in those particular sections. The last two questions (items 23 and 24) asked for any additional general information and asked participants what could be done in road environments to facilitate independent movement for their specific mobility limitations.

The targeted number of participants was 30 but, in the end, there were 33 responses, minus those from the pilot run. Participants were recruited individually through convenience sampling and then snowballing was utilised. The researcher introduced themselves to potential participants through email, attached the survey and requested participation. These were people who had been identified on the social media pages of organisations that work with PWDs. To facilitate more effective recruitment, one organisation was approached to assist with reaching out to interested participants and they then

facilitated the filling in of the survey. The assistant was free to use any version of the tool, but the researcher would eventually receive all responses on the online version to maintain anonymity.

3.4.2.1 Pilot

A test run of the survey was made with four participants to determine the kind of responses the survey was eliciting. These were key informants as well as PWDs from an organisation which had been approached to help in reaching out to participants. These individuals would also give feedback to the researcher regarding format and structure of the survey before it was fully deployed to other PWDs. They informed that an online survey may be challenging for a number of respondents thus, the researcher made a version that is available offline to include those individuals who might have been unable to respond online. Upon analysis of the test responses, there were some items that needed to be added to receive the required data. Missing questions were added, ambiguous and repetitive questions were adjusted accordingly, and the instrument was finalised then distributed. In the final version, responses lasted between 10 and 32 minutes. Some participants gave more detailed responses than others in the open-ended questions. Some started off detailed then gave shorter responses as the survey progressed. That is one known downside of having several open-ended questions on a survey; respondents grow tired.

3.5 Data Analysis

Data analysis for the RSI was through revisiting the captured images from the inspected road section and consulting the filled in inspection checklist/ form. The specific spots with deficiencies and the potential hazards they caused were noted and entered into the investigation form, which is part of the inspection report.

For the online survey, descriptive statistics and visualisations were generated from Qualtrics. These were prepared for the multiple-choice responses which were mostly demographic information. Crosstabs were also used to explore relationships in the data. These statistics served to understand and to give an overview of the characteristics of the respondents in the sample. By identifying these characteristics, the researcher would be able to interpret participants' responses.

For the open-ended questions, analysis was done item by item, maintaining the order that the questions appeared in on the survey. All responses from participants on a particular question were exported from Qualtrics in Microsoft Word format. The responses were printed and read by the researcher, whilst taking note of arising themes. A second round of coding was conducted by means of a laptop computer. This second reading of the text was to ensure that no possible themes had been missed. The downloaded text reports were fed into Quirkos, a computer-assisted qualitative data analysis software (Azzopardi Meli, 2018; www.quirkos.com). Whilst in the software, the researcher read the responses and generated themes as they came up. The software allows one to code or highlight text, thereby grouping it with other excerpts in the same theme. Upon completion of coding, the resulting themes and substantiative evidence from the responses were downloaded to the device in Microsoft Word format.

Data was presented in tabular form, highlighting codes and the specific content from the participant responses. Some quotes from the responses were included to illustrate the personal experiences of respondents. The researcher's observations together with the participants' responses were compared to point out the condition of the road environment under study and the experiences of PWDs in that environment. From the analysed data, conclusions could be drawn regarding perceived challenges and the possible, acceptable countermeasures.

3.6 Conclusion

This chapter has delved into the nature of the study and the methods that were used for data collection and analysis. The inclusion and exclusion criteria for participants have also been alluded to. Ethical considerations that were included have been highlighted as well.

CHAPTER 4

RESULTS

4.1 Inspection report

The report presents the findings of a road safety inspection based on the World Road Association (PIARC)'s Guidelines for Safety Checks of Existing Roads, conducted on sections of the roads surrounding St. Giles Rehabilitation Centre, namely: Princes Road, Clayton Road and Drummond Chaplin Road.

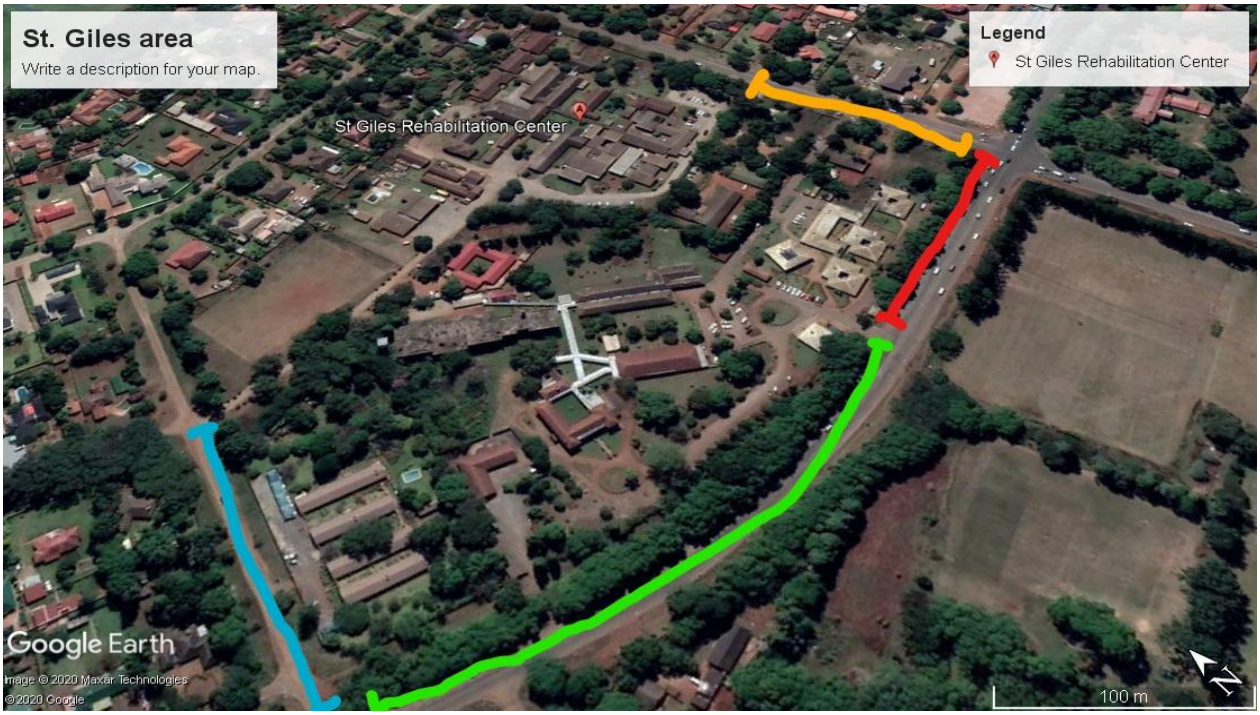

FIGURE 4 Sectioned inspection area (Google Earth, 2021).

General data of the road

Date: January 2021 ***Time:*** 14:15

City: Harare

Length: approximately 0.820km in total

***Max speed*:** 40-60km/hr zone

***Traffic and accident data*:** unavailable

***Function*:**

Princes and Drummond Chaplin are local roads; they serve transit traffic.

Clayton is an access road, leading to a residential area and to one of the two entrances of St. Giles Centre.

***Cross-section*:** Generally flat terrain area

Alignment:

All roads are straight, except for a slight curve and slope on Princes Road (between the turnoff into Snowdon Road and the entrance of Wilkins Hospital)

Intersections:

There is one traffic-light controlled intersection at the corner of Princes and Drummond Chaplin Roads.

Along Princes Road, there are two access roads namely: Snowdon and Clayton.

Services:

St. Giles Rehabilitation Centre, St. Giles Primary School and St. Giles Hospital which can be accessed from either Clayton or Drummond Chaplin Road.
Wilkins Hospital with an entrance on Princes Road.
The area is also residential and there is a primary school which can be accessed from Snowdon Road.
Princes Road also leads to a service station, a clinic, post office and a shopping centre, but those are outside the bounds of the inspection.

***Vulnerable road users*:**

Pedestrians (schoolchildren, people with disabilities) cyclists, motorcyclists.

Traffic signs, markings, and lighting:

Two zebra crossings on Princes Road- one in front of the entrance of Wilkins Hospital, the other at the bus stop on Princes.
All roads are lined with tower lights.
Direction and crossing signs are available.

Roadside features and passive safety installations:

Traffic lights available at the intersection of Drummond and Princes Roads.
Rocky and grassy outcrops. Generally flat surrounding terrain.

Images of deficiencies

No visible bus stop infrastructure
Road edges are not smooth
Zebra crossing not visible

Poor sight distance
Access road (Snowdon) blocked by vegetation

Cracked surface; no sidewalk

Potholes filled with water

No sidewalks; muddy desire paths

Road edges not smooth; stony and grassy

Overgrown grass on designated pedestrian pathway

Road sign covered by vegetation

Pedestrian crossing not visible

Discontinuous path (plus parked vehicles)

No designated sidewalk; unpaved footpath

Parked vehicles and vendors' carts in road edge (close to carriageway; block pedestrian traffic)

No lamp heads on lamp posts

No sidewalk; footpath sandy and grassy
No visible markings on road

No visible markings on road
Traffic lights not working

FIGURE 5 Identified safety deficiencies

Assessment of the deficits:

The inspection revealed several deficiencies along the entire site. On Clayton Road, there were large potholes which were filled with rainwater. The surface was not smooth and the tarmac was non-existent in many areas. These potholes make movement very difficult for vehicles on the road, making them travel on the edges of the road which are also used by pedestrians as there are no designated sidewalks. By virtue of this, the road is also dangerous for pedestrians. There were also desire paths that had formed which were noted in the inspection site. On the corner of Clayton and Princes, there was a big path which is highly used by pedestrians. The path however gets muddy when it rains, making it slippery and potentially risky for all road users. Pedestrians can slip and fall, and if vehicles pull over, they may skid.

Along the entire length of Princes Road, the edges were noted to not be smooth. Such edges pose danger for motorcyclists who may cycle on such an area and lose balance. The same edges may also cause sprains in pedestrians who may be walking on the road because the edges are unfriendly for walking. The footpaths along Princes Road were also sandy/muddy, stony, and surrounded by outgrown grass and trees. This vegetation was also blocking some features of the road, for example, one crossing sign was completely hidden from view, and one access road was entirely concealed by the grass. The road surface was not in the best condition as there were cracks and potholes in the tarmac.

