CIV5017Z: DISSERTATION FOR MASTERS PROJECT

THE IMPACT OF NMT INFRASTRUCTURE ON PEDESTRIAN MOVEMENT IN THE CITY: THE CASE OF POLOKWANE CITY, LIMPOPO PROVINCE, SOUTH AFRICA



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Dissertation submitted in fulfilment of the requirements for the degree of "Masters in Engineering"

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Abstract

As a developing economy, South Africa has challenges, such as poor economic infrastructure that hinders growth and development. The transport infrastructure is one of the driving forces for economic growth and social development. Like most metropolitan cities, the City of Polokwane, as the economic hub of the Limpopo Province, is also experiencing high traffic congestion during peak hours, which affects the movement of pedestrians and vehicles. The study aimed to assess the movement of pedestrians in the study corridor within the city centre of Polokwane and the availability of appropriate Non-Motorised Transport infrastructure. The study used the mixed method of combining qualitative and quantitative approaches to collect the required data for analysis. The primary data was collected from the field through the monkey survey instrument, while secondary data through the literature review approach. Main findings: The City of Polokwane as the transport authority, developed NMT policy frameworks. However, the researcher identified gaps within the policies, especially the NMT Master Plan, based on the research results. The gaps within the Master Plan are unavailability of plans for improvements and maintenance of existing NMT infrastructure within the city centre. The results also indicate that the existing NMT infrastructure along the study corridor does not meet minimum standard as per NMT infrastructure guidelines developed by South African National Department of Transport in 2014. Moreover, the study recommends that the city reviews their NMT Master Plan to consider maintenance and improvement plans on existing NMT infrastructure within the city centre to meet minimum standards required for NMT infrastructure. The study also recommends decreasing the number of vehicle traffic lanes to extend the footpath in order to allow universal NMT access and improve pedestrian level of service.

Acronyms and abbreviations

CITP	Comprehensive Integrated Transport Plan
CoP	City of Polokwane
DEA	Department of Environmental Affairs
NDoT	National Department of Transport
NMT	Non-motorised Transport
PLOS	Pedestrian Level of service
PTIS	Public Transport Infrastructure and System
RTSMS	Road Traffic Safety Management System
LOS	Level of Service

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1. Introduction

1.1 Background to Study

As a developing economy, South Africa faces challenges such as poor economic infrastructure which hinder growth and development. According to the National Planning Commission (2010), South Africa needs to invest in a strong network of economic infrastructure designed to support the country's medium- and long-term economic and social objectives. This economic infrastructure is a precondition for providing basic services, such as electricity, water, sanitation, telecommunications, and public transport, and it needs to be robust and extensive enough to meet industrial, commercial, and household needs.

Arguably, the transport infrastructure is recognised as one of the driving forces for economic growth and social development. It is essential to development since it provides accessibility and mobility within communities (National Department of Transport, 1997). South African cities are facing pressing economic, social, and environmental challenges where the public transport network is considered an integral feature of an efficient public transport system. The traffic congestion in cities and car ownership increases daily, while most of the people still depend on public transport to perform their daily trips (Pillay & Seedat, 2007). The South African National Household Survey (2013) reported that 76% of households use public transportation as a mode of transport. That being the case, most of the people walk (or cycle) from their homes to reach the nearest public transport stop for their daily trips. Moreover, in the city centres, the private vehicle owners park their cars at allocated parking areas and walk to their destinations.

As custodians of transport, the South African Department of Transport has developed different policies and strategies to support non-motorised transport (NMT). According to Luke and Heyns (2013), the National Transport Policy is one of the strategic documents that identifies NMT as the main component of the transport system in the country for both urban and rural settlements. At the same time the department is encouraging authorities at local government levels to develop their policies and strategies guiding the implementation and support of NMT. The purpose is to ensure a safe and reliable NMT system at the local level. However, there are still gaps in the implementation of NMT regardless of all the initiatives of framework policies developed. Moreover, the South African government has invested more in transport infrastructure, including NMT, towards the 2010 FIFA World Cup on the host cities, such as the City of Polokwane, that participated in the programme. Even though NMT infrastructure was developed only on the part of the stadia, the expectation that more attention should be given to the city centre, as there is more movement of pedestrians, especially during peak seasons.

NMT is a sustainable and reliable mode of transport with characteristics of safe, comfortable efficiency to economic and energy (Yazid et al., 2011). NMT is also known as a mode of transport that is not propelled by active motor. It is rather human-powered and

includes activities such as walking, cycling, animal-drawn, and wheelchair travel. It provides recreational and transportation and is essential to short trips (University of Mumbai, 2016). That being said, Litman (2003) thinks that some NMT activities, such as walking, are undervalued by transportation practitioners because they are difficult to measure than vehicle travel. This is happening despite Hook's (2003) argument that the transport authorities should promote NMT as it reduces air pollution, greenhouse gases, and noise pollution. Due to the lack of affordability for private vehicles, the majority of society in the country are walking, cycling, and using public transport as predominant transport modes. Given the benefits of the NMT, with regards to health and the environment, it is imperative for the cities to incorporate the issue of walkability into their planning. NMT is a transport mode connecting people with public transport through walking (Tiwari & Jain, 2013). Hence, there is a need for provision of the integrated transport to promote the use of NMT. Haning et al., (2011) indicate that walking is the most enjoyable mode of transport, that is healthy and convenient, which replaces the cars short trips in cities. However, it could be a challenge due to vehicle traffic conditions and the availability of infrastructure.

Forsyth (2015) defined walkability as the extent to which the built environment is designed to accommodate walking by providing comfort and safety of pedestrians. More importantly connecting people with a different destination within a reasonable time. Walkability is measured through the quality condition that includes safety, comfort, and convenience (Litman, 2007). However, Forsyth (2015) argue that there is much talk about creating a quality walkable environment and improving walkability especially in urban design. Walking as a mode of transport accounts for a large amount of travel time that covers considerable distances, and it accommodates everyone, including children and elderly members of poorest households (Behrens, 2005).

According to Litman (2003), walking provides different benefits to the society, such as accessibility, consumer cost savings, public cost savings, efficient land use, public health and improved fitness, economic development, and equity objectives support. Furthermore, Litman (2007) indicates that decision-makers tend to ignore walking and assume that it can take care of itself since there is a lack of pedestrian facilities such as sidewalks as they are given low priorities. On the other hand, Sinnett et al. (2011) argue that walkability helps reduce the amount of land needed for developing transport facilities and further encourages more accessibility.

The City of Polokwane is the economic hub and growth point of Limpopo province. Policy frameworks concerning support and consideration of NMT have been developed though there is still a challenge of traffic congestion during peak hours that affects the movement of the pedestrians within the city centre. The city is situated in a strategic position and serves a high number of communities from surrounding villages/townships and towns. The City of Polokwane's mode of travel, presented in Figure 1-1, indicates that the many people walk to work places or schools, followed by public transport.

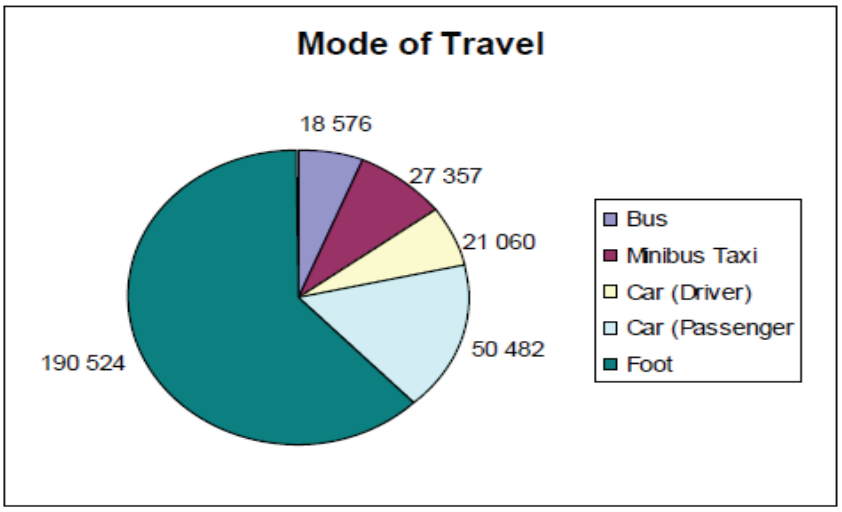


Figure 1-1: City of Polokwane Mode of Travel, (City of Polokwane, 2009)

Walking is one of the transport modes affordable and is promoted as healthy cost-effective even though there are barriers associated with it that relate to safety and provision of adequate infrastructure (Republic of South Africa Department of Environmental Affairs, 2012). The South African Department of Environmental Affairs (DEA) initiated implementation of NMT programmes to promote social, economic, and environmental development. The South African DEA, in partnership with KFW Development Bank and the DoT, initiated the Green Cities Program, that was promoted in the conference that was held in August 2012 to promote National Greening Programme. The strategic element of the programme was to encourage the implementation of NMT investing in walking and cycling.

The City of Polokwane was one of the cities identified for piloting the programme of expanding the infrastructure for NMT and making the city liveable for the communities. Furthermore, the city declared cycling and walking a priority in 2014, focussing on NMT as the vital mode of transport due to its flexibility and reliability (Review, 2014.). The city's smart mobility projects were launched as part of the integrated urban realm and movement plan as a way of future, where non-motorised lanes opened to support the initiatives and ensure that pedestrians are safe. Due to the high number of communities served by the city, this research will investigate the impact of NMT infrastructure on the movement of pedestrians within the case study area.

1.2 Social Problem

Private vehicle ownership is growing in South Africa. According to StatsSA (2018), households in metropolitan areas such as the City of Polokwane have a considerable number of vehicle ownership compared to the rural areas. Furthermore, several communities rely on walking, cycling and public transport as predominant transport modes. The transport authorities are faced with challenges of space to expand the road infrastructure to resolve the vehicle traffic congestion, especially in the city centres of most the South African cities. As

the economic hub of Limpopo province, the City of Polokwane is also experiencing high traffic congestion during peak hours, which affects the movement of pedestrians and vehicles (Department of Transport, 2020). Despite all these challenges faced by the city of Polokwane, merging a public mode of transport and NMT infrastructure is supposed to improve the mobility and accessibility of society. In addition, NMT is considered a sustainable and cheap mode with environmental benefits, such as reduced traffic congestion, noise, and air pollution.

1.3 Research Problem

Traffic congestion is a challenge within South African cities, and the irony is that NMT, which is a way of alleviating such problems by other major cities in other countries, is still not recognised during the planning and designing of transport infrastructure. Traffic congestion happens even though the South African National Department of Transport has developed policies and strategies to improve and promote NMT, especially in city centres. However, there are difficulties with implementing the developed strategies by the transport authorities.

Transport is essential to development as it provides accessibility and mobility. Therefore, without an effective transport system, poverty seem to prolong, and quality of life does not improve. The South African National Household Survey (2013) accounts for 76% of households that use Public Transportation as a mode of transport. The South African Department of Transport, as custodians of transportation in the country has developed different strategies and policy frameworks on NMT for the promoting of walking and cycling as a reliable modes of transport. Most cities in South Africa have developed strategies for the provision and promotion of NMT, which integrate into the transit within their area of jurisdiction.

NMT is a mode of transport not propelled by an active motor and human-powered. It includes walking, cycling, animal-drawn, and wheelchair travel. It further reduces vehicle traffic congestion; however, the transport planners and designers overlook walking while it is inexpensive and saves costs for consumers (Litman, 2007). It appears that the City of Polokwane is one of the transport authorities overlooking the improvement of NMT infrastructure in the city centre even though there is evidence of high traffic congestion during peak hours in the city centre that moves pedestrians with difficulty due to the unavailability of proper infrastructure. This research will only focus on walkability, which refers to the movement of pedestrians and how passengers connect with public or private transport.

1.4 The aim of the research

The study aims to assess the movement of pedestrians in the study corridor within the city centre of Polokwane and the availability of proper NMT infrastructure.

1.5 Objectives and research questions

a) To determine the existence and relevancy of NMT policy frameworks for the promotion of pedestrian movement in the city;
   - Are the NMT policy frameworks available in the City of Polokwane and their relevance to national policy and legislative framework requirements for NMT?

b) To evaluate the impact of existing NMT infrastructure on the movement of a pedestrian in case study corridors within the city centre of Polokwane;
   - Does the existing NMT infrastructure meet the South African minimum standard requirement of NMT infrastructure?
   - Are there any plans for the improvement of NMT infrastructure within the city centre?
   - How can the pedestrian level of service in case study corridors within the city centre of Polokwane be improved?

1.6 Concepts and output of the research

The study will be assessing the movement of the pedestrians in the corridors within the case study area and therefore the concepts listed below will carefully be considered. It is further expected that the conclusion of the study should reach the outputs as listed in this section.

Concepts:

a) Policy framework,
b) Definition of walkability,
c) Adequate NMT infrastructure,
d) Pedestrian environment qualities,
e) built environment and walking,
f) Safety and personal security, and
g) Pedestrian level of service.

Outputs:

a) Policy recommendation for effective implementation of NMT to improve the movement and safety of pedestrians within the city centre,
b) Perception of walkability in a corridor,
c) Assessment and comparison of the existing NMT infrastructure within the city centre,
d) Benefits of adequate NMT infrastructure within the city, and
e) Benchmarking the existing city NMT policy framework with South African minimum standard requirement of NMT.

1.7 Research and concept framework

The major concepts of the study as presented in Section 1.6 were used to form the following conceptual framework as per Figure 1-2. The frameworks present the key components and process the study to conclude. It shows how the concept of the research are linked and how it influences one another.

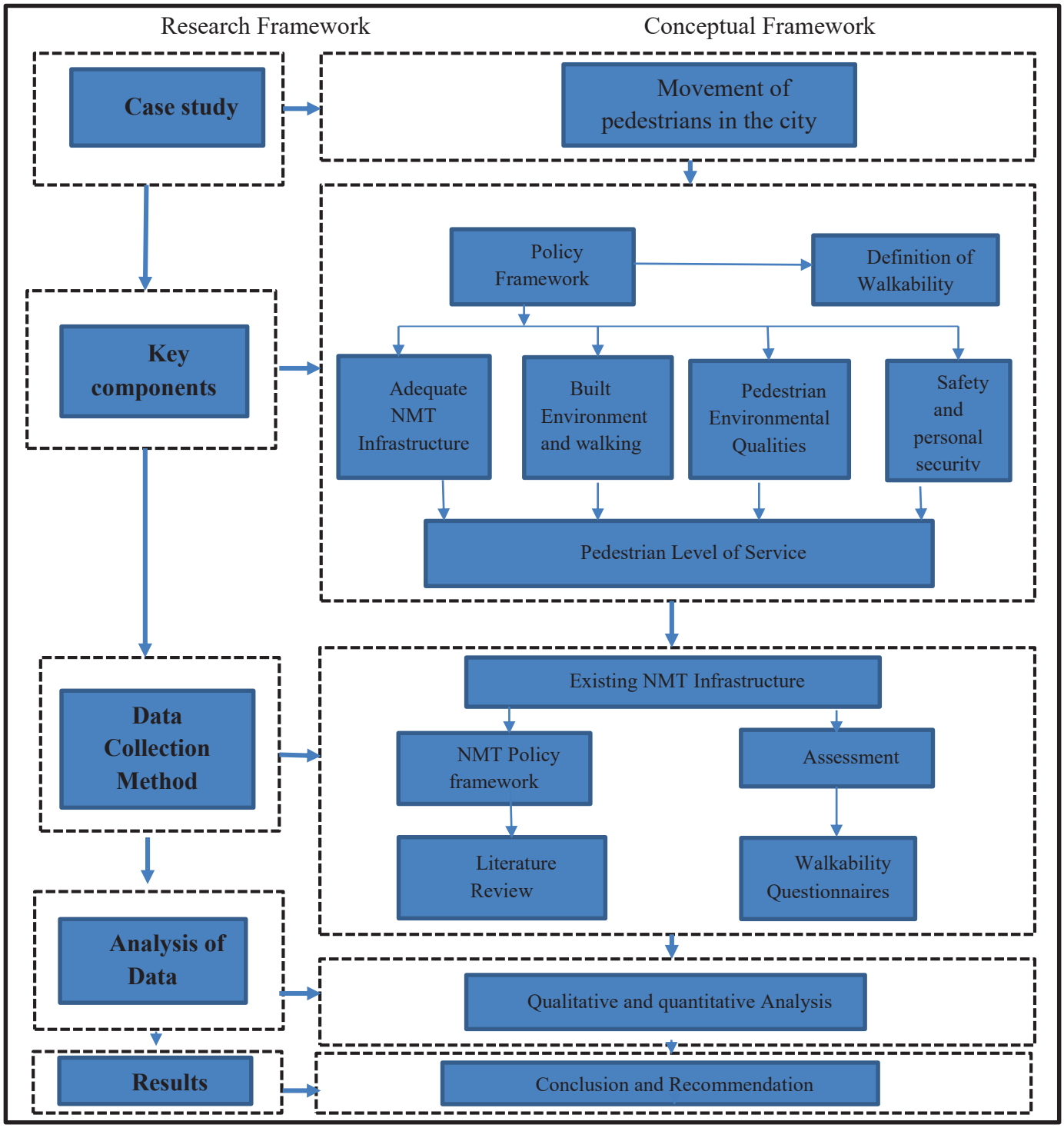


Figure 1-2: Research and conceptual framework

1.8 Scope and limitation

The current study is a case study based in the City of Polokwane, Limpopo Province, South Africa, focusing on the Landdros Mare corridor, which has a high volume of pedestrian movement. Polokwane is one of the South African cities that hosted the 2010 FIFA world cup. Therefore, this research is limited to a city in a developing country where vehicle traffic congestion is still a challenge affecting the movement of pedestrians.

