Creating a South African walkability audit tool to guide the planning of pedestrian friendly spaces

CM van der Walt

orcid.org/0000-0001-8628-2552

Dissertation accepted in fulfilment of the requirements for the degree *Master of Science in Urban and Regional Planning* at the North-West University

Supervisor:	Prof EJ Cilliers
Co-supervisor:	Dr LG Lategan

Graduation May 2020

25221272

PREFACE

This research (or parts thereof) was made possible by the financial contribution of the NRF (National Research Foundation) South Africa. Any opinion and conclusions or recommendations expressed in this study are those of the author and therefore the NRF does not accept any accountability in regard thereto.

A sincere thank you to:

My Heavenly Father for gifting me with the ability, patience and skill to complete this thesis.
My parents, Mercia and Martin van der Walt for all their endless love and support.
The North-West University - Potchefstroom for making this possible.
Lecturer and research supervisor Prof Juanee Cilliers for all her advice, insight, patience, after work WhatsApp's and constant motivation ('vasbyt').
Co-research supervisor Dr. Louis Lategan for all his ideas and advice.
The Coetzees for their support and snacks.
All my friends I had to say no to.
Ferdinand Postma Library for their research facilities and services.
The individuals that took the time to complete the questionnaire.

ABSTRACT

Walkable cities and the quality of the walking environment has become an important issue in planning and design, substantiated by the health agenda on the one hand and the green agenda and emphasis on non-motorised transportation opportunities on the other hand. The reality in South Africa suggests that walking is one of the most important modes of transportation, as it comprises 20.4% of the population's daily mode of transportation to work. However, in most cases, there are inadequate infrastructure, knowledge and guidelines to support walkability, let alone enhance walking as a mode of transportation. Studies illustrated that higher levels of physical activity were found in areas where well-planned sidewalks were present, suggesting a correlation between infrastructure provided in the built environment and walking as a chosen mode of transportation. This research, therefore, considered walkability and the planning of pedestrian-friendly infrastructure, specifically relating to design, accessibility and safety of such infrastructure. It reflected on existing walkability audit tools and a local case study to conclude on the challenges and opportunities of walkability in South Africa, and how spatial planning can contribute to creating walkable cities. The research recommends a walkability audit tool to help guide the planning of pedestrian-friendly spaces within a South African context.

Keywords: Walkability, Pedestrian-friendliness, Audit tool, Urban design, Spatial planning.

OPSOMMING

Loopbare stede en die kwaliteit van die omgewings het 'n belangrike kwessie geword in beplanning en ontwerp, gestaaf deur die gesondheidsagenda aan die een kant en die groen agenda en die klem op nie-gemotoriseerde vervoergeleenthede aan die ander kant. Die werklikheid in Suid-Afrika dui daarop dat stap een van die belangrikste maniere van vervoer is, aangesien dit 20.4% van die bevolking se daaglikse manier van vervoer na hul werk uitmaak. In die meeste gevalle is daar egter onvoldoende infrastruktuur, kennis en riglyne om loopvermoë te ondersteun. Studies het geïllustreer dat hoër vlakke van fisieke aktiwiteit gevind is in gebiede waar goed beplande sypaadjies aanwesig was, wat dui op 'n korrelasie tussen infrastruktuur wat in die beboude omgewing voorsien word, en stap as 'n gekose vervoermiddel. Hierdie navorsing het dus loopbaarheid oorweeg en die beplanning van voetgangervriendelike infrastruktuur, spesifiek verwant aan ontwerp, toeganklikheid en veiligheid van die infrastruktuur. Dit het weerspieël in bestaande ouditgereedskap en 'n plaaslike studie om af te lei oor die uitdagings en geleenthede van loopbaarheid in Suid-Afrika, en hoe ruimtelike beplanning kan bydra tot die skep van wandelbare stede. Die navorsing beveel 'n loopbaarheidsouditinstrument aan om die beplanning van voetgangervriendelike ruimtes binne 'n Suid-Afrikaanse konteks te help lei.

Sleutelterme: Loopbaarheid, Voetgangervriendelikheid, Ouditinstrument, Stedelike ontwerp, Ruimtelike beplanning.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

1.1 Introduction and problem statement

Although walking is often undervalued, it is an important mode of transportation as every trip starts and concludes with a walk. Walking is inexpensive and may be used as a mode of transport, physical activity or leisure (Litman, 2019:2). In South Africa (SA) 67.7% of learners walk to school each day and 20.4% of the population use walking as their mode of transportation to and from work (Statistics South Africa, 2019:16). SA has increased efforts to reduce road-related fatalities in recent years, despite these efforts the fatality numbers remain high. Road-related fatalities have increased, from 12 702 reported deaths in 2014 to 14 050 in 2017. In 2017, 33% of these fatalities were alleged to be pedestrians (Department of Transport, 2018). Pedestrian fatalities continue to be a serious concern for health and road safety authorities, particularly in lower and middle-income countries (Arrive Alive, 2017). According to Albers *et al.* (2010:1), the roadside environment is a key factor that may influence the number of pedestrian fatalities, as pedestrians make up a large number of the South African road users.

Walking requires no specific equipment; however, according to Gunn *et al.* (2017:2), the built environment is a fundamental aspect in developing pedestrian-friendly spaces that encourage walking. The degree to which an area accommodates the movement of pedestrians can be measured by the concept of walkability. An area with high levels of walkability meets people's needs for walking or spending time in an area on foot (Rafiemanzelat *et al.,* 2017:98). A pedestrian-friendly space, as such, has a sense of safety in terms of interaction with traffic and perceived crime (Forsyth and Southworth, 2008). There are numerous advantages of walkability, which stresses the importance of creating pedestrian-friendly spaces (McNally, 2010:8). Sidewalks play a significant role in developing a sustainable pedestrian-friendly space, as almost every trip involves the use of a sidewalk. Quality sidewalk infrastructure encourages walking which promotes physical activity and allows walking to be a viable mode of transport (Frackelton et al., 2013:1). Planning for walkability is of utmost importance to promote healthy living, enhance social life, create sustainable communities and to improve the economy (Singh, 2016: 643). A walkability audit tool can be established to help guide the planning of pedestrian-friendly spaces. This walkability audit tool may provide local planners and community members with data to identify areas of improvement or to guide the planning of new developments to increase the level of walkability (Aghaabbasi *et al*., 2018:475)

1.2 Aims and objectives of this research

The main research aim is to create a South African walkability audit tool to guide the planning of pedestrian-friendly spaces. Research objectives include to:

- Consider walkability, planning of sidewalks and pedestrian-friendly spaces from a spatial planning perspective.
- Consider international and local walkability audit tools to identify characteristics that may be used to inform a South African Walkability Audit Tool (SAWAT).
- Identify and consider walkability characteristics derived from the local perspective in South Africa by means of a structured e-questionnaire, to further inform the South African Walkability Audit Tool.
- Employ the proposed SAWAT characteristics within a local case study (Potchefstroom) to illustrate how the SAWAT characteristics may be used to contribute to the planning of pedestrian-friendly spaces.
- Recommend a South African Walkability Audit Tool to guide the planning of pedestrian-friendly spaces.

1.3 Primary research question

Four research questions were expressed in terms of the research aim and objectives. These research questions include:

- Why are walkability and pedestrian friendly-spaces important and how can these concepts be implemented?
- How may existing international and local walkability audit tools help inform the South African Walkability Audit Tool (SAWAT)?
- Why is it important for the SAWAT to be informed by the local perspective?
- How may the SAWAT be used to guide the planning of pedestrian-friendly spaces?

1.4 Methodology

The research included a literature review and an empirical investigation to inform conclusions and planning recommendations.

1.4.1 Comprehensive literature review

The literature review followed a thematic investigation on the concept of walkability and its benefits from a spatial planning perspective, as well as the importance of pedestrian-friendly spaces and its connection with walkability (Chapter 2). Thematic analysis is a common form of investigation within qualitative research. It focuses on recording, pinpointing and examining

themes within data (Komori & Christine, 2013). Planning and design components related to walkability and sidewalks design characteristics (Chapter 3) and the importance thereof in creating pedestrian-friendly spaces were reflected on, in an attempt to identify walkability and sidewalks design characteristics that were further explored as part of the empirical investigation. Policies and legislation that currently control walkability and pedestrian-friendly spaces were explored.

1.4.2 Empirical investigation

The empirical investigation comprised of three phases:

Phase one (Chapter 4) departed from the qualitative inquiry into existing international and local walkability audit tools to reflect on the respective walkability and sidewalk design characteristics included in relevant walkability audit tools. There were several walkability audit tools identified during this study. Therefore, each of the walkability audit tools included were purposefully selected for this thesis. The audit tools selected for the empirical investigation specifically focused on the assessment of the walkability and pedestrian-friendliness of a built environment and included similar categories of the walkability and sidewalk design characteristics identified in the literature study. The selected audit tools were reviewed according to the categories identified in the literature study: design, infrastructure, vehicle and pedestrian interactions, safety and aesthetics. Audit tools from different countries were included and reviewed, to identify the most frequently used characteristics and to inform the priority of the walkability and sidewalk design characteristics in the proposed South African Walkability Audit Tool (SAWAT). The methodology of this Chapter is further explained in Chapter 4.2.

Phase two (Chapter 5) of the empirical investigation attempted to capture the local perspective related to walkability in SA based on the viewpoint of a convenience sample of pedestrians. The pedestrians stated their opinions with regard to the walkability and sidewalk design characteristics identified in the literature study. The local perspective was captured through a quantitative inquiry by employing a structured e-questionnaire (e-questionnaire is attached as Annexure A), implying no direct contact with the participants, as distribution of the e-questionnaire was done via Facebook, WhatsApp and emails, where participation was voluntary, and consent was obtained by virtue of completing the e-questionnaire (see Chapter 5.2). The e-questionnaire was completed by 115 respondents. The local perspective on each of the characteristics was furthermore used to determine the priority of the walkability and sidewalk design characteristics included in the proposed SAWAT. The methodology of this Chapter is further explained in Chapter 5.1.

Phase three (Chapter 6) of the empirical investigation attempted to provide an example of how the SAWAT characteristics may be used to identify opportunities for improvement. Opportunities

for improvement were identified by comparing the current state of the selected study area and the qualities of the SAWAT characteristics in terms of the pedestrian friendliness of the area. If the respondents of the e-questionnaire indicated that they lived in Potchefstroom, they could answer the last section of the e-questionnaire as further explained in Chapter 5.2. This means only participants with adequate knowledge of the selected study area were included in the analyses. The Potchefstroom respondents indicated walkability and sidewalk design characteristic categories with which they were unsatisfied. These categories were used to illustrate how the proposed SAWAT walkability and sidewalk design characteristics may be used to identify the opportunities for improvement. The methodology of this Chapter is further explained in Chapter 6.1.

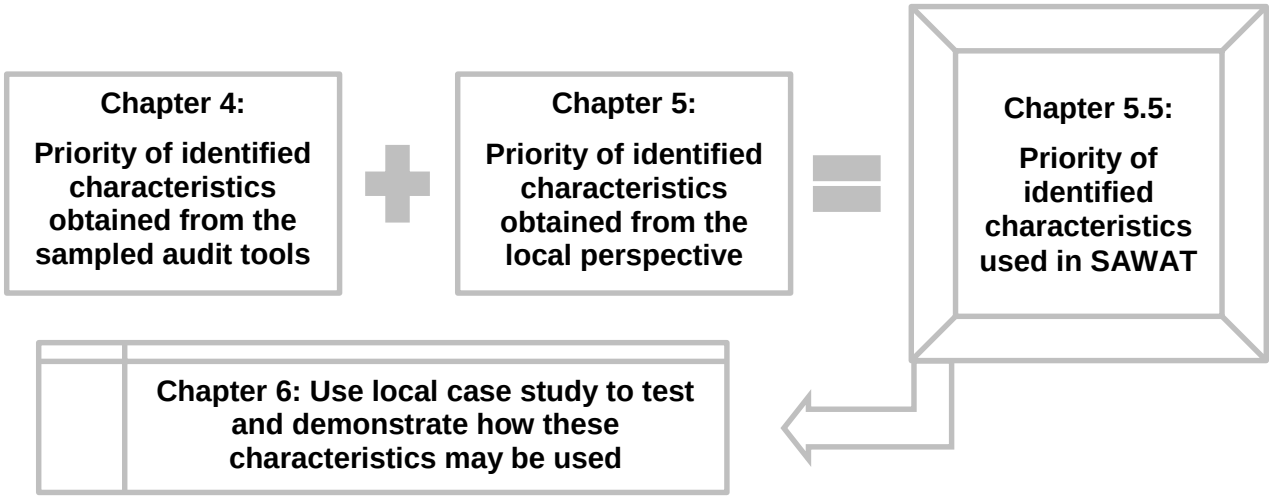


Figure 1- 1: The structure of the empirical section

Source: Own construction (2019).

All three phases (audit tool comparison, local perspective and opportunities for improvement) were considered collectively, to refine a theoretical walkability audit tool for the South African context. In the conclusion (Chapter 7) and recommendation chapter (Chapter 8), the final SAWAT was proposed.

1.5 Delineation of the study area

Phase 3 of the empirical investigation refers to a study area located in Potchefstroom, North West, SA. The research area is located in Northern Potchefstroom, next to the North-West University (NWU) campus as illustrated in Figure 1-2. The central coordinates of the study area are 26°41'32.1"S 27°05'37.9"E. The study area consists of sections of four streets namely Meyer Street, Steve Biko Street, Borcherds Street and Hoffman Street. These sections are all single lane, two-way streets. The area selected was due to its high volume of pedestrian movement and because general pedestrian infrastructure problems were observed. This area can be considered

a pedestrian area as it acts as a central connection point between several land uses and activities. These include residential, institutional, business and recreational uses. This forms a natural flow of pedestrians between the residential, institutional, business and recreational uses during the day and continues between the residential, business and recreational uses at night. The chosen area is a popular pedestrian orientated space due to the proximity of all these uses and activities but lacks several pedestrian related infrastructures.

Figure 1- 2: Location of study area

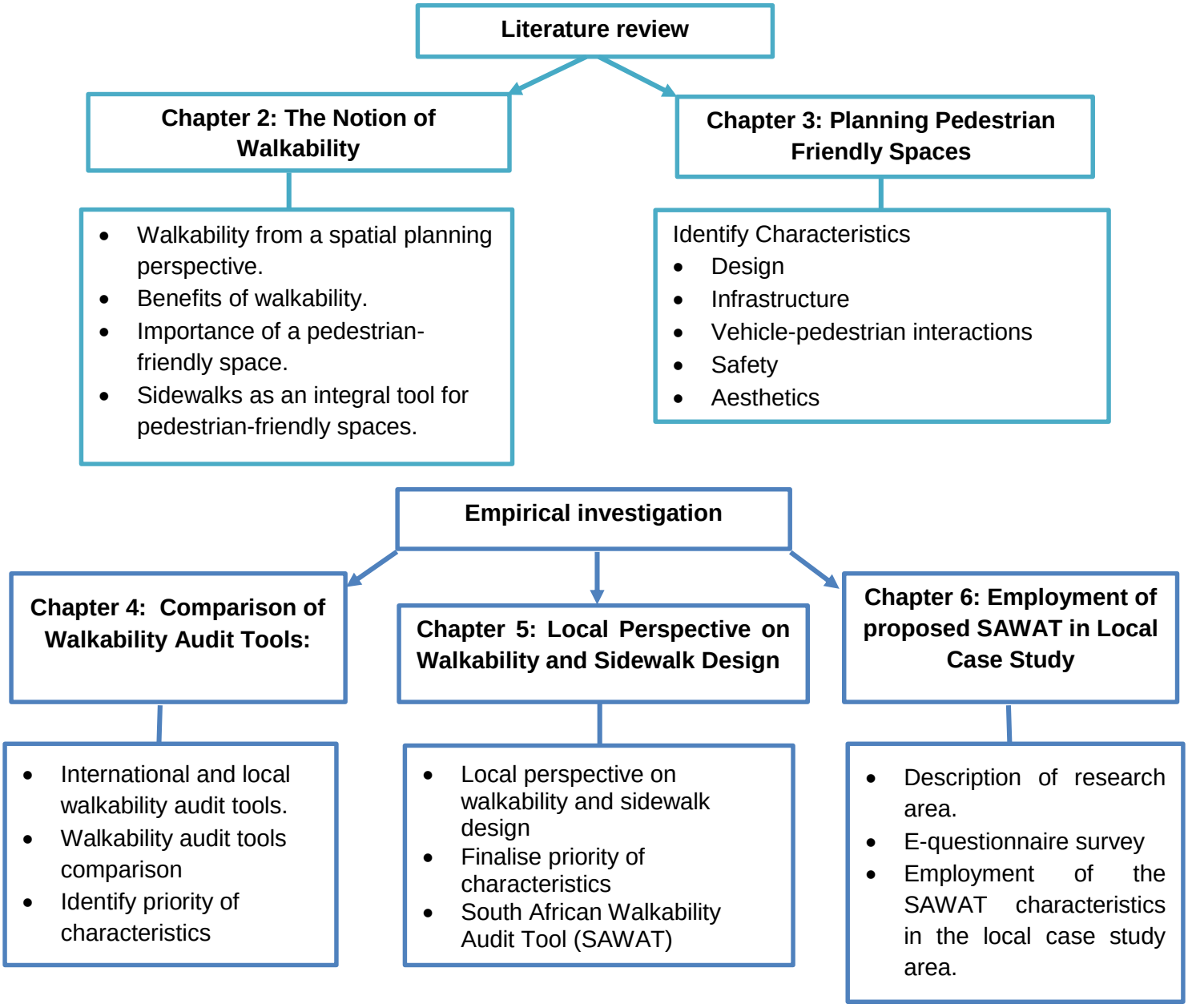
1.6 Limitations of the research

This study focuses on creating a South African walkability audit tool to guide the planning of pedestrian-friendly spaces but recognises the following limitations:

- The target population is not explicit to any particular group, which means no specific ethnic group, age group or sexual orientation are targeted.
- The sample size used to gain the local perspective of South Africans on walkability is limited due to the selection of a convenience sample of individuals that were willing to respond to the e-questionnaire. The local perspective in this research referred to 115 respondents.
- The success or weaknesses of each of the sampled audit tools were not evaluated in practice.
- Photographs of the street sections in the local case study were captured during the day only and not at night due to the lack of lighting.
- As limited studies have been conducted on walkability audit tools for the South African environment, this research serves as a point of departure and pilot study to inform further research.