The road markings in all inspected sections were not visible, be it at pedestrian crossings, median lines, road edges or at intersections. The road had lights but if they work could not be verified as a night inspection was not conducted. There were, however, some lights in critical points of the road which had no lamp heads, therefore, would not illuminate the road sufficiently. An example of this was the intersection of Drummond Chaplin and Princes Roads where two lamp posts had no heads on them.

There were no paved, smooth sidewalks on any of the inspected sections. Pedestrians either walked on desire paths that had formed over time, or they walked on the edges of the road, sharing the carriageway with vehicles.

Generally, the traffic signs were in good condition, but this is based on a daytime inspection, the same cannot be concluded for night-time. At the time of inspection, the traffic lights were not working and there was a continuous flow of vehicles without really giving way to pedestrians or to other vehicles. The lights did not seem to have a backup power source, so they were completely out, causing a bit of chaos and confusion on the road.

4.2 Survey Results

33 participants completed the survey with 17 of them being female, 14 male and two preferred not to disclose. Majority of participants (16 out of 33) were aged between 25 and 34. Table 3 illustrates this distribution.

TABLE 3 Distribution of participants by age and sex

Age group / Sex	Male	Female	Other	Total
18-24	0	1	0	1
25-34	7	9	0	16
35-44	6	3	1	10
45-64	1	4	1	6
65+	0	0	0	0
Total	14	17	2	33

Table 4 shows that approximately 61% of the participants reported that they were employed or self-employed. 11 out of the 20 employed were females whilst 9 were male. 21% were unemployed whereas 12% were students and the remaining 6% comprised of retired people.

TABLE 4 Distribution of participants by occupation and sex

Occupation / Sex	Male	Female	Other	Total
(Self) Employed	9	11	0	20
Unemployed	3	3	1	7
Student	1	2	1	4
Retired	1	1	0	2
Total	14	17	2	33

Table 5 illustrates that 12 out of the 33 PWDs used wheelchairs, with only one being motor-powered. The rest were manual, and most wheelchair users were females. Crutches were the second most used device, with 9 out of 33 participants reporting to use them. 6 respondents stated that they did not use any device whilst 2 mentioned other devices such as prosthetic legs.

TABLE 5 Distribution of participants by assistive device used

Device / Sex		Males	Females	Other	Total
Crutches		4	5	0	9
Walker		1	1	0	2
Cane		0	2	0	2
Wheelchair	**manual**	4	7	0	11
	powered	0	0	1	1
None		3	2	1	6
Other		2	0	0	2
Total		14	17	2	33

Table 6 illustrates the distribution of participants by mode of transport frequently used. An equal number of participants reported to use public transport and personal cars. Of the 11 who used cars, 6 stated that

they drive themselves whilst the remaining 5 received assistance from drivers. 8 participants said they used taxis the most whilst 3 reported walking (including wheelchair use) as their main mode.

TABLE 6 Distribution of participants by transport mode used the most

Mode / Sex		Males	Females	Other	Total
Bus/kombi		5	6	0	11
Car	**Self-drive**	4	2	0	6
	Have driver	2	3	0	5
Taxicab		2	5	1	8
Pedestrian (+wheelchair)		1	1	1	3
Total		14	17	2	33

Table 7 shows that almost all participants reported travelling alone at some point in time. 15 stated that they did so daily. The second highest response was "occasionally", with 11 out of the 33 participants highlighting this. Only 1 participant said that they never travelled alone. The participant stated that they were employed and travelled every day, mostly by taxi, and also required no assistance.

TABLE 7 Distribution of participants by frequency of lone travel

Frequency / Sex	Males	Females	Other	Total
Never	0	1	0	1
Daily	12	3	0	15
At least 2 or 3 times per week	0	5	1	6
Occasionally (once a month etc)	2	8	1	11
Total	14	17	2	33

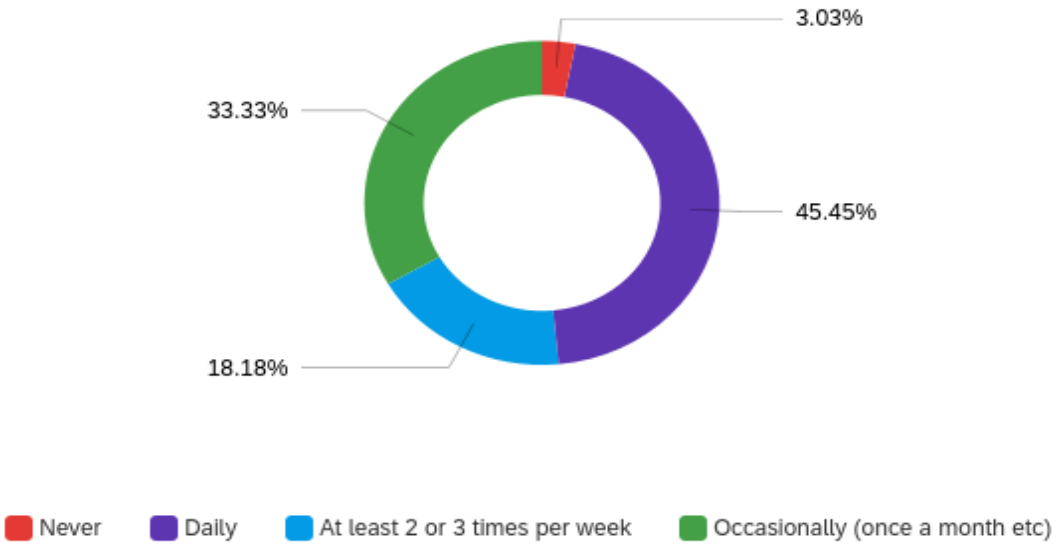

FIGURE 6 Frequency of lone travel

For those who travelled alone daily, the most common reason for travel was work, followed by recreational reasons. Six out of the 15 who travelled alone on a daily basis said that they required little help, only 4 said they needed no help and the remaining 5 needed moderate assistance. The device used by these daily travellers the most was the crutch, with six out of the 15 using this device. Those who used no assistive device were also amongst the high numbers of daily travellers. Majority of PWDs who travel daily also said that they used the bus the most, followed by the car, where all who used the car self-drove. The devices used by car users were varied and not skewed towards any specific device.

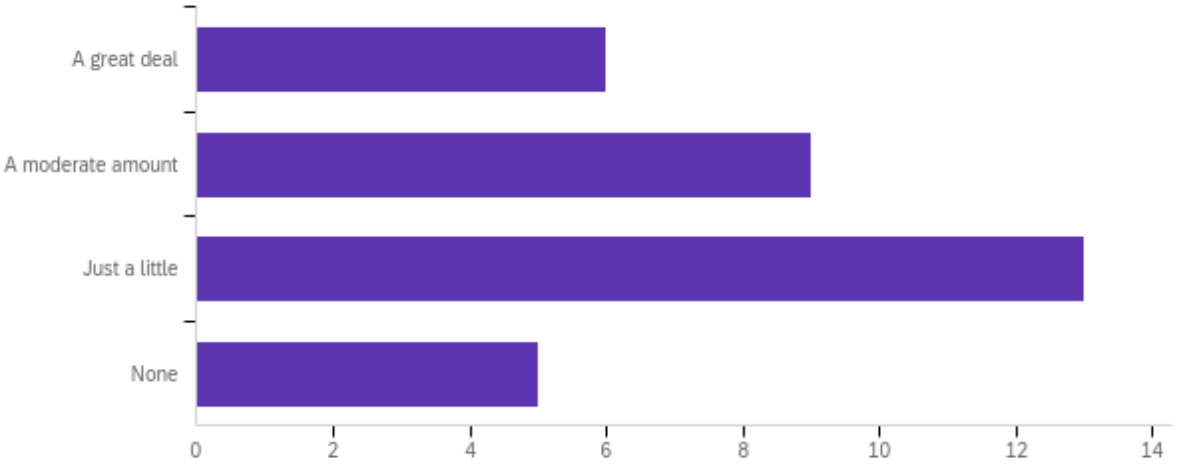

FIGURE 7 Distribution of participants by amount of human assistance required

Figure 7 shows that a larger proportion (27 out of 33) of the sample reported that they did not need a great deal of assistance (a moderate amount, just a little, none) from other people when travelling. 6 reported requiring a lot of help. Interesting to note was that all who stated that they required a great deal of assistance were all wheelchair users, highlighting the need to make the road much more accessible for them. This finding was consistent with other studies (Stahl, 2008) where wheelchair users required sufficient space to manoeuvre their device, and a lot more help at kerbs and other such conflict points in their journey. Second highest necessity for help was from crutch users who required a moderate amount of assistance. Three out of the nine crutch users stated that they did not need any assistance, whilst the remaining six required little to moderate help.

Those who required a great deal of help reported to only travel alone occasionally. That can be attributed to the inconvenience that the road and transport setup causes to them. It requires a lot of effort to prepare to leave the house and if they have no assistant, it means asking strangers on the road for help, or trying to navigate the road by themselves, which is risky. This finding is also consistent to Yau et al's (2014) assertion that a single negative experience can limit one's propensity for further travel. In such a way, activity participation is limited and PWDs are excluded.

FIGURE 8 Examples of kerb ramps (ITDP & UN Habitat, 2018)

The images in figure 8 were presented to participants to gauge their perception regarding usefulness of kerb ramps. 30 out of 33 participants stated that kerb ramps at crossings and intersections were useful, with most being wheelchair users, followed by crutch users. 1 stated that the question was not applicable for them. That participant was a user of crutches who self-drives. Two did not respond to this question. Figure 9 shows the distribution of responses.