Polokwane's central business district is the economic core of the city. It represents the large volume of economic activities of the Limpopo province (City of Polokwane, 2016). Therefore, it influences daily trips of the communities in Limpopo Province due to land use management and serves a higher population of the province. The majority of the people in Polokwane use public transport for daily activities. The selected corridor is in proximity with the main public transport facility and core retail area, and therefore there is high pedestrian movement. It is worth noting that there are other corridors within the city with a high-volume movement of pedestrians, but due to time and unavailability of funding, only one was chosen.

1.9 Definition of Concepts

Pedestrian: Pedestrian is defined as any person travelling with foot, whether running or walking from point of departure to destination in other to access amenities or public transport.

Pedestrian Movement: Flow of pedestrian traffic in a public area using the available NMT infrastructure.

Walking: Walking is found to be one of the fundamental transport modes inaccessible and sustainable cities both developed and developing (Lindelöw et al., 2014 and Feuillet et al., 2016). Itis one of the active transports responding to environmental pollution supported by the transport sector (Zannat et al., 2019)

Walkability: Forsyth (2015) defines walkability as building environment quality designed to attract people to move around on foot. Pedestrian safely walk to amenities within a reasonably distance. Walkability is known as the movement of pedestrians using the provided infrastructure.

Assessment of Movement: Evaluating the flow of pedestrians on provided infrastructure within the study corridor.

1.10 Contents of the report

Chapter 1, presented the introduction and background of the study, the problem statement, objectives, and research questions. It will also contain the problem statement,

research aim, and objectives, conceptual framework, ethical considerations, and significance of the study.

Chapter 2, the literature review explores research documents that link to the objectives of the study. It comprises what other researchers are saying concerning the topic of the study.

Chapter 3, the ‘Research Methodology’ provides a discussion that explores the research methodology which includes the details of research design, data selection, and analysis methods.

Chapter 4, the ‘Data Analysis and Interpretation’ presents the data analysis, findings and discussion of findings in order to reach the conclusion of the study.

Chapter 5, presents conclusion and recommendation of the study for his chapter includes the conclusion and recommendations for further study.

2. Literature Review

2.1 Introduction

The literature review chapter mainly focuses on walkability as the movement of pedestrians and the requirement of infrastructure for an appropriate walking environment. It also focuses on the attitude of a pedestrian using the provided infrastructure for walking. The section also focuses on the literature on the provision of better NMT infrastructure to improve the movement of pedestrians within the city centre.

2.2 Policy framework

The core mandate of the South African Department of Transport is to develop a policy framework to guide and support the authorities on the implementation of NMT as a mode of transport. The expectation is that transport authorities should develop their policy framework at the local level for the promotion of NMT. Despite initiative by the National Department of Transport, transport planners and engineers still ignore NMT in the planning and implementation of the transportation network (Litman, 2003). Due to this problem, the department National Land Transport Act has developed the Comprehensive Integrated Transport Plan (CITPs) to ensure that the planners consider the NMT during the planning and further integrate it with the public transport system (National Department of Transport, 2008). The guideline outlines the design principles for the integrated public transport network to ensure that it provides a direct, accessible, and safe pedestrian connections to facilities without barriers.

As a transport authority, the City of Polokwane has developed the Integrated Urban Realm and Movement Plan in 2009 through the Public Transport Infrastructure and System (PTIS) Grant established by the South African National Department of Transport. The plan was to assess the existing situation, develop a short, medium, and long-term implementation plan for the upgrading of the city, and further provide a balance between all modes of transport. Based on Integrated Urban Realm and Movement plan 67% of people walk to work or school and, therefore, the movement, of people in the city is the priority as the main mode of transport (City of Polokwane, 2009). The focus was on the corridors where there are desired lines for pedestrians and the proposals for the improvement of walkability environment proposed, which are based on international best practices. The recommendation of the plan is project-based initiatives aiming to develop an attractive, equitable, and sustainable city.

The city developed a CDB plan and urban strategy to upgrade the living condition of communities residing within Polokwane and further create an integrated urban environment (City of Polokwane, 2016). The plan has considered the promotion of NMT as a need to integrate non-vehicular movements with the transport network. It further indicates that the majority of the population in Polokwane depends on public transport, cycling and walking,

while the available road infrastructure does not accommodate the NMT. Therefore, various level of NMT infrastructure needed within the city was recommended as per the NMT facility guidelines for South Africa (South African National Department of Transport, 2014).

Furthermore, the city developed the NMT By-law in 2014 as mandated by the South African Constitution impacting NMT and NMT users. The By-law intended to regulate accessibility to transport and NMT and further forces the safety of pedestrians, joggers, and cyclists. The process took into account the national and provincial policies on NMT. The By-laws specify the rules by which the road users including pedestrians, should protect one another on the road (City of Polokwane, 2014b). It further states that the movement of pedestrians, or wheelchairs on walkways should not be obstructed unless it is essential to do so for safety or security reasons, and the request should be done and approved by the authority. The By-law was developed in relation to National and Provincial NMT standard requirements to make walkways usable by all categories of persons and pedestrians with disabilities.

Moreover, the city developed a NMT Master plan as plan to promote the accessibility of the city, determine the household's transport demand and focus on designing routes used by most pedestrians and the availability of infrastructure facilities (City of Polokwane, 2014a). The Master plan further recommends the interventions, infrastructure strategies, and proposed implementation. It encourages the integration of NMT into a transport system. This plan was developed in conjunction with the city NMT policy that serves as a strategy to regulate and influence the transport planning and implementation of NMT (City of Polokwane, 2014b). The policy assists the city to establish the NMT needs and prioritising projects to meet the minimum standards required.

The city was declared a city of cycling and walking in 2014, prioritising NMT as the vital mode of transport due to its flexibility and reliability (Review, 2014). To implement this initiative, the city has developed a NMT plan in 2014 to ensure that NMT becomes the mode of choice for people who are commonly using it, such as commuters, learners and recreational users (City of Polokwane, 2014a). The Master Plan considers the need of users and strives to improve universal access to promote mobility and accessibility within the city centre. All the city policy frameworks strive to advocate the NMT as the mode of transport by ensuring the provision of safe infrastructures such as pedestrian walkways within the city centre that improves accessibility and mobility.

2.3 Definition of walkability

The developing cities still have a high number of walking than in developed cities (Mateo-Babiano, 2016). Walking is an enjoyable and healthy mode of transport and the most common way for short trips (Haning et al., 2011). Different environmental attributes encourage pedestrians to walk. Walking behaviour is influenced by the connectivity of the street and the proximity of the destination (Owen et al., 2007). Walking is one of the active transports responding to environmental pollution supported by the transport sector (Zannat

et al., 2019). Forsyth (2015) defines walkability as building environment quality designed to attract people to move around on foot. The researcher indicates that a walking environment should have physical infrastructure that will invite people to walk and encourage people to use walking as a mode of transport that is faster and more convenient. Walkability depends on the extent to which the characteristics of both the built environment and land use may/may not encourage residents within the area to walk (Hung et al., 2010). Generally, walkability is when the pedestrian is recognised by providing adequate infrastructure and safety within the environment. The term is also used in professional and research as the means of making the area walkable environment by ensuring that is traversable, compact and safe (Forsyth, 2015).

Walkability measures how the area is friendly for a person to walk considering the factors, such as quality of infrastructure of the footpath, sidewalks, pedestrian rights-of-way, and more importantly both safety and personal security. The environment is walkable if it has less vehicle traffic volume and or protection for pedestrians such as signalized crosswalks, and traffic calming measures with no obstacles along the footpath. More importantly, walking as other modes of transport reduces vehicle traffic and air pollution. Due to its benefits associated with public health, sustainability, economy, and social life is receiving more attention to planning and design of transport infrastructure (Choi, 2012). Walking is a physical activity and it is known that is influenced by the built environment and urban planning (Weiss et al., 2010). Most of the people are walking for transport and walking for recreational or exercise which has been found that it contributes significantly to physical activity of adults or elderly people (Owen et al., 2007).

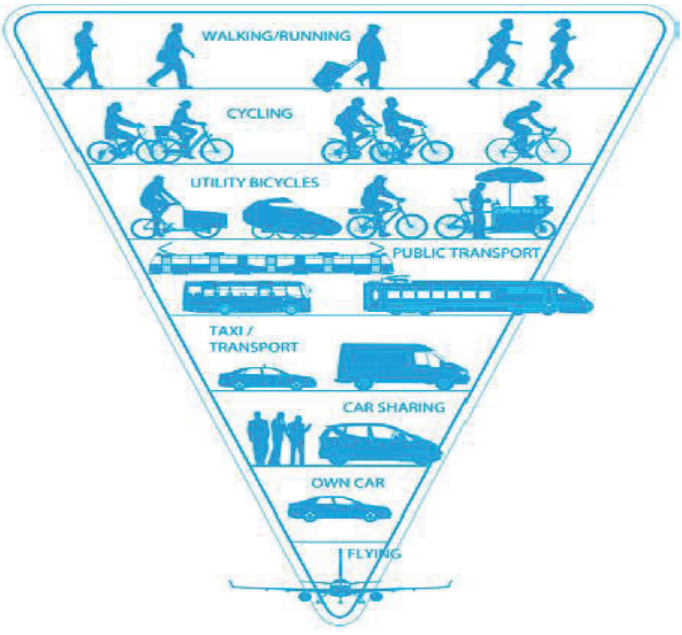


Figure 2-1: The Reverse Traffic Pyramid, (Gil, 2019)

As illustrated in Figure 2-1, walking is the priority as a mode of transport is affordable, quick, convenient and everyday physical activity. Therefore, walking is considered as a need

for all society to initiate all the trips. However, Vanderschuren, (2015) indicates that there is a need to introduce appropriate traffic calming on an intersection to ensure the safety of NMT modes, especially pedestrians.

2.4 Adequate NMT infrastructure

The Department of Transport has recently developed facility guidelines guiding the design of cities and towns for the NMT users to benefit (South African National Department of Transport, 2014b). The guidelines define a way of designing streets and roads addressing the issues of safety and sustainability of NMT users. The guidelines were developed in 2014 whereby South Africa was the second-highest in terms of road traffic fatalities, due to high level of motorists, high speed, drivers' behaviour together with lack of NMT infrastructure (National Department of Transport, 2014). The purpose of these guidelines is to direct the planning and designing of streets and roads to ensure safe NMT, such as pedestrian, bicycle and other low carbon modes of transport. It further strengthens well-designed NMT infrastructure for the improvement of the physical environment and safety of NMT.

Goyal and Advisor (2014) developed integrated planning for NMT in urban areas for Asian cities where the majority of trips are done on foot, however, there is still a challenge of poor infrastructure. The plan identifies the five key requirements for NMT planning, which are captured by the acronym SPACE and each letter is described as follows:

Safety: The speed of the vehicle to be reduced and they should be separated. The infrastructure provided should guarantee the safety of pedestrians with lighting and adequate crossing access.

Priority/Direct route: The implementation of the pedestrian route should be constructed at desired lines and be direct to avoid possibilities of shortcuts.

Accessible/Coherent: The NMT infrastructure should be linked to the origin and destination of the pedestrian with adequate signs.

Comfort: The width of the route should be enough to accommodate different types of pedestrians as per NMT facility guidelines and barrier-free within the NMT facilities. Furthermore, where there is mixed traffic. Priority should be given to the pedestrians and at an intersection; they should feel safe to cross the road.

Enjoyable/Attractive: The walking route should be designed in a way that it will attract the users to choose the best option and further enjoys the walking environment.

It is required that the designers understand the importance of providing enough walking space when designing the facilities to accommodate the streets, other streets activities and enable free movement of pedestrians. There should be a provision of adequate NMT infrastructure that will provide equal access to all types of pedestrians within the city (Tiwari & Jain, 2013). Therefore, there is a need for the provision of safe and comfortable facilities. This can be done by ensuring that the NMT infrastructure is integrated with the public transport system, and it should be able to connect the pedestrians from their point of

departure to destinations. The transport planners and designers have developed the standard guidelines for the provision of NMT infrastructure to assist the authorities to implement the facilities that meet the minimum standard. Given the number of people the City of Polokwane serves, DEA identified the city to benefit from the green cities programme and provide support on the provision and implementation of the NMT system.

The city has evaluated the NMT infrastructure within their area of jurisdiction and it was found that the CBD has significant NMT infrastructure than in Villages (City of Polokwane, 2014a). However, the condition of the existing NMT infrastructure is in good to poor condition. The plan indicates that the challenge with the infrastructure is an interaction between NMT facilities and street furniture, which led to capacity reduction of facilities resulting in unsafe conditions for pedestrians. Therefore, the NMT infrastructure within the CBD is, generally, not adequate while it has most of the pedestrian attractors.

2.5 Pedestrian environmental qualities

The pedestrian environment qualities in the urban world are becoming more important where walking is promoted and encouraged (Raad & Burke, 2018). The quality of walking conditions, safety, comfort, and convenience are some of the quality measures for walking environment (Litman, 2003). The NMT facility guidelines developed by the Department of Transport define a way of designing the streets and roads addressing the issues of safety and sustainability of NMT users. The guidelines were developed in 2014, when South Africa scored the second-highest in terms of road traffic fatalities, due to high number of motorists, high speed, drivers' behaviour together with lack of NMT infrastructure (National Department of Transport, 2014). The purpose of the guidelines is to guide the planning and designing of streets and roads to ensure safe NMT such as pedestrian, bicycle and other low carbon modes of transport. It further strengthens well-designed NMT infrastructure for the improvement of the physical environment and safety of NMT. Moreover, Forsyth (2015) indicates that a walkable environment in terms of traffic should have low traffic volume and the pedestrians should be protected using traffic calming measures, signalised crosswalks or intersections, footpaths, and pedestrian walking. Though this can be provided, the challenge will be the behaviour of both pedestrians and motorists.

Haning et al. (2011) developed a walking strategy for Western Australia and define four aspects that help to create a quality-walking environment. The aspects are described as follows:

- Access: accessibility of facilities by all categories of people by ensuring that the footpaths are continuous
- Aesthetics: the footpaths to be creative and attractive to encourage to use it
- Safety and Security: walkers to feel free and safe when walking without any fear with personal security prioritised
- Comfort: footpaths to be wide enough without any obstacles and well maintained.

Moreover, Western Australia's walking strategy identified 5Cs (connected, comfortable, convenient, convivial, and conspicuous) as a key aspect of the walking environment, which is required on footpath infrastructure to encourage walking. Mateo-Babiano (2016) confirms that there is high more walking in developing countries than in developed countries and there are different challenges and opportunities in the pedestrian environment. The researcher further indicates the environmental attributes encouraging pedestrians to participate in walking and walking-related activities. To satisfy the needs of pedestrians, the designers need to consider the environmental attributes which will help pedestrians to make choices of walking or not walking within the environment. It is known that when an individual move from point of origin to the destination would have a certain expectation of the walking environment. The research conducted by Mateo-Babiano (2016) on pedestrian's needs matters, considers the pedestrian needs for the walking environment as presented in Table 2-1.

Table 2-1: Pedestrian needs on walkways, (Mateo-Babiano, 2016)

Pedestrian needs	Description
Mobility	Barrier-free walkways with enough space as described in NMT guidelines
Protection	Personal safety and securing within the walking environment
Ease	The connected, comfortable, convenient, convivial and conspicuous walking route
Equitable access	Equal access to everyone by allowing various activities to take place within the walking environment
Identity	Sense of belonging place

2.6 Pedestrian safety and security

Safety and security are some of the strategies supporting the walking environment and further assist in contributing to the achievement of the walking target (Haning et al., 2011). Walkers should feel safe during their trips and also feel that their belongings are secure. It is known that urban areas are more exposed to criminal activities than rural areas. Safety and personal security for pedestrians is an important aspect that needs to be considered when designing and implementing roadways. The higher the number of pedestrians on the roadway, the more it becomes safer as it will make the drivers travel at a lower speed (Rafiemanzelat et al., 2017). The safety of pedestrians, especially at mixed traffic roadways can be increased by providing traffic calming measures to control the speed of vehicles.