1.7 Structure of research

The structure of this research is captured in *Figure 1-1* below:



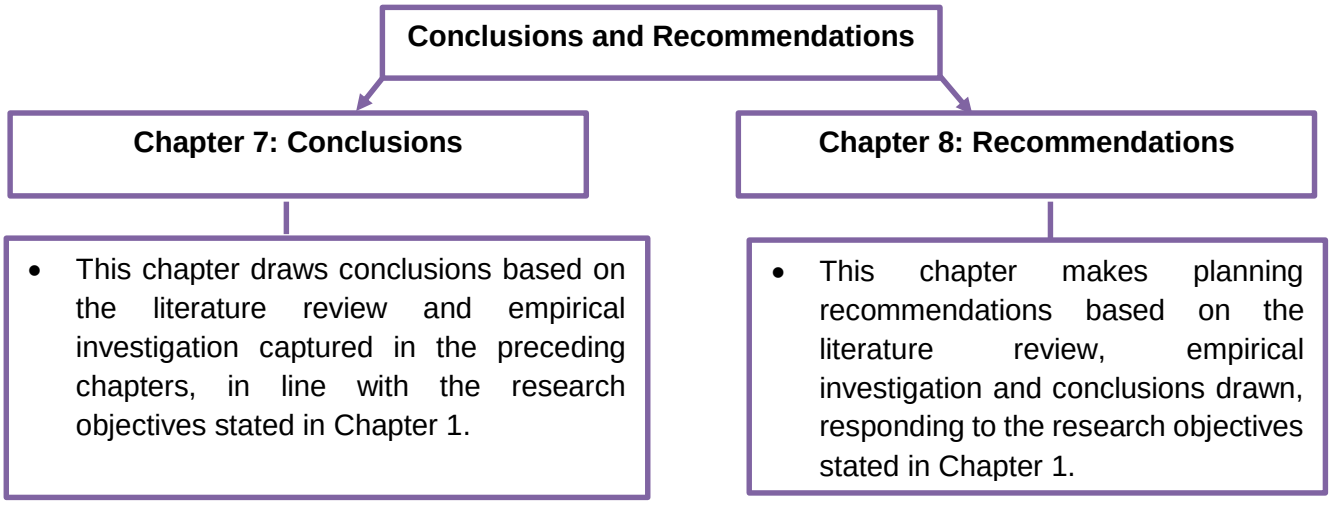


Figure 1-3: Research Structure

Source: Own construction (2019).

1.8 Definitions and Acronyms

1.8.1 Definitions

Pedestrian-friendly spaces	A pedestrian-friendly space is defined as an area that is walkable with urban structures that support active living (Reyer *et al*., 2014:5850).
Sidewalk	Sidewalks are standardised pieces of hard material usually located between roads and surrounding buildings. Sidewalks delineate suitable places for people to walk and provide areas for the ease of other modes of transport. Sidewalks are also known as footways, pavements, footpaths or sometimes platforms (Minnery, 2012).
Walkability	Walkability measures the degree to which an area accommodates pedestrian movement (Rafiemanzelat *et al*.,2017:98).
Walkability Audit Tool	A Walkability Audit Tool is a tool used to identify gaps and opportunities to enhance the safety of pedestrians, amenity and accessibility, identify appropriate solutions, and record the findings of the current situation in an audit report that may be used to provide a Municipality with an action plan. An audit tool may be used by government officials, professional consultants and community groups (Aghaabbasi et al., 2017).

Source: Own construction (2019).

1.8.2 Acronyms

The following acronyms used in this dissertation:

ANC	Active Neighbourhood Checklist
CSIR	Council for Scientific and Industrial Research
IDP	Integrated Development Plans
LUPA	Land Use Planning Act
MAPS	Microscale Audit of Pedestrian Streetscapes
NMT	Non-motorised Transport Policy
NWU	North West University
PEAT	Pedestrian Environment Assessment Tool
RIFSA	Road Infrastructure Strategic Framework for South Africa
SA	South Africa
SAWAT	South African Walkability Audit Tool
SDF	Spatial Development Frameworks
SPLUMA	Spatial Planning and Land Use Management Act
SMME	Small Medium and Micro Enterprises
SPACES	Systematic Pedestrian and Cycling Environmental Scan
SWAT	Scottish Walkability Assessment Tool
USA	United States of America
WHO	World Health Organisation

Source: Own construction (2019).

CHAPTER 2: THE NOTION OF WALKABILITY FROM A PLANNING PERSPECTIVE

2.1 Points of departure

The chapter aims to consider walkability and planning of sidewalks from a planning perspective. The essence of walkability and pedestrian-friendly spaces will be discussed, reflecting on the significance of pedestrian-friendly spaces and the benefits of walkability. The function of sidewalks and the importance of planning efficient public sidewalks to create pedestrian-friendly spaces will also be discussed as a point of departure to contextualise this research.

2.2 Walkability from a spatial perspective

Walkability is a concept that is used to measure the degree to which an area accommodates the movement of pedestrians. It is the extent to which an area fulfils people's needs for walking and offers a supportive environment where people can spend more time in an area on foot (Malambo *et al*., 2017:98). Walkability is the construct of walk and ability. The Oxford Advanced Learner Dictionary (2011) defines the term 'ability' as the "fact that somebody or something is able to do something" which means it is an environment where pedestrians are provided with the choice to use their ability to walk (Shamsuddin *et al*., 2012:168). Furthermore, walkability refers to the level of personal safety and comfort experienced by pedestrians through the existence of characteristics like high quality connected pedestrian paths, spaces with landscape elements and protection from fast-moving traffic (Zakaria & Ujang, 2015:643). Litman (2004:7) defines walkability as an environment where walking is freely available, well connected, accessible and a safe way of transport. Walkability may be seen as a concept that is directly related to several elements of the built environment (Adkins *et al*., 2012:501)

Moreover, the term walkability is considered as a measurement of comfort in a pleasant walking environment which encourages a healthy lifestyle and improves the quality of life of residents (Shamsuddin *et al*., 2012:168). According to McNally (2010:8), walkability is a multidimensional concept consisting of various features of a community that ensures an area that supports travels without the use of automobiles. It is seen to be a part of the approach for liveable, sustainable cities and does not only mean a walking-friendly area but a place where pedestrians can participate in social attractions and have more assurance of the environment in which they live (Tran, 2016:1). Walkability forms part of active living, a system that embraces physical activity as a part of daily routines, inclusive of a variety of activities comprising of walking and cycling for exercise, transport, pleasure, participating in sports, working in the garden, playing in parks and recreational facilities (Edwards & Tsouros, 2006:14).

2.3 Benefits of walkability

According to McNally (2010:8), there are several advantages of walkability, which indicates the importance of having an efficient and sustainable walking environment. McNally (2010:8) states that the advantages of a community that has high levels of walkability may be seen across a variety of subtopics which includes economic, environmental and social aspects. There are numerous benefits associated with walkability found throughout literature. Benefits include health benefits (Tudor-Locke & Myers, 2001:3), environmental benefits (Litman, 2011), social benefits (Southworth, 2005:248), transportation benefits (Tudor-Locke & Myers, 2001:3), economic benefits and safety benefits (McNally, 2010:6).

2.3.1 Health benefits

Health is the most prominent benefit of walkability in a community, as walking allows for direct and indirect forms of exercise (Rafiemanzelat *et al*., 2017:99). According to Tudor-Locke & Myers, (2001:3), walking has numerous mental and physical health benefits. Walking is the most affordable and accessible approach to promote healthier lifestyles and increase levels of physical activity and allows people to exercise without them being aware of it. This means without realising it people can become more physically active through the creation of pedestrian-friendly spaces (O'Hanlon *et al*., 2016). When individuals walk at least 30 minutes per day, it decreases the levels of obesity and lowers the risk of diabetes, levels of depression, cardiovascular disease, high cholesterol and even decreases the risk of cancer. The World Health Organisation (WHO) recommends 150 minutes of regular physical activity per week which can be facilitated by a community that has a high level of walkability (World Health Organization, 2010; Rafiemanzelat *et al*., 2017:99). A community with high levels of walkability allows residents to select the healthy option and make walking their main form of transportation (McNally, 2010:5). Research illustrates that walking improves cognitive performance, reduces stress and anxiety, improves sleep and enhances the feeling of wellbeing, thus overall has a positive effect on mental health (Claris & Scopelliti, 2016:36). According to Litman (2011), the overall health of people may improve, should planners create walkable cities where people can make walking the primary source of transportation.

2.3.2 Environmental benefits

Planning for walkability reduces the dependency on automobiles, which means harmful gasses emitted from cars are reduced as more people choose walking as a mode of transport (McNally 2010:5; Depart of Transportation, 2013:39; O'Hanlon *et al*., 2016). Litman (2011), states that walking is an environmentally-friendly form of transportation with a low environmental impact. The reduction in roads designed for cars means that there are lower levels of pollution emissions and

energy consumption which therefore reduces the “heat island” effect which takes place when tar absorbs and releases heat (Shaaban., 2019:1). Moreover, fewer roads mean less water runoff from roads and a reduction in water pollution. South Africa emits 1.2% of global carbon dioxide and is the world’s 15th largest carbon dioxide emitter (Vosper & Mercure, 2016:25).

2.3.3 Economic benefits

Walkable communities allow residents to reduce expenses linked with operating and owning cars. In a walkable community, households spend half as much money on transportation than those in car reliant neighbourhoods (O’Hanlon *et al*., 2016). Communities that are pedestrian-friendly and that facilitate walkability have higher retail, residential and office rental value (O’Hanlon *et al*., 2016). According to McNally (2010:6), increasing the walkability of a neighbourhood increases economic and business opportunities and promotes economic activity within the community by increasing shopping at local stores and supporting employment creation (Claris & Scopelliti, 2016:63). Walking provides accessibility and basic mobility for individuals to reach activities such as essential errands, medical services, employment and education. This usually affects people in lower-income groups who are disadvantaged in terms of transportation. Communities with poor walkability can, therefore, cause economic exclusion. Walking can help with the economic development of an area as walking allows commercial areas to be more attractive. Most importantly, walking will enable consumers to save on transportation costs (Litman, 2017:9).

2.3.4 Safety benefits

A safe environment can be made possible by the creation of a walkable environment. Pedestrians tend to feel safer in communities that implement crosswalks, street buffers and other applicable sidewalk infrastructure that increase the level of walkability (McNally, 2016:6). Research indicates that pedestrian-friendly cities and neighbourhoods designed to accommodate pedestrians have a lower number of traffic fatalities in comparison to areas that are primarily car orientated (O’Hanlon *et al*., 2016). By creating a walking culture, pedestrian movement increases, which generates a greater awareness of pedestrian movement under vehicle users. Walkable communities tend to have lower speed limits which reduce the number of pedestrian injuries, especially for the elderly and young children (Rafiemanzelat *et al*., 2017:99).

2.3.5 Social benefits

According to the Centre for Disease Control and Prevention (CDC), walking is a form of exercise which may improve psychological wellbeing and quality of life. Walking can increase wellbeing and increase a sense of community and residents in a walkable community may experience a greater sense of belonging (Rafiemanzelat *et al*., 2017:100). Mixed-use pedestrian-friendly neighbourhoods enhance social capital as they facilitate the interaction between residents which

may be accidental or intentional. Brief conversations, accidental “bumping into” neighbours or just waving hello may inspire a sense of connection and trust between people and the community they live in. To many individuals, such encounters may be the source of a sense of predictability and familiarity which most people find comforting (Leyden, 2003:1546). Furthermore, research indicates that communities with high levels of walkability have increased community cohesion and neighbourhood interaction (Zhu *et al., 2014*:93).

2.3.6 Transportation benefits

Lower maintenance costs, less traffic congestion and better air quality, may be achieved by providing multi-modal transportation options, that include walking. A balanced transportation system may make walking to transit a practical option, rather than the construction of new multi-lane highways and streets. (O’Hanlon *et al*., 2016). A walkable environment supports the use of public transportation that is provided by the authorities. Authorities may use walkability to support the public transportation infrastructure (Devlin *et al*., 2009:3).

2.4 Importance of pedestrian-friendly spaces from a spatial planning perspective

A walkable environment has many advantages which increase the general pedestrian friendliness of an area (McNally, 2010:6). It is, therefore, important to consider, what a pedestrian-friendly space is and the significance of such an area. A pedestrian-friendly space is defined as an area that is walkable with urban structures that support active living (Reyer *et al*., 2014:5850). In a pedestrian-friendly space, pedestrians do not have to walk far to reach a variety of goods and services, especially beneficial to people who do not own cars. This space generally doesn’t have many barriers and is relatively traversable. A pedestrian-friendly space has a sense of safety in terms of interaction with traffic and perceived crime (Forsyth and Southworth., 2008). There are various reasons why there is a need for pedestrian-friendly spaces. Walking is often not given high priority when planning new towns or cities. According to Franklin (2006:57), walking is often undervalued. There is a need for pedestrian-friendly spaces as it provides individuals with the opportunity to live actively (Saelens *et al*., 2003:83) and allow active transportation as well as transportation equity (O’Hanlon *et al*., 2016).

2.4.1 Active living through the creation of pedestrian-friendly spaces

Internationally physical inactivity has progressively become a product of the car-orientated built environment (Brownson *et al*., 2009:100). According to the World Health Organization (2011), adults ought to do at least 150 minutes of aerobic physical activity per week. Most people do not meet these guidelines, which means inactivity is posing a threat to public health. Activity-supportive built environments improve levels of physical activity and have many other benefits much social, economic, environmental and health benefits. Creating an environment that is

pedestrian-friendly and activity-friendly has been linked to progressive changes in injury prevention, chronic illness, traffic congestion, mental health, social benefits, economic benefits, carbon emissions and air pollution (O'Hanlon *et al*., 2016). Numerous studies have been done to examine walking and cycling as a form of transportation or to examine components of walkability in high and low walkable neighbourhoods (Litman, 2003), (Rafiemanzelat *et al*., 2017), (Frackelton *et al*., 2013:4). These studies consistently indicate that walking and cycling are the most efficient and sustainable forms of transportation when supported by activity-friendly infrastructure (Saelens *et al*., 2003:83). Studies indicate that residents in a community that is pedestrian-friendly have more than double the chance to meet the physical activity recommendations than those who live in communities with low levels of walkability (Frank et al., 2005:119). Studies performed by the United States Transportation Research Board states that levels of physical activity performed by residents are directly linked to the design of the community (Sallis *et al*., 2006:91).