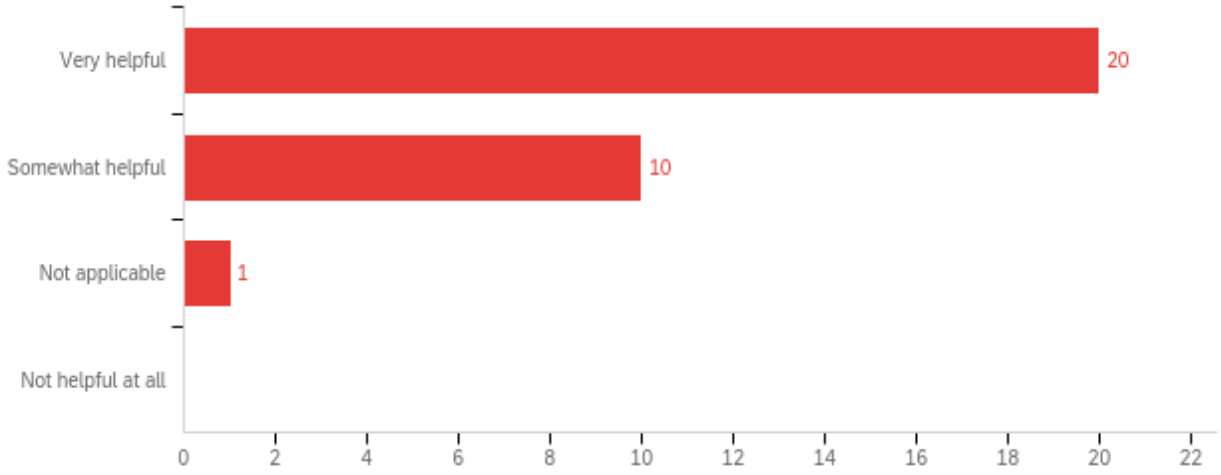

FIGURE 9 Distribution of participants by usefulness/preference of kerb ramps

Figure 10 highlights that many of the trips made by the sample in general, are work trips. The second highest trip purpose was reported to be for leisure or exercise within their neighbourhoods.

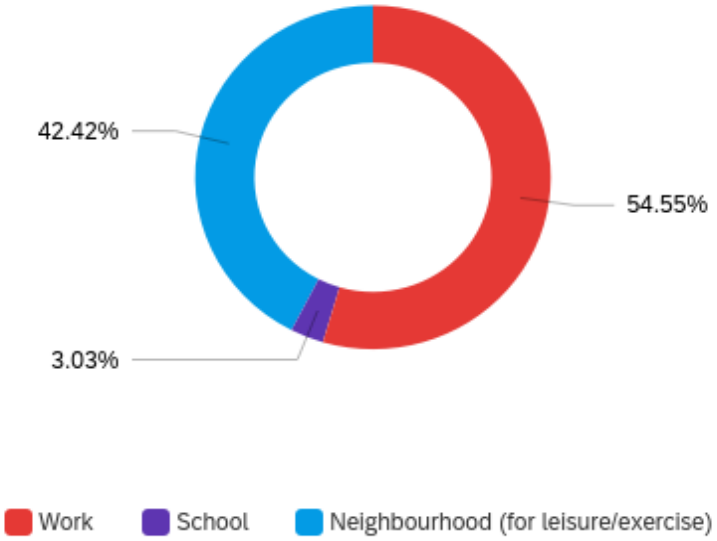

FIGURE 10 Distribution of participants by trip purpose

Question 12 of the survey presented respondents with an image of a faded zebra crossing along Princes Road in the inspection site. Participants were asked what challenges they would likely face at that crossing.

FIGURE 11 Faded pedestrian crossing on Princes Road

From the image of the zebra crossing, participants reported that they were likely to have problems with going across the road as drivers would not give way to them. Some of the responses to support this were,

"I have to wait for all cars to clear in order to get right of way instead of the cars to give me right of way."

"…the cars would not be stopping for me…"

"Drivers don't stop even though they are supposed to."

"Drivers may not stop…"

"…most motorist ignore zebra crossing and will not give precedence to pedestrians…"

"Most cars would not stop at the zebra crossing."

"…motorists not giving much attention as to whether I care to cross or not."

From these responses, it is evident that trying to cross at such a point in the road would pose a challenge for PWDs. The RSI findings also support this, and it is a challenge not only for PWDs but for all pedestrians. Other respondents mentioned that there was not enough space on the road edges for them to wait before crossing the road.

"One has to actually stand in the road to be visible so that the driver can stop and this poses as a danger to one."

*"*There is no stable sideway for stopover before crossing."

The RSI also highlighted the road edges as a deficiency in the road section. Pedestrians would be faced with the challenge of waiting on the shoulders of the road, which places them too close to the moving vehicular traffic on the carriageway. Users of crutches and canes highlighted the difficulty of trying to balance their assistive devices on an unsmooth surface.

The obvious issue in the image was the lack of visible markings to show the presence of the pedestrian crossing. One respondent commented, *"The zebra crossing lines are faint, it would be hard for both the motorists and the pedestrians to tell if there is a zebra crossing or not*." The markings do not only work for pedestrians but also alert drivers of the crossing place in order for them to give way to pedestrians wishing to go across. As a result of the unclear marks, there is an increased crash risk. The risk is even higher for pedestrians as they are vulnerable road users; they have no protection barrier from the impact of a crash.

The RSI highlighted cracks in the road surface and that the surface was not smooth. The rough surface does not only affect the smooth movement of cars and other vehicles, but it also affects the movement of PWDs on wheelchairs. Many complaints arose from wheelchair users who reported that a surface that is not smooth gives for a bumpy and uncomfortable ride.

Another theme that came up from the survey was increased crossing time. Participants reported that because of the lack of markings, they had to be extra vigilant and wait until the road was clear for them to be able to go across it. Some stated that they would require assistance to go across this section. The other reason for the increased crossing time was the lack of ramps to help in transitioning from the road edges to the carriageway. Some participants said that they would not be able to cross on time, which makes the situation a very dangerous one for them. One participant said they would encounter, "hooting

cars for me to move fast yet am slow." That also highlights the indignity that PWDs must face whilst travelling.

FIGURE 12 Pedestrian pathway, Corner Clayton and Princes Roads

When presented with an image of a gravel pedestrian pathway, participants reported that they would have difficulty with the surface as it is not smooth, and it hinders their movement. One wheelchair user reported that it would require all their strength to be able to push their wheelchair on such a surface. They also stated that it would be damaging to their wheelchair. There was also mention of the surface becoming muddy when it rains, making movement difficult yet again. One respondent who uses an artificial leg also mentioned that having to drag their leg in the sand would be hard for them. One cane user said that with such roads, their pace is reduced, and they must be extra careful when moving.

All participants who used an assistive device reported to likely face difficulty with their device on the section shown in figure 12. For the wheelchair users, specifically manual wheelchairs, the challenges were to do with sinking wheels and challenges with self-propelling. For the crutch users, the issues were to do with steadiness and how the shown surface would not provide them with stability. As a result of these challenges, there was also a risk of losing balance, falling, and injuring oneself.

A reduction in movement speed was one of the issues of concern. Participants reported feeling frustrated which is compounded on by the sandy surface. One participant stated that they would require assistance with manoeuvring their wheelchair at such a point, as it would get tiring for them.

Some of the reported concerns by participants were also revealed by the RSI. The surface, which was not smooth, for example, would lead to pedestrians moving on the shoulders of the carriageway in a bid to

avoid the sandy footpath. The surface was also likely to get muddy after rainfall which poses a risk of slipping and falling for pedestrians. All in all, the surface negatively affects movement for pedestrians.

Item 15 of the survey presented participants with an example of a best practice pathway to assess how they would feel about using such a pathway and that kind of road environment.

FIGURE 13 Best practice pathway (ITDP & UN Habitat, 2018)

Most respondents stated that the path would make movement along the road much easier. Wheelchair users stated that the surface would make self-propelling much easier. They also said that they would move freely as the road has no bumps. One response stated, "*Having a tarred surface or just any flat surface can make one's movement more swift."* The paved and smooth pathway was favoured by respondents as it would allow them to move faster, with no barriers. All respondents appreciated that the sidewalk was far from the carriageway and that there was designated space for pedestrians, as well as for cyclists. Despite the general positive response to the best practice path, some respondents pointed out that the path would still need markings on it to make it clearer which road user would be using which part. Some responses also alluded to risk in sharing a path with cyclists. One response from a user with an artificial leg stated that the path "*… has cyclists and sometimes cyclists can be dismissive of people with disabilities which may lead to potential harm or injury."*

FIGURE 14 Pedestrian paths

Item 16 of the survey presented 2 images of pathways as shown in figure 14. For image A participants, which was part of the inspected site, participants highlighted that they would likely have difficulties with the surface as it would be slippery, especially in rainy weather. The path would also cause inconvenience with the devices. The responses were similar to those earlier noted, which include difficulty in self-propelling, sinking crutches and canes, risk of falling and needing assistance because of a challenging surface. Path A was also reported to have barriers in the form of fruit on the road.

Path B was generally well accepted, with respondents highlighting that it would be easier to move on. One wheelchair user said it allowed them enough space and freedom to move. Other wheelchair users also highlighted the amount of ease and independence they would have on path B as compared to A. Path B was reported to be safe as it is far away from the main road, meaning that pedestrians are not exposed to high-speed vehicles. B was also deemed as a better path as one would not require too much effort to push themselves. One response however spoke on the surface of B, stating that despite being a flat and paved surface, the ride on such a path would be a bumpy and uncomfortable one.

FIGURE 15 Discontinuous pathway on Princes Road

For figure 15, participants highlighted challenges with the surface of the path. They also highlighted that the path was unsafe and inaccessible. The path was said to be too close to the carriageway with no form of barrier to protect vulnerable road users and, it appeared as though cars could just pull over into the pathway and block movement. Regarding inaccessibility, the lack of ramps on the kerbs would pose a challenge in going across that section of road. The RSI had also marked that area as a discontinuous path, which is not favourable for pedestrians. Wheelchair users stated that the path was too narrow and not wide enough for their movement.

Participants also spoke of right of way in the section shown. They reported that it would be difficult to navigate the road as there are also no signs and markings to give direction. Concerns over being hit by cars were also brought up.

Figure 16 was presented to participants to hear the sort of experiences they would have with that path. The first and most prominent theme that emerged was the lack of formal pedestrian infrastructure. One participant mentioned that it was a game trail and it *"just emanated from nowhere because people had to avoid being runover by cars as there is no pathway for pedestrians on the proper road."* Others also mentioned that they would be forced to move on the road, which is unsafe, because there is no accessible pathway for them. The path was most unfavourable for the wheelchair and some walker users as they have to roll/push their device and that path has a lot of resistance to their easy movement. Slow movement along the path for cane and crutch users was reported as they have to take time to balance their device before moving forward otherwise, they would fall and risk injuring themselves.

FIGURE 16 Desire path on Drummond Chaplin Road

The grass on the path was indicated as a barrier, as well as the stones lining the path. The terrain was not smooth and would present challenges in movement for all assistive devices. Participants also stated that as a result of moving too closely to the road, they would be at a high risk of being involved in a crash. There was minimal separation from the carriageway therefore, no protective barrier from vehicles in the case of an accident.