Walking is the most important natural mobility, however, some factors are taken into consideration when choosing walking as the mode of transport (Zegeer et al., 2006). Pedestrian safety and security are the most common factors influencing walking as the mode of transport. The report indicates that climate change, pollution and health can significantly

contribute by improving the walking environment. Zegeer et al. (2006) developed a report on how to develop a pedestrian safety action plan. The purpose of the report is to develop a guideline and framework of pedestrian safety to resolve the specific problem of walking. Its objective is to guide the state and local authorities in enhancing pedestrian safety programmes and activities. Globally pedestrian crashes resulting in death and injuries are a serious problem that makes walking difficult.

In South Africa, safety is one of the barriers to NMT use and there is a need for traffic law enforcement. Pedestrian crash risks are very high on wide roads without the provision of pedestrian crossing which is one of the factors influencing crashes (Zegeer et al., 2006). The report further indicates that most of the crashes especially in urban areas are due to pedestrian behaviour and unsafe motor vehicle drivers. Moreover, the factors that impact pedestrian safety is identified such as street design, street connectivity, site design, land use, and access management. Figure 2-2, illustrates pedestrians crossing wide streets without signals. Arterial streets are designed to smoothen the flow of motor vehicle traffic while they make it difficult and uncomfortable for a pedestrian to cross. Furthermore, the other factor which influences walking is safety from crime such as street lights, other people, and cleanliness (Ferrer & Ruiz, 2018).



Figure 2-2: Pedestrians crossing along the wide streets, (Zegeer et al., 2006)

2.7 Built environment and walking

Most of the literature covers the relationship between the built environment and walking in the developed world (Wasswa, 2017). The link between urban street design and the built environment has increased interest in the field of urban studies during the past decades, which is motivated by the possibilities of design principles associated with the built environment (Wey & Wei, 2016). The built environment is one of the factors influencing the decision to walk for short distances (Ferrer & Ruiz, 2018; Rafiemanzelat et al., 2017). Urban designers need to consider walkability when designing the cities as it has an impact

on the sustainable city. The various field of science such as urban planning, psychology, geography and public considered built environment as the appropriateness and attractiveness of walking within the urban areas (Rafiemanzelat et al., 2017). The researchers' states walkability as an extent to which the built environment allows people to walk and spend time in an area. Furthermore, five (5Ds) dimensions of the built environment known as density, diversity, design, distance, and destination have been identified as the ones determining walking and walkability. Rafiemanzelat et al., (2017) revealed that walking and built environment directly correlate and have a high impact on one another as illustrated in Figure 2-1.

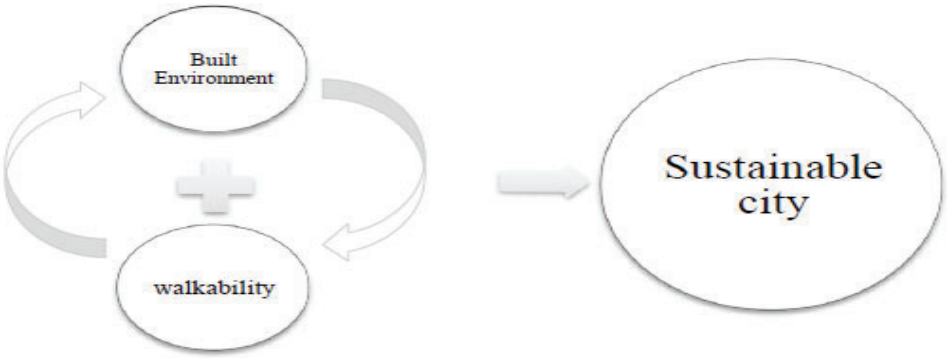


Figure 2-3 : Relationship between the built environment and walkability, (Rafiemanzelat et al., 2017)

Wasswa (2017) indicates walking can be achieved through the support of the built environment by improving its operationalisation. Furthermore, Sallis and Glanz (2006) found many links between the built environment , physical activities and the development patterns such as lack of sidewalks, walking long distances and crossing of busy streets are also found to be factors discouraging walking. If the authorities can improve such barriers, the rate of walking can be increased. Walking allows time-efficient and low accumulation physical activity and built environments are constructed to accommodate and support walking (Wasfi, Dasgupta, Eluru, & Ross, 2016). Mostly when the urban planners are planning to town development, they make provision for the pedestrian to walk in front of the building. The developed of physical built environment plays an important role in walking and cycling activities (Wang et al., 2016). The researchers show how the built environment encourages people from walking and cycling. The Wang et al., (2016) study was achieved by identifying the barriers of walking activities and specific characteristics of the physical built environment attributes within the neighbourhood. Therefore, designers and planners should be able to create a supportive environment within the residential neighbourhood.

Walking is found to be one of the fundamental transport modes inaccessible and sustainable cities both developed and developing (Lindelöw et al., 2014 and Feuillet et al., 2016). The researchers conducted the study on the perspective of walking as a feature in the built environment. Walking is the mode of transport to reach a destination performing day-to-day activities. Lindelöw et al., (2014) conducted a study on "exploring perceptions of

walking in the built environment and the context of everyday life" in the City of Malmö, Sweden. The objective of the study was achieved by examining the components' relationship with the walking frequency reported which were examined with binary logistic regression and the study reveals that the built environment can limit pedestrians.

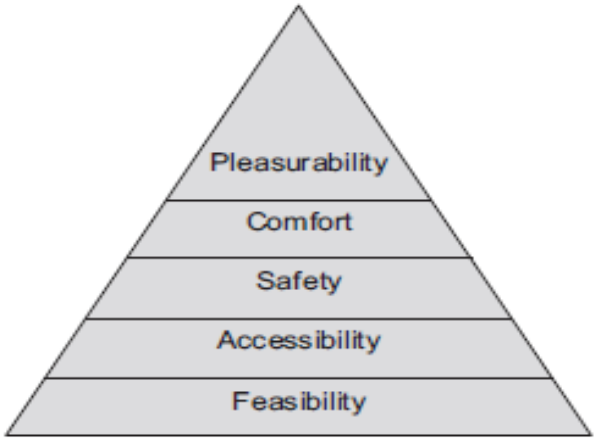


Figure 2-4 Hierarchy of walking needs, (Lindelöw et al., 2014)

Figure 2-2 shows the model of walking needs in a hierarchy linked directly to the decision to walk meaning that persons may have different thresholds where demands are sufficiently met (Lindelöw et al., 2014). This hierarchy indicates the level of pedestrian walking needs which ranges from feasibility to pleasurability. It further links limits of day-to-day activities and responsibilities. However, it is clear from the hierarchy that feasibility is more important than pleasurability when deciding to walk to reach the destination. A study by Ferrer et al., (2015) identify built environment factors that influence walking distances of adults (18-65 years) for transportation with special attention to micro-scale attributes. The objectives of the study were achieved by collecting data from short non-shopping trips and thematic analysis performed and factors related to the built environment have emerged. The results of the study show personal safety such as crime is the most important to walking, availability of parking at the destination and the size of sidewalks, presence of trees low traffic volume is identified as a secondary factor.

Walking deserves further attention in health-related transportation studies as is the most common and everyday physical activity (Feuillet et al., 2016). The researchers focus their study on the correlation between walking and built environment in Paris, France were collected for shopping and non-shopping. The results show that there is a relationship between the built environment and walking across the entire studied area. Most of the researchers have proven that there is a relationship between the built environment and there is a need for urban designers and planners to accommodate walking when planning within the neighbourhood.

2.8 Pedestrian Level of Service

In most urban intersections the mixed traffic of both pedestrians and motor vehicles are common, which affect the performance of the intersection and the development of the pedestrian level of service (PLOS) at the intersection is intended to indicate the difficulties in crossing the intersection (Muraleetharan et al., 2005; Kadali & Vedagiri, 2016). PLOS is an overall measurement of pedestrian movement on the route, path or facility which is liked factors affecting mobility, comfort and safety (Gallin, 2001). PLOS is the measuring tool to evaluate the extent to which the roadway/footpath can accommodate the pedestrians within the acceptable level of comfort and safe walking environment (Zannat et al., 2019). The researchers developed a model for a case study of the Chittagong Metropolitan Area in Bangladesh where a comprehensive framework was presented to measure how the pedestrian facilities influence the PLOS. The finding of the study shows that the condition of the facilities influences the PLOS where accessibility and attractiveness are the factors. Therefore, the PLOS depend highly on the availability, maintenance and planning of the facilities.

The PLOS can also be taken into consideration during the design of the new sidewalks by estimating the number of people who will be using the infrastructure. Marisamynathan and Lakshmi (2018) proposed the method for the evaluation of sidewalks PLOS in India. The questionnaire survey of 09 sidewalks was conducted to determine the PLOS model using the regression analysis method. The results indicate that the model can be used by the designers during the design of sidewalks to accommodate the pedestrian travel mode. The road designers have to investigate the mechanism which is necessary to promote walking (Muraleetharan et al., 2005; Marisamynathan & Lakshmi, 2018). Therefore, the designers need to consider PLOS during the designing of infrastructure to determine whether there is enough space to accommodate the movement of pedestrians when crossing the intersection. The design practitioners should design pedestrian facilities that are safe, efficient, and comfortable (Russo et al., 2018).

The same process used for designing road infrastructure to determine the capacity of the available space to carry the vehicle traffic is used in determining of capacity for walkways to accommodate the number or volume of pedestrians comfortably (South African National Department of Transport, 2014b). Most of the intersections in developing countries are unsignaled as they do not warrant signal installation due to their positions and volume of traffic (EBSCO Information Service, 2019). The purpose of the study (EBSCO Information Service, 2019) was to explore various parameters which affects the perceived satisfaction level of a pedestrian crossing at an unsignaled intersection. The study was done in India where pedestrians and drivers do not follow traffic rules due to its population. The results show that the PLOS depend on the volume of motorised and non-motorised traffic, pedestrians and crossing delays at the intersection. Moreover, Zhao et al., (2014) developed the PLOS model for the overall unsignaled midblock crossing of the road in China where the data was collected at 30 different locations with 948 participants. The results show that

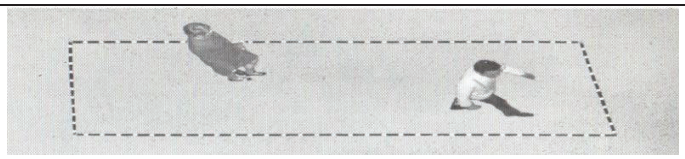
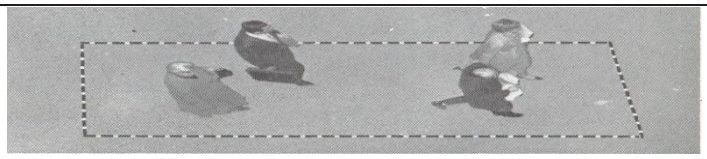
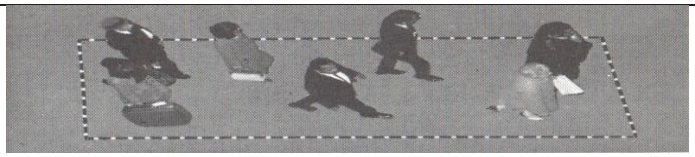
the PLOS of the overall unsignaled midblock crossing depends on the volume of the two-way motor vehicle with the distance between marked and unmarked crosswalks. This indicates that the PLOS at the unsignaled crosswalks depends more on the size of the crossing.

Furthermore, Muraleetharan et al., (2005) conducted the study to identify the factors affecting PLOS at intersections and develop the model. This study proposed the method for the estimation of PLOS at an intersection. The data was collected by requesting pedestrians to rate each intersection based on their experience in Sapporo, Japan to perform the stepwise multivariable regression analysis. The primary factors such as space at the corner, crossing facilities, turning vehicles, delay at signals and pedestrian-bicycles identified which affects the PLOS (Raad & Burke, 2018). These factors were performed by derived stepwise regression modelling to develop a function of identified factors. Therefore, the demand for improving the pedestrian facilities is based on the difficulties of pedestrians to cross the intersections with high volume traffic (Muraleetharan et al., 2005 and Kadali & Vedagiri, 2016).

The peak demands are also taken into consideration during the pedestrian traffic design, which lower quality level-of-service (LOS) standard is applied to obtain economical designs. However, when selecting design standard near-maximum capacity levels it should be cautioned as critical pedestrian density is likely to be exceeded at this level. Therefore, the analytic methods outlined by Fruin (1971) as LOS standard is based on occupancy of the area/space by pedestrians. This method also covers the design volumes for walkways and stairways. The higher design volume is assumed if the traffic is comprised of commuters or workers, while the lower design volume is recommended if designing for the traffic comprised of shoppers, persons carrying baggage or if there are conflicting traffic movements.

There are six different LOS as illustrated in Table 2-2 applicable in the pedestrian traffic design standard, which is based on walking speed, pedestrian spacing, and the probabilities of conflict at various traffic concentrations. The PLOS A represents the highest and F the lowest. The standard assists in determining the applicable means of design quality of corridors, sidewalks, and entranceways. The method further outlined the factors to be considered in walkways, stairs, and queuing designs. It further determines the width of the pedestrian walkway depending on the number of pedestrians to be occupied and the purpose of the walking trips that will be taken daily. Therefore, the analytic method presented by Fruin (1971) is based on the LOS standard which depends more on the occupancy of the available space by pedestrians.

Table 2-2: Pedestrian Level of Service, (Fruin ,1971)

Level of service	Image
A	
B	
C	
D	
E	
F	

The quality of pedestrian facilities in sub urban is affected by less congestion, high safety walking and the environment (Miller et al., 2000). However, the highway capacity manual does not consider such factors when measuring PLOS and the researchers proposed the innovative scale that will consider factors. When rating the pedestrian facilities, the proposed scale uses measurable characteristics, such as the width of walkways, median openings, signalised parameters, user perception such as continuity and convenience. The Florida Department of Transportation sponsored the study by Petritsch et al., (2006) to develop the LOS model representing the pedestrian perception of how the urban arterials with sidewalks meet their needs. The model also considers the traffic volumes of the adjacent roadway and exposure such as crossing width at intersection and driveway. However, this study proposed the PLOS model for a roadway which is based on the Pearson correlation

analyses and stepwise regression of about 500 combined real-time perceptions which were observed from a pedestrian walking.

It has been revealed that analyses of pedestrian-related issues have been gaining much attention in recent years especially pedestrian safety and PLOS where the focus method shifted from quantitative to qualitative (Kadali & Vedagiri, 2016). Furthermore, Baltes and Chu (2002) conducted a study on the pedestrian level of service for the mid-block street crossing where the methodology for pedestrian crossing locations was developed. The methodology provides measures of the effectiveness indicating pedestrians perceive the quality of service in crossing roads at midblock intersections. The objective of the study was to determine variables that are correlated with pedestrian perceived quality of service. The statistical calibration and validation were used to analyse the data collected at the selected midblock location through a sample of persons on actual site characteristics and stated quality of service. The results indicate that people tend to find that presence of pedestrians signals lower the level of crossing difficulties at midblock intersections. It shows that when the midblock intersection is signalised with pedestrian signals it makes the crossing very easier than unsignalized.

The sidewalks are also an important part of urban walking traffic systems like the midblock crossing intersections which affect the route chosen by the pedestrian to reach the destination. Tan et al., (2007) conducted a study on methods of assessing PLOS for the sidewalks. Their study is different from other researchers as they consider traffic flow to assess the standard of PLOS for vehicles and further take into consideration pedestrian comfort and safety. Furthermore, this paper developed the method of assessing PLOS by analysing the relationship between pedestrian perceptions and quality of the rate of physical fatalities and traffic flow. The researchers developed a step-wise regression model with the PLOS categories as per table 2-2 based on the main factor. Assessment of the sidewalks is an integral component of the walkability assessment tool and no study adequately covers the relevancy of the existing walkability audit (Aghaabbasi et al., & Arjomand Kermani, 2018). The researchers indicate that their research reviewed the walkability audit tools in-depth than other researchers. Their study was conducted to determine whether the existing tools, such as safety, attractiveness, disability issues and path conditions are considered when assessing the sidewalk.