2.4.2 Active transportation & transportation equity through pedestrian-friendly spaces

Pedestrian-friendly spaces foster active transportation which is essential in creating sustainable communities. Any form of transport that is human-powered is known as active transport (Greaves & Standen, 2019:60). Pedestrian facilities and infrastructure that are well planned, built and maintained have a positive impact on the promotion of active transport. Due to the dangers caused by vehicular traffic and lack of biking and pedestrian services, people are often unwilling to use alternative forms of transportation (O'Hanlon *et al*., 2016). Almost every trip that includes the use of bicycle, public transit, or car starts with walking, which makes every individual a pedestrian. Numerous roads are planned only with cars in mind, but more than 20% of people in South Africa do not drive as they cannot afford a car. (Department of Transport, 2013:13). Many non-driving individuals have difficulty navigating areas that are not pedestrian-friendly. Walking is frequently the first and last kilometre link for individuals who depend on public transport. These individuals are often people who do not own cars, individuals with disabilities, people who do not drive or economically underprivileged individuals. To create transport equity for people with special needs or individuals with limited mobility, it is important to create walkable, pleasant and safe pedestrian-friendly areas (O'Hanlon *et al*., 2016).

2.4.3 Pedestrian-friendly spaces are undervalued

Walking is often overlooked and undervalued, especially from a spatial planning perspective (Franklin, 2006:57). When planning travel modes, pedestrian-friendly spaces are given very little attention, which indicates walking is often not considered by planners that deal with transportation issues (Litman, 2018:6). Compared to motorised transport, walking is often considered to have a lower status. Motorised transport is likely to be related to progress and success, where walking is

predominantly used by lower-income people, which usually means walking tends to be denounced (Litman, 2018:6). A pedestrian-friendly space may reduce consumer costs as walking is inexpensive (Litman, 2018:6). One of the main reasons why walking is disregarded is because it is cheap, which often means there is limited dedicated funding. This is the reason why there is no industry for walking, where the industry for transit, air travel and automobile are increasing. General planning practices tend to undervalue and ignore the benefits of public health and physical activity that could be provided by improved mobility and active transportation. Pedestrian-friendly spaces are often taken for granted by decision-makers, who regularly accept that walking can take care of itself (Litman, 2017).

2.5 Sidewalks as an integral tool for pedestrian-friendly spaces

Sidewalks are standardised pieces of hard material usually located between roads and surrounding buildings. Sidewalks delineate suitable places for people to walk and provide areas for the ease of other modes of transport. Sidewalks are also known as footways, pavements, footpaths or sometimes platforms (Minnery, 2012). The term “pavement” or “footway” is generally preferred in most Commonwealth countries. In contrast, the term “sidewalk” is more common in other countries like North America. According to the Department of Housing (2005) the guidelines for human settlement planning and design indicate that the term “sidewalk” or “pedestrian paths” are formally used in South Africa. Sidewalks play a key role in developing a sustainable pedestrian-friendly environment. Quality sidewalk infrastructure encourages physical activity and allows walking to be a viable mode of transport (Frackelton *et al*., 2013:4). According to Landis *et al.* (2005:83), good quality sidewalks have been found to improve the general satisfaction of a pedestrian environment. Sidewalks are known to have both social and economic functions (Deacon, 2013).

2.5.1 Development of the concept of sidewalks

Studies indicate that sidewalks were constructed in ancient times. Historically, sidewalks first surfaced around 2000 BC in what is today known as modern Turkey (Deacon, 2013:10). It is claimed that the city of Corinth had paving in the 4th-century. The Romans were very creative “semitas” builders which also was the name of their sidewalks. The middle ages brought a new narrow road design as it was used by both wagons and pedestrians with no separation between these two modes of transportation. Research illustrates that around 1623 there were some attempts to maintain sidewalks and footways in Britain, but it was often found not to be effective (Loukaitou-Sideris & Ehrenfeucht, 2009). Sidewalks evolved to paved surfaces from dirt paths. During the 18th century, the House of Commons released a series of paving Acts. These Acts instructed the City of London Corporation to build Purbeck stone footways all along London’s streets. The Corporation was also authorised to raise the footways to create separation between

the street and the paths. Other responsibilities included the repairing and cleaning of footways for which tax was charged in 1766. Spacious pavements were constructed in the late 19th century throughout the European capitals and were seen as an urban necessity (Clarke, 2012). In Northern America sidewalks could be seen in the 19th century. Residents had to pay for their own sidewalks, or they were at risk of being sued by the Supreme Court, which was the case in Louisiana in 1917. In 1991 regulations were introduced which instructed developers to construct sidewalks on at least one side of every new street. The same year, an Act was released by Congress which led to the funding of the construction of walking and cycling infrastructure for the first time by reassigning highway funds (Martin, 2017).

2.5.2 The importance of sidewalks in spatial planning

Planners often identify the benefits of the provision of good quality sidewalk infrastructure for safety, quality of life and accessibility, but frequently overlook the data that is needed to encourage and support the implementation and development of improvement projects (Frackelton *et al*., 2013:4). Most people use sidewalks every day, and almost every trip that is taken involves the use of a sidewalk even if it is for a brief period only. According to Loukaitou-Sideris and Ehrenfeucht, (2010:469) sidewalks do not only have one function, although the primary function of a sidewalk is transportation, it also has social and economic functions. Sidewalks allow pedestrians to walk comfortably and safely. Specific regulations and guidelines are followed when designing sidewalks, and other sidewalk features including buffers and crosswalks which impact the spatial character of an area (McNally, 2010:8).

Sidewalks have an economic function because it often acts as the front door to most businesses. Sidewalks that are well-maintained, safe and accessible are vital and indispensable investments for cities, and it has illustrated to improve general health and grow social capital (US Department of Transportation, 2009). The fact that sidewalks provide essential corridors for goods, people and commerce indicate that well-planned pedestrian networks that promote walkability have a progressive influence on land values (US Department of Transportation, 2009). Sidewalks are also economically sustainable since it has a lifespan of around 25 years depending on the material used, with only some maintenance needed (Cortright, 2009). Sidewalks support street vending and provide recyclers with the opportunity to collect bottles and cans for recycling, which furthermore means that sidewalks allow the informal economy to prosper which is important as South Africa has an enormous informal economy (Deacon, 2013).

According to the Advanced Sidewalks and Streets Toolkit (2011) sidewalks are a vital part of city life and act as channels of access and movement which promotes walkability and improves connectivity. Sidewalks allow pedestrians to have their own area of circulation that is demarcated

from other modes of transportation which indicates that sidewalks play a significant role in the built environment of a city (Deacon, 2013).

2.6 South African legislative and policy that guides the planning of walkability

The Constitution of the Republic of South Africa, Act 108 of 1996 Section 85 (1) (b) orders the Department of Transport to develop a transport policy (Constitution of the Republic of South Africa, 1996). The Department of Transport has a great responsibility to attend to the mobility needs of all citizens, and therefore the Non-Motorised Transport Policy (NMT) was created in an attempt to address this matter. This NMT is governed by several legislations including the National Land Transport Transition Act, Act No. 22 of 2000, National Land Transport Strategic Framework, White Paper on National Transport Policy (1996) Public Transport Action Plan (2007) and other legislation such as the Rural Transport Strategy for South Africa 2007, Animal Protection Act 71 of 1962, National Road Traffic Act, Act 93 of 1996 and Local Government By-Laws (Department of Transport, 2008:12).

The objectives of the NMT policy include; the incorporation of the NMT into the transport system through spatial and transport planning, develop infrastructure that supports and maintains NMT as an important mode of transportation, to reduce the number of non-motorised road uses fatalities, promotion of NMT safe, healthy, reliable and accessible mode of transport, enablement of the use of NMT as a mode of transport, allocation of sustainable funding for the promotion of NMT, improvement of traffic legislation that supports and recognises NMT as an essential mode of transport, to facilitate and assist NMT as a feeder structure to other transport modes, encourage new initiatives and research that improves NMT and to empower small medium and micro enterprises (SMME) through NMT (Department of Transport, 2008:15).

The NMT policy refers to the NMT Facility Guideline Manual, which governs the walking and cycling infrastructure in SA. This document seeks to incorporate cyclist and pedestrian amenities with other government initiatives or documents to ensure a built environment that support these road users. This Guideline is aligned to the Moving South Africa Action Agenda (2020), the National Land Transport Act of 2009, Shova Kalula Rollout Plan (2007), Municipal Integrated Development Plan (IDP) and the Road Infrastructure Strategic Framework for South Africa (RIFSA). The Facility Guideline Manual is linked to other manuals including South African Road Safety Manual and the South African and SADC Road Traffic Signs Manual. (Department of Transport, 2014:1).However, by observing the NMT facility guidelines it is evident that there is a lack of integration with town planning policies such as the Spatial Planning and Land Use Management Act (SPLUMA), Land Use Planning Act (LUPA), Spatial Development Frameworks (SDF's) and planning by-laws (Department of Transport, 2014).

The Neighbourhood Planning and Design Guide (Red Book) is a guide that concerns the quality of the built environment, natural resources and engineering services. This document is the outcome of concerns raised by several government departments lead by the Department of Housing and contracted to the Council for Scientific and Industrial Research (CSIR). This document discusses specific design characteristics of sidewalks, pedestrian orientated streets, public utilities and the geometric design and layout planning of roads which addresses a few designs and the planning of pedestrian-friendly areas (Department of Housing, 2003).

There are a few policies and legislation that are responsible or have a relationship with the guidance and implementation of spaces that accommodate pedestrian movement. Many of these guidelines are yet to be implemented and integrated with other planning policies

2.7 Conclusion of Chapter 2

Walkability is a concept that allows the measurement of the extent to which an area accommodates and provides for pedestrians related activities (Rafiemanzelat *et al*., 2017:98). Walkability has many benefits which include; health benefits (Litman, 2011), environmental benefits (Tudor-Locke & Myers, 2001:3), economic benefits safety benefits (McNally, 2010:6), social benefits (Southworth, 2005:248) and transportation benefits (Tudor-Locke & Myers, 2001:3).

This indicates the importance of the integration of walkability into every neighbourhood and development of future towns and cities. Sidewalks are an integral tool to create pedestrian-friendly spaces. Sidewalks have three functions, namely economic, social and transportation functions (Frackelton *et al*., 2013:4; Deacon, 2013). Walkability and sidewalk design characteristics will be investigated in depth in Chapter 3 to determine their impact on the development of a pedestrian friendly-space. A pedestrian-friendly space is defined as an area with urban structures like sidewalks that support active living and high levels of walkability (Reyer *et al*., 2014:5850). The growing body of research indicates that walkability should be an active implementation in the daily life of each individual. A few policies govern the pedestrian environments in South Africa, but many of these policies are outdated. Implementation of pedestrian environments is not regulated and is not a high priority, as the notion of walkability is not actively accessed in town planning applications as mentioned above. Chapter 2 illustrated that walkability and sidewalks play an integral role in creating a pedestrian-friendly space. The next chapter will investigate the walkability and sidewalk design characteristics in-depth and illustrate the significance of these characteristics in creating pedestrian-friendly spaces.

CHAPTER 3: PLANNING PEDESTRIAN-FRIENDLY SPACES

3.1 Points of departure

In Chapter 2, the essence of walkability, sidewalks and pedestrian-friendly spaces were discussed. If the advantages (Litman, 2011), (Tudor-Locke & Myers, 2001:3),(McNally, 2010:6), (Southworth, 2005:248), (Tudor-Locke & Myers, 2001:3) of pedestrian-friendly spaces are observed, it is evident that further investigation is needed to identify the characteristics that are required to implement such spaces. Chapter 3 considers walkability and sidewalk design characteristics that enhance the planning of pedestrian-friendly spaces from a spatial planning perspective. The essence of the characteristics that promote pedestrian-friendly spaces is discussed.

3.2 Walkability and sidewalk design characteristics

Walkability is a concept which is more than the ability to walk. It includes the planning and design of the built environment to support walkability by considering various elements or characteristics of the built environment. Southworth (2005) uses six elements, or attributes, including land-use patterns, connectivity, path quality, path context, safety and linkages to other transportation modes. Similarly, Moudon *et al*. (2006) use three elements: origin, route and area. Jan Gehl a forerunner in urban design believes that walkable environments should include perceptions of people as well as the physical environment and uses principles and criteria, and categorises them as protection, comfort and enjoyment (Jamal *et al*., 2017). The walkability and sidewalk design characteristics discussed below have been gathered from various forms of literature, including, published articles, design guidelines, government policy documents and review articles related to walkability, planning of sidewalks. Accordingly, the walkability and sidewalk design characteristics have been categorised for this research paper as follows: design, infrastructure, vehicle and pedestrian interactions, safety and aesthetics.

3.2.1 Design

According to Ewing (2005), there needs to be an emphasis on the built environment; to be redesigned to support communities and neighbourhoods that promote physical activity through walkability. Therefore, it is essential to observe how mixed land uses, residential density and layout accessibility influence the levels of walkability of an area. Neighbourhoods that are characterised by mixed land use, moderate to high-density layouts and connected streets tend to be associated with high levels of walkability (Saelens *et al*., 2003). The high-density layouts and connected streets reduce the inconveniences caused by low-density development and increase levels of walkability (Department of Transport, 2003:209).

In the mid-twentieth century, “traditional” neighbourhoods were planned to enhance the movement of pedestrians to enable common activities like going to school and shopping. These neighbourhoods were characterised by mixed land use, moderate to high density and connected streets. Homes, government services, stores and employment centres were located close to each other, often with buildings that had multiple zonings (Saelens *et al*., 2003). To create a community that is walkable, there must be destinations for residents to travel to. This may include anything from cafes, offices, restaurants, transit stations, parks, commercial, and retail. Streets automatically become livelier when destinations are available within a 5- minute radius of housing, as residents no longer need to use automobiles to travel to a form entertainment, stores and recreational areas (McNally, 2010:8). Walking and biking are the more viable option when commercial, residential and recreational uses are in close proximity of each other.

According to Litman (2011:20) neighbourhoods with mixed land uses provides an increase in the safety and convenience of those walking and cycling. Residential neighbourhoods that are closer to other uses like shops, restaurants and businesses allow residents to drive significantly less. Handy *et al.* (2006:68) found a positive relationship between times people walked to a store in a neighbourhood where businesses were approximately 800m from a household. There was a positive association between walking, biking and the number of diverse business types more or less 400m from a household. According to Cao *et al.* (2009:), there was an increase in cycling and walking during good weather in relation to the number of business types in a 1,6km proximity of a household. This indicates that there is a positive relationship between the number of different land uses and the amount of walking and cycling. Mixed land uses can enhance the perception of security in a neighbourhood because mixed land uses usually attract a higher number of people.

Furthermore, mixed land use draws pedestrians and supports the revival of community life by creating public spaces and pedestrian-orientated shopping, where people tend to meet (Litman, 2011). Communities that have a proper mixed land use design do not only increase walking for errands but also increases walking for leisure (e.g. walking to recreational facilities or parks). Such mixed-use communities stimulate residents to increase their levels of walking through the provision of a selection of destination like shops, parks, public spaces, beaches, public transport and recreational facilities (Sallis *et al*., 2004). However, according to Foster *et al.* (2013) certain destinations or surrounding uses, such as night clubs and liquor stores, may reduce the perceived sense of safety of an area.

Residential density is the ratio of the human population to the land area used for residential purposes (Ng, 2009:4). Alternatively, it can be measured by the number of houses per hectare or the number of people per hectare (Towers, 2013:45). Communities or neighbourhoods that have

a higher residential density tend to be more walkable (Oakes *et al*., 2007). Communities that are denser and less dependent on vehicles encourage walking as a mode of transportation to reach destinations such as neighbourhood shops (Cao *et al*., 2009). Similarly, Lee *et al.* (2007) found high levels of walkability are present in a high-density neighbourhood which includes mixed land use, such as the proximity of houses, shops and work. Active living is promoted when shops and other services are near residential areas; businesses within 1 km from homes increase walking and cycling (Malambo *et al*., 2017), (Chatman, 2009). According to Frank *et al.* (2005), walking and cycling can be negatively affected by lower residential density. People living in higher residential density neighbourhoods have found to be more active than people living in lower-density areas which may be because higher density areas tend to be interconnected with mixed land uses. Higher density communities increase the readiness of individuals to walk instead of drive since a more significant number of residents are within walking distance to services than those residents of a lower density community. Medium to high-density neighbourhoods supports commercial and retail businesses which helps strengthen the economic base of a community due to the increased number of people near businesses. Communities with low-density development have a lower concentration of residents in an area which means that they are further from services which often leads to less vibrant streets than those in a high-density community (McNally, 2010:8). The South African Pedestrian and Bicycle Facility Guidelines follow the idea of a compact city layout that limits urban sprawl to densify South African cities. The layout design may have a significant impact on the walkability of an area. Small street blocks have shown to increase the amount of walking done by residents (Oakes *et al*., 2007). Block length is the element that has the most significant impact on levels of walkability. Communities with shorter block lengths have illustrated to increase accessibility in an area for pedestrians (McNally, 2010:8).