In line with the RSI, the participants' responses echoed what the RSI had revealed as safety hazards. The stones lining the road would be barriers for movement of pedestrians. If one is to slip and fall, they also risk falling on those stones, exacerbating injury. Because of the path surface, movement is also likely to be difficult in rainy weather as both the sand and grass become slippery. There is also no barrier to separate pedestrians and vehicles, thus, pedestrians are exposed to speeding vehicles. Both the RSI and the participants' survey revealed the path as an unsafe and inaccessible one.

A 2-minute recording and observation of the intersection of Drummond Chaplin Road and Princes Road captured challenges and potential hazards in an uncontrolled intersection. The intersection has traffic lights but at the time of inspection, the lights were not working. From the researcher's observations, it was noted that it took a longer time for pedestrians to be able to fully go across the road in those conditions. They had to keep checking both sides whilst going across, even stopping in the middle of the road to give way to fast-moving cars. There were no visible markings on the road, which made the stopping in the middle of the road even more dangerous because drivers would not have any guiding lines to direct them. Vehicles were moving across the intersection in an unsystematic way, which was risky for all road users.

From the accessibility survey, four main themes regarding barriers to movement at the intersection emerged, namely:

- Uncontrolled traffic
- Crossing precedence
- Increased crossing time and
- Safety and crash risk

Participants indicated that crossing the road would be difficult especially since cars would be moving from all directions and there is no police or traffic light to control movement of vehicles. Participants also highlighted that it would be challenging to go across because drivers generally do not give way to pedestrians. Some of the responses that captured this are as follows:

> *"It will be very difficult to cross this junction as motorists have a tendency of only stopping for other motorists and they don't respect pedestrians on situations like this. It might happen that one motorist can tell you to cross and stop. But others may take it as an opportunity for them to pass too. It once happened to me."*

> *"…crossing the road will be difficult due to moving traffic who will not observe that there is a disabled person trying to cross the street."*

> *"There is no security for my movement as some motorists are not taking due care."*

Participants reported that it would be risky for them to cross as precedence would not be given to them. They cannot walk onto the road and expect the same precedence given to a car. Way may be given by one motorist, but the pedestrian must make sure that there are no other vehicles coming from a second lane or the other direction, so it is very risky. Respondents also mentioned that because of their impairments, even after being given way, swift movement is expected by motorists but is impossible for the PWDs. One comment elaborated, *"It's dangerous to cross such areas. Should one motorist stop and say pass, as a wheelchair user, you should make sure all the motorists saw you before you pass."* The participants would have to negotiate for safe crossing which can take time, increasing their crossing time and ultimately, the entire journey time. There were concerns for not being able to cross in time once one enters the intersection, exposing them to the risk of being hit by a car. Oncoming traffic was specified as a major threat to crossing in such conditions. PWDs underscored fear for their lives in such conditions.

Presented with a best practice intersection (figure 17), participants were asked to highlight their likely experiences at such a point. The intersection was generally well received although a few negatives were also pointed out. The participants' responses were to an extent coloured by the traffic shown in the image which somewhat influenced participants answers. Unlike earlier images which showed road sections, the image of the intersection also had human traffic on the surrounding sidewalks, giving the impression of a busy road section.

FIGURE 17 Best practice intersection (ITDP & UN Habitat, 2018)

Participants stated that it would be easier to navigate the road in the conditions shown in the image. They said that if the traffic lights were working, and traffic was controlled, they would not face difficulty trying to go across the road. There was also appreciation of the clear and visible markings on the road surface. PWDs felt that the markings were beneficial for accommodating them. The responses indicated that participants felt safer and much more mobile at the shown intersection. Some of the responses recorded stated that,

"The intersection is clearly demarcated, accommodating pedestrians and it's controlled hence allowing me to feel safe and cross the road with little challenges."

"…uninterrupted movement."

"It would make my movement easier as there are plenty zebra crossing."

"…this will enhance my mobility because there is safety, the intersection is labelled very well."

Some respondents however felt that there were too many pedestrians, which might slow down the process of crossing the road. Some felt that the road was too long to cross, with no relief lay-by area. There was concern for the full functionality of the traffic lights, with participants reporting that if the lights were not working, then they would face some challenges with crossing.

Item 23 asked participants what other challenges road environments generally pose for them. Figure 18 highlights the themes that arose in response to the challenges faced, and it reiterates some of the challenges already presented from previous questions that were based on the inspection site images.

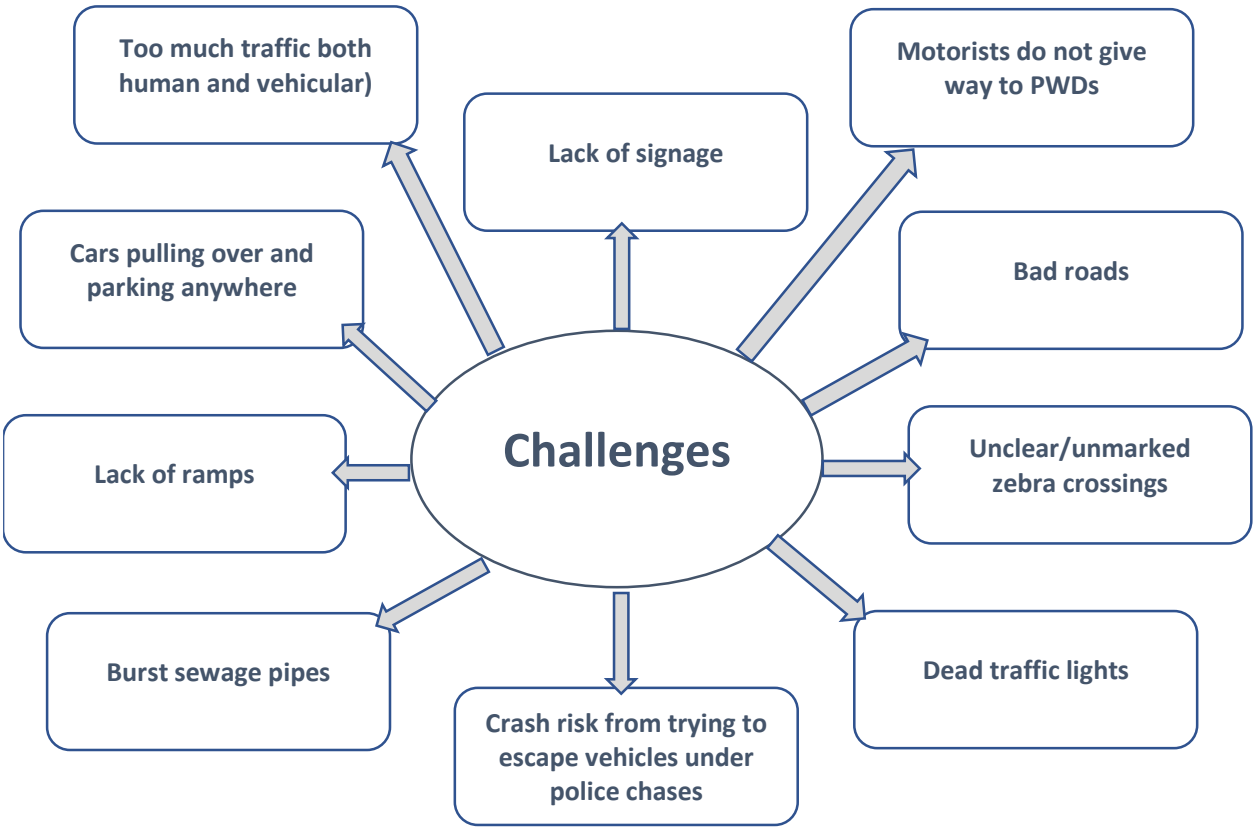

FIGURE 18 Challenges faced by PWDs on the road (Author, 2021).

Some participants reported that there is a lot of traffic on the roads, both vehicular and human, which make it difficult for them to navigate their way on the roads. Majority of the participants that reported this challenge were wheelchair users as they must roll their devices at a constant pace. Another issue was the lack of ramps on roads, which makes independent movement particularly difficult at sites with kerbs. Bad roads, dead traffic lights, lack of markings and signage were also reported as barriers to independent movement.

The last item in the survey asked participants for the type of solutions they would like to see on the roads to cater for their mobility needs. The responses included:

- *Signage and markings*
  PWDs stated that they would appreciate designated and accessible pathways clearly stating who should use as such. They also mentioned the usage of specific signage for wheelchair users.

- *Disability-friendly environments*
  Participants highlighted that they would like disability-friendly environments where they are able to have free movement, to rotate their wheelchair for example. They also mentioned creating environments that cater for all disabilities.

- *Separation between shared use paths and roadways*
  Participants said that they would like to have special lanes that they can use. Wheelchair users stated that having a restricted lane for them on pathways would make their lives easier. They spoke about having wider sidewalks and having paths away from main roads.

- *Working traffic lights*
  Respondents of the survey indicated that they would like to see traffic lights always working as that controls traffic and enables them to have a chance to cross without negotiating with drivers of vehicles.

    - *Sufficient crossing time*
      They said that intersections must always be controlled, and they should be given access to stop the traffic when there is too much traffic. They stated that they would also like to have sufficient time to cross because some lights change before the person has reached the middle of the road. Some busy and wide roads should have enough time to allow those whose movement is limited.
    - *Solar-powered lights*
      Some respondents said that having solar traffic lights might help to avoid having traffic jams at intersections and will help in controlling traffic.

- *Having traffic police to assist*
  Other mentioned that having traffic police to assist them at conflict areas may help them to cross safely.

- *Smooth surfaces*
  It was stated that pedestrian pathways need to be level to enable smooth movement. One respondent wrote, *"I would like to see a situation whereby those in wheelchairs have their smooth pathways alongside the roads/main roads to allow them free movement in their day-to-day routines."*

- *Ramps*
  A need for ramps was emphasised. Respondents stated that ramps make it easy to get off the road, at intersections for example, and onto the sidewalks. The incline should however be smooth.

- *Road rehabilitation projects*

  Respondents said that many roads needed rehabilitation and that government and council needed to be involved in these reconstruction programs. It was said that roads needed to be renovated for them to be accessible and to meet Universal Accessibility standards. The roads also need to be fixed to encourage safety and to rid them of potholes.