3. Research methodology

3.1 Introduction

The research method refers to methods/techniques used to conclude the research (Kothari, 2004). The research method can also be defined as a systematic way of resolving the research problem. This chapter outlines the various steps adopted in the research to achieve the objectives of the research. The research will adopt the case study approach since it involves walkability assessment with the study corridor. Furthermore, the literature on existing policy frameworks will be reviewed and compared to National NMT standards to achieve the objective of the study.

3.2 Research approach

There are different research approaches that the researcher can employ to resolve the research problem and achieve its objective. In this research, the mixed research method combining both qualitative and quantitative methods will be employed to collect the required data. The same approach was applied by Hung et al., (2010) who conducted the walkability study in Hong Kong to assist the city planners with the identification of shortcomings on the existing pedestrian.

3.2.1 Mixed method research

The school of thought refers to mixed-method research as the research approach from any relevant angle involving employing both qualitative and quantitative research methods. It draws largely on qualitative and quantitative strategies. Mixed methods research involves employing both qualitative and quantitative research methods. Many research problems have both qualitative and quantitative dimensions and the researcher should use both techniques to fully address the problem. The mixed methods research draws largely on qualitative and quantitative research strategies. Though the trickiest part of the mixed methods study is in combining the two methodological traditions into a research endeavour in which all aspects substantially contribute to a single, greater whole (Leedy et al., 2015).

3.2.2 Case study

The school of thought refers to the case study as the research where the researcher applies the qualitative descriptive looking at individuals, a small group of participants, and collection of data of participants through observations, interviews, tests, the examination of records, and writing samples. In addition, to achieve the objective of the study, data will also be collected through literature review, field observation, interviews and field survey with various participants.

3.3 Study Area

This study will be based on the corridors of the City of Polokwane where there is a high movement of pedestrians. The City of Polokwane is located in the Limpopo Province,

South Africa. The study will focus on Landdros Mare Streets corridor. The starting point for the study is where the pedestrians are connected from Public Transport to places of employment and retail shops for shopping purposes.

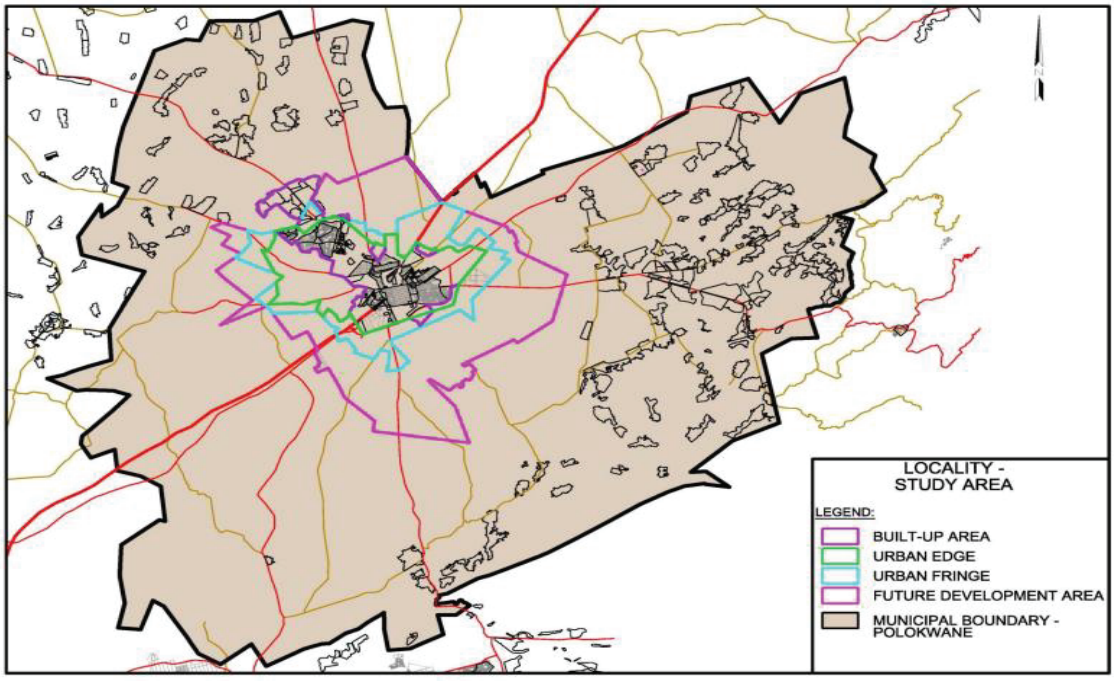


Figure 3-1: City of Polokwane Map, www.polokwane.gov.za

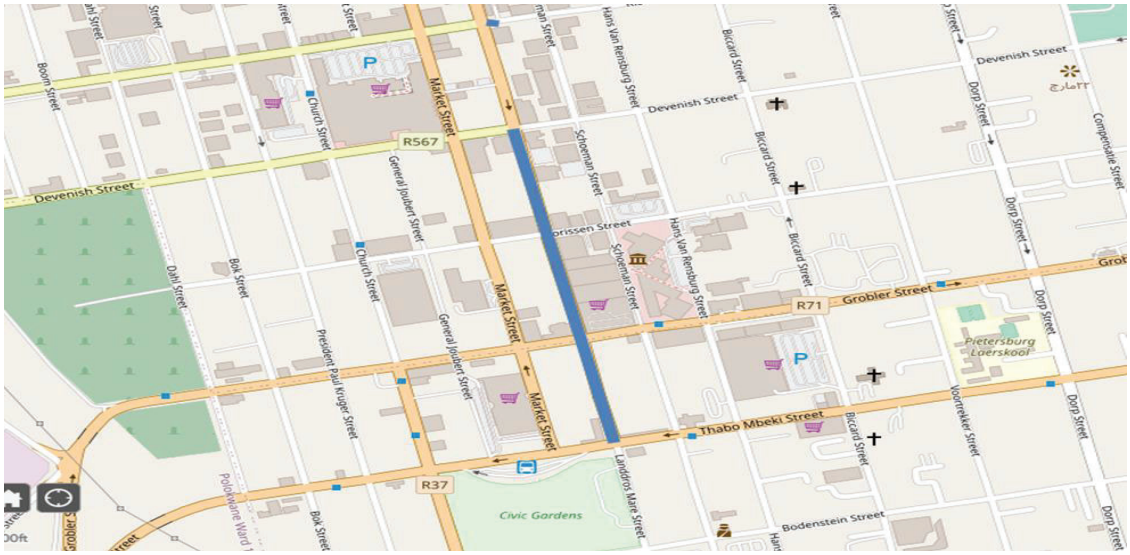


Figure 3-2: Study route, Street view

3.4 Population

According to Census (2011), the total population of the City of Polokwane is estimated to be around 628 999 with 178 000 households and the total population in the Polokwane city centre is about 130 028.

3.5 Sample, Sampling Methods and Sample Size

The survey of pedestrians in the study corridor conducted through the developed questionnaires which focuses on the difficulties encountered by the pedestrians when walking along the corridors. The survey target computer literate pedestrians as the potential respondents since are the users of the corridor frequently with walking experience. Moreover, the field survey involves a responding to questionnaires through monkey survey system on walking experience within the identified corridor and pedestrians to be randomly selected to rank the different variables selected.

3.6 Data Collection

Data collection is a technique of gathering the research data. According to Robson and McCartan (2016), there are different types of data that are classified as primary and secondary data. Primary data can be collected by events, such as observations, interviews or questionnaires and the secondary data is mainly obtained from sources such as documents or archives. This study makes use of both the primary and secondary data and as indicated in section 3.5, data collection be done through monkey survey. Observations or field surveys involve the walkability assessment, responding to questionnaires by pedestrians, and literature review. The literature review on the available framework policies will also be done evaluating as to whether the existing policies within the city are still relevant to support walking as a mode of transport.

3.6.1 Evaluation of the existing NMT facilities

The evaluation of the existing NMT facilities be performed using developed walkability questionnaires. The pedestrian be requested to use the questionnaires to evaluate the facilities to determine the gaps in terms of the needs. The questionnaire is written in English and translation be done where possible. The information which is not relevant to walkability on the questionnaires be ignored.

3.6.2 Literature review

The literature review was done on the available NMT policies of Polokwane City to identify the gaps compared with the South African National NMT facilities guidelines. Furthermore, to check the plans of the city to improve walkability within the corridor.

3.6.3 Field survey

The walkability assessment be performed within the study area rating the conditions and acceptable level of the NMT facilities for pedestrians. The survey be done to determine

the availability and quality of pedestrian infrastructure within the corridor and further assess the difficulties of pedestrians crossing the road. The pedestrians also participate in scoring the roadway. The designed walkability assessment questionnaires be used to observe five (05) factors and allocate the score of between 1 and 5, where 1 is excellent and 5 is poor. The factors are as follows:

Table 3-1: Walkability factors ,Walkability App dashboard

Factor	**Description**	**Score scale**
Safety	- How the walking environment are safe - Observation of motorist's behaviour over pedestrians - Check whether the crossings are at logical places	1 = very safe 5 = very unsafe
Security	- The personal safety of the pedestrian along the corridors	1= very good security, 5 = very unsecured
Infrastructure	- Maintenance of the footpaths	1 = Excellent, 5 = very poor
Comfort	- Any obstacles along the footpaths - Are the footpaths wide enough for the movement of the people	1 = Excellent, 5 = very poor
Availability	- Availability of footpaths on both sides of the corridor and check as to whether are continuous	1 = Excellent, 5 = very poor

Furthermore, the questionnaires be used to determine how COVID-19 pandemic affected the movement of pedestrians within the corridor as follows:

Table 3-2: Walkability factors COVID-19 , Walkability App dashboard

Factor	**Description**	**Score scale**
Safety	- How did the COVID-19 pandemic affect the walking environment - How did COVID 19 affect safe crossing on the road	1 = not at all, 5 = very much
Security	- Did the COVID-19 pandemic improve the personal security along the corridor	1= very good security, 5 = very unsecured

3.7 Data Analysis

The data be collected from the field through the monkey survey instrument and literature review. Data collected through the monkey survey instrument be analysed employing an excel spreadsheet and be used to generate a histogram and pie chart for interpretation of the result.

4. Data Analysis and Interpretation

4.1 Introduction

The study used both primary and secondary collected through walkability assessment questionnaires completed by the respondents and a literature review. The questionnaires were crafted and created in such a way that it responds to the research objectives and questions. The responses were exported to an excel spreadsheet to develop pivot tables and charts.

This section presents the analysis of the results responses made through literature review and questionnaires. The objectives of the study are as follows:

- To determine the existence and relevancy of NMT policy frameworks for the promotion of pedestrian movement in the city;
- To evaluate the impact of existing NMT infrastructure on the movement of a pedestrian in a case study corridor within the city centre of Polokwane.

4.2 Presentation of results based NMT policy frameworks

The purpose of this research was to assess the movement of pedestrians within a selected corridor in the city centre of Polokwane and the availability of proper NMT infrastructure. The NMT policy frameworks in the city can assist in the development of proper NMT infrastructure that will promote the movement of pedestrians. As discussed in Section 2, the city has developed policy frameworks to promote the movement of pedestrians as follows;

- Integrated Urban Realm and Movement plan 2009,
- CDB plan and Urban strategy 2016,
- Non-Motorised Transport policy 2014,
- Non-Motorised Transport Master plan 2014, and
- Non-Motorised Transport By-law 2014.

The researcher found that all the policy frameworks have been developed in conjunction with the South African National Department of Transport and the Limpopo Provincial Department of Transport. The policy frameworks guide the provision of adequate NMT infrastructure. The frameworks are developed based on the required specifications and standards. Furthermore, the plan is to connect the city centre with surrounding townships and villages by providing NMT infrastructure that serves as the vital mode of transport connecting people with public transport. To facilitate the implementation of policies, the city has developed a NMT by-law in 2014, which was advertised for public comments. The by-law creates a relationship between all road users by protecting one another on the road.

It was further found that the city has been declared the city of cycling and walking in one of the local newspapers. To implement the declaration, during 2014 the city developed all these policy frameworks to ensure that NMT becomes the mode of choice for people who

are commonly using it, such as commuters, learners and recreational users. Therefore, all the frameworks developed strive to promote NMT as the mode of transport by ensuring the provision of safe infrastructures such as pedestrian walkways within the city centre which improves accessibility and mobility.

Moreover, the city developed policy frameworks on NMT to outline the minimum standard of NMT infrastructure per South African National Department of Transport 2014 guidelines. However, a gap identified in the policy framework is the unavailability of street furniture along the study corridor and lack of maintenance. The policy does not enforce the maintenance of existing infrastructure, but it concentrates more on the developing of the new infrastructure and its intention is to connect NMT infrastructure with the public transport and amenities such as retail shops, schools and clinics.

There are gaps identified in the policy frameworks, such as accommodation of people with disabilities and street furniture such as benches and dustbins specified in South African NMT infrastructure guidelines. Furthermore, the pedestrian crossing facilities are not specified with tactile paving to lead visually impaired people and the study corridor route leading to amenities within the city and public transport.

4.3 Presentation of results-based walkability assessment

The initial plan to collect data on the assessment of NMT infrastructure and how it affects the movement of pedestrians was to collect it through developed questionnaires (See Appendix A). The intention was to distribute questionnaires to the participants walking in the corridor daily. The researcher was going to make sure that the pedestrians were able to read and understand the questionnaires. Due to the South African COVID-19 restrictions, the completion of questions was done online through the monkey survey. The participants were able to score the safety, comfort, security, availability of footpath and infrastructure between 1 and 5, where 1 was excellent and 5 very poor. Moreover, the impact of COVID-19 on walkability was also assessed through rating where 1 was not at all and 5 very much. The results of the analysis are presented as follows:

4.3.1 Response rate

The questionnaires link was distributed to a total number of 45 pedestrians walking on the corridors daily and only 29 were able to complete the questionnaire, giving a response rate of 64% as per Table 4.1 below. According to (Fincham, 2008), a survey response rate of 60% and above will assist the researcher to reach conclusion of the study. Figure 4.1 below represents the rate of responses per gender. The results show that out of 30 responses, 52% were females while 48% are males.

Table 4-1: Respondents by gender

Gender	Frequency	Percentage (%)
Female	15	52%
Male	14	48%
Total	**29**	**100%**

Figure 4.1 shows that respondents between the ages of 35- 44 years are the majority of those who were walking on the corridor accounting for 41%, followed by the age group of 25-34 years which was 31%.

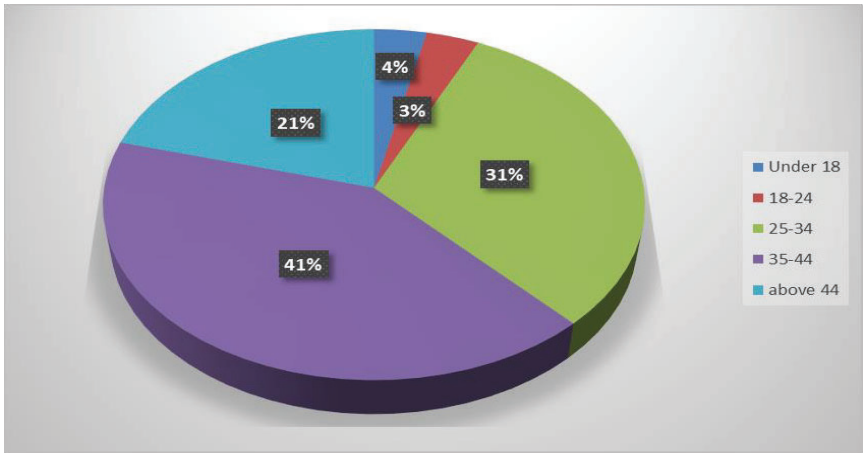


Figure 4-1 Respondents by age group

Furthermore, Figure 4.2 shows that most of the respondents are males with an age group of 35-44 who participated in the survey, followed by females with an age group between 25-34 years. This indicates that most of the males walks along the study corridor than females.

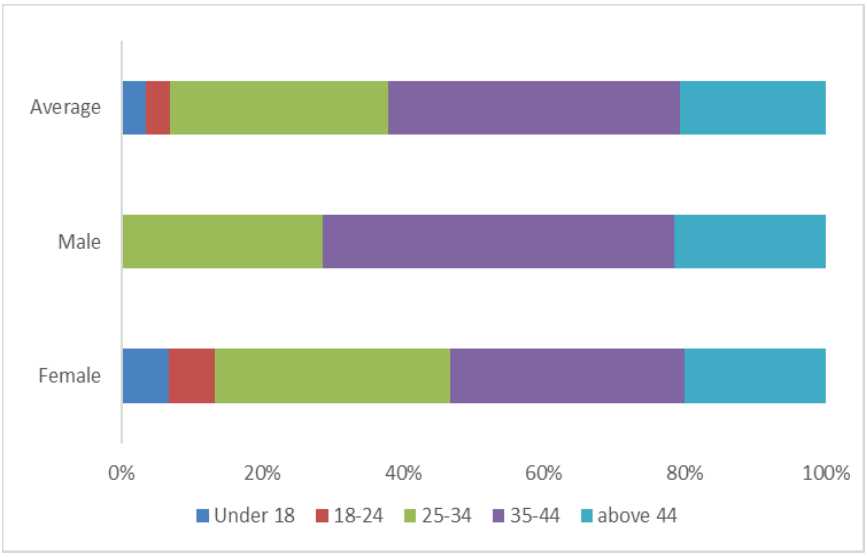


Figure 4-2: Responses per age group and gender

The results in Figure 4.3 shows that a larger number of male respondents (53%) have access to the motorist driving while female respondents (58%) does have access to the motorist driving. On average, figure 4.4 shows the times most of the respondents travels from and to public transport 0-4 times a week.