Accessibility is an essential component of walkability. A community that is accessible provides residents with equal opportunity to use and enjoy public spaces. It is therefore important that the layout of communities is designed to accommodate pedestrian accessibility (Zakaria & Ujang, 2015:644). Intersections and specifically four-way intersections are found to increase walking and cycling. Communities with more intersections are seen to increase walking compared to those with less (Chatman, 2009). Furthermore, people seem to achieve the WHO recommendations of 150 min of physical activity when intersections are in closer proximity to each other (Owen *et al*., 2005). This is due to the fact that individuals using the sidewalks have more options to change direction, and it provides them with greater accessibility. Shorter block lengths offer pedestrians with more direct routes and increase the available number of crossings, as well as restricting vehicles from gaining too much speed due to the number of intersections. These block lengths help disperse traffic, which means roads in such communities are not as heavily congested (McNally, 2010:8).

Walking is supported by street grid layouts and cul-de-sacs which create an environment of safety for children to walk, run and play and in the long run, promotes physical activity for children (Loon, 2011). Neighbourhoods with a grid street layout provide users with a direct route between destinations, easy navigation and it enhances connectivity which improves the levels of walkability on sidewalks. Streets are laid out in a grid pattern that creates high levels of connectivity and offers pedestrians direct routes from place to place (Saelens *et al*., 2003). Street grid layouts are accessible layout patterns which allow residents to meet their daily needs without the use of automobiles. This means daily needs can be reached by travelling to destinations on foot within 10 to 20 minutes dependent on the context of the area. Activities that may fall within walking distance include uses such as grocery stores, fitness centres, laundries, banks, cafes, shops, libraries, elementary schools and parks (Southworth, 2005:250). According to the South African Pedestrian and Bicycle Facility Guidelines, it is important to develop a coherent network that supports the pedestrian movement. A cohesive network is characterised by well connect origins and destinations with many through routes (Department of Transport, 2003:134)

Street connectivity can be defined as how well streets are connected to one another and the frequency at which intersections occur (Mecredy *et al*., 2011:1). Street connectivity enhances access to pedestrian orientated routes by providing a greater range of path choices. It allows pedestrians to easily access more locations and decreases the distance needed to travel. Street connectivity increases sidewalk connectivity which enhances levels of walkability (Sugiyama *et al*., 2012). Street connectivity may be improved through efficiently using the correct designs that help support walkability. The design that supports walkability may be characterised by finer-grained patterns, interconnected patterns and smaller blocks which provide well-connected paths. Street connectivity's biggest enemy is barriers which restrict pedestrian movement. Barriers such as busy arterials, dead-end streets and cul-de-sacs should be avoided, as this reduces connectivity which negatively affects walkability (McNally, 2010:8). According to the South African Pedestrian and Bicycle Facility Guidelines, effective street connectivity may be achieved by providing an "open" network rather than a "closed" network. The provision of a highly connected network with functional connectivity between origins and destinations may help overcome several barriers to walking. All the essential locations should be included in the network to provide a complete system for pedestrian mobility. Important locations should consist of all the major attractions of daily living (Department of Transport, 2003:136).

3.2.2 Infrastructure

Sidewalk paths are one of the most significant facilities that should be provided to support pedestrian movement (Frackelton et al., 2013:3). Where there is pedestrian movement near streets, sidewalk infrastructure should be provided, even if pedestrian traffic is light. Additional

supportive infrastructure is also needed to increase walkability and the comfortability of walking within a community (Department of Transport, 2003:138). Path connectivity, path directness, path gradient, path condition, path obstruction, provision of recreational facilities, and path availability on both sides of the road all impact levels of walkability.

Neighbourhoods with sidewalks tend to increase the levels of physical activity by offering spaces for walking, running, hiking and other forms of physical activities (Wang *et al*., 2016). Interestingly, even the construction of low-cost walking trails has illustrated to increase levels of walkability (Brownson, 2000). However, according to Sallis *et al.* (2016), the opposite is also true, when sidewalks are present but poorly maintained and overcrowded, walkability declines. The main influencing factor in the avoidance of sidewalk usage is the condition of the path. Sidewalks that are in poor condition may cause individuals to walk on the roads instead. This indicates that the presence of sidewalks is not enough, sidewalk maintenance is vital to ensure that individuals make use of the provided infrastructure (Wicramasinghe & Dissanayake, 2017:4070). Path conditions and the presence of obstructions also have an impact on pedestrian mobility, safety and quality of life (Frackelton *et al*., 2013:4).

Ideally, sidewalks should consist of different zones to accommodate different needs. The American National Association of City Transportation's official guide for sidewalks suggests that sidewalks should consist of four different zones. The frontage zone is illustrated in Figure 3-1 by number one. The frontage zone is the area of sidewalk that acts as the building's extension, which could include doors and entryways or cafes on sidewalks. The pedestrian through zone is illustrated in Figure 3-1 by number two. The pedestrian through zone is the key area on the sidewalk, which consists of a pathway that is parallel to the road. The through zones ensure that the pedestrians have a clear and safe space to walk. The street furniture/curb zone is illustrated in Figure 3-1 by number three. The street furniture zone is the area between the curb and the through zone in which benches, lighting, tree pits, utility poles and bicycle parking can be found.. The buffer/enhancement zone is illustrated in Figure 3-1 by number four. This zone is located next to the sidewalk where many different elements may be found. This may include stormwater features, curb extensions, parking, cycle tracks, bike racks or curb side bike lines (Urban street design guide, 2013:38)

Figure 3- 1: **Proposed sidewalk zones**

Source: Urban street design guide (2013:38)

Obstructions that interfere with the right-of-way of pedestrians such as mailboxes, newspaper vending machines rubbish, broken paths, parked vehicles, curbs without ramps and utility poles may have a negative impact on walkability by narrowing the pathway or even blocking crosswalks (Southworth, 2005:250; Wicramasinghe & Dissanayake, 2017:4070). The presence of obstacles is another factor that may cause pedestrians to veer off the sidewalk into the road to avoid obstacles on the path. Obstructions and obstacles may often cause a sidewalk to be narrowed which decreases walkability. Even though street furniture and vending carts generally have positive impacts on walkability it may also have adverse effects on walkability. The placement of street furniture and vending carts, for example, may become obstructions if they are not placed correctly (Neckerman, 2009:266). Road works and roadside constructions often act as obstructions to pedestrians on sidewalks and reduce the connectivity of the area. To ensure the safety of the pedestrian, provision must be made for constructions sites in the form of signs and delineated paths through or around these sites (Department of Transport, 2003:181)

According to Moura *et al.* (2017:284), path connectivity is the extent of linkage of pedestrian networks between the main origins and destinations of services in a neighbourhood. Connectivity is a significant element of a built environment as it provides shorter and more direct routes towards essential destinations. The provision of direct and linked sidewalk infrastructure reduces the distance and time needed to walk which may encourage individuals to walk rather than use cars to drive (Saelens *et al*., 2003). Presence of paths, path continuity and the absence of barriers are

the elements that determine path connectivity. Walking distance is often described “as the crow flies” which is not the case for fragmented street patterns. Interconnected streets with smaller block sizes allow the actual mileage to be closer to the distance described by “as the crow flies”. Barriers to path connectivity such as busy arterials, railroads, dead-end streets, cul-de-sacs, power lines right of way and rivers should be avoided as far as possible (Southworth, 2005:249).

According to the Bicycle Federation of America Campaign to Make America Walkable (1998) sidewalks on both sides of the road allow a community to have a higher level of sidewalk connectivity. By providing paths on both sides of the street will enable pedestrians to face approaching traffic on any side of the road which may improve the safety or perceived safety of walking in this area. Sidewalks on both sides of the street reduce the number of times that pedestrians have to cross the streets. Sidewalks on both sides of a street are not always necessary, a path on one side of a lower order street is enough, especially in areas where there initially was no sidewalk (Urban street design guide, 2013:40). The number of paths is often limited by certain factors which include pedestrian circulation patterns, physical limitations and available space. In certain areas, it is better only to have a path on one side of the street, which is strategically placed to reduce crossings. These strategically placed paths may often be found at schools or near bus stops. According to the South African Pedestrian and Bicycle Facility Guidelines, it is safer for pedestrians to walk while facing vehicular traffic. This indicates that it is safer to provide sidewalks on both sides of the street. In areas where there are low volumes of pedestrians, it is not always necessary to provide sidewalks on both sides of the street. It is also not essential to provide sidewalks on both sides of the streets when in an interim phase of providing sidewalks on streets (Department of Transport, 2003:139).

Studies indicate that well-connected paths and tarred paths provide people with the chance to walk more (Lee *et al*., 2006; Malambo *et al*., 2017). According to Li (2005), loose materials on paths surfaces may decrease the enjoyment of walking. Wijlhuizen *et al.,* (2008), states that the elderly would rather not walk in situations where there were uneven paths due to the fear of falling or difficulty controlling their balance. Zamora (2008) states that sidewalks with texture are much better than a shiny surface. A sidewalk with a texture increases the perception of safety especially amongst the elderly. Sidewalks should have gritting or sanding to reduce the fear of slipping or falling and increase the mobility of pedestrians (Hjorthol, 2013). Outdoor leisure paths often have different types of materials which may impact different types of physical activities. Earth soil may be suitable for walking, but puddles on the soil may have a negative impact on cycling. Asphalt paths may be suitable for cycling but bad for walking. Pebbles are also often used as it provides a crude or rough appearance and is popular for jogging. In China, pebbles are used for their aesthetic qualities which allows it to be compatible with its natural surroundings. Synthetic

surfaces have become more popular as it provides comfort for walking and reduces the risk of slipping or sustaining an injury (Li *et al*., 2005).

According to the NMT Facility Guidelines, sidewalks should generally be paved with hard surface material. The following criteria are followed to allow the use of good quality sidewalk surfaces (Department of Transport, 2014:143):

- Even and smooth surfaces
- Well-drained
- Firm and stable
- Free from obstructions
- Sufficient traction

Sidewalks that are filthy and narrow often encourage pedestrians to travel on the road, jeopardising pedestrian road safety. This behaviour is highly dangerous to most individuals; both young and old may be vulnerable (Corazza *et al*., 2016:205). To enhance the level of sidewalk usage, the width of the paths should to be considered to support these paths according to the type of activity. The width of the sidewalk should be reliant on the location and the number of users (Wang *et al*., 2016). Sidewalks may be used more effectively when the width of the paths are designed according to different types of activities. Sidewalks should be designed differently according to their specific location in a city. Sidewalks in residential areas should be different compared to those in retail or commercial core of communities. Sidewalks should be at least 1.5m wide to allow enough room for two pedestrians to travel side by side (McNally, 2010:8). The Institute of Transportation Engineers in America support a sidewalk width of at least 1.5m which is comfortable for two people to walk next to each other (Wang *et al*., 2016). The minimum sidewalk widths that are proposed by the NMT Facility Guidelines are illustrated in Table 3-1.

Table 3-1: Minimum sidewalk width according to the NMT Facility Guidelines

Facility	Accepted Minimum– Recommended Minimum Width	Optimal width (m)
Pedestrian walkway width	1.2 - 1.5m	2 - 3m
Min corner splay	2 - 3m	5m
Sidewalks in business centres	3m	3m

Source: Department of Transport (2014:124)

Path surfaces and terrain may have a significant impact on levels of walkability, especially in cities built on inclined plains. Cities that have steep hills may require railings and steps to accommodate pedestrians. Such encroachments may impact walkability (Southworth, 2005:250). Walking may be encouraged when sidewalks are levelled and well maintained primarily for elders (Pucher *et al.*, 2010). Physical activity may decrease in areas with excessively inclined sidewalks and roads (Su *et al.*, 2010:496). Sidewalk steepness is an important characteristic which may impact the level of walkability. For this reason, the suggestion is that the path gradient should not exceed 10% (Park, 2008:35). Table 3-2 illustrates the maximum gradient according to the NMT Facility Guidelines.

Table 3-2: Suggested path gradients according to the NMT Facility Guidelines

Facility	Accepted Minimum– Recommended Minimum	Optimal gradient
Pedestrian walkway	1:15 – 1:20	1:25
Crossfall / Camber	1:50	1:50

Source: Department of Transport (2014:148)

When path surface, width and gradient is considered accessibility should accommodate the able and wheelchair users. Any resident may be restricted if a community is not accessible. In contrast, if a community is to be considered accessible even a blind person, a wheelchair user or an elderly person should not have to feel impaired (Zakaria & Ujang, 2015:644).

Wheelchair accessibility to toilets, car parks and water fountainsare some of the most significant sidewalk design qualities that is needed to assist individuals that are impaired to access sidewalk networks (Asadi-Shekari *et al*., 2013:180; Asadi-Shekari *et al*., 2014:185; Aghaabbasi *et al*., 2017:99). Studies describe how signals, tactile pavement, accessible signage and curb cuts may allow sidewalks to be more accessible and welcoming, especially to people with disabilities (Monteiro & Campos, 2012; Fearnley *et al*., 2011:85; Kochtitzky, 2011:130). Research illustrates that the elderly would rather avoid walking when they face high steps due to fear of falling and injuring themselves (Wijlhuizen *et al.*, 2008). According to Meyers *et al.* (2002), when there is a deficiency of wheelchair ramps, parking facilities, grass, mud or the presence of ramps that are too steep, it cuased difficulty for wheelchair users to make use of pedestrian facilities or even other daily facilities. Pedestrian infrastructure that provides access to both people with impairments and without impairments encourages higher rates of active transport (Wang *et al*., 2016). According to the South African Pedestrian and Bicycle Facility Guidelines, state bodies and government departments have the responsibility to cater for people with disabilities, providing access to the same sidewalk infrastructure and pedestrian-friendly facilities. Government bodies

have this responsibility because the Constitution of South Africa protects the rights of people with disabilities. Therefore resources should be used in such a way that every pedestrian is given the same opportunity whether disabled or not (Department of Transport, 2003:16).

Access to recreational facilities may also increase walkability. Common sense would suggest that individuals that have access to recreational facilities located near their residence are more likely to take part in physical activity than those individuals who may not have access (Sallis *et al*., 2000). According to Norman *et al.* (2006), a lack in the provision of recreational facilities may lead to a decrease in the levels of active transportation. Research indicates a relationship between youth physical activity and access to recreational facilities, stating that recreational activities lead to more physically active youths. Recreational facilities may play a decisive role in increasing physical activity, especially for the youth (Estabrooks *et al*., 2004).

3.2.3 Vehicle-pedestrian interactions

The interaction between pedestrians and moving traffic often takes place in a pedestrian environment. To protect pedestrians from moving traffic it is important to implement appropriate road safety measures. This does not only encourage individuals to walk more but encourages parents to allow their children to take part in outdoor physical activities (Carver *et al*., 2008:217). Pedestrian accidents are a major cause of injury and death, which indicates that pedestrian safety should be a primary concern. Designing sidewalks, roads and crosswalks should be a priority to foster a safe pedestrian environment (Grossman, 2000:25). In South Africa pedestrians are most exposed to road fatality in comparison to other road users, with 35 – 40% of road deaths in South Africa being pedestrian-related (Arrive Alive, 2017). Vehicle- pedestrian interactions may be made safer by implementing traffic calming measures, buffer zones, crosswalks, effective parking lots, reduction in traffic volumes, better road conditions, appropriate speed limits and more public transportation stops.