CHAPTER 5

DISCUSSION AND RECOMMENDATIONS

5.1 Implications

In line with previous research in both LMICs and HICs, the current study highlighted similar barriers to the independent movement for PWDs such as uneven and cracked surfaces, narrow paths, rubbish, vendors, and vehicles in the line of movement. The socio-demographic characteristics of participants did not have an impact on the challenges faced on the road. Bad road conditions posed accessibility challenges for all the participants. The only notable differences were the kind of challenge, based on the mobility aid used. For wheelchair users, they required space to move around and rotate more than crutch users for example. Those who used crutches, canes and artificial legs reported experiencing difficulties with balancing their devices on unsmooth surfaces, which put them at risk of falling. Wheelchair users also experienced a bumpy and uncomfortable ride on unsmooth surfaces, which was also a falling risk. This complaint is similar to what was noted in prior research where PWDs showed concern for falling and were afraid of aggravating their injuries, for those who had injuries (King, 2018; Newton et al., 2010).

When it came to crossings and intersections, PWDs expressed that they feel unsafe as motorists are not patient. From the survey responses, it is evident that there is need for motorists to be sensitised on giving way to pedestrians and especially PWDs as they require a bit more time to go across the road. With regards to the inspection site, signs to warn drivers of the higher volume of PWDs perhaps making way to the rehabilitation centre, may need to be put up to keep them alert. There is need to educate the general population on the difficulties that their actions may impose on a PWD trying to use the road. If separate lanes are to be introduced, then other pedestrians would need to be made aware of the purpose of separating lanes, to cater specifically for those with “special needs”.

One of the goals of the current study was to explore the experiences of PWDs on their way to St. Giles Rehabilitation Centre, where they receive medical services. By virtue of the road being inaccessible, based on participants’ responses, the road in itself limits the independent movement of PWDs in accessing basic services. Yau et al. (2014) highlight that a single negative experience can limit one’s propensity for further travel, which means that they are not as active. Ndebele (2020) echoes this, citing an experience of a PWD whose dignity and independence were compromised because of inaccessible roads and transport. PWDs have different walking distance and speed abilities, and walking may only be possible with the help of mobility equipment. Effective street design is therefore critical in supporting PWDs with a range of abilities and health conditions to get out and about (Newton et al, 2010). The current study did not focus on the aesthetics of the road environment, but that is also one area that encourages travel in PWDs and generally uplifts people’s moods, so it is also advisable to create appealing environments.

The implications of this study to policy include advocacy and awareness raising for the creation of inclusive roads to encourage participation by PWDs. Good street design will not only benefit PWDs but will allow all road users to have more accessibility and safety in the road environment. Urban planners are

encouraged to consider the needs of PWDs as that is in line with Zimbabwe's NDP. Following the release of the newly adopted NDP, different agencies responsible for the roads are urged to follow through with the stipulations put forward in the document. With information such as that provided by the current research, evidence-based interventions can be put in place to meet the specific requirements and desires of PWDs. Implementation of the recommendations is what is needed to accomplish inclusive, safe, and accessible streets for all.

Based on the Universal Design principles, this research has addressed the following principles:

- *Equitable use* - Design that is useful and marketable to persons with diverse abilities.

The current study highlights the importance of making roads that will be useful and usable to PWDs and all people, regardless of their abilities. The focus of this study is physical disabilities however, other disabilities also need to be catered for.

- *Flexibility in use* - Design that accommodates a wide range of individual preferences and abilities.

The study has identified the needs of PWDs with different assistive devices. The recommendations proposed indicate the input that was provided as preferences by the participants of the study. By incorporating those preferences, the solutions to the road challenges will provide flexibility for the users.

- *Simple and intuitive use* - Design that is easy to understand, regardless of the user's experience, knowledge, language skills, or concentration level.
- *Perceptible information* - Design that communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.
- *Tolerance for error* - Design that minimises hazards and the adverse consequences of accidental or unintended actions.

Regarding simple and intuitive use, perceptible information and, tolerance for error, the RSI recommendations propose interventions that make the road easier to use. The line markings and signs are an example for this. Keeping signs clear and visible is necessary as signs convey important information that encourages easier navigation within the road environment for all road users. The RSI identified potential safety hazards and pointed out the countermeasures that make the roadside forgiving. An example that illustrates how *tolerance for error* was addressed in the study is the recommendation to remove the rocks on the path along Drummond Chaplin Road as they pose a risk for injury if PWDs, or any other road user, fall there. Vendors and parked vehicles along Princes Road were reported to be too close to the carriageway, which exposes all road users to error. By moving these further away, then the tolerance for error is improved as people are not as directly exposed to the risk of crashes.

- *Low physical effort* - Design that can be used efficiently and comfortably and with a minimum of fatigue.

- *Size and space for approach and use* - Design that provides appropriate size and space—for approach, reach, manipulation, and use, regardless of the user's body size, posture, or mobility.

5.2 Proposals and recommendations

The noted deficiencies by the researcher as well as by the participants were taken into cognisance and the following countermeasures are proposed. The countermeasures are classified as "mandatory", "necessary", "recommended", and "optional". The mandatory proposals are basic features that should be present in the road environment, according to design standards, whereas the optional are not requirements. Table 8 indicates the recommendations to improve the safety and accessibility of the road environment in the inspected site.

TABLE 8 Recommendations for improvement of the inspected site

Section	Countermeasure	Benefit
Princes Road	Put "bus stop" and "zebra crossing" signs **NECESSARY**	Notifies all road users of the position of the formal stop and prevents public transport drivers from stopping anywhere on the road
All sections	Provide separate, paved, and smooth sidewalks for pedestrians; demarcate usage for pedestrians and cyclists **MANDATORY**	Dedicated space allows PWDs to move swiftly in the paths
Princes Road	Put ramps at kerbs and crossing points **NECESSARY**	Will allow PWDs to smoothly transition from road to sidewalk and the other way round
Entire length of Princes Road	Trim and maintain vegetation **NECESSARY**	Signs and access roads will be more visible
Clayton Road	Cover potholes and resurface road **MANDATORY**	Provides smooth surface for movement for both PWDs/pedestrians and vehicles; less damage to assistive devices and cars
All sections	Repaint road markings **MANDATORY**	All road users will receive guidance regarding their position on the road
Cnr Drummond Chaplin Road and Princes Road	Repair streetlights **MANDATORY**	Visibility will be greatly improved (at night or foggy conditions)
Princes Road	Put up "no parking" signs or provide parking space and stall space for vendors **RECOMMENDED**	Disturbance in path movement for pedestrians and cyclists will be removed

Cnr Drummond Chaplin Road and Princes Road	Repair traffic lights ○ Install solar traffic lights **MANDATORY**	Traffic will be controlled, providing all users a turn to cross the intersection
All sections	Lower speed limits – create a 30km/hr zone **RECOMMENDED**	Creates a conducive environment for safe movement; lessened injury severity risk

5.2.1 Effectiveness of Proposed Countermeasures

Table 9 presents some of the proposed interventions for the inspected road section. The interventions are based on the World Bank's "Guide for Road Safety Interventions: Evidence of What Works and What Does Not Work", a guide designed specifically for road safety interventions in Low and Middle-Income Countries (LMICs). The guide mentions that there are interventions that:

- reduce crash severity – such as roadside and central barrier systems on high-speed roads, roundabouts at intersections, etcetera.
- reduce exposure to risk – such as access control/management, separating vulnerable road users from other road users
- reduce the likelihood of a crash occurring in the first place – such as signs and line markings, traffic signals and infrastructure that supports speed reduction.

It is said that infrastructure interventions can produce immediate impact and can also produce ongoing benefits (World Bank, 2020). Once installed, they will continue to deliver at a similar level, although some maintenance may be required. It is for this reason that the current recommendations are made.

TABLE 9 Potential effectiveness of countermeasures (World Bank, 2020).

INTERVENTION	DESCRIPTION	POTENTIAL EFFECTIVENESS
Medians	Segregation of vehicles traveling in opposing directions of travel, either through constructed or painted areas of separation	Highly effective
Pedestrian footpaths	A section clear of the roadway used by pedestrians	Highly effective
Pedestrian crossings	Crossing point giving priority for pedestrians, including signalized crossings or grade separated crossings	Highly effective
Separated bicycle facilities	Bicycle path or lane that is physically separated from motorized traffic	Effective
Signs and Line Marking	Warning, directional, and other traffic signs and line marking	Effective

INTERVENTION	DESCRIPTION	POTENTIAL EFFECTIVENESS
Improving surfacing on poor quality roads without additional infrastructure improvement	Providing a high-quality road surface (that is, surfacing a dirt road) on a poor-quality road (that is, with poor alignment and width)	Not effective: increased risk
Lower speed limits	Mandatory maximum speed limits for vehicles, most effective when these are set to provide safe mobility for all road users and supported with appropriate infrastructure design	Highly effective

Medians - Medians provide a degree of segregation between vehicles moving in opposite directions and are effective at reducing head-on collision. They can also be used in urban areas, including to help pedestrians stagger their crossing movement. With respect to this, the intersection of Drummond Chaplin Road and Princes Road was lacking in medians hence, posed a danger for all road users as vehicles were not guided and pedestrians staggered their crossing without a guiding median line. Constructed medians, however, tend to produce a greater safety benefit than painted medians.

Pedestrian footpaths – These are an area adjacent to the roadway for use by pedestrians. To be effective, footpaths must be of adequate width, well maintained, and free from obstructions, including parked vehicles, signs, traders, and so forth.

Pedestrian crossings – These can be marked priority crossings, otherwise known as zebra crossings, they can be signal -controlled intersections or pedestrian over- and underpasses. The current paper recommends the zebra crossing as it is a low-cost measure, and it also maintains the standard already used in the country. There is however limited information on the benefits of pedestrian crossings in LMICs but there is a 40 – 70% reduction of pedestrian injuries in High-Income Countries (HICs).

Separated bicycle facilities- These facilities include off-road paths, on-road lanes, and dedicated facilities at intersections. Such a lane was one of the preferences indicated by wheelchair respondents of the study, where they said it would allow them to move without having to interact with pedestrians (on foot). Reductions of around 15% in cyclist injuries have been noted from the use of cycle lanes adjacent to traffic (Chen et al, 2012).