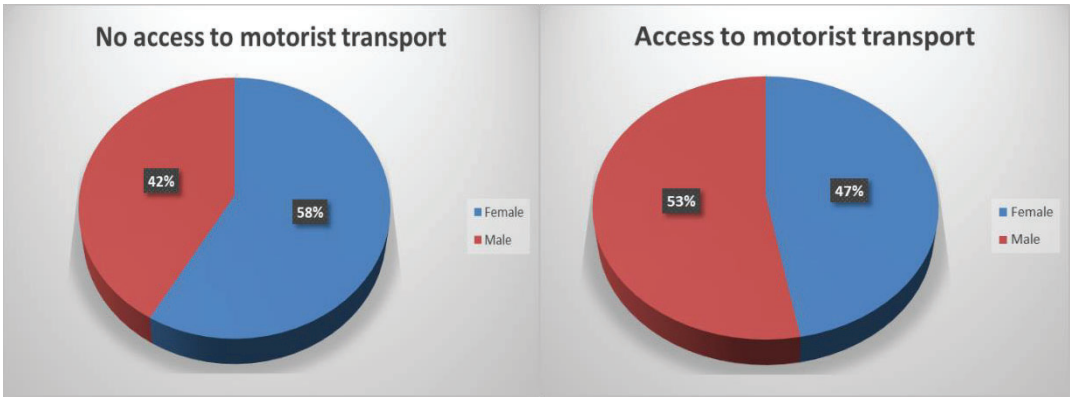


Figure 4-3: Access to motorist transport

Figure 4.4 shows that most males responded counted walks 10 times and above to public transport on a weekly basis. In average most females counted responded walks 10 and above times on a weekly basis from and to public transport facilities. This proves that most of the respondents walks from and to public transport on a daily basis.

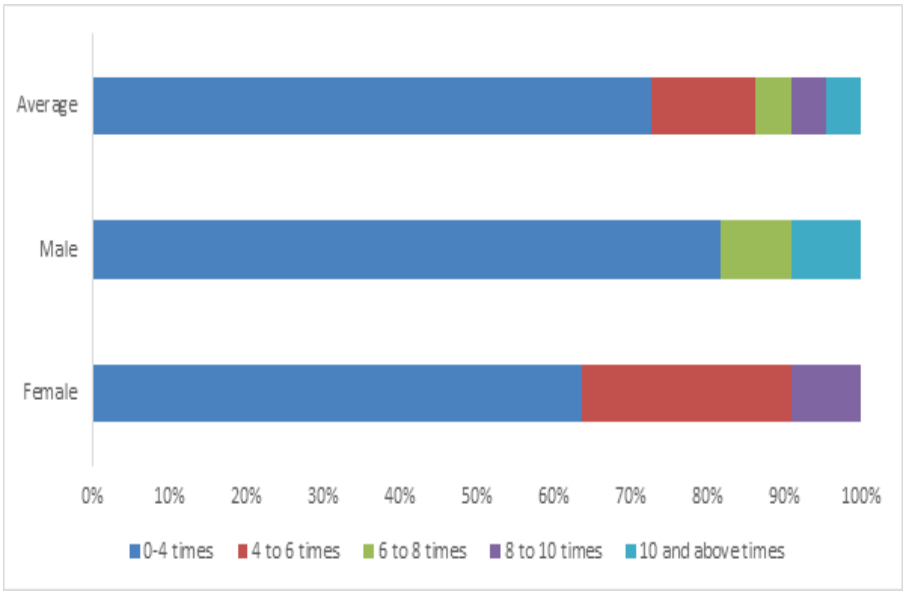


Figure 4-4: Number of trips from and to public transport a week

4.3.2 Walkability Assessment of the Corridor

The quantitative data collected from responses through Monkey Survey were exported to a spreadsheet and graphs were developed for analysis. The results be presented as follows:

4.3.2.1 Safety

The respondents were requested to rate how safe they feel against motorists within the environment. As discussed in chapter 3, the rating is ranging between 1 and 5, where 1 = very safe 5 = very unsafe. The ratings were allocated to the safety of the walking environment, observations of motorists' behaviour over the pedestrians and further assessing as to whether crossings are at logical places.

Figure 4.5 shows that the average walking environment within the route is good which is also been rated well by both male and female pedestrians. Generally, the walking environment along the study corridor has been rated good to poor.

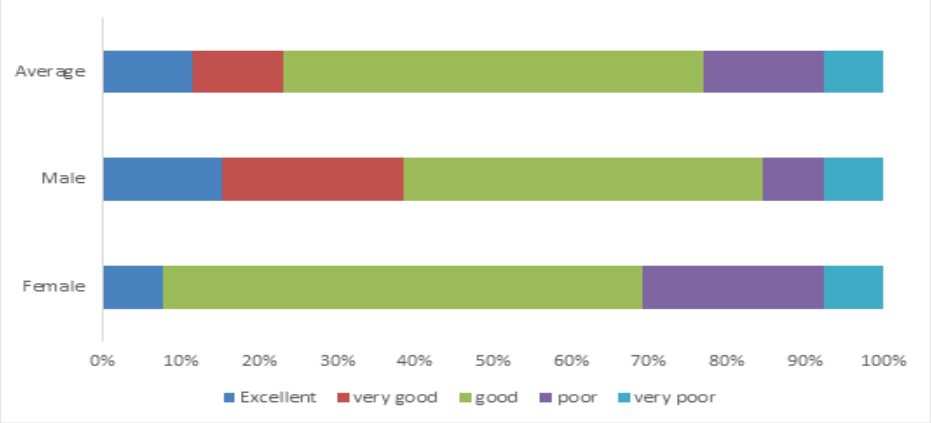


Figure 4-5: Walking Environment

Figure 4.6 shows the results on the behaviour of motorists towards pedestrians along the route. The results indicate that on average, the behaviour of motorists driving on the corridor is poor and it has been rated by most of the females. Mostly the behaviour of motorists towards pedestrians when sharing the route is not good as they are not adhering to the rules of the road.

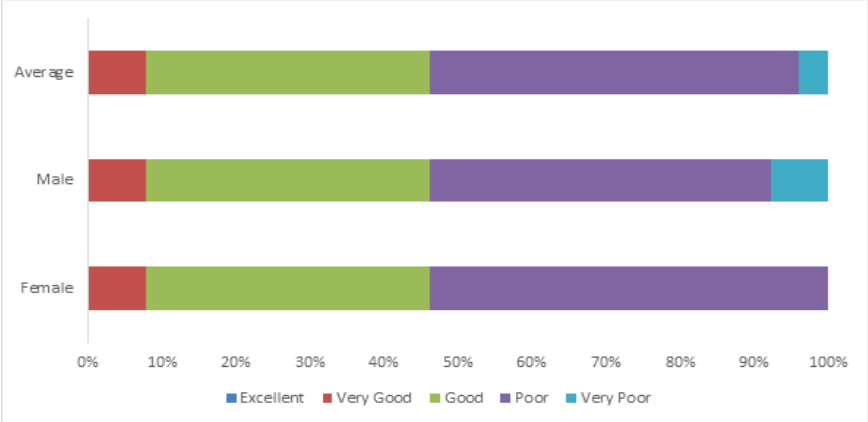


Figure 4-6: Behaviour of Motorists

Figure 4.7 represents the rating on the safety of the crossing facilities along the route and the results show that on average, the facilities are good. This means the crossing facilities are located at logical places and they are safe to be used by pedestrians. During peak hours, there is high traffic along the route for both motorists and pedestrians. Therefore, adequate pedestrian crossing facilities are essential to improve safety.



Figure 4-7: Safe crossing facilities along the route

Most of the males rates the safety of pedestrians against motorist as good as per Figure 4.8, while most of the female's rate is poor. However, on average, the rating shows that the level of safety of pedestrians against motorists is good. This shows that there is a separation between the motorist and pedestrian routes. The walkways are situated on both sides of the route in front of retail shops and there is separation which makes pedestrians feel safe against motorists.

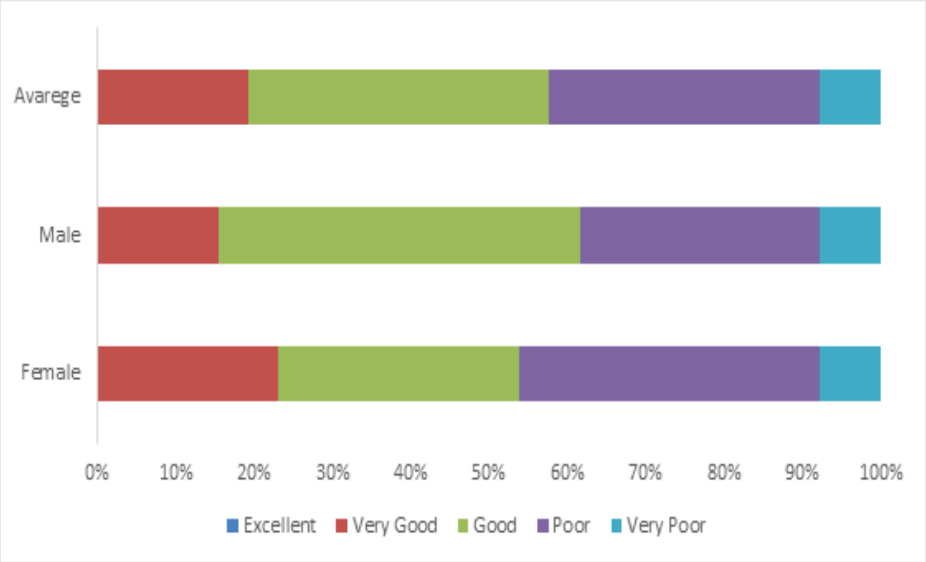


Figure 4-8: Level of pedestrian safety against the motorists

Furthermore, the study deemed it necessary to determine the various components under the safety factor and the results are summarised in Figure 4.9.

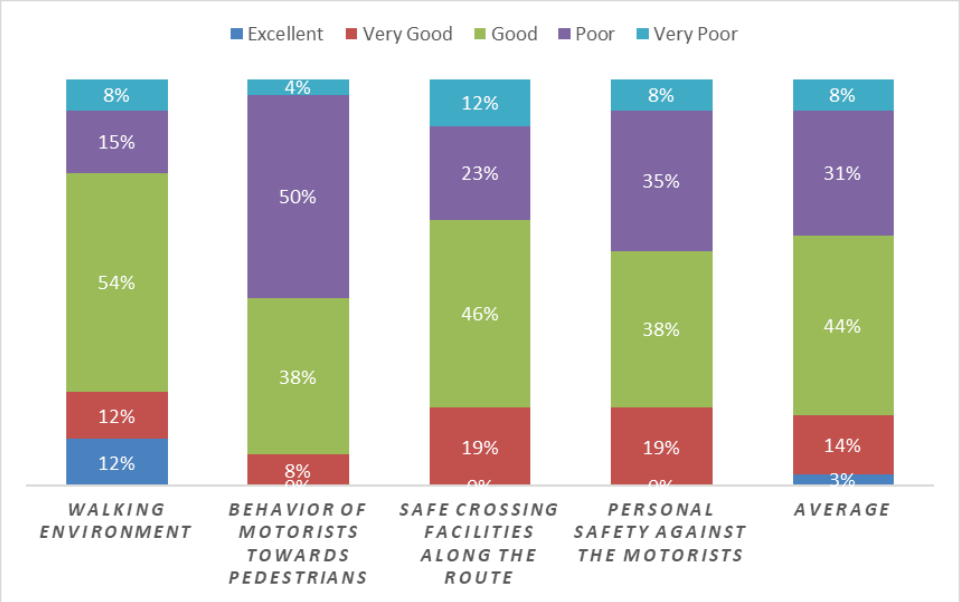


Figure 4-9: Safety of Pedestrians

Various components were rated under safety factor and Figure 4.9 shows that the level of safety walking on the corridor on average is good. These results show that the walking environment within the corridor is good.

4.3.2.2 Security

Security is related to personal security when one is walking through the route. The respondents were requested to rate the level of personal security between 1 and 5, where 1= very good security, 5 = very unsecured.

Figure 4.10 shows that most of the female respondents do not feel safe walking on the corridor as they have rated the personal safety using the sidewalk poor. On average, the feedback shows that the personal security along the route is poor. Compared to male respondents their rate is between very good and poor.

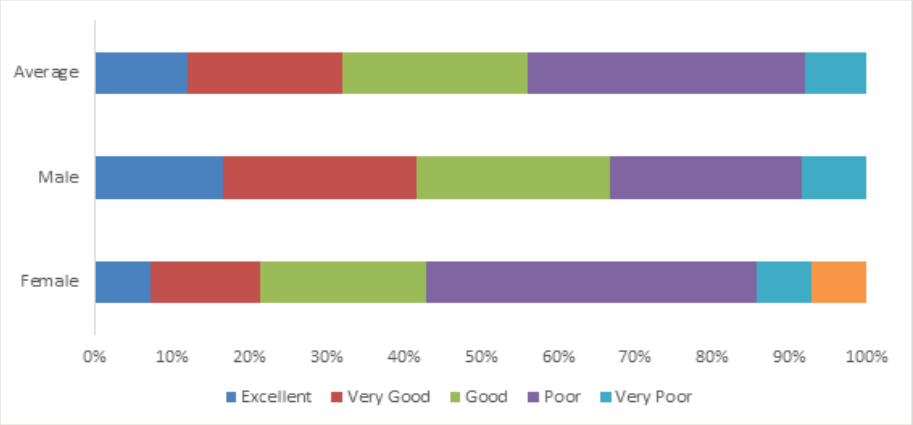


Figure 4-10: Personal security using the sidewalk

Figure 4.11 shows that on average, the respondents rated the streetlights as very good and good. However, most of the male rated the streetlights good and females poor and very good.

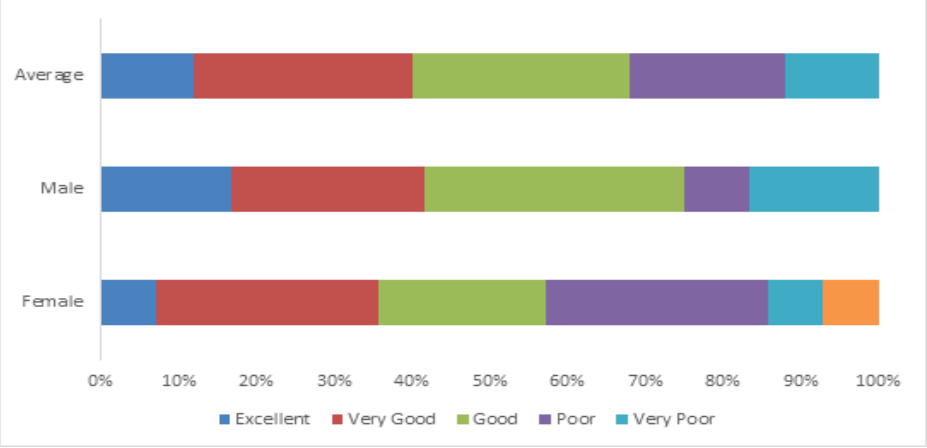


Figure 4-11: Streetlights on the path

On average the results as per Figure 4.12, shows that human activities along the street are good and most of the male respondents rated it well while most of the females rated it poorly. Therefore, the level of activities along the street has been generally rated between good and poor. This shows there is street activity along the study corridor.