Traffic calming methods slow road traffic down which allows an area to be more walkable by using features such as speed humps, chockers, narrowing of streets, elevated crosswalks, coarse paving, traffic diverters, landscaping and roundabouts (Inoue *et al*., 2010). By incorporating designs that use traffic calming measures, sidewalks and streets may become more desirable and pleasant areas for pedestrians. By making pedestrians feel welcome, comfortable and safe in these areas, there is a much greater chance that walkable and lively streets become a reality (McNally, 2010:8). Residents have more significant opportunities to undertake walking through the provision of traffic calming features. Traffic calming allows pedestrians to feel safer when walking on sidewalks parallel to the street and it ensures that pedestrians feel confident using the sidewalk infrastructure. According to the South African NMT Facility Guidelines, speed humps,

mini traffic circles, raised crosswalks, neckdowns, chokers, chicanes and half road closure are the most common traffic calming techniques used in South Africa to reduce traffic speed (Department of Transport, 2014:95-106).

Surroundings that support efficient and fast automobile modes of transportation are not safe or pleasant for pedestrians (Southworth 2005:251). This indicates that speed limits impact walkability and lower speeds limits could increase walkability due to the perceived safety of the pedestrians. According to the American Planning Association (APA) the ideal vehicle speed limits that should be allowed in neighbourhoods that promote walkability should be around 35 to 40 kilometres per hour, with busier roads that have considerably higher amounts of traffic around 60 kilometres per hour. Anything higher than these speed limits indicates that the neighbourhood may be vehicle orientated rather than pedestrian orientated and does not support a walkable environment (McNally, 2010:8). According to the South Africa Pedestrian and Bicycle Facility Guidelines, the chance that a pedestrian is fatally injured through making contact with a car increases as the speed of the vehicle increases. Pedestrians should only be allowed to walk along streets that have speed restrictions and safe crossings, to keep pedestrians safe (Department of Transport, 2003:42).

Crosswalks may be one of the most dangerous parts of a pedestrian network due to the vehicle-pedestrian interactions, but with the right design, this can be areas where pedestrians walk safely and confidently. An ideal crosswalk design that supports walkable streets may be characterised by sidewalks flare, well-marked crosswalks, smaller corner radii and mid-block crosswalks. Well-marked crosswalks allow pedestrians to use the designated crossing areas and decreases dangerous crossings. Mid-blocks provide safe crossings and decrease the speed of the automobiles (Park, 2008:32). Providing crosswalk flares reduces the length of the crosswalk and slows down traffic speed by narrowing the road (McNally, 2010:8). Crosswalks in streets with busy traffic provide pedestrians with a sense of safety to cross the roads which ensure that people still enjoy walking when they choose. It allows pedestrians to cross the roads safely, quickly and confidently (Malambo *et al*., 2017). According to the South African Pedestrian and Bicycle Facility Guidelines, street crossings must be found every 50 – 100m (Department of Transport, 2003:54).

The provision of safe crosswalk facilities is just as necessary as efficient buffer zones between the vehicle traffic and the pedestrian paths. (Department of Transport, 2003:63). According to Li (2005), many studies indicate that buffer zones between traffic zones and pedestrian zones are significant because they protect pedestrians from fast-moving traffic. The buffer zone is the space between the verge of the traffic lane and the verge of the sidewalk. Landscape strips, bike lanes and parking lanes are typical street elements which buffer zones may consist of. The South African Pedestrian and Bicycle Facility Guidelines has suggested buffer zone widths. Where there

is no road reserve, a 0.6 m buffer zone is recommended. Where there is provision of on-street parking a 0.6 m buffer zone is also suggested. When there is a road reserve it is advised that the buffer zone be 1.2 – 1.5 m wide. When there are trees planted between that path and the street a minimum of 1.5 m is proposed for the buffer zone. The desirable space for a buffer zone is 3.0 m if there is space (Department of Transport, 2003:145).

According to Norman *et al.* (2006), lower rates of active transport have been linked to areas with heavy traffic. According to Park (2008:31), narrow streets are more pedestrian-friendly as wider streets attract faster moving and a greater volume of vehicular traffic which reduces the sense of safety. The benefits of narrow streets are that it reduces the traffic volume and more importantly the crossing (Park, 2008:32). Collisions involving pedestrians may be reduced by improving road traffic conditions, and this can significantly enhance levels of physical activity undertaken by a community. This is especially important for elderly people and people with any form of disability (Yee at al., 2006). Road markings improve the conditions of roads as this provides a clear and definite indication to the pedestrian and the vehicles where to go and where not to go (Department of Transport, 2014:158)

Another area where there is a considerable amount of interaction between pedestrian and vehicles are in parking areas. According to Adkins *et al.* (2012:507), on-street parking which acts as a physical and visible buffer between vehicles and pedestrian's increases levels of walkability due to the separation between the walking environment and vehicle traffic. However, according to Zakaria & Ujang (2015:644), streets that have an extensive frontage in the form of parking may decrease the access of pedestrians to buildings as they now have to cross the parking lot. Pedestrians seek the shortest path available and having to walk around the parking may have a negative impact on levels of walkability (Zakaria & Ujang, 2015:644). According to the South Africa Pedestrian and Bicycle Facility Guidelines an individual should not have to travel more than 100m from a parking area to a building entrance (Department of Transport, 2003:54). According to Norman *et al.* (2006), lower rates of active transport are linked to areas with heavy traffic. The benefits of narrow streets include lower traffic volumes and crossing distances (Park, 2008:32). Collisions involving pedestrians may be reduced by improving road traffic conditions, and this can significantly enhance levels of physical activity undertaken by a community. This is especially important for elderly people and people with any form of disability (Yee *at al*., 2006).

Furthermore, public transport facilities are another place where there is interaction between pedestrians and vehicles. When a neighbourhood has limited to no public transit available, this might also impact the levels of active transportation. Public transport often allows people to walk to and from public transportation stops which means it also promotes walkability (Norman *et al*., 2006). Communities with efficient transportation networks allow people to be less dependent on

vehicles and encourage people to walk more often (Lau & Chan, 2003). While providing internally well-connected paths or pedestrian networks, it is vital to connect communities with larger cities and different regions. This may be done by providing accessible and convenient links to other modes of transport such as trains and buses within a reasonable distance. To have an effective well-connected pedestrian network, there should be connectivity between different modes of transport (Southworth, 2005). According to the South Africa Pedestrian and Bicycle Facility Guidelines an individual should not have to travel more than 300 m to a public transport stop and not more than 500m to a rail station (Department of Transport, 2003:54). A high number of pedestrians are regularly found around public transport facilities such as bus stops, taxi ranks and railway stations (Department of Transport, 2003:231).

3.2.4 Safety

The most significant need for a pedestrian-friendly environment is safety and security. If an area is not perceived to be safe and secure pedestrians will not use the facilities (Department of Transport, 2003:33). Safety problems may be avoided by implementing efficient barriers and pedestrian signs. Security problems may be avoided by implementing efficient lighting, surveillance and have enough activity or “eyes” on the streets. Safety and security will be discussed further below.

Pedestrian scaled path lighting offers a greater sense of safety and can promote night time walking. In South Africa, safety is a major concern due to the high crime rate as emphasised in a study done on leisure activity when feeling safe (Malambo *et al*., 2017). In South Africa, walking is often used as a form of transportation during the day. It is suggested that street lighting could promote walking at night for leisure as it is perceived as safe (Oyeyemi *et al*., 2012). Similarly, Lee *et al.* (2007) state that well-lit streets, safety and convenience, support increased levels of walkability. Furthermore, a study by Stafford *et al* (2007), illustrates that people may be afraid to walk alone after dark if there is a lack of street lights. According to the South Africa Pedestrian and Bicycle Facility Guidelines, lighting should be provided at all pedestrian facilities as lighting increases pedestrian safety, security and comfort (Department of Transport, 2003:189). Light as well as surveillance allows for a greater sense of safety (Timperio *et al*., 2015:50; Malambo *et al*., 2017)

Path surveillance may include cameras, security stops, security patrol, gated or boomed communities. When there is path surveillance, people tend to feel safer walking (Southworth, 2005:250). Surveillance plays an essential role in making people feel safe, as indicated by studies stating that walkability may increase in a neighbourhood where people have a sense of personal safety (Astell-Burt *et al*., 2015:121; Foster *et al*., 2014:164; Timperio *et al*., 2015:50) “Eyes on the

street" refers to the number of people that are able to keep an eye on individuals as they walk in a particular area, which may also be seen as a form of surveillance. Building fronts facing the streets tend to put more eyes on the street which could increase the perceived safety of the sidewalk users. When there are "eyes on the street", people tend to feel safer walking. (Southworth, 2005:251)

Barriers or buffers protecting pedestrians from road traffic may increase pedestrian's perceived sense of safety which makes an area more walkable (Forsyth, 2015:275). Separating sidewalks from road traffic was associated with higher levels of walkability. This includes the presence of on-street parking and space between sidewalks and roads, which provides a physical and visual buffer between pedestrians and automobile traffic (Adkins *et al*., 2012:507). The presence of plants and hedges act as barriers and will furthermore support the infrastructure and encourage walking (Forsyth, 2015:275). Southworth (2005:250) also mentions that landscape features such as hedges help shield pedestrians from moving traffic. It is important that these hedges are well maintained as overgrown vegetation may act as a hiding place for criminals (Kruger *et al.,* 2001:56).This indicates that sidewalks should include a buffer zone to ensure the separation of pedestrians and vehicles. Buffers may consist of an area with plants that are planted to insulate pedestrians or street furniture separating sidewalks and roads which may also shield pedestrians from road traffic. Both these options may include additional on-street parking which further increases the space between pedestrian and vehicles. These buffers tend to increase the pedestrian's sense of safety which may increase levels of walkability (McNally, 2010:8). According to the South Africa Pedestrian and Bicycle Facility Guidelines, safety barriers may be used at locations where pedestrians need protection from moving traffic and at sites where there is a high number of accidents (Department of Transport, 2003:193).

Pedestrian signs help individuals to navigate, or it may indicate what may be done where and this keeps pedestrians safe and provides them with confidence to use walking as a mode of transport (Southworth, 2005:249). According to the South Africa Pedestrian and Bicycle Facility Guidelines, pedestrian signs and traffic signals may be fitted and operated in agreement with the Road Traffic Signs Manual and the National Road Traffic Regulations (Department of Transport, 2003:93).

Safety is a necessity when planning any form of pedestrian facilities. Individuals tend to walk where they feel safe and comfortable, and if not individuals may walk elsewhere if they do not feel at ease (Marisamynathan, 2014). According to Kent *et al.* (2011), safety plays a significant role in how individuals respond to the built environment; the perception of feeling unsafe is frequently a vital contributor to inactivity. An excellent example of this is when parents report having anxiety about the safety of their neighbourhood they limit the time they allow their children to play outside which indirectly reduces the walkability of the area. When people reason that a neighbourhood

feels unsafe it may decrease levels of physical activity undertaken. Physical activity has several barriers, but violent crime may be a noteworthy obstacle. This illustrates that sense of safety has an impact on the levels of physical activity undertaken and not only the actual crime rate (Van Dyck *et al*., 2013). The perception of crime rather than real crime has shown to have a more significant impact on rate of walking activities (Mason & Kearns, 2012:219).

3.2.5 Aesthetics

According to Ferreira *et al.* (2007), there is adequate evidence that suggests that aesthetics have a positive effect on walkability. The presence of greenery, trees and fewer abandoned buildings and walls covered in graffiti may influence walkability. Aesthetically pleasing scenery, cleanliness, greenery, public open spaces, tree presence, architectural variety, garden maintenance, drinking fountains, pedestrian seating, abandoned buildings, vacant lots and public art may all have an impact on levels of walkability. These aesthetics related to walkability characteristics are discussed further below.

Natural views and pleasant scenes are generally favoured by people. Urban public spaces, park landscapes, greenery and seaside views could all lead to increased amounts of walking for all ages (McCormack *et al*., 2010:715). Studies indicate that well-designed green streets with high-quality design features enrich the appeal of walking environments and increases walkability. This illustrates that aesthetically pleasing areas may be considered more walkable (Adkins *et al*., 2012). Other than the natural scenery, an area's aesthetics may also impact levels of walking done by people and motivate individuals to undertake physical activity (Bedimo-Rung *et al*., 2005:161). Poor environmental quality, poor aesthetic appearance or discomfort due to bad weather conditions can weaken motivation to undertake activities like walking or cycling. (Li *et al*., 2005).

Greenery plays a vital role in the provision of an aesthetically pleasing environment, reducing noise annoyance and purifying the air (Mårtensson *et al*., 2009:1150). Greenery increases levels of physical activity that is undertaken by residents not only by proving them with shade but by attracting individuals in the community to partake in physical activity (Krenichyn, 2006:632; Lee & Burney, 2011). Residential proximity to green spaces has shown a growth in levels of physical activity. Furthermore, urban green trails and cycling routes have been associated with an increase in cycling and walking (Maas *et al*., 2006). People tend to enjoy walking in areas with greenery which may enhance the perceived walkability of a community (McCormack & Shiell, 2011:125).

There are three different types of greenery that have diverse effects on walkability. The different forms of greenery include point, line and surface. Point greenery may be found at the nodes of roads or at turning points in the road to help direct people and point greenery may also be found

in forms of shrubs or blocks of lawn next to pavilions or benches which can increase levels of walkability. Line greenery or shrubs in the form of hedges and other plants are usually found along both sides of a sidewalk, and this helps guide pedestrians. Line greenery found along paths may also provide them with shade, therefore, increasing walkability. Surface greenery is usually in the form of flowerbeds or a tract of meadows located between buildings or in a central green area which often acts as a primary attraction. Shrubs and plants are commonly used to delineate spaces like fitness stations or playgrounds. This attracts pedestrians and promotes walkability (Mårtensson *et al*., 2009:1151).

Parks and public spaces are key components that support walkability in cities (Bedimo-Rung *et al*., 2005:165; Mytton *et al*., 2012:1036). Public open spaces provide a communal area where individuals may partake in physical activity. Public spaces not only provide opportunities for walking but also serves as a place where individuals can communicate and socialise. When planning and designing a public open space, attraction and area are two key components to consider as this can often impact the levels of walkability in a community (Cohen *et al*., 2010; Giles-Corti *et al*., 2005:173). When planning an area, space should be planned and designed carefully according to the number of users in the community to achieve the best levels of community involvement and to keep the area lively (Giles-Corti *et al.* 2005). Overcrowded or empty spaces may have a negative impact on levels of walkability. Empty spaces could increase levels of insecurity, while crowded areas could decrease interests of visiting such places (Bedimo-Rung *et al*., 2005:165).

Public open spaces and areas designed to accommodate individuals to walk should be planned to cater for different groups of people including people with special needs, children, adults and elders. Public spaces ought to be designed to lower crime rates and to make people feel safer especially in countries like South Africa that have a high crime rate. By providing floodlights, security and streetlight, the crime rate may be lowered (Lopez & Hynes, 2006). According to the South Africa Pedestrian and Bicycle Facility Guidelines an individual should not have to travel more than 400m to a community facility or park (Department of Transport, 2003:54).

According to Mårtensson *et al.,* (2009) trees along paths provide pedestrians with shade and some protection from misty rain and encourages walking. Trees do not only provide shade but also guide pedestrians along paths especially when trees are present on both sides of the sidewalk. Walkability is enhanced by greenery and trees, which often shield pedestrians from traffic or protect them from sunlight. Trees planted beside the road not only protect pedestrians from harmful sunlight, but it also enhances the street space (Emery *et al*., 2003). According to Park (2008:35), several studies indicate that street trees are significant. Street trees provide a psychological and physical buffer from fast vehicular traffic (Park, 2008:35). Trees have shown to

increase levels of walkability, but in some European cities, this does not always apply as there are highly walkable streets without trees, due to fascinating architecture, street space, and street life (Southworth, 2005:249). The abovementioned indicates that the sense of place and aesthetic beauty of architecture can play a role in the amount that people may want to walk in a specific area.

According to Corazza *et al.* (2016:205), dirty and badly maintained sidewalks may cause pedestrians to jaywalk or to simply walk on the road to get to their destination. Communities that are full off rubbish and litter may have a negative impact on levels of walkability; for this reason, sidewalks cleanliness is essential. Graffiti and vandalism may also impact the sense of cleanliness of an area and therefore influences the amount that people walk (Ferreira *et al*., 2007:135); (Stafford *et al.* 2007). Pedestrians of all ages use sidewalks, choosing to walk on sidewalks they feel most comfortable with. As soon as individuals do not feel at ease they tend to detour from their current course towards a route that they feel more comfortable (Marisamynathan, 2014:105).