Signs and Line Marking - There are a range of signs and line marking as well as other options that can provide advanced warning of hazards and provide guidance to road users about their required position on the road. This solution is relatively low cost and produces valuable safety benefits.

Improving surfacing on poor quality roads without additional infrastructure improvement - An assumption is often made that when paving a road or improving the current road surface, safety benefits will ensue. However, increases in risk can occur, especially if other improvements, specifically for safety, are not made at the same time. This is particularly true in LMICs where the quality of the road before

resurfacing can be very poor, leading to very low speeds (Sekhar et al., 2016). The recommendation is to first seek expert advice regarding the road alignment and cross section conditions before surfacing to avoid fruitless interventions.

Lower speed limits - Low speed environments provide a greater degree of safety for vulnerable road users, including pedestrians. Pedestrians have a reasonably good chance of surviving when struck by vehicles at or below 30 km/h, but above this speed, the chances of survival reduce dramatically (Elvik et al., 2009). Reduction in serious injuries to pedestrians can be very high with this treatment.

5.3 Limitations

- The research design was descriptive in nature, and as a result, interpretations cannot be made regarding predictive or casual relationships among variables.
- The current study focuses on the experiences of PWDs in urban areas in Zimbabwe and neglects those of PWDs in rural areas. It however acknowledges that the experiences of these individuals may differ significantly as the travel environments are different, and generalisability of results in this regard is compromised.
- As a result of travel restrictions in the period of the study, only one RSI was conducted when ideally three or more are preferred, and they should be conducted at different times of the day, in different weather conditions to control for situational differences. Because of the single day time inspection, conclusions regarding the night-time conditions of the road cannot be made. The reflectiveness of signs on the road could not be judged, as well as the markings and visibility at night.
- The inspection was also carried out by a sole person whereas it requires a team of experts under normal circumstances. As a result, no technical details regarding the site were included because no technical equipment or expert staff were available to the researcher.
- There were no crash data available for the area under study, so the inspection was carried out without that information. Crash data helps in identifying specific spots that need remedial action but because this was not available, the researcher worked without it. Crash data availability is one of the challenges that Zimbabwe still must rectify as there is no unified crash database, and for the data that is available, it is not readily accessible for public use.
- The ideal methodological approach for the accessibility assessment would have been face-to-face photo-elicitation interviews, a focus group, or a walkabout with PWDs. That would have allowed probing and further elaboration of answers. The researcher however had to circumvent challenges with internet access by using an online questionnaire with open-ended questions, which was also available in a Microsoft Word format that could be downloaded and filled in offline. Care had to be taken to limit the questions because open-ended items can excessively burden participants, which may result in incomplete responses. The researcher is also aware that images may not entirely capture the complete experience of the road environment under study as participants were unable to encounter the traffic conditions and other such influential factors, but it can be argued that the focus was the infrastructure.

- There were also financial limitations in recruiting participants. Upon reaching out to individuals, many of them reported that other PWDs would not have access to the internet to complete the survey. The researcher could have otherwise provided data bundles for participation but there was no budget for that. To evade this challenge, a Microsoft Word version was also provided, which could be filled in offline and then forwarded to the researcher. This would however compromise the anonymity of respondents; thus, an intermediary was used. The researcher collaborated with an organisation working with PWDs to reach out to participants and collect data in paper format then they would do the data entry to the online survey for easier storage and aggregation of the data.

5.4 Future research suggestions

Future research can focus on facilitating independent movement for PWDs with other impairments apart from physical, and modes other than walking. The focus may also be on the road environments of other key destinations.

Further research can also focus on night-time inspections and having the same participants who actually use the road section under investigation. Consulting people who may have never used the road section may not necessarily give an actual indication of the experiences, though people may draw from similar situations.

There is a mental and emotional anguish that comes with the experiences of using an unfriendly road. That is also another avenue that may be explored to further understand the barriers encountered by PWDs.

CHAPTER 6

CONCLUSION

From the findings, it is clear that the road environment affects accessibility and the independent movement of PWDs. With that in mind, it is necessary to create roads that are safe and accessible to facilitate independent movement. People with a disability are often viewed through stereotypes of inability and dependency (King, 2018), which limits the opportunities available to them however, this study has highlighted that PWDs do travel alone and often but inaccessible environments limit their movements. They carry out the same daily routines that their able-bodied counterparts also participate in. The study has therefore, highlighted that there is a need for roads to be usable and to cater for PWDs' specific travel needs.

This study does not only benefit Zimbabwe, but the results may also be used to inform action and interventions in other LMICs with similar issues. Some of the issues, such as cracked paths and narrow lanes, are not unique to LMICs but may also be relevant to HICs, so they can also benefit from the recommendations of the study. Because walking is a basic and essential mode of transport, there are lessons to be drawn from this research, applicable to all.

In line with Universal Design principles, the improved accessibility for PWDs does not only benefit them but also, other groups in society. By making improvements in the road infrastructure, people using bicycles also benefit through footpaths where ramps are established and maintained. Children, pregnant women, and individuals with temporary injuries are also able to use the friendly road environment for their benefit and safely. There is increased access to healthcare, education, and employment. By designing universally accessible and safe roads, all people can participate in society, increasing the chances of achieving the Sustainable Development Goals. Creating a physical environment that reduces handicaps and thus enables the disabled to move about with a level of ease and protection similar to that of other road users is not only a safety measure, but also a basic action to treat the disabled with equity and fully integrate them in society.

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Appendix 1

Questionnaire

Title of the research: Facilitating the Autonomous Movement of People with Decreased Mobility: Road Safety and Accessibility in Pedestrian Environments.

Name + contact details of the researcher:

Ruvimbo Machingaidze,
Hasselt University, Martelarenlaan 42, 3500 Hasselt, Belgium
email: *ruvimbo.machingaidze@student.uhasselt.be*

Purpose and methodology of the research:

Dear respondent,

My name is Ruvimbo Machingaidze, and I am currently doing a master thesis for my master's degree in Road Safety at Hasselt University, Belgium. The goal of my study is to facilitate improvements in the road environment through identifying safety and accessibility barriers in order to provide the option of independent or autonomous movement for people with decreased mobility (in low and middle-income countries). This survey seeks to explore specific accessibility challenges in identified unsafe areas. Some demographic information will also be asked.

The survey will take you approximately 10 minutes. You will be asked questions based on shown images then a 1-minute video. You are asked to select an answer from the choices (click on the checkbox) or to fill it in the spaces provided.

Before starting the survey, please read the information below thoroughly:

- I have read the above information about this study.

- I understand the purpose of this research as well as what is expected of me during this research.

- I understand that my participation in this study is voluntary and that I have the right to discontinue my participation at any time during the intake. I do not have to give a reason for this, and I know that no disadvantage can arise for me.

- I understand that the results of this research may be used for scientific purposes and may be published. My name will not be published, and the confidentiality of my data is guaranteed at every stage of the research.

- I know that the results of this research will be kept until December 2021 and will be deleted after this period.

- For questions, I know I can contact: Ruvimbo Machingaidze (*ruvimbo.machingaidze@student.uhasselt.be*)

- For any complaints or other concerns regarding the processing of personal data, I can contact the UHasselt data protection officer: dpo@uhasselt.be

- For more information about exercising my rights or submitting a complaint, please see our *Privacy statement*. *(https://www.uhasselt.be/UH/Actueel/Gebruikersvoorwaarden-Privacyverklaring-Cookiebeleid.html#tabs2)*

I have read and understood the above information and received answers to all my questions regarding this study.

Q1. Would you like to participate in this study?

☐ *I agree to participate in this study and to proceed to the survey.*

Q2. Sex

☐ Male

☐ Female

☐ Non-binary/third gender

☐ Prefer not to say

Q3. How old are you?

☐ 18-24

☐25-34

☐35-44

☐45-64

☐65+

Q4. Occupation

☐Student

☐Retired

☐Employed/self-employed

☐Unemployed

☐Other (specify) _____

Q5. Mobility aid used

☐Crutches

☐Walker

☐Cane

☐Wheelchair

☐None

☐Other _____

Q6. (If wheelchair) Is your wheelchair

☐Powered

☐Manual

Q7. How often do you travel alone?

☐Never

☐Daily

☐At least 2 or 3 times per week

☐Occasionally (once a month, etc)

Q8. How much help do you require from another person?

☐A great deal

☐A moderate amount

☐Just a little

☐None

Q9. Mode of transport used the most

☐Bus

☐Personal car

☐Taxi

☐Pedestrian (wheelchair included)

☐Other _____

Q10. (If car) Do you?

☐Self-drive

☐Have a driver

Q11. Where do you travel to?

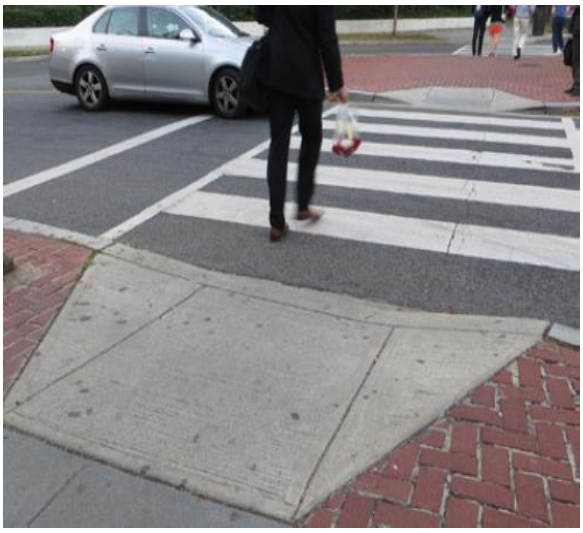
☐Work

☐School

☐Neighbourhood (for leisure/exercise)

Q12. If you were to walk on this road section, what challenges might you encounter at this zebra crossing?

Q13. How much would ramps at zebra crossings and intersections allow you to cross the road without someone else's assistance?