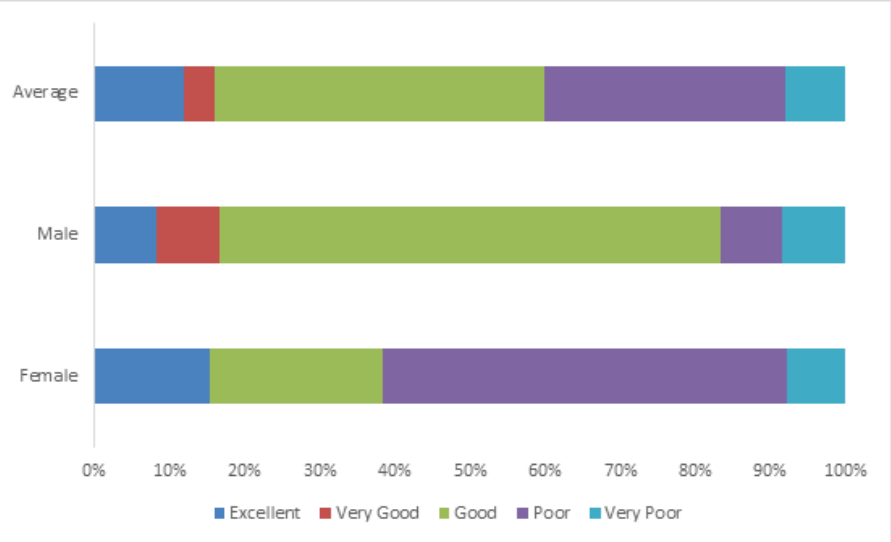


Figure 4-12: Level of human activities along the street

The security factor was also rated and the results as per Figure 4.13 show that it is good. On this factor, the researcher aimed to find the personal safety of pedestrians walking on the selected corridor. It shows that security along the route is between poor and good which results in pedestrians not feeling safe when walking along the route. This will affect most of the female pedestrians as they will always prefer to feel safe when walking along the route.

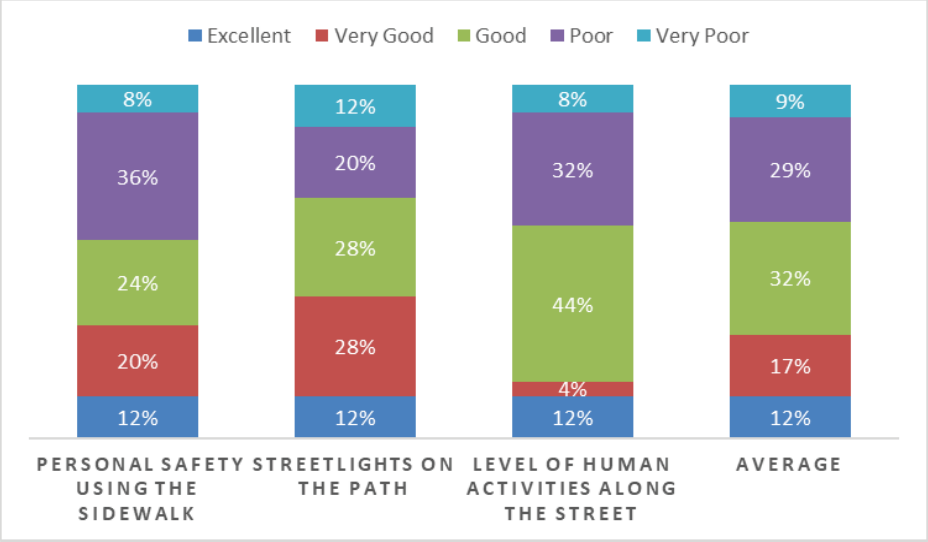


Figure 4-13: Personal Security

4.3.2.3 Infrastructure

This factor has been used to assess the quality of the pavement material on the existing road, which evaluate the condition of the route. Based on the results, Figure 4.14 shows that most of the females rated the quality of material poor while males rated it good. Therefore, on average, the condition of the existing pathway has been rated poor.

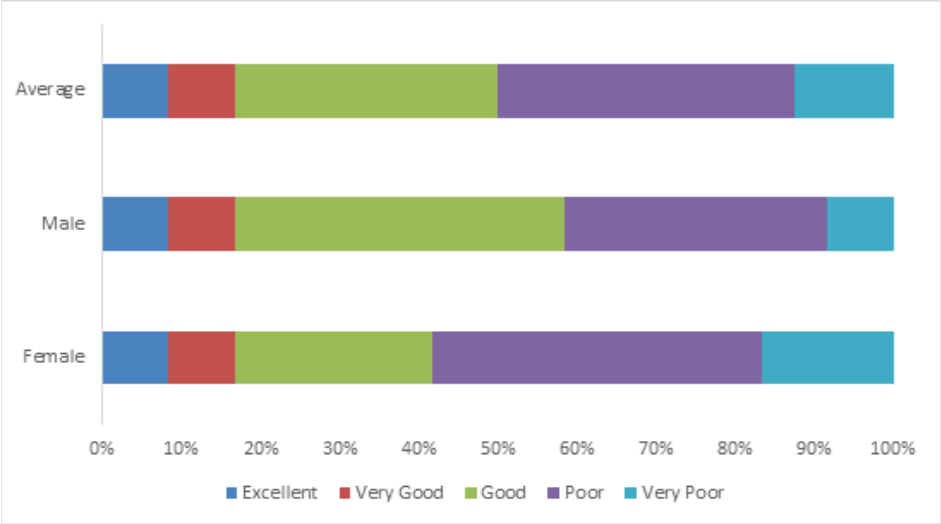


Figure 4-14: Quality of pavement material along the street

The provision of walking space along the street which needs to be a minimum of 2 mm based on NMT infrastructure guidelines by the South African National Department of Transport (2014) is rated good on an average, and most males' respondents gave a rating of good while females rated it poorly. Figure 4.15 present the results on the provision of walking space.

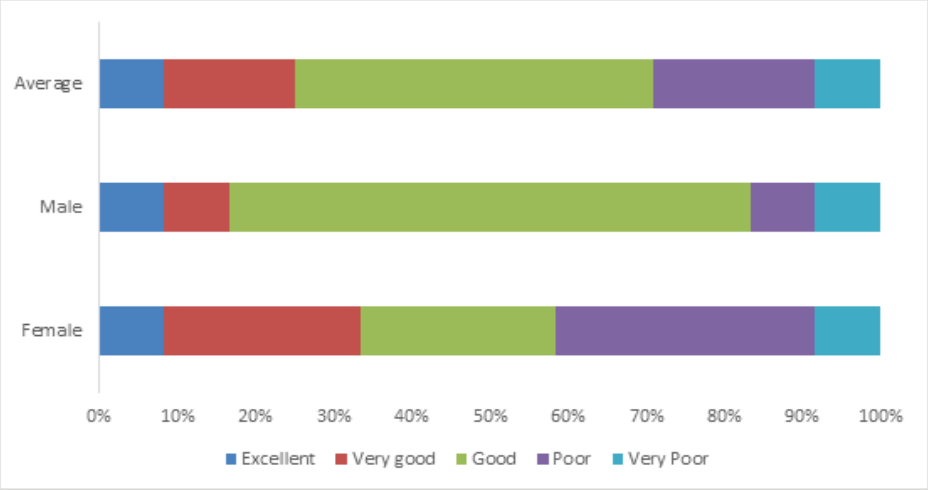


Figure 4-15: Provision of walking space (minimum 2m) along the street

The respondents were requested to rate the different components under the infrastructure factor. The purpose of this was to check whether the existing infrastructure is of quality and maintained regularly to allow the movement of pedestrians. Based on the results as per Figure 4.16, it shows that the infrastructure of the corridor is Good.

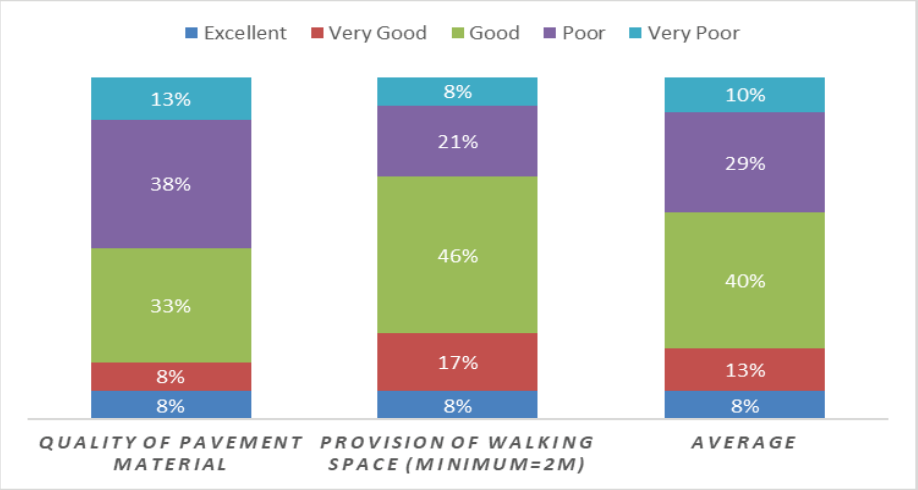


Figure 4-16: Existing NMT Infrastructure

4.3.2.4 Comfort

On this factor, the researcher wants to establish whether the walking environment is clean and the availability of amenities such as dustbins, benches and further check any obstructions along the route. The respondents assessed the route and rate it on a scale of 1-5, where 1 = Excellent and 5 = very poor.

Figure 4.17 shows that most of the female respondents rated the cleanliness and maintenance of the walking environment and males' respondents rated it good. On average, the route has been rated poor for cleanliness and maintenance.



Figure 4-17: Cleanliness and maintenance of the walking environment

In terms of absents of obstructions along the route, Figure 4.18 shows that most of the male's respondents rated better than females. On average the route is good, meaning that obstructions along the route are just normal.

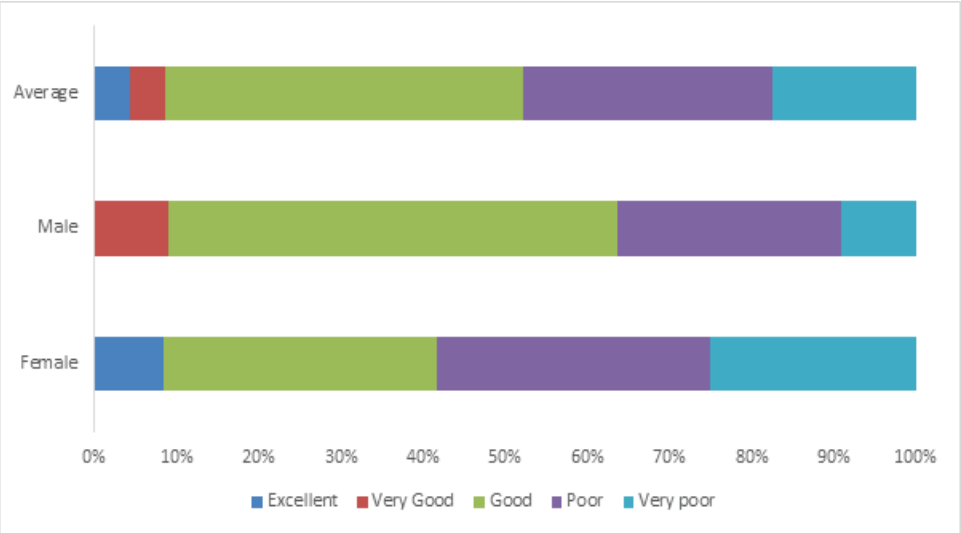


Figure 4-18: Absents of obstructions along the route

Figure 4.19 shows that there are no amenities along the route such as dustbins and benches. Both males and females rated the availability of amenities along the route poor. On average this factor has been rated poor followed by very poor. This shows that most of the respondents are not happy with the provision of amenities along the route such as dustbins and benches.

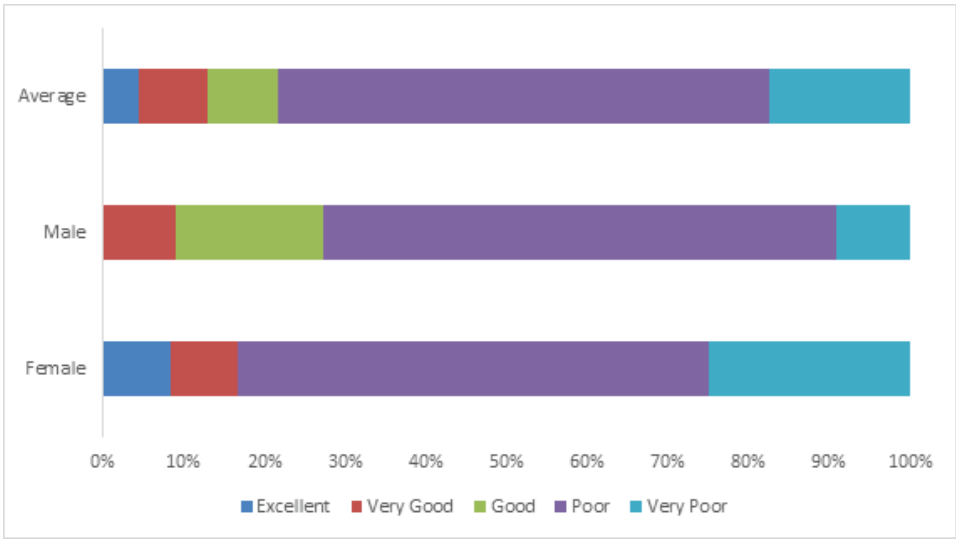


Figure 4-19: Availability of amenities along the route, such as dustbin and benches

Figure 4.20 shows that the degree of path drainage along the route on average is good, while most of the female respondents rated it poorly. The rating shows that there is drainage along the route is good.

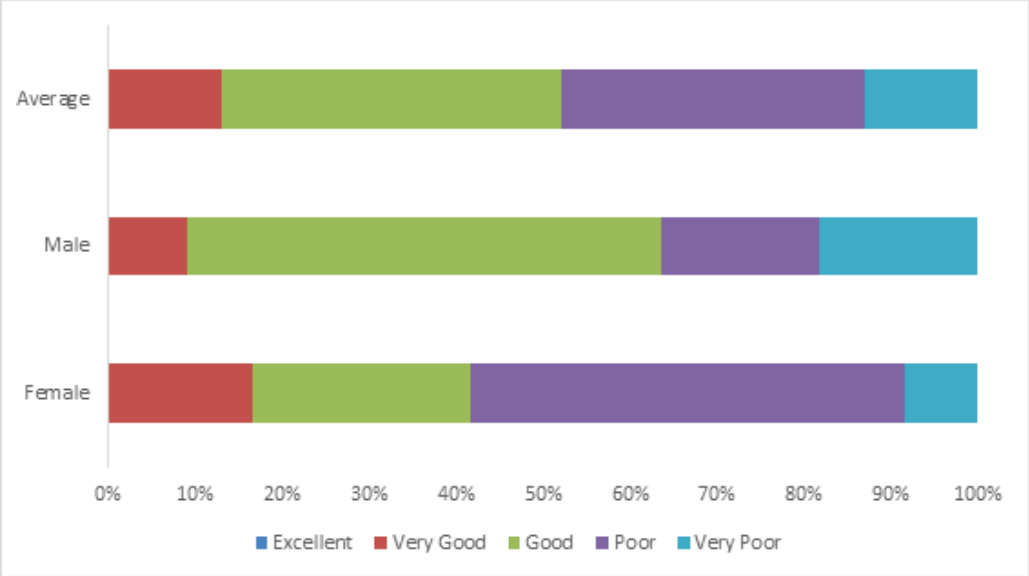


Figure 4-20: Availability of amenities along the route, such as dustbin and benches

The continuity of the sidewalk is one of the important aspects of NMT infrastructure which need to be considered during the designs. This gives the pedestrians direction of the route. Figure 4.21 shows that on average the continuity of the sidewalk is good, however most of the females' respondents.

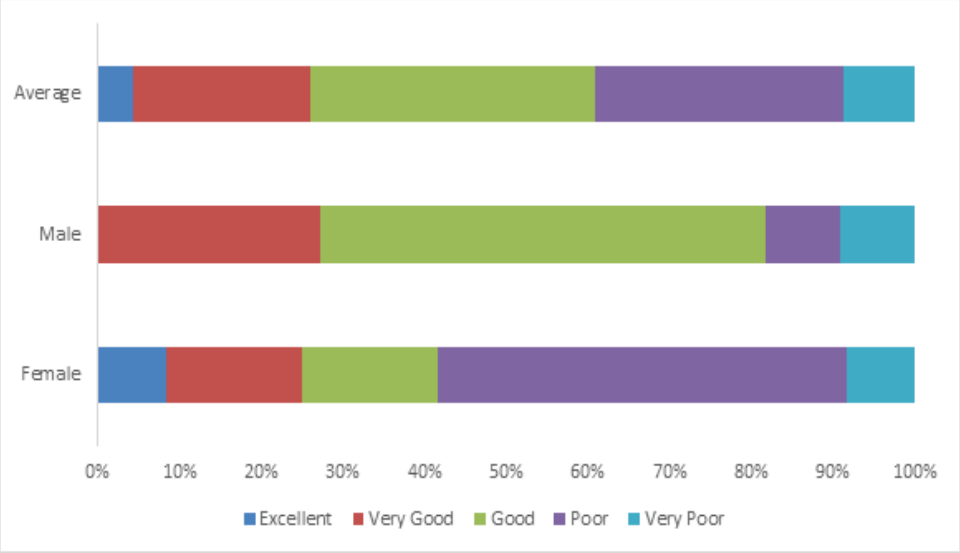


Figure 4-21: Continuity of the sidewalk along the route

The comfort factor determines whether the corridor has bins where pedestrians can through their rubbish, availability of benches for resting and any obstructions along the walkway which will disrupt the movement of people. Figure 4.22 shows that on average comfort within the corridor is poor.