Pleasant landscaping appeals to people which means, individuals may be encouraged to spend additional time walking or cycling in such an area. The perception of neighbourhood attractiveness greenery, neatness, landscaping, and lightning including well-maintained sidewalks could have a positive influence on transport-related and leisure walking (Cerin *et al*., 2006). This illustrates that neat gardens or landscaping can make a neighbourhood more attractive, encouraging residents to walk more. Planted verges and trees that line the streets can improve the aesthetics of an area and act as a natural barrier protecting pedestrians from moving traffic. (Southworth, 2005:251).

Abandoned buildings and vacant lots are often associated with unlawful criminal actions which have a negative impact on the pedestrian friendliness of the area (Park 2008:37) ;(Garvin *et al*., 2013). Reduction in walkability is strongly related to the perception of people about crime and the feeling of safety, more than the actual crime itself (Mason *et al*., 2013).

The provision of facilities adjacent to sidewalks that support individuals when walking namely water fountains and benches may increase levels of walkability. Providing individuals with water could motivate pedestrians to walk more often (Cohen *et al*., 2006:1384). Neighbourhoods that have a lack of resting areas may act as a major barrier to a walkable community, especially among elderly users. It is important to provide benches to accommodate all ages and needs within the community to encourage walkability (Su *et al*., 2010:499). Such supportive facilities could be incorporated with art as the implementation of art into an environment provides a sense of excitement, community and a place where people can enjoy social networking (Jamal *et al*., 2017). The one supports the other, walkability encourages creativity, and this offers viable

initiatives which are appealing and attracts people (Grodach, 2011). There seems to be an increase in walking behaviour when pedestrian directional and information's signs are readily available(Koh & Wong, 2013).

3.2.6 Conclusion of Chapter 3

Walkability and sidewalk design characteristics include numerous elements of the built environment (Southworth, 2005). The characteristics discussed have been categorised for this study as follows: design, infrastructure, vehicle and pedestrian interactions, safety and aesthetics. Each of these characteristics impacts the built environment and contribute in some way to a pedestrian-friendly space. Several walkability and sidewalk design characteristics were placed under each category. The design category observed the ideal layout design and land uses of a pedestrian-friendly environment. The infrastructure category observed the sidewalk design characteristics and supportive pedestrian infrastructure that creates a pedestrian-friendly environment. The vehicle-pedestrian interactions category observed characteristics that may be implemented to ensure pedestrians and vehicles interact in a way that is safe and efficient. The safety category observed the characteristics that provide a sense of safety and security to individuals in a pedestrian-friendly environment. The aesthetics category observed the characteristics that impact the sense of place through their aesthetic qualities. Each category forms part of creating a pedestrian-friendly space. These categories will be investigated by comparing multiple existing walkability audit tools to realise which of these characteristics are used most often and are therefore significant in creating pedestrian-friendly spaces.

CHAPTER 4: A COMPARISON OF WALKABILITY AUDIT TOOLS

4.1 Points of departure

In Chapter 3, walkability and sidewalk design characteristics were considered thematically. Chapter 4 constitutes phase one of the empirical investigation which considers certain existing international and local walkability audit tools and subsequently aims to identify characteristics from these audit tools that could inform a South African Walkability Audit Tool (SAWAT). The methodology and selection process of these audit tools was explained in Chapter 1.4. Each audit tool is considered in terms of walkability characteristics, based on the frequency of use of each identified characteristic, within the six selected audit tools. Higher frequency (use of the characteristic) was related to the characteristics having a greater significance and role in terms of planning successful pedestrian-friendly spaces.

4.2 International and local walkability audit tools

As mentioned in Chapter 1.4, each of the international and local walkability audit tools was purposefully selected based on the applicability of these tools in different countries. The audit tools that specifically focused on the assessment of the walkability and pedestrian-friendliness of a built environment and included similar categories related to the walkability and sidewalk design characteristics identified in the literature study were considered and specific tools were selected to ensure they represent a balanced geographical distribution across the globe. Six tools were included in the research, namely the Systematic Pedestrian and Cycling Environmental Scan (Australia), Scottish Walkability Assessment Tool (Scotland), Microscale Audit of Pedestrian Streetscapes (United States of America), Active Neighbourhood Checklist (United States of America), Seven Key Dimension Audit Tool (Portugal) and the Pedestrian Environment Assessment Tool (Tshwane). The international audit tools selected provide a wide scope of knowledge and techniques that may be used to inform a walkability audit tool. The local walkability audit tool that was selected, is the only local walkability audit tool available in South Africa and was compiled in Tshwane Metropolitan Area. The five international and one local walkability audit tools were considered and discussed in terms of purpose, test area tool administration and characteristics considered, to provide context and identify the walkability characteristics considered in each respective audit tool. The identified walkability and sidewalk design characteristics that are considered in each of these tools will be sorted under the following categories identified in Chapter 3: design, infrastructure, vehicle and pedestrian interactions, safety and aesthetics.

4.2.1 Systematic Pedestrian and Cycling Environmental Scan (SPACES), Australia.

This audit tool developed by Pikora *et al.* (2000) was purposefully selected as explained above to consider the specific characteristics which informed this tool and the overlap and comparison with other selected walkability audit tools from other locations across the globe.

Table 4- 1: SPACES evaluation

Purpose	The purpose of SPACES is to observe and study the physical environment in local communities. This tool considers what is needed to make an environment walking and cycling friendly.
Testing area	Perth, Australia
Tool administration	This tool uses street segments as testing areas. These segments are sections of the street between intersections, and each of these segments is labelled with a unique number for identification (Pikora *et al*., 2000).

Source: Own construction (2019).

Characteristics considered: SPACES consider land uses and the layout accessibility of an area under the design category. Under the infrastructure category, the audit tool observes sidewalk infrastructure, path location, path continuity, path surface, path slope, path maintenance, path obstructions and whether there are paths on both sides of the street. In the vehicle-pedestrian interactions category, the audit tool considers traffic calming, buffer zone, crosswalks, parking areas, traffic volume, public transport stops and the road conditions of the study area. Lighting, barriers, buffers and surveillance are observed in the safety category. In the aesthetics category, the tool considers aesthetically pleasing scenery, tree presence, cleanliness, and architectural variety (Pikora *et al*., 2000).

4.2.2 Scottish Walkability Assessment Tool (SWAT), Scotland

This audit tool developed by Millington *et al.* (2009) was purposefully selected as explained above to consider the specific characteristics which informed this tool and the overlap and comparison with other selected walkability audit tools from other locations across the globe.

Table 4- 2: SWAT evaluation

Purpose	The purpose of SWAT is to quantitatively record aspects of the physical environment that have an impact on walkability in urban Scotland to help individuals reach the Scottish exercise guidelines and encourage overall walkability.
Testing area	Glasgow, Scotland
Tool administration	This tool is used to evaluate the sides of the streets separately. Each street side is evaluated through the use of a checklist/audit tool (Millington *et al.*, 2009).

Source: Own construction (2019).

Characteristics considered: The SWAT audit tool considers land uses, residential density and layout accessibility in the design category. Under the infrastructure category, the audit tool observes the sidewalk infrastructure, path directness, path surfaces, path width, path slope, path maintenance, path obstructions and public recreational facility with a study area. In the vehicle-pedestrian interactions category the audit tool considers traffic calming, buffer zone crosswalks, parking areas, traffic volume, road conditions and public transport stops, lighting, surveillance, pedestrian signs and the sense of safety is observed in the safety category. In the aesthetics category, the tool considers the surrounding scenery, greenery, public open space, tree presence, graffiti, vandalism, cleanliness, architectural variety and garden maintenance (Millington *et al.*, 2009).

4.2.3 Microscale Audit of Pedestrian Streetscapes (MAPS), USA

This audit tool developed by Cain *et al*. (2012) purposefully selected as explained above to consider the specific characteristics which informed this tool and the overlap and comparison with other selected walkability audit tools from other locations across the globe.

Table 4- 3: MAPS evaluation

Purpose	The purpose of MAPS is to observe the effects of microscale attributes on walkability.
Testing area	San Diego, Seattle and Baltimore, USA
Tool administration	*Tool administration:* This tool uses street segments in urban and suburban areas as testing areas (Cain *et al*., 2012).

Source: Own construction (2019).

Characteristics considered: MAPS consider land uses in the design category. In the infrastructure category, the audit tool observes sidewalk infrastructure, path slope, path obstructions, and public recreational facility. In the Vehicle-pedestrian interactions category, the audit tool observes the crosswalks, parking areas, traffic volume and public transport stops. Barriers and buffers are considered in the safety category. In the aesthetics category the tool considers tree presence and abandoned buildings within the chosen study area (Cain *et al*., 2012).

4.2.4 Active Neighborhood Checklist (ANC), USA

This audit tool developed by Hoehner *et al*. (2007) purposefully selected as explained above to consider the specific characteristics which informed this tool and the overlap and comparison with other selected walkability audit tools from other locations across the globe.

Table 4- 4: ANC evaluation

Purpose	The purpose of ANC is a checklist which assesses whether or not the neighbourhood environment supports walkability. It considers the physical environment to determine if it is pedestrian-friendly.
Testing area	St. Louis and Missouri, USA
Tool administration	This tool uses street segments as testing areas. These segments are sections of the street between intersections, and each of these segments is labelled with a unique number for identification (Hoehner *et al*., 2007).

Source: Own construction (2019).

Characteristics considered: The ANC audit tool considers land uses in the design category. Under the infrastructure category, the audit tool observes path directness, path continuity, path width, path slope, path maintenance, path obstructions, public recreational facility, accessibility to people with disabilities, and whether there are paths on both sides of the streets. In the Vehicle-pedestrian interactions category the audit tool considers traffic calming, buffer zone, crosswalks, parking areas, traffic volume and public transport stops. Lighting, barriers and buffers are observed in the safety category. In the aesthetics category the tool considers aesthetically pleasing scenery, greenery, public open space, tree presence, graffiti, vandalism, cleanliness, drinking fountains, street furniture, abandoned buildings, vacant lots and public art (Hoehner *et al*., 2007).

4.2.5 Seven key dimensions (7C's layout), Portugal

This audit tool developed by Moura *et al*. (2017) purposefully selected as explained above to consider the specific characteristics which informed this tool and the overlap and comparison with other selected walkability audit tools from other locations across the globe.

Table 4- 5: 7C's Layout

Purpose	The purpose of the 7C's layout is to gain insight to improve walkability by evaluating the ease, and difficulty pedestrians might face while walking.
Testing area	Lisbon, Portugal.
Tool administration	This tool uses parks and districts to evaluate the walkability of the area. These areas include 367 pedestrian links, 448 crossings and 32 km of walkways (Moura *et al*., 2017).

Source: Own construction (2019).

Characteristics considered: The 7C's layout audit tool considers land uses, residential density, layout accessibility and street connectivity under the design category. Under the infrastructure category, the audit tool considers sidewalk infrastructure, path directness, path continuity, path surfaces, path width, path slope, path maintenance, path obstructions and public recreational facility. In the Vehicle-pedestrian interactions category, the audit tool considers crosswalks. Lighting, "eyes on the street", building fronts and pedestrian signs are observed in the safety category. In the aesthetics category the tool considers tree presence, cleanliness, water fountainsand the architectural variety in the study area (Moura *et al*., 2017).

4.2.6 Pedestrian Environment Assessment Tool (PEAT), Tshwane

This audit tool developed by Albers *et al*., (2010) purposefully selected as explained above to consider the specific characteristics which informed this tool and the overlap and comparison with other selected walkability audit tools from other locations across the globe.

Table 4- 6: PEAT evaluation

Purpose	The purpose of PEAT is to gain insight into the pedestrian environment in Tshwane by evaluating certain factors which are considered to be important to ensure adequate pedestrian safety.
Testing area	Tshwane Metropolitan Area, Gauteng.
Tool administration	This tool uses intersections and sections between intersections as testing areas. These segment and intersections are labelled with a unique number for identification (Albers *et al*., 2010).

Source: Own construction (2019).

Characteristics considered: The PEAT audit tool considers land uses in the design category. In the infrastructure category, the audit tool observes the sidewalk infrastructure, path surfaces, path slopes, path maintenance and path obstructions within the chosen study area. In the Vehicle-pedestrian interactions category, the audit tool considers traffic calming, buffer zones, crosswalks, parking areas, traffic volumes, road conditions, public transport stops and speed limits. In the safety category the tool observes the street lighting, surveillance, “eyes on the street” or building fronts, barriers, buffers, pedestrian signs and the sense of safety. In the aesthetics category the tool considers the tree presence, graffiti, vandalism, cleanliness, street furniture, abandoned buildings and vacant lots found within the testing area (Albers *et al*., 2010).

Three international audit tools were used to inform this the PEAT tool. This audit tool was implemented in five sites throughout Tshwane. After the implementation of this tool, particular challenges were encountered, and recommendations made accordingly. The recommendations made were related to the implementation process and not characteristics observed. The PEAT audit tool used three international tools to find common factors that are applicable to South Africa, but the tool did not include any input from local pedestrians or the general public.

4.3 Walkability audit tools comparison

The selected walkability audit tools were evaluated within the categories identified in Chapter 3, which includes design, infrastructure, vehicle-pedestrian interaction, safety and aesthetics related walkability and sidewalk design characteristics. The evaluation of these walkability audit tools was done by considering the frequency of which each of the walkability and sidewalk design characteristics, identified in Chapter 3, occurs in each of these tools. If the walkability and sidewalk design characteristics were found in all of the sampled walkability audit tools, then it was categorised as important. This means that this characteristic is likely to have a higher priority in the SAWAT. In contrary, if the walkability and sidewalk design characteristics were only found in

one of the sampled walkability audit tools then it was characterised with a lower priority which means that this characteristic is likely to have a lower priority in the SAWAT. Table 4-1 illustrates the frequency that the walkability and sidewalk design characteristics occur at in the sampled audit tools.

Table 4-7: Walkability audit tool comparison checklist

Walkability Characteristics	SWAT (Scotland)	SPACES (Australia)	MAPS (USA)	PEAT (SA)	ANC (USA)	7C's layout (Portugal)	Frequency
Design							
Mixed land uses	√	√	√	√	√	√	100%
Residential density	√	X	X	X	X	√	33%
Layout accessibility	√	√	X	X	X	√	50%
Street connectivity	X	X	X	X	X	√	17%
Infrastructure							
Sidewalk infrastructure	√	√	√	√	√	√	100%
Path directness	√	X	X	X	X	√	33%
Path continuity	X	√	X	X	√	√	50%
Path surface	√	√	X	√	X	√	67%
Path width	√	X	X	X	√	√	50%
Path slope	√	√	√	√	√	X	83%
Path maintenance	√	√	X	√	√	√	83%
Path obstructions	√	√	√	√	√	√	100%
Public recreational facility	√	X	√	X	√	√	67%
Special needs zones	X	X	X	X	√	√	33%
Path on both side	X	√	X	X	√	X	33%
Vehicle-pedestrian interactions							
Buffer zone	√	√	X	√	√	X	67%
Traffic calming	√	√	X	√	√	X	67%
Crosswalks	√	√	√	√	√	√	100%
Parking areas	√	√	√	√	√	X	83%
Traffic volume	√	√	√	√	√	X	83%

Walkability Characteristics	SWAT (Scotland)	SPACES (Australia)	MAPS (USA)	PEAT (SA)	ANC (USA)	7C's layout (Portugal)	Frequency
Road condition	√	√	X	√	X	X	50%
Public transport stops	√	√	√	√	√	X	50%
Speed limit	X	X	X	√	X	X	17%
Safety							
Lighting	√	√	X	√	√	√	83%
Surveillance	√	√	X	√	X	X	50%
“Eyes on the street”/ Building fronts	X	X	X	√	X	√	33%
Barriers/Buffers	X	X	√	√	√	X	50%
Pedestrian signs	√	X	X	√	X	√	50%
Sense of safety	√	X	X	√	X	X	33%
Aesthetics							
Aesthetically pleasing scenery	√	√	X	X	X	√	50%
Greenery	√	X	X	X	√	X	33%
Public open spaces	√	√	X	X	√	X	50%
Tree Presence	√	√	√	√	√	√	100%
Cleanliness	√	√	X	√	√	√	83%
Architectural variety	√	√	√	X	X	√	67%
Garden maintenance	√	√	X	X	X	X	33%
Public seating	X	X	X	√	√	√	50%
Abandoned buildings	X	X	√	√	√	X	50%
Vacant lot	X	X	X	√	√	X	33%
Drinking fountains	X	X	X	X	√	X	17%
Public art	X	X	X	X	√	X	17%

Source: Own construction (2019).