☐Not helpful at all

☐Somewhat helpful

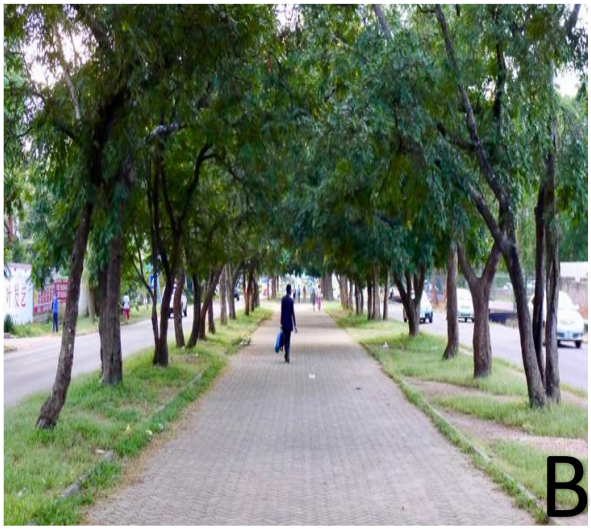
☐Very helpful

☐Not applicable

Q14. How would the road surface on this pedestrian pathway affect your movement?

Q15. How would this road environment facilitate or inhibit your independent movement?

Q16. The images show paths that are used by pedestrians. What might you experience whilst using them?



Q17. The image shows a pedestrian pathway. What might you experience on this road section?

Q18. What challenges might you encounter whilst moving on the shown pathway? Why?

Q19. Would the parked cars and vendors' carts on the path present a safety and/or accessibility barrier to you?

☐Safety

☐Accessibility

☐Both

☐None of the above

Q20. You will now see a short video. At the time of recording, the traffic lights were not working. What might you face whilst crossing the intersection here?

(Q21 --)

Q22. How would the shown intersection affect your movement across the road?

Q23. What other challenges does the road environment generally pose for you?

Q24. How can the road environment be improved for your specific mobility needs?

Please leave any other comments or suggestions you would like to make below.

We thank you for your time spent taking this survey.

Your response has been recorded.

APPENDIX 2

RSI Checklist

URBAN MAIN ROADS ROAD SAFETY INSPECTION ……. …..STREET BETWEEN ……. AND …… DATE:				
Characteristics	No.	Question	Yes (√) No (x)	Comments
1. Function, operating elements, and surroundings	0	Have eventual final audit results from previous audit phases been taken into consideration?		
	1	Are there any issues from accident data if available?		
	2	Are there specific traffic composition characteristics to be taken into consideration?		
	3	Are special measures required for particular groups e.g. for young people, older people, sick people, physically handicapped, hearing-impaired or blind people?		
	4	Is the design of the road in accordance with its function and hierarchy in the network?		
	5	Is access to abutting properties appropriate for road safety?		
	6	Are there accumulations of events such as curves + intersections etc?		
	7	Are transitions installed between different functions and road characteristics?		
	8	Are there traffic islands and lane shifts at the entrance of the town and other traffic calming measures inside?		
	9	Can road maintenance service vehicles be parked safely?		
	10	Is stopping sight distance guaranteed along the entire section?		
	11	Are all fixed or planted obstacles that can be dangerous placed outside the safety zone?		
	12	Is the transition from a built-up to a rural road or from an illuminated to an unilluminated road appropriately designed (village/town outskirts)?		
	13	Does the road “communicate” well with the driver so that he realizes the situation without any surprises?		
2. Cross section	1	Is the cross section appropriate to the function?		
	2	Does the road surface provide the required grip over the long term where small radii occur (e.g. also on ramps)?		
	3	Are there any doubts regarding the surface grip because of excess bleeding or polished components?		
	4	Is the surface even and free from grooves?		

	5	Is the surface free from short or long waves?		
	6	Is there sufficient drainage for the road and its surroundings?		
	7	Is there sufficient cross / diagonal fall?		
	8	Is the cross fall in straight sections constant?		
	9	Is stopping sight obstructed, for example by safety barriers, plants?		
	10	Is narrowing of the carriageway required and, if so, designed in such a way to ensure traffic safety?		
	11	Have suitable measures been taken to ensure that speed limits are obeyed?		
	12	Have the needs of public transport and its users been taken into consideration?		
	13	Is slow and non-motorized traffic separated from fast and heavy traffic? Or have pedestrian and cyclist requirements been considered (e.g. separate cycle facilities)?		
	14	Is there a median? Does it have a safe design, e.g. safety barrier or sufficient width to prevent turn accidents?		
	15	Is a separating strip required between the cycle path and parking strip?		
	16	Are there any bottlenecks? If so, are they properly signed?		see 5.3 public transport
	17	Do curves with small radii have an enlarged width of the pavement?		see 6 needs of vulnerable road users
	18	Does the embankment require passive safety installations?		
	19	Do the elements of the cross section realize the situation for the road users?		
3. Alignment	1	Is sight obstructed, for example by safety barriers, fences, road equipment, parking areas, traffic signs, landscaping/greenery, bridge abutments, buildings?		
	2	Does the alignment guide the drivers well without any irritations about the main direction of the road course?		
4. Intersections	1	Are the intersections perpendicular?		
	2	Is the main direction clearly recognizable? and if so, is the right of way clearly recognizable?		

4.1 Geometry and Layout	3	Are the movements guided clearly and easy to understand? are traffic flows guided by markings?		
	4	Are the auxiliary lanes or tapers for turning movements large enough?		
	5	Is the intersection fully visible and recognizable in time from all approaches for different driver eye heights of: cars, trucks, motorcycles, bicycles, etc, and are the required sight triangles clear?		
	6	Does the ambient lighting present any special requirements?		
	7	Is sight obstructed, for example by safety barriers, fences, road equipment, parking areas, traffic signs, landscaping/greenery, bridge abutments, buildings?		
	8	Are the type and design of the intersections suitable for the function and traffic volume of the intersecting roads? (separate answers for each intersection!)		
	9	Is pedestrian/cyclist routing at intersections adapted to the actual conditions and clearly marked and signposted?		
	10	Are all approaches equipped with pedestrian and cycle crossings?		
	11	Has right of way been specified and clarified at cycle crossings, in particular for cycle paths that are set back?		
	12	Is the transition safely designed if footpaths and cycle paths end on an intersection or road or are directed across the road?		
	13	Are stop lines for motorists further back for the benefit of cyclists?		
	14	Have suitable measures been taken to ensure that speed limits are obeyed?		
	15	Are there “no-stopping” zones?		
	16	Is there random and unorganized parking within the intersections? Are the pedestrian crossings as narrow as possible?		
	17	Does the obligation to yield right of way need to be reinforced (e.g. using repetition)?		
	18	Are pedestrian crossings clearly marked? Is each section equipped with signals (including railway structures)?		
	19	Are the crossings for pedestrians and cyclists provided with low kerbs?		

	20	Should turns be prohibited (block diversion)?		
	21	Are the type and spacing of different crossing installations coordinated (e.g. railway crossings, traffic signals, zebra crossings)?		
	22	Is right of way clearly defined at points where cyclists come into contact with each other or with motorized traffic?		
	23	Are refuges large and wide enough for crossing pedestrians and cyclists to stand and wait?		
	24	Are the islands above the level of the carriageway?		
	25	Are the islands made only by markings?		
	26	Are the islands clearly visible and of a suitable design?		
	27	Is there a danger of underestimating speed and overestimating distance of crossing vehicles?		
4.2 Roundabouts	1	Are all approaches to roundabouts perpendicular and radial to the centre?		
	2	Is the central island of the roundabout shaped as a hill?		
	3	Is the through-visibility effectively stopped by the roundabout and the hill?		
	4	Is the central island of the roundabout free of fixed obstacles which could be reached by vehicles?		
4.3 Traffic Signals	1	Is the stopping line correlated with the traffic signal so that the signal can be seen?		
	2	Have any turning movements been excluded from signal control? If so, is traffic management safe?		
	3	Are traffic signals easily recognizable?		
	4	Have cyclists' requirements been considered (e.g. route through the intersection)?		
	5	Are stop lines for motorists further back for the benefit of cyclists?		
	6	Are all approaches equipped with pedestrian and cycle crossings?		see 6 needs of vulnerable road users
	7	Are pedestrian crossings clearly constructed? Is each section equipped with signals (including railway structures)?		
	8	Are exclusive green phases provided for pedestrians and cyclists where necessary?		
	9	Can pedestrians cross the road in one attempt? Is the green time sufficient?		

	10	If there is no exclusive pedestrian phase, is a leading pedestrian interval provided?		
	11	Are phase offsets required for pedestrians and cyclists within the cycle?		
	12	Are separate signals provided for cyclists? (are the signal aspects correctly located for the cyclists? estimate clearance times for cyclists? Avoid protected turn phases/ risk of cyclists crossing on red.)		
	13	Is the maximum delay reasonable for cyclists? are cyclists partially or totally removed from signal control?		
	14	Are the type and spacing of different crossing installations coordinated (e.g. railway crossings, traffic signals, zebra crossings)?		
	15	Are the signals are affected at dawn/dusk by direct sunlight?		
	16	Are advanced warnings provided for traffic signals that cannot be seen in time?		
	17	Have the locations for the signals been selected correctly, additional signals, overhead signals, etc		
	18	Are secondary signals provided as necessary?		
	19	Does the existing road lighting lead to conflicts in recognizing the yellow indication (sodium discharge lamps)?		
	20	Is access from abutting properties affected and, if necessary, included in signal control?		
	21	Are perspectives that appear to be continuous (passage effect) interrupted by highlighting the nearest signals?		
	23	Are the traffic signals properly situated so that they can be distinguished by each particular traffic flow?		
	24	Are there any additional signs correlated with the traffic signals to show the direction to which that traffic signal is referring?		
	25	Is the visibility of the traffic signal ensured on a sunny day?		
	26	Is the stopping line correlated with the traffic signal so that the signal can be seen?		
	27	Are signals covered/ obstructed (e.g. by traffic signs, lighting masts, plants, traffic jams)?		
4.4 Railway Crossings	1	Is the type of railway crossing in accordance with the traffic volume?		