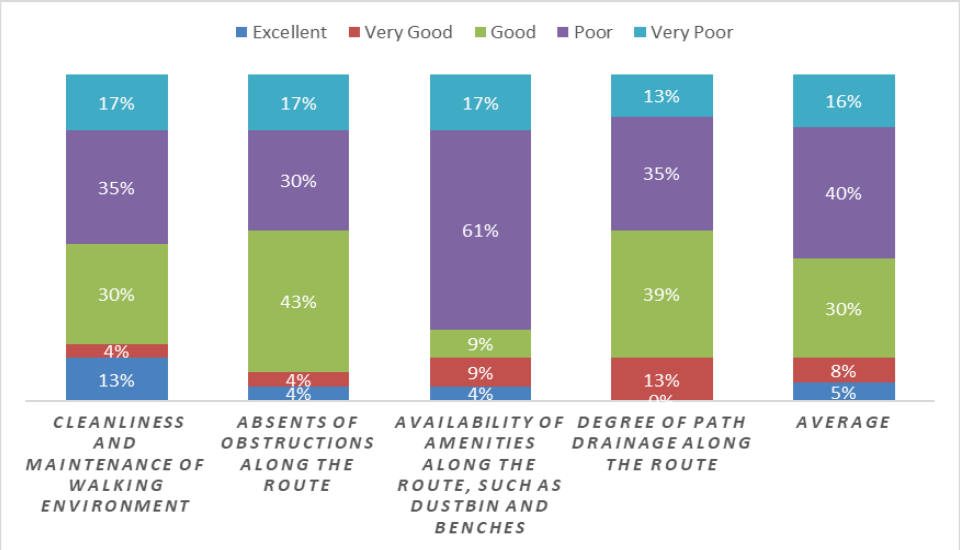


Figure 4-22: Comfort Walking Along the Route

4.3.2.5 Availability of Footpath

The respondents were requested to rate between 1 and 5, where 1 = Excellent and 5 = very poor the availability of sidewalks on both sides of the route and also the access of people with disability. The NMT guidelines encourage the designers to always consider access for people with disability when designing NMT infrastructure.

Figure 4.23 shows that on average the availability of the sidewalks on both sides of the route are poor while most female's respondents rated it poor and males both between good and very good.

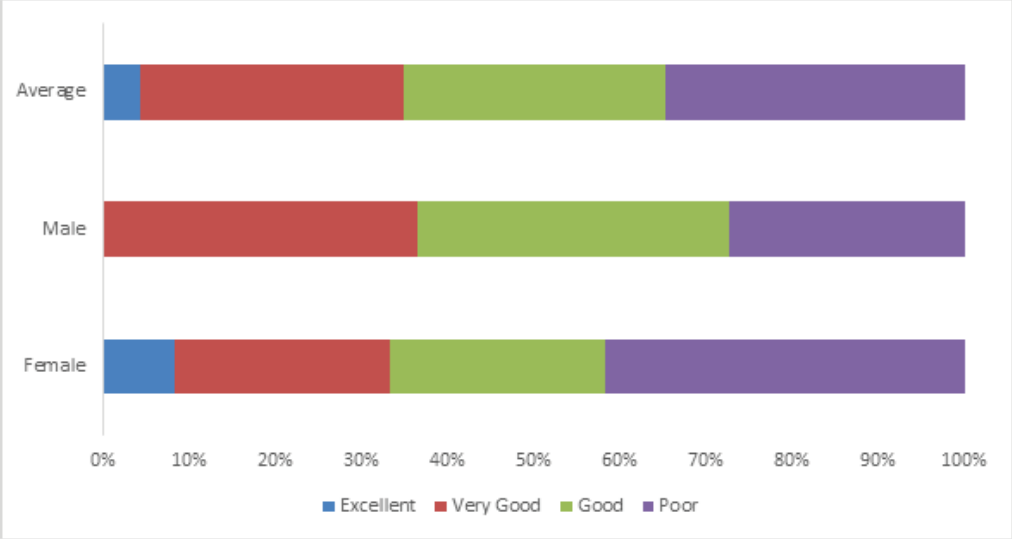


Figure 4-23: Sidewalk located on both sides of the route

In terms of availability of access for people with disability on the route, on average it has been rated poor as per Figure 4-24 and most female respondents also rated the route poor while males are saying very good and poor. This shows that the pathways do not provide an access to people with disability.

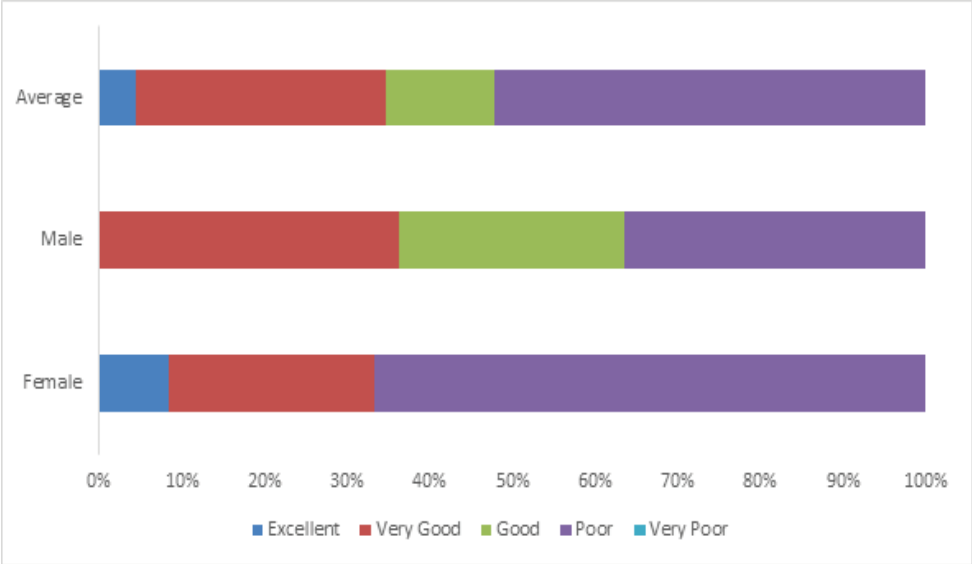


Figure 4-24: Access for people with disability on the route

Based on the results as presented in Figure 4.25, it shows that the rating of availability of footpath on average is poor. Furthermore, the access for people with disability was found to be poor.

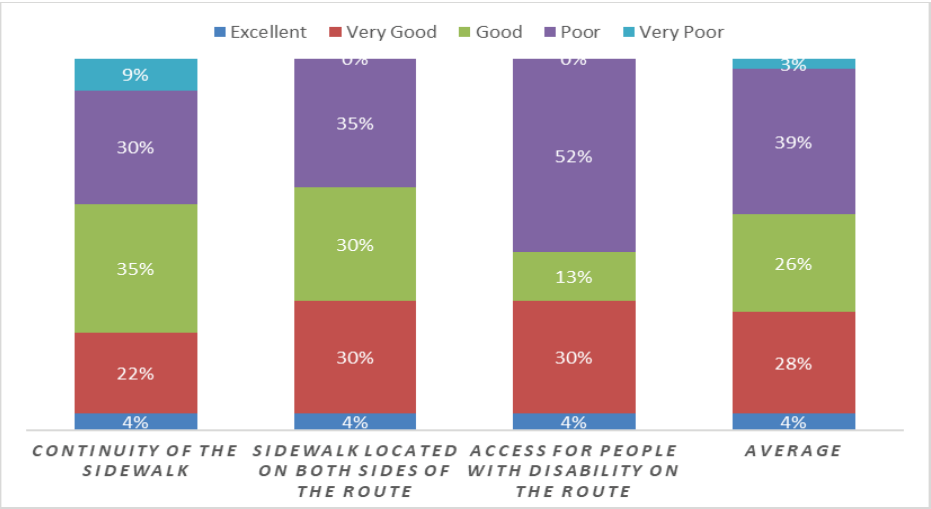


Figure 4-25: Availability of Footpath

4.3.2.6 Important Factors Associated with choosing the Route

The respondents were requested to state any factor which is associated with choosing the route to complete their trips. Individual pedestrians have their preferences which motivate them to choose the route. The researcher grouped all the factors (See Appendix B) of the research and Figure 4.26, shows that most female respondents were motivated by safety when choosing the route. Male respondents don't have any specific choices. However, on average the respondents' choice of the route is based on the safety within the environment, followed by access to amenities such as banks, schools, shops, municipal offices, etc.

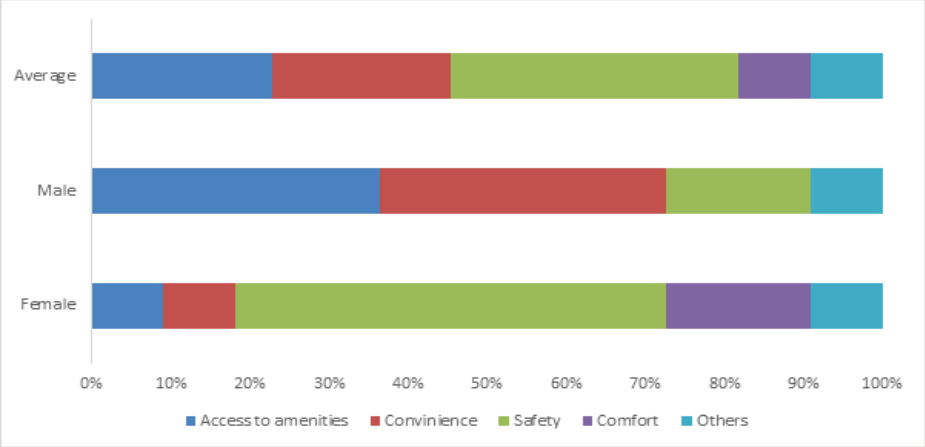


Figure 4-26: Important Factors Associated with choosing the Route

4.3.2.7 Impact of COVID 19 Pandemic to Walkability

The researcher intended to find out whether the COVID- 19 pandemic has affected the movement of pedestrians on the corridor. The respondents were further requested to respond on how the pandemic affected their movement by rating the safety and security factors. The purpose of this is to find out whether the COVID-19 pandemic has changed or improved the

walking environment within the corridor. The results are presented in Figure 4.27, and it shows that on average the pandemic did not change or improve walking along the corridor. This means the walking environment in terms of safety along the corridor is still the same as before the pandemic.

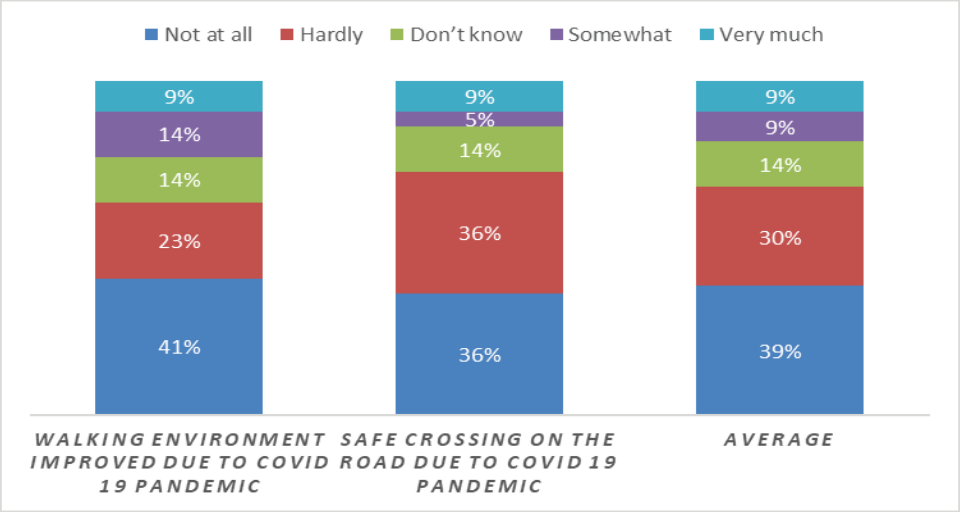


Figure 4-27: Impact of COVID-19 Pandemic to NMT user safety

Moreover, the respondents were requested to measure the level of personal security through rating. The researcher aims to find whether the COVID-19 pandemic changed or improved the level of personal security of pedestrians when walking on the corridor. Figure 4.28 shows that the COVID-19 pandemic did not change or improve the level of security towards pedestrians walking along the corridor.

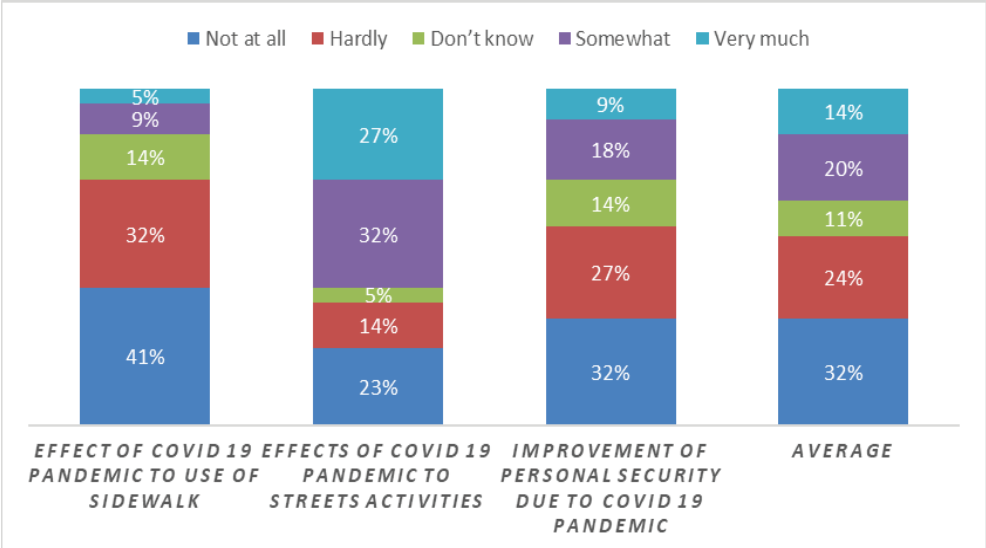


Figure 4-28: Impact of the COVID-19 Pandemic to NMT user security

5. Conclusion and Recommendation

5.1 Introduction

The study assessed the movement of pedestrians in the study corridor within the city centre of Polokwane and the availability of proper NMT infrastructure. The data was collected through the questionnaire on a monkey survey System and literature review. The research underlines five (05) important walkability assessment factors and standard requirements of NMT infrastructure. In the first chapter of this research, four (04) questions were established leading us to the findings. Therefore, this chapter presents the research findings concerning the research questions.

5.2 Summary of Findings

The researcher intended to determine the relevance of the City of Polokwane's NMT policy framework to the South African National Department of Transport as mandated by the South African National Department of Transport, if the City of Polokwane is one of the transportation authorities that developed NMT policy frameworks to promote NMT. The strategic objective of the South African National Department of Transport are to integrate NMT into the transport system. To implement this objective, the Department of Transport has developed policy frameworks to guide provincial and local transport authorities to develop policies to achieve the objectives.

The city, as the transport authority, developed NMT policy frameworks. However, the researcher identified gaps within the policies, especially the Master plan. The NMT Master plan is supposed to regulate the designs of NMT infrastructure. The findings indicate that the Master plan specifies the pedestrian and wheelchair footpath with separation from the motorist path. The gaps within the plan are the specifications on the crossing facilities, accommodation of people with disabilities. Therefore, the NMT policy frameworks available does not accommodate people with disability. Moreover, the frameworks do not enforce the street furniture required along the footpath as per National NMT infrastructure guidelines.

Regarding the safe walking environment, the level of safety on the study corridor is good, helping the pedestrians enjoy walking on the pathway. However, the findings show that the behaviour of the drivers was relatively poor, which shows that they do not obey the rules of the road through the pedestrian crossing facilities located at logical places. The results also established that some drivers are not complying with the city's NMT By-law stipulating that the road users should protect one another to improve safety on the road.