As seen in Table 4-7, the characteristics related to vehicle-pedestrian interaction was most prominent in the sampled audit tools, followed by infrastructure, safety, aesthetics and design-related characteristics respectively. Every characteristic found in each of the audit tools has some form of impact on the walkability and pedestrian-friendliness of their applicable areas. The characteristics that are prominent in most of the sampled audit tools, specify characteristics that

may play a significant role in the pedestrian-friendliness of an area. The characteristics that are characterised with higher priority according to the evaluation of the existing audit tools are highlighted in green in Table 4-7. The characteristics that are characterised with lower priority according to the evaluation of the existing audit tools are highlighted in red in Table 4-7.

4.4 Conclusions of Chapter 4

In this chapter, five international and one local walkability audit tools were considered. The selected walkability audit tools are from five different countries which provides a wide spectrum of knowledge with regards to the characteristics that would significantly improve the pedestrian-friendliness of an area. This chapter identified the priority of walkability and sidewalk design characteristics according to the frequency with which these characteristics occurred in the sampled audit tools. In the next chapter the local perspective of South African respondents was gained by the means of and e-questionnaire to further define the priority of the characteristics to inform the SAWAT as indicated by Figure 4-1 below. The walkability audit tools from each country included various characteristics that contribute to a pedestrian-friendly space which may depend on the needs, culture, topography, weather and interest of the individuals from those countries To develop an accurate walkability audit tool for the South African environment, it is essential to gain the local perspective on walkability, as captured in the next chapter.

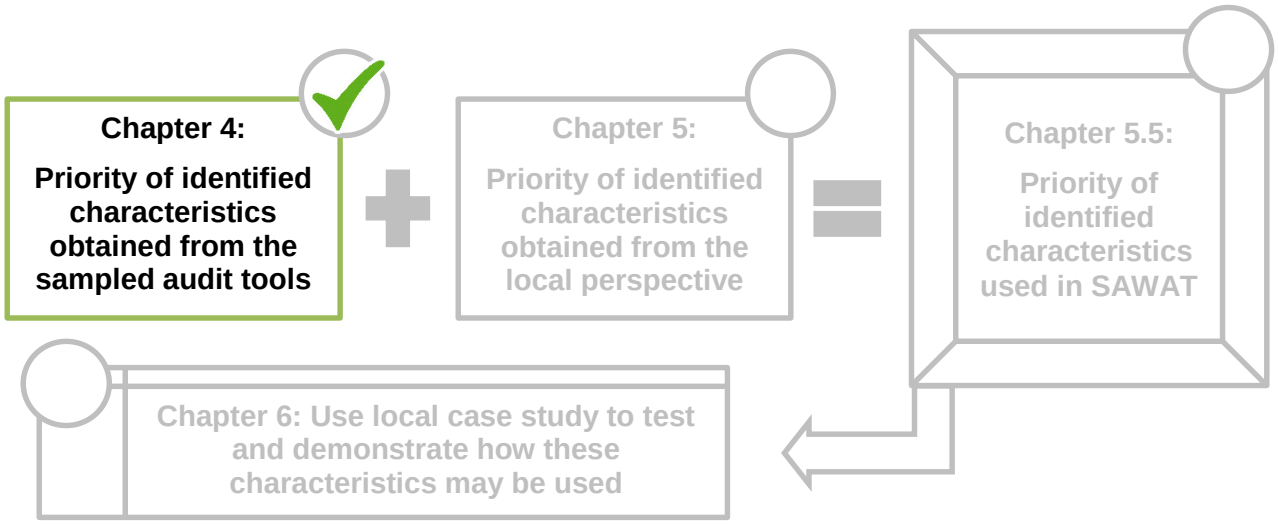


Figure 4- 1: The structure of the empirical section

Source: Own construction (2019).

CHAPTER 5: LOCAL PERSPECTIVE ON WALKABILITY CHARACTERISTICS

5.1 Points of departure

Chapter 4 reflected on purposefully selected walkability audit tools, both international and local, to investigate specific design characteristics pertaining to walkability and sidewalks, in an attempt to inform a South African Walkability Audit Tool (SAWAT). This chapter constitutes phase two of the empirical investigation. To further prioritise the walkability and sidewalk design characteristics and inform the SAWAT it is important to identify the needs of the local South African community. In this chapter the priority of the walkability and sidewalk design characteristics will be determined according to the local perspective. The local perspective of South African residents in terms of walkability preferences will be identified and considered by means of a structured e-questionnaire. The priorities of the walkability and sidewalk design characteristics according to a local perspective and the sampled audit tools evaluated in Chapter 4 will be combined to prioritise the final SAWAT characteristics.

5.2 Community survey methodology

To gain the local perspective on walkability and sidewalk design characteristics and their impact on pedestrian spaces, an e-questionnaire was compiled (e-questionnaire is attached as Annexure A). The google forms e-questionnaire was shared on a variety of public platforms including Facebook, WhatsApp and emails. The link was placed on various community and public groups and pages and shared by individuals on numerous other community and social groups. The questionnaire was open for 21 days in September 2018 for anyone to answer. The e-questionnaire was divided into three sections. Section one included four questions pertaining to the participant profile. Section two considered the significance of each characteristic identified in Chapter 3 in relating to the impact on daily walking behaviour. A 5-point Likert scale/multiple-choice grid was used which included the following answers: Fully agree, agree, disagree, strongly disagree or not sure. Section three instructed respondents to complete the section only if they resided in Potchefstroom to evaluate their levels of satisfaction or dissatisfaction with regards to the pedestrian-friendliness of the specific area according to the six categories. Section three of the e-questionnaire will be further explained and used in Chapter 6. The e-questionnaire results are attached as Annexure B.

5.3 Profile of respondents

A total of 115 respondents completed the e-questionnaire. Respondents were from the following provinces: 60% from North West, 24% from Gauteng, 8%from Western Cape, 7% from Free State

and 1% from Northern Cape. The age groups of the respondents include: 73% were 18-24 years old,10% were 25-39 years old, 10% were 40-60 years old and 7% were 60 years old or older. The respondents were 57% female, 42% Male and 1% other. The physical status: All respondents reported being able to walk. Overall 52% walked daily for more than 3km, 30% walked daily for less than 3km, 16% walked weekly for approximately 3km and 2% walked less than 3km per week. Approximately 59.1% (68 respondents) of the respondents indicated that they were users of the specific study area which provides valuable insight and knowledge about this area. Additionally, the remaining respondents that reside in several other parts of South Africa provides a wider spectrum and a greater insight into the needs and desirability for walkability or pedestrian infrastructure of South African respondents from different communities. The pool of respondents therefore provides a substantive and representative input to address the research objectives.

5.4 Local perspective results

The results of section two of the e-questionnaire are illustrated through descriptive statistics as shown in Table 5-1 and Table 5-2. Section two of the e-questionnaire had the following primary question with regards to the walkability and sidewalk design characteristics: Which of the following characteristics will have a positive impact on my daily walking behaviour? If most respondents answered ‘Fully agree’ to a specific characteristic, the mean ranged between 1 - 1.49 or if the majority respondents answered ‘Agree’ to a specific characteristic, the mean ranged between 1.5 - 2.49 as indicated in Table 5-1 and Table 5-2. If the majority responded ‘not sure’ the mean is found within the range of 2.5 to 3.49. If most respondents answered ‘Disagree’ to a specific characteristic, the mean ranged between 3.5 - 4.49 or if the majority respondents answered ‘Strongly disagree’ to a specific characteristic, the mean ranged between 4.5 - 5 as indicated in Table 5-1.

Table 5-1: Local perspective of walkability and sidewalk design characteristics

Fully agree	Agree	Not Sure	Disagree	Strongly disagree
1 (1-1.49)	2 (1.5 – 2.49)	3 (2.5 – 3.49)	4 (3.5 – 4.49)	5 (4.5 – 5)

Source: Own construction (2019).

Table 5-2 portrays the opinion of the local perspective on whether the identified characteristics have an impact on the walkability and pedestrian-friendliness of an area. Column ‘N’ illustrates the number of respondents that answered each question. The extremes of each answer are illustrated by the ‘minimum’ and ‘maximum’ columns. The mean and standard deviation is also specified in Table 5-2.

Table 5-2: Local perspective of walkability and sidewalk characteristics

Walkability and sidewalk design characteristics	N	Minimum	Maximum	Mean	Std. Deviation	Disagree	Agree	Fully Agree
Design								
Mixed land uses	113	1	5	**1,67**	0,829		X	
Well-connected roads	113	1	5	**2,04**	0,91		X	
Higher density of buildings	113	1	5	**2,32**	1,096		X	
Layout accessibility	113	1	5	**2,32**	1,096		X	
Infrastructure								
More sidewalk infrastructure	115	1	3	**1,41**	0,605			X
Maintained sidewalks	115	1	5	**1,47**	0,841			X
Special needs supportive infrastructure	115	1	5	**1,69**	0,882		X	
Connected sidewalks	114	1	4	**1,73**	0,744		X	
Direct sidewalk paths to location	114	1	4	**1,75**	0,878		X	
Wider sidewalk	115	1	5	**1,9**	1,063		X	
Sidewalks on both sides of the street	115	1	5	**1,97**	1,135		X	
Path surfaces	115	1	5	**2,02**	1,009		X	
More recreational activities along sidewalks	115	1	5	**2,03**	1,092		X	
Less sidewalk obstructions	115	1	5	**2,09**	1,174		X	
Less slopes in sidewalk	115	1	5	**2,41**	1,091		X	
Vehicle-pedestrian interactions								
More space between sidewalk and road	115	1	4	**1,7**	0,794		X	
More crosswalks to cross the road	115	1	5	**1,83**	0,92		X	
Public transport stops along roads	112	1	5	**1,85**	0,961		X	
Less road traffic	113	1	5	**2,11**	1,047		X	
Better road conditions	114	1	5	**2,13**	1,141		X	
Speed limits	114	1	5	**2,20**	1,148		X	
More traffic calming infrastructure	115	1	5	**2,41**	1,154		X	
Reduced parking areas	115	1	5	**3,61**	1,023	X		
Safety								
Sense of safety	115	1	5	**1,46**	0,787			X

Better lighting on paths	115	1	5	**1,5**	0,799		**X**	
Surveillance on paths	114	1	5	**1,54**	0,884		**X**	
Pedestrians signs	113	1	5	**1,7**	0,854		**X**	
Houses and buildings facing the streets	115	1	4	**1,77**	0,798		**X**	
Barriers between road and sidewalks	115	1	5	**1,98**	1,076		**X**	
Aesthetics								
Presence of trees	113	1	4	**1,35**	0,55			**X**
Aesthetically pleasing scenery	113	1	4	**1,5**	0,746		**X**	
Less abandoned buildings	113	1	5	**1,52**	0,767		**X**	
Less vacant lots	113	1	5	**1,52**	0,757		**X**	
Garden maintenance	113	1	5	**1,62**	0,938		**X**	
More public open spaces	112	1	5	**1,68**	0,922		**X**	
Greenery	112	1	5	**1,82**	0,962		**X**	
Architectural variety	113	1	5	**1,96**	0,981		**X**	
Public art	113	1	5	**1,97**	0,991		**X**	
More public seating along paths	113	1	5	**1,98**	1		**X**	
More water fountains along paths	113	1	5	**2,26**	1,208		**X**	

Source: Own construction (2019).

Table 5-2 illustrates, that according to the local perspective all but one of the walkability and sidewalk design characteristics are significant in creating a walkable and pedestrian-friendly space. The results indicated that 10% of the total characteristics were fully agreed to be important, 88% of the total characteristics agreed to be important, and 2% of the total characteristics disagreed to be important to increase the walkability of an area. The walkability and sidewalk design characteristics in the design category were all agreed to be important. The infrastructure characteristics were all agreed to be important including two characteristics that were fully agreed to. Vehicle-pedestrian interaction related walkability and sidewalk design characteristics were all agreed to be important except for one characteristic (parking area) that was disagreed to. Safety-related walkability and sidewalk design characteristics were all agreed to be important, and one characteristic (sense of safety) was fully agreed to. Similarly, aesthetics related walkability and sidewalk design characteristics were all agreed to be important, and one characteristic (Tree presence) was fully agreed to.

The presence of trees is the most important according to the respondents as it was the characteristics that most individuals answered ‘fully agreed’ to, with a mean of 1.35. Overall, the respondents ‘strongly agreed’ that more sidewalk infrastructure would improve the walkability and

pedestrian-friendliness of the area, with a mean of 1.41. Not only did the local perspective indicate that more sidewalk infrastructure is necessary, but also the maintenance of the current infrastructure should be carefully controlled, as maintained sidewalks were rated as important by the respondents with a mean of 1.47. Sense of safety was the third most important characteristic according to the local perspective with a mean of 1.46. Better path light, with a mean of 1.5, confirms that safety plays a significant role in creating a perception of a pedestrian-friendly space according to the respondents. Aesthetically pleasing scenery was also highly regarded to increase the level of walkability with a mean of 1.5.

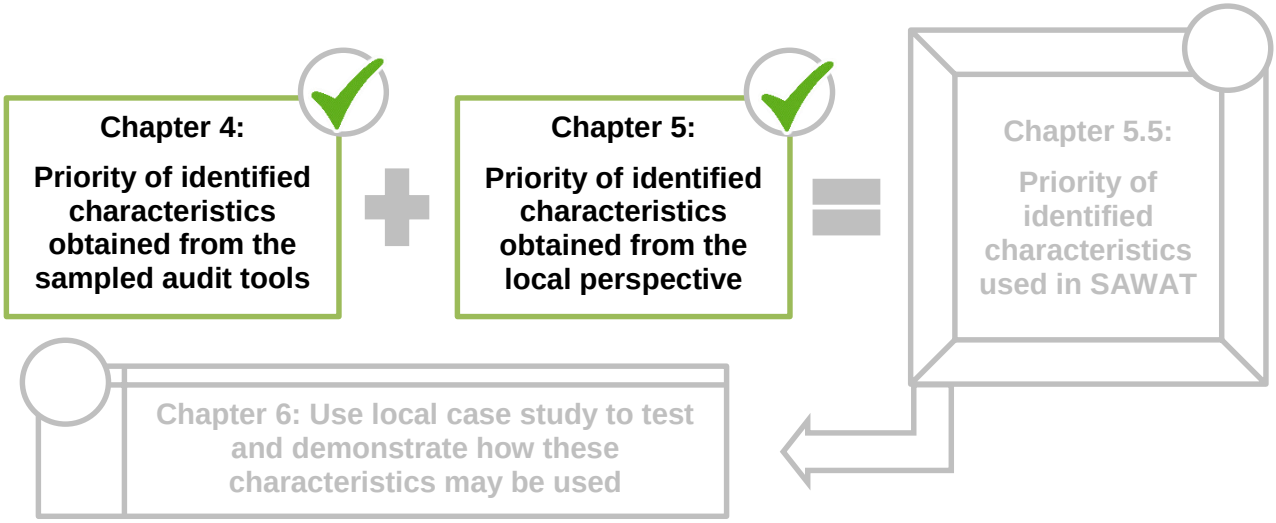


Figure 5- 1: The structure of the empirical section

Source: Own construction (2019).

As Figure 5-1 illustrates, the priorities of the walkability and sidewalk design characteristics according to the local perspective have been identified. This will be used to inform the priority of the final SAWAT characteristics.

5.5 Prioritising of characteristics to be included South African Walkability Audit Tool (SAWAT)

The findings of the walkability audit tools sampled in Chapter 4 and the survey results from section 5.5 were used to assemble a proposed SAWAT. To further define and inform the proposed SAWAT, the walkability and sidewalk design characteristics were prioritised according to their occurrence in the six audit tools considered as well as the characteristics identified by the local perspective. The priorities of the walkability and sidewalk design characteristics allow this tool to be implemented in different phases where it may be necessary. There are three levels of priority, Priority A, Priority B and Priority C, illustrated and explained in Table 5-3.

Table 5-3: Identification of characteristic priority

Priority A
Walkability and sidewalk design characteristics: • In more than 50 % of sampled audit tools **+** local perspective indicated 'fully agree'
Priority B
Walkability and sidewalk design characteristics: • In more than 50 % of sampled audit tools **+** local perspective indicated 'agree' or • In less than 50 % of sampled audit tools **+** local perspective indicated 'fully agree'
Priority C
Walkability and sidewalk design characteristics: • In more than 50 % of sampled audit tools **+** local perspective disagrees or strongly disagrees or • In less than 50 % of sampled audit tools + local perspective agrees with

Source: Own construction (2019).