	2	Are passive safety devices at the required locations?		
	3	If the railway crossing is situated in a curve, are the traffic signs doubled on the other side of the road?		
	4	Are traffic control devices required and optimally set up with regard to future traffic developments?		
	5	Are safeguards in place if required as a result of seasonal use of the railway crossing?		
	6	Is reconcilability guaranteed?		
	7	Is good visibility guaranteed?		
	8	Is lighting required and appropriately installed?		
	9	Does the ambient lighting present any special requirements?		
	10	Are prohibition of overtaking and speed limits in place as necessary?		
5. Public and private services, parking	1	Are there major traffic generators such as a city hall, religious sites and cemeteries, hospitals, housing or shopping centres, petrol stations and tourist attractions? if so, are they taken into account?		
	2	Are the accesses suitable for the amount of traffic?		
	3	Are the dimensions of the parking areas sufficient for parking for passenger vehicles, trucks, and buses?		
	4	Are parking areas easily accessible and do they provide sufficient manoeuvring space?		
	5	Are "*no-stopping" zones* provided as necessary?		
	6	Have measures been taken to ensure safe access for rescue vehicles at hospitals from all directions?		
	7	Is the arrangement of parking (parallel, diagonal or perpendicular) along the road sides safe?		
	8	Are loading areas provided next to the road at shops and restaurants?		
6. Public Transport (See also 7.1)	1	Are tram lines separated from the vehicle traffic?		
	2	If not, is the course of the tram lines clearly recognizable for the other road users?		
7. Needs of vulnerable road users	1	Are stops easily and safe accessible to pedestrians and are the pedestrian crossings located at the rear of the bus stop?		
	2	Are the bus stops signposted and detectable by the drivers? is reconcilability guaranteed?		

7.1 At public transport stops	3	Are the bus stops situated outside of the carriageway where appropriate?		
	4	Are areas for waiting pedestrians and large enough?		
	5	Are the queuing areas for waiting passengers sufficient?		
	6	Is sight obstructed, for example by safety barriers, fences, road equipment, parking areas, traffic signs, landscaping/greenery, bridge abutments, buildings?		
	7	Is cyclist routing safely designed in the area near public transport stops?		
	8	Is cyclist routing safely designed in the area near public transport stops?		
	9	Is lighting required? and if so, is it appropriately designed?		
7.2 Other needs of pedestrians and cyclists	1	Are the pedestrian crossings located where most required by pedestrian traffic?		
	2	Have pedestrian crossings been appointed in such a way that collective use is guaranteed and the road will not be crossed at other points?		
	3	Is there a risk of pedestrian underpasses and bridges being bypassed? are suitable measures in place?		
	4	Are further crossing aids required?		
	5	Are areas for waiting pedestrians and cyclists sufficient?		
	6	**A**re refuges large and wide enough for crossing pedestrians and cyclists to stand and wait?		
	7	**A**re crossings over special railway structures of a safe design?		
	8	**I**s two-way visual contact ensured between pedestrians and motorists?		
	9	Have cyclists' requirements been considered (e.g. route across central refuges, bottlenecks)?		
	10	Has priority been given to cyclists over other traffic where necessary?		
	11	**I**s the visibility for motorised traffic adequate to see cyclists along the road?		
	12	**A**re parked vehicles obstructing the visibility of the road users regarding cyclists?		
	13	**A**re points where cyclists cross intersecting roads provided with low curbstones?		
	14	**A**re the pedestrian ways physically separated by kerb stones, barriers, or greenery?		

	15	**Is** there a speed limit? and if so, is it respected by the drivers?		
	16	**A**re there traffic islands at the entrances of these areas?		
	17	**A**re the pedestrian crossings signposted and detectable by the drivers?		
	18	Have pedestrian crossings been emplaced in such a way that collective use is guaranteed and the road will not be crossed at other points?		
	19	**A**re the islands clearly visible and properly placed?		
	20	**I**s lighting provided where necessary?		
7.3 Motorcyclists' requirements	1	**A**re motorbikes a significant percentage of the traffic?		
	2	Have devices or objects that might destabilize a motorcycle been avoided on the road surface?		
	3	Have barrier kerbs been avoided in high speed areas?		
	4	**I**n areas more likely to have motorcyclists run off the road is the roadside forgiving or safety shielded?		
8.Traffic signing, marking and lighting	1	Have speed limits been signed appropriately (start, end, height, location)?		
	2	Are there speed limitations of 70/60 km/h ahead of intersections and build up areas?		
	3	**I**s the visibility of the road course assisted by edge delineation?		
	4	**I**s sight obstructed by the traffic or by the signs?		
	5	**I**s prohibition of overtaking for trucks, buses, etc. appropriately designed and located? are there warning signs ahead of the intersection prohibiting overtaking?		
	6	**C**an the signs be clearly recognized and read (size of signs)?		
	7	**A**re there more than 2 different traffic signs at one place and are all traffic signs necessary?		
	8	**I**s a reduction in speed when approaching the intersection assigned to the correct place and properly designed?		
	9	**I**s signing logical and consistent? Does it show the right of way clearly?		
	10	**I**s signing for service and rest areas clear?		
	11	Have variable direction signing or traffic control systems been installed and are they fully functional?		

	12	Is pedestrian/cyclist routing at intersections adapted to the actual conditions and clearly signposted?		
	13	**A**re the installations shared by pedestrians and cyclists, including underpasses and bridges, properly signposted?		
	14	**I**s right of way clearly defined at points where cyclists come into contact with each other or with motorized traffic?		
	15	**I**s it clear to the motorist whether he is crossing a one-way or two-way cycle path?		
	16	**A**re advanced warnings in place for features that cannot be seen in time?		
8.1 Signing	17	**C**ould greenery lead to safety problems if the vegetation grows (e.g. as a result of covered road signs)?		
	18	**A**re signs located in such a way as to avoid restricting visibility from approaches or intersecting roads?		
	19	**I**s the roundabout fully visible and recognizable from all approaches and are the markings and signs clear and unambiguous?		
	20	**A**re signs retro reflecting or are they illuminated at night? in daylight and darkness, are signs satisfactory regarding visibility?		
	21	**A**re the additional information panels uniform?		
	22	**A**re there misunderstanding or misguiding traffic signs or additional information panels?		
	23	**I**s readability ensured at the required distance? are there background problems?		
	24	**W**here needed, have signs been located above the carriageway?		
	25	Do the signs have a dimension according to the type of road?		
	26	**A**re the signs provided with protective edges?		
	27	**A**re the signs at a uniform position, compared to the pavement?		
	28	**A**re the sign masts and foundations sufficiently protected against collisions?		
	29	Do the traffic signs including their supports have sufficient passive safety by: low mass and/or break away structure and/or are they beyond the safety zone?		
8.2 Markings	1	Do all signs and markings correspond without any contradictions?		

	2	**A**re the road markings clear and recognizable?		
	3	Have old markings/signs been completely removed (phantom markings)?		
	4	Have any turning movements been excluded from signal control? If so, are markings clear for turning motorists?		
	5	**A**re the markings in a parallel line to the edge of the road surface?		
	6	**I**s right of way clearly defined at points where cyclists come into contact with each other or with motorized traffic?		
	7	**I**s it clear to the motorist whether he is crossing a one-way or two-way cycle path?		
	8	**A**re stop lines for motorists further back for the benefit of cyclists?		
	9	Is pedestrian/cyclist routing at intersections adapted to the actual conditions and clearly marked and signposted?		
	10	**A**re the markings appropriate for the function and category of the road?		
	11	**A**re the markings likely to be effective under all expected conditions (day, night, wet, dry, fog, rising and setting sun)?		
	12	Are the markings according to the pedestrian/cyclist traffic flow?		
	13	**I**s the obligation to yield right of way enforced by markings according to the one enforced by signing?		
8.3 Lighting	1	**I**s the road sufficiently illuminated?		
	2	**I**s the stationary lighting appropriate?		
	3	**I**s the lighting of special situations (transition zones, changes in cross section) suitably designed?		
	4	Do remaining unlit areas present potential problems?		
	7	Does the existing road lighting lead to conflicts in recognizing the yellow indication (sodium discharge lamps)?		
	8	Does lighting need to be changed so that crossing pedestrians are clearly visible?		
	9	**I**s contrast lighting required at the intersection?		
	10	Does the ambient lighting present any special requirements?		

	11	**C**an the stationary lighting cause problems in recognizing the traffic signs or the alignment of the road?		
	12	**A**re the lighting masts situated outside of the safety zone or properly protected?		
	13	Is stationary lighting at intersections/service and rest areas properly situated?		
	14	**I**n the areas where there is no stationary lighting, are there any potential dangers?		
9. Roadside features and passive safety installations Miscellaneous road equipment	1	**A**re road equipments such as signalization boxes, masts for overhead traffic signing and lighting etc placed without the safety zone?		
	2	**A**re they protected by passive safety installations?		
9.2 Plantings	1	**I**s there any vegetation along the road?		
	2	Does it obstruct the visibility on the traffic signs or the intersections and pedestrian crossings?		
	3	Does the greenery and type of planting preclude irritations to the road users (e.g. Alignment)?		
	4	Does the greenery or will the growth of greenery lead to future safety problems?		
	5	Is visual contact between motorist-pedestrian-cyclist restricted by greenery?		
	6	Is the vegetation along the road old and could it lead to safety problems?		
	7	Does road side vegetation guide the drivers in curves continuously?		
9.3 Civil engineering structures	1	Is reconcilability guaranteed?		
	2	Are passive safety installations set up at the required locations?		
	3	Are parapets and overpasses at a safe distance from the road?		
	4	Have masts, abutments, supporting walls, bridge railings etc. Been safeguarded?		
	5	Is lighting appropriately designed?		
	6	Have cyclists' requirements been considered (e.g. Separate cycle facilities)?		
9.4 Drainage	1	Is the drainage system a linear obstacle with deep ditches in the safety zone?		
	2	Are the constructions of culverts obstacle like?		

9.5 Other obstacles	1	What is the distance of the road directional signing to the pavement?		
	2	Are the light poles to be considered as an obstacle (steel, concrete construction)?		
	3	Are there unprotected supports for other cables than lighting in the obstacle-free zone?		
	4	Are traffic signs (other than road directional signs) to be considered as dangerous obstacles?		
	5	Are there unprotected advertisement boards or other fixed obstacles outside the safety zone are they avoidable, or safeguarded?		
9.6 Passive safety installations	1	Are fixed obstacles avoidable, set up at sufficient distances or safeguarded (masts, abutments, supporting walls, bridge railings, trees etc.)?		
	2	Have passive safety installations been set up at the required locations?		
	3	Are all road safety barriers in place and safely located so that they are not obstacles themselves?		
	4	Is the length of any guardrail adequate?		
	5	Is the guardrail correctly installed, regarding: End treatments: Anchorages, Post spacing, Post depth, Rail overlap?		
	6	Are dangerous windows of guardrails avoided?		
	7	Are all necessary medium barriers in place and properly signed or delineated?		
	8	Are barriers placed so that they don't restrict visibility?		