Generally, the pedestrian sense of security along the corridor was found to be between good and poor. However, the female respondents found their sense security to be poor since they felt most vulnerable to safety though findings show that there is enough lighting along the route that is supposed to improve safety of pedestrians.

The condition of the existing NMT infrastructure on the study corridor was found to be good with the material used being non-slippery and even. However, adequate maintenance is not provided accordingly. The width of the pathway meets the standard requirement of 2m as per NMT infrastructure guidelines.

The comfort of the footpath was found to be a challenge. The pedestrians indicate that they do not feel enough comfort when walking along the study corridor since it has been rated poor. The findings indicate that the corridor does not have amenities such as dustbins and benches to be used by pedestrians, thus making the environment not to be clean. However, the drainage has shelters to cover pedestrians from the sunlight.

The provision of footpath on both sides of the corridor and continuous. However, the challenge is provision of access to people with disabilities. Therefore, the footpath along the corridor does not meet the minimum required standard of NMT infrastructure.

5.3 Responses to the research questions

- ***Research Question 1: Are the NMT policy frameworks available in the city of Polokwane and their relevance to national policy and legislative framework requirements for NMT?***

The South African National Department of Transport as custodians of transport has developed various policies and strategies to encourage transport authorities to implement and improve NMT. Luke and Heyns (2013) state that national transport policy is a strategic document formulated that identifies NMT as an important component of the transport system. At the same time, national encourages local transport authorities to develop their transport policies guiding implementation and support of NMT. The department developed CITP guiding the planners to consider NMT and further integrate it with the public transport system. This guideline outlines the design principles for the integration of public transport networks to ensure that it provides a direct, accessible and safe pedestrian connection to facilities without barriers. Furthermore, in 2014 the NDoT revised NMT facility guidelines providing the guidelines in designing towns and cities to benefit NMT users. Moreover, the NDoT developed a National NMT policy prescribing the need for the development of minimum standard and specification NMT taking cognition of safety.

CoP as one of the local transport authorities and implementers of national and provincial policies has developed their own NMT policy frameworks guiding implementation and provision of NMT as a mode of transport. Their plan is also to integrate NMT with the transport system and indicate that the movement of people in the city is their priority as the main mode of transport (City of Polokwane, 2009). All relevant NMT policy frameworks, such as Master Plan, policy and By-law has been developed. However, there are gaps identified within the NMT Master Plan which do not give guidance to the designers in terms of NMT infrastructure. The current study finds that the city of Polokwane's NMT Master Plan focuses more on the development of NMT infrastructure in areas where is not provided and no provision is made for the improvement of the existing NMT infrastructure in the city

centre to meet the guidelines as developed by NDoT. Furthermore, there is no guidance in terms of provision of traffic calming measures, crossing facilities, signalised and unsignaled intersection and further provision of tactile on the footpath to lead impairment people.

Therefore, in responding to the above research question, the CoP has developed relevant NMT policy frameworks as a local transport authority. However, the policy framework does not meet the South African minimum standards requirements of NMT provided in the National NMT Master plan and policy.

- ***Research Question 2: Does the existing NMT infrastructure meet the South African minimum standard requirement of NMT infrastructure?***

Transport infrastructure is recognised as one of the forces driving economic growth and social development. Therefore, is essential for local transport authorities to invest more in transport infrastructure. Pillay & Seedat (2007) indicates that traffic congestion remains a problem in the cities and car ownership increases daily, while on the other hand most of the people still depend on public transport. It is known that most of the people walk or cycle to reach the nearest public transport and in the city centres, private vehicle owners park their cars at allocated parking areas and walk to reach their destinations. This shows that pedestrians need to be recognised and provided adequate infrastructure and safety within the walking environment.

In support to ensure adequate NMT infrastructure with a safe walking environment is provided, the NDoT has developed NMT infrastructure guidelines in 2014 to guide the planning and designing of streets and roads ensuring the safety of the users. According to the guideline, for the NMT to meet the minimum required standard, there are five (05) components that need to be provided on the footpath to provide equal access for pedestrians. The walkability assessment was done on the study corridor as per the results in chapter 4 of the study and results are summered on Table 5-1.

Table 5-1: Summarised results on walkability assessment

Component	Results	comments
Safety	Good	The walking environment is good, motorists behave well towards pedestrians and pedestrians feel safe, crossing facilities provided on the corridor.
Security	Good - Poor	Pedestrians do not feel secure when walking on the corridor though there is enough lighting along the footpath

Infrastructure	Good	The provision of walking space meet minimum of 2m and the quality of pavement material is poor
Comfort	Poor	No provision of adequate maintenance of the existing footpath, no provision amenities such as dustbins and benches
Availability of footpath	Poor	The footpath is provided on both sides of the road, however, there is no access for people with disability.

Based on these findings, the existing footpaths of the study area do not meet South African minimum standard requirements of NMT infrastructure due to poor conditions of some of the components as presented in table 5-1. The NDoT is striving towards universal access to accommodate all pedestrians including people with disability and the existing footpath does not provide access.

- ***Research Question 3: Are there any plans for the improvement of NMT infrastructure within the city centre?***

The CoP as a local transport authority has developed an NMT Master plan guiding the provision of NMT infrastructure on prioritised areas within their area of jurisdictions. However, the plan does not cover the maintenance of the existing NMT infrastructure. The Master plan identifies that the NMT infrastructure within the city centre is in a fair to good condition and identifies challenges as the interaction between NMT facilities and street furniture, which led to a reduction in unsafe conditions for pedestrians (City of Polokwane, 2014a). Furthermore, the plan recommends minor upgrades to cater for the universal access to the footpath but the plans for implementation together with priorities is not covered. Therefore, the city does not have any plans for the improvement of NMT infrastructure within the city centre, especially in the case study corridor.

- ***Research Question 4: How can the pedestrian level of service in case study corridors within the city centre of Polokwane be improved?***

Pedestrian Level of Service is used to measure the extent to which pedestrian movement can be accepted at a comfortable and safe walking environment (Zannat et al., 2019). The conditions of the walking or footpath facilities is one of the factors influencing mobility, comfort and safety of pedestrians along the route which depend on the maintenance of the

facilities. The existing road infrastructure of the study area consists of 4 vehicle lanes one-way traffic circulation as per Figure 5.1, with no dedicated bicycle lanes. However, the pedestrian footpath is allocated in front of retail shops as per Figure 5.2, which is showing total separation from the vehicle traffic. During peak hours, the pedestrians have difficulties crossing the road due to high traffic and they are forced to cross at signalised intersections and allocated signalised crossing. The CoP is the economic hub and growth point of Limpopo province and it serves a high number of communities from surrounding villages/townships. The study corridor is situated along with the retail shops in the city centre and therefore it is expected to have a high number of pedestrians.



Figure 5.1: Existing road infrastructure along the study corridor



Figure 5.2: Existing footpath along the study corridor

5.4 Conclusion and recommendation

The CoP should review their policy framework especially the NMT Master plan to include the maintenance and improvement plan of the existing NMT infrastructure. The improvement of the existing NMT infrastructure should be outlined in this Plan as per NMT infrastructure guidelines developed by South African National Department of Transport. The guidelines will be able to guide the planners and designers on required specification for acceptable minimum standard on NMT infrastructure.

The pedestrian level of service on the corridor can be improved by first proving regular maintenance of pavement material to ensure mobility, safety and comfort. Furthermore, the bicycle lane should be provided on the corridor to accommodate cyclists with adequate crossing facilities to avoid waiting time. Therefore, the recommended PLOS on the study corridor is C as is more economical. According to Fruin (1971), this level of service provides sufficient space for normal walking speed and freely bypass other pedestrians. It is, therefore, recommended that the number of vehicle traffic lanes be reduced to extend the footpath considering a high number of pedestrians walking along the corridor for the people to enjoy their space and further convert the corridor into NMT universal access.

5.5 Limitation of scope

The researcher intended to collect through literature review, field observation, interviews and field survey with various participants. However, due to the COVID-19 pandemic, the usage of questionnaires in the form of hard copies failed. This was mainly because of the movement restricted in the city, due to lockdown regulations. As result, the study had to resort to the usage of online services such as emails and WhatsApp platforms to reach the participants. The challenge with this approach was the access to email addresses and phone numbers were difficult hence the study could not find the anticipated number of responses. Furthermore, due to the technicality of the gadgets to respond to questionnaires, the participants were limited to professionals only.

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7. Appendices

Appendix A： Extract of Questionnaires from Monkey Survey System

Walkability Audit Tool: Route: Corner Devinish and Landross Mare to Thabo Mbeki Street

Welcome to My Survey

My Name is Reginah Makgata studying Masters of Engineering in Transportation Studies at University Cape Town. I am currently conducting research study on the "Impact of NMT Infrastructure on Pedestrian Movement in the City of Polokwane. The aim of the study is to assess the movement of pedestrians within the part of Landross Mare corridor in the city and availability of proper NMT infrastructure. It will take you not more than 30minutes to walk on the corridor and respond to questionnaires.

Thank you for participating in the survey. Your feedback is important.

1. Please indicate your gender.

- ◯ Female
- ◯ Male
- ◯ Other

2. Please indicate your age category.

- ◯ Under 18
- ◯ 18-24
- ◯ 25-34
- ◯ 35-44
- ◯ above 44

3. I agree to participate in the research study and I understand the purpose and nature of this. I am participating in this study voluntarily and I understand that I can withdraw at any time without penalty or consequences.

- ◯ Yes
- ◯ No

Walkability Audit Tool: Route : Corner Devinish and Landross Mare to Thabo Mbeki Street

Safety

4. How do you rate walking environment?

Excellent	very good	Good	poor	very poor
○	○	○	○	○

5. How do you rate the behavior of motorists towards pedestrians?

Excellent	Very Good	Good	Poor	Very Poor
○	○	○	○	○

6. Are there safe crossing facilities along the route?

Excellent	Very Good	Good	Poor	Very Poor
○	○	○	○	○

7. How do you rate level of your safety against the motorists?

Excellent	Very Good	Good	Poor	Very Poor
○	○	○	○	○

Walkability Audit Tool: Route : Corner Devinish and Landross Mare to Thabo Mbeki Street

Security

8. Is your personal safety good, using the sidewalk?

Excellent	Very Good	Good	Poor	Very Poor
○	○	○	○	○

9. How do you rate streetlights on the path?

Excellent	Very Good	Good	Poor	Very Poor
○	○	○	○	○

10. How do you rate level of human activities along the street?

Excellent	Very Good	Good	Poor	Very Poor
○	○	○	○	○

Walkability Audit Tool: Route : Corner Devinish and Landross Mare to Thabo Mbeki Street

Infrastructure

11. How do you rate the Quality of pavement material?

Excellent	Very Good	Good	Poor	Very Poor
○	○	○	○	○

12. How do you rate the provision of walking space (minimum=2m)?

Excellent	Very good	Good	Poor	Very Poor
○	○	○	○	○

Walkability Audit Tool: Route : Corner Devinish and Landross Mare to Thabo Mbeki Street

Comfort

13. How do you rate the cleanliness and maintenance of walking environment?

Excellent	Very Good	Good	Poor	Very Poor
○	○	○	○	○

14. How do you rate the absents of obstructions along the route?

Excellent	Very Good	Good	Poor	Very poor
○	○	○	○	○

15. How do you rate availability of amenities along the route, such as dustbin and benches?

Excellent	Very Good	Good	Poor	Very Poor
○	○	○	○	○

16. How do you rate the degree of path drainage along the route?

Excellent	Very Good	Good	Poor	Very Poor
○	○	○	○	○

Walkability Audit Tool: Route : Corner Devinish and Landross Mare to Thabo Mbeki Street

Availability of footpath

17. How do you rate the continuity of the sidewalk?

Excellent	Very Good	Good	Poor	Very Poor
○	○	○	○	○

18. How do you rate the sidewalk located on both sides of the route?

Excellent	Very Good	Good	Poor	Very Good
○	○	○	○	○

19. How do you rate access for people with disability on the route?

Excellent	Very Good	Good	Poor	Very Good
○	○	○	○	○

Walkability Audit Tool: Route : Corner Devinish and Landross Mare to Thabo Mbeki Street

Demographics and general questions

20. What is the most important factor associated with choosing the route?

21. Do you have an access to motorised transport along this route?

22. How many times do you walk to and from public transport facility in a week?

- 0-4 times
- 4 -6 times
- 6 -8 times
- 8-10 times
- 10 and above times

Walkability Audit Tool: Route : Corner Devinish and Landross Mare to Thabo Mbeki Street

Explain how COVID19 has changed and improved walking Safety

23. Did COVID 19 pandemic improve walking environment?

Not at all	Hardly	Don't know	Somewhat	Very Much
○	○	○	○	○

24. Did COVID 19 Pandemic improve safe Crossing on the road?

Not at all	Hardly	Don't know	Somewhat	Very Much
○	○	○	○	○

Walkability Audit Tool: Route : Corner Devinish and Landross Mare to Thabo Mbeki Street

Explain how COVID19 has changed and improved walking

Security

25. How does the COVID 19 pandemic affect the use of sidewalk use?

Not at all	Hardly	Don't know	Somewhat	Very much
○	○	○	○	○

26. How does COVID 19 pandemic affects Street Activities?

Not at all	Hardly	Don't know	Somewhat	Very much
○	○	○	○	○

27. Is there any personal Security improvement due to COVID 19 Pandemic?

Not at all	Hardly	Don't know	Somewhat	Very much
○	○	○	○	○

Walkability Audit Tool: Route : Corner Devinish and Landross Mare to Thabo Mbeki Street

28. What are the challenges of Non-motorized Transport (NMT) within Polokwane City?

Appendix B: Important Factors Associated with choosing the Route

Grouping	Row Labels	Female	Male	Grand Total
Access to amenities	Access to amenities	1		1
	Access to banks, municipal office, and shops,etc.		1	1
	Access to the N1 and the Polokwane Municipality		1	1
	CBD, availability of most amenities and civic services		1	1
	Closer to work, enroute to shops		1	1
Convenience	Convince		1	1
	Distance to destination		1	1
	Easy access to town	1		1
	I avoid it at all cost when busy		1	1
Safety	It's safe and having many shops that are needed	1		1
Convenience	Less traffic		1	1
Others	None	1		1
	Nothing		1	1
comfort	One way	1		1
Safety	safety	2		2
	Safety	1	1	2
	Safety and accessibility	1		1
	Safety, walkability, continuity	1		1
	Street lights and traffic lights		1	1
comfort	Very day route	1		1
	Grand Total	11	11	22

Appendix C : Research Ethics Approval

Application for Approval of Ethics in Research (EIR) Projects
Faculty of Engineering and the Built Environment, University of Cape Town

ETHICS APPLICATION FORM

Please Note:
Any person planning to undertake research in the Faculty of Engineering and the Built Environment (EBE) at the University of Cape Town is required to complete this form before collecting or analysing data. The objective of submitting this application *prior* to embarking on research is to ensure that the highest ethical standards in research, conducted under the auspices of the EBE Faculty, are met. Please ensure that you have read, and understood the EBE Ethics in Research Handbook (available from the UCT EBE, Research Ethics website) prior to completing this application form: http://www.ebe.uct.ac.za/ebe/research/ethics1

APPLICANT'S DETAILS		
Name of principal researcher, student or external applicant		MAMUDI REGINAH MAKGATA
Department		CIVIL ENGINEERING
Preferred email address of applicant:		makgatareginah@gmail.com
If Student	Your Degree: e.g., MSc, PhD, etc.	MENG
	Credit Value of Research: e.g., 60/120/180/360 etc.	60
	Name of Supervisor (if supervised):	Prof. Marianne Vanderschuren
If this is a research contract, indicate the source of funding/sponsorship		
Project Title		

I hereby undertake to carry out my research in such a way that:

- there is no apparent legal objection to the nature or the method of research; and
- the research will not compromise staff or students or the other responsibilities of the University;
- the stated objective will be achieved, and the findings will have a high degree of validity;
- limitations and alternative interpretations will be considered;
- the findings could be subject to peer review and publicly available; and
- I will comply with the conventions of copyright and avoid any practice that would constitute plagiarism.

APPLICATION BY	Full name	Signature	Date
Principal Researcher/ Student/External applicant	Mamudi Reginah Makgata		20/11/2019
SUPPORTED BY	**Full name**	**Signature**	**Date**
Supervisor (where applicable)	M Vanderschuren		20/11/19

Student will collect data from a small sample of Human Subjects

APPROVED BY	Full name	Signature	Date
HOD (or delegated nominee) First authority for all applicants who have answered NO to all questions in Section 1; and for all Undergraduate research (including Honours).	Dyllon Randall		07.07.2020
Chair: Faculty EIR Committee For applicants other than undergraduate students who have answered YES to any of the questions in Section 1.			