Table 5-4 combines the priorities identified in the six sampled walkability audit tools (see Table 4-1) and the local perspective (see Table 5-2). These walkability and sidewalk design characteristics listed in Table 5-4 with their priorities will be used in the SAWAT. These characteristics may be used as a guideline to create pedestrian-friendly spaces. The characteristics are placed under the appropriate categories and in the applicable priority.

Table 5-4: Characteristics included in SAWAT and their priorities

Walkability Characteristics	**Frequency in sampled audit tools**	**Local perspective**	**Priority (A, B or C)**
Design			
Mixed land uses	100%	Agree	**B**
Layout accessibility	50%	Agree	**B**
Residential density	33%	Agree	**C**
Street connectivity	17%	Agree	**C**
Infrastructure			
Sidewalk infrastructure	100%	Fully agree	**A**

Walkability Characteristics	Frequency in sampled audit tools	Local perspective	Priority (A, B or C)
Path maintenance	83%	Fully agree	**A**
Path obstructions	100%	Agree	**B**
Path slope	83%	Agree	**B**
Path surface	67%	Agree	**B**
Public recreational facility	67%	Agree	**B**
Path continuity	50%	Agree	**B**
Path width	50%	Agree	**B**
Path on both sides	33%	Agree	**C**
Path directness	33%	Agree	**C**
Special needs zones	33%	Agree	**C**
Vehicle-pedestrian interactions			
Crosswalks	100%	Agree	**B**
Traffic volume	83%	Agree	**B**
Traffic calming	67%	Agree	**B**
Buffer zone	67%	Agree	**B**
Road condition	50%	Agree	**B**
Public transport stops	50%	Agree	**B**
Speed limit	17%	Agree	**C**
Parking areas	83%	Disagree	**C**
Safety			
Lighting	83%	Agree	**B**
Surveillance	50%	Agree	**B**
Barriers/Buffers	50%	Agree	**B**
Pedestrian signs	50%	Agree	**B**
Sense of safety	33%	Fully agree	**B**
“Eyes on the street”/ Building fronts	33%	Agree	**C**
Aesthetics			
Tree Presence	100%	Fully agree	**A**
Cleanliness	83%	Agree	**B**
Architectural variety	67%	Agree	**B**
Aesthetically pleasing scenery	50%	Agree	**B**
Public open spaces	50%	Agree	**B**
Fewer abandoned buildings	50%	Agree	**B**
Public seating	50%	Agree	**B**
Greenery	33%	Agree	**C**
Garden maintenance	33%	Agree	**C**
Vacant lot	33%	Agree	**C**
Water fountains	17%	Agree	**C**
Public art	17%	Agree	**C**

Source: Own construction (2019).

Table 5-4 illustrates the different walkability and sidewalk design characteristics, in their combined priorities. The list of characteristics in Table 5-4 may be seen as the preliminary SAWAT that will be tested in the next chapter and further refined in the recommendation chapter.

The priorities identified in Table 5-4 may further assist the upgrading or development of pedestrian-friendly communities according to the SAWAT priority. The priorities provided in the preliminary SAWAT allows for a phased implementation of the characteristics. This allows users to set up payment schedules and reduces immediate bulk input costs. This reduces project risk and provides well-defined phases that may be better controlled. Priority A characteristics are those that may be considered or implemented first. Thereafter, Priority B characteristics may be implemented followed by priority C characteristics. However, certain characteristics cannot be implemented independently as they may be dependent on other characteristics. In such cases, even lower priority characteristics must be escalated for development to make sense in practice. Priority A characteristics include sidewalk infrastructure, path maintenance and tree presence. Priority B characteristics include mixed land uses, layout accessibility, path obstructions, path slope, path surface, public recreational facility, path continuity, path width, crosswalks, traffic volume, traffic calming, buffer zone, road condition, public transport stops, lighting, surveillance, barriers/buffers, pedestrian signs, sense of safety, cleanliness, architectural variety, aesthetically pleasing scenery, public open spaces, fewer abandoned buildings and public seating. Priority C characteristics include residential density, street connectivity, path on both sides, path directness, special needs zones, speed limit, parking areas, “eyes on the street”/ building fronts, greenery, garden maintenance, vacant lot, water fountains and public art

5.6 Conclusion of Chapter 5

Obtaining the local perspective allows the proposed SAWAT characteristics to be further defined and prioritised. The e-questionnaire provides valuable input from a local community. Combining the sampled audit tools and the local perspective provides an informed priority that may be used for implementation. The local perspective portrayed in this study does not necessarily represent all of SA but provides a basis for practical implementation. The SAWAT has a three-tier priority which provide a practical framework for implementation of this tool. Chapter 6 will illustrate how the SAWAT characteristics may be used to evaluate the local case study.

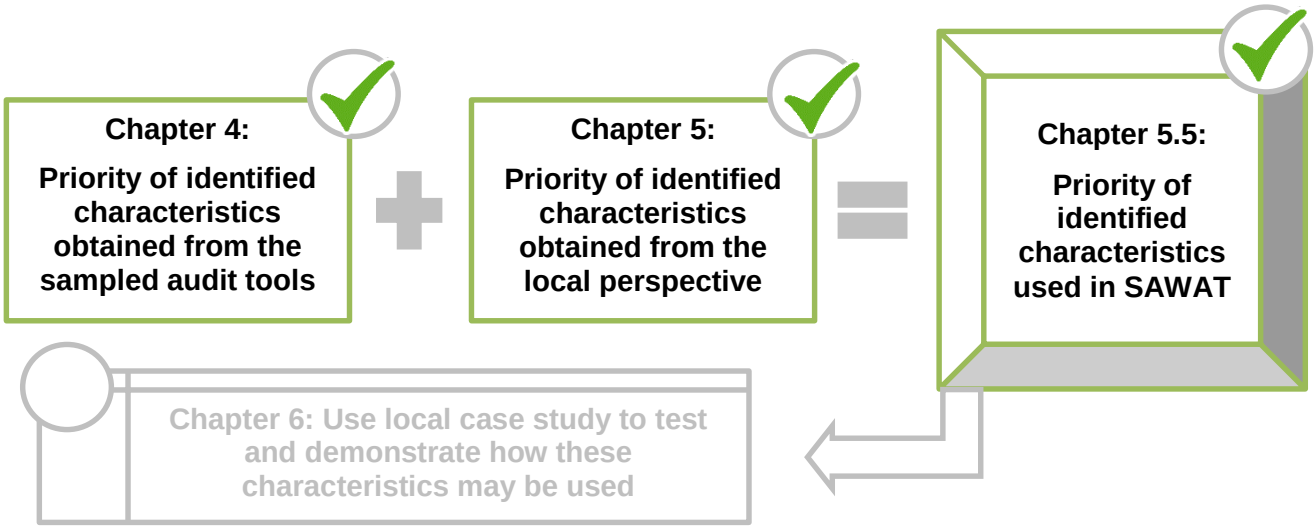


Figure 5-2: The structure of the empirical section

Source: Own construction (2019).

CHAPTER 6: REFLECTING ON THE IMPLEMENTATION OF PROPOSED SAWAT IN LOCAL CASE STUDY

6.1 Points of departure

In Chapter 5, the preliminary SAWAT was formulated from the sampled walkability audit tools and the local perspective through the identification of the key characteristics needed to create a pedestrian-friendly space and assembled under the six categories identified in Chapter 3. Chapter 6 is phase three of the empirical investigation. In this chapter, the preliminary SAWAT was implemented in a local case study to illustrate how the tool may be used to identify possible opportunities for improvement in the walkability and pedestrian-friendliness of an area. The area chosen for the implementation of these characteristics is located in Potchefstroom. The Potchefstroom perception on levels of satisfaction of the six SAWAT categories (design, infrastructure, vehicle-pedestrians interaction, safety and aesthetics) were evaluated. The categories indicated by the Potchefstroom respondents to be dissatisfactory were evaluated according to the SAWAT characteristics to determine the opportunities for improvement which may have caused these levels of dissatisfaction. The local Potchefstroom perception was gained only to provide a platform where the preliminary SAWAT could be implemented and tested, as a reflection on the role and impact of the proposed SAWAT within the local context.

6.2 Description of the study area

This study area is located in Potchefstroom, North West, South Africa. It is situated in the Northern part of Potchefstroom, next to the NWU campus. The central coordinates of this location are 26°41'32.1"S 27°05'37.9"E. This area has a high volume of pedestrian movement due to it being located near the NWU campus. General problems in terms of pedestrian-friendliness can be observed.

The study area consists of four street sections namely, Meyer Street, Steve Biko Street, Borcherds Street and Hoffman Street as illustrated by Figure 6-1. Meyer Street is a 2-lane road (single carriageway): that runs parallel to residential uses in the north and commercial uses to the west. Steve Biko Street is a single carriageway that runs parallel to commercial and residential uses in the east and commercial uses to the west. Borcherds Street is a single carriageway that runs parallel to commercial uses in the north and public open space to the South. Hoffman Street is a single carriageway that is adjacent to institutional land use in the west and commercial uses to the east. The study area includes four intersections as illustrated in Figure 6-1.

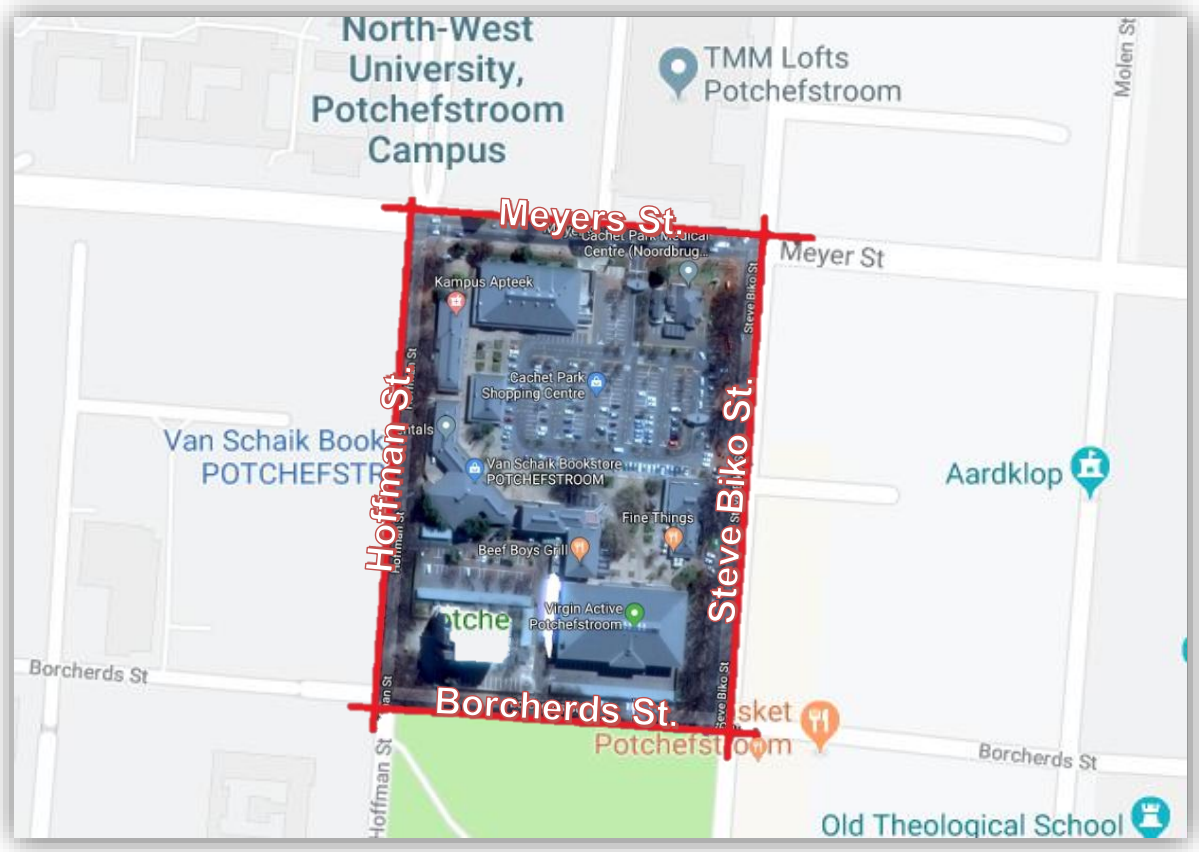


Figure 6-1: Street sections

Source: Google Maps (2018).

6.3 Potchefstroom perception of the general walkability of the study area

The local Potchefstroom perception was gained to provide a platform where the preliminary SAWAT could be implemented and tested. Section three of the e-questionnaire was used to identify the Potchefstroom perception, as mentioned in Chapter 5.2. Section three instructed the respondents to complete this part of the e-questionnaire only if they resided in Potchefstroom to ensure that the individuals answering this section were familiar with the case study area to capture an accurate perception of this area (E-questionnaire is attached as Annexure A). A sample of 91 respondents answered this section of the e-questionnaire. The respondents were asked the following questions: Are you satisfied with the overall design of this area? Are you satisfied with the overall pedestrian infrastructure in this area? Are you satisfied with the overall vehicle-pedestrian interaction in this area? Are you satisfied with the overall safety in this area? Are you satisfied with the overall safety in this area? Are you satisfied with the overall aesthetics in this area? The respondents could respond with the following answers: satisfied, dissatisfied, or not sure as illustrated in Figure 6-2.

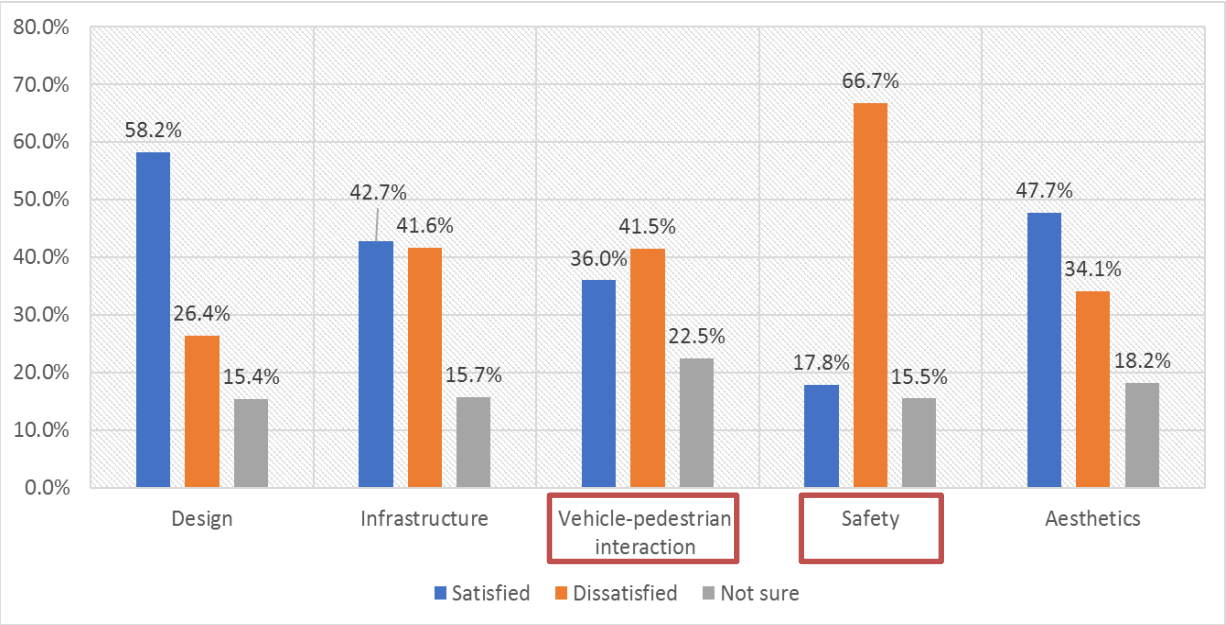


Figure 6- 2: Potchefstroom residents' perception of the case study area in terms of walkability and sidewalk design.

Source: Own construction (2019).

Figure 6-2 indicates that the respondents from Potchefstroom were generally satisfied with the design (58.2%), pedestrian infrastructure (42.7%) and the aesthetics (47.7%) relative to the levels of dissatisfaction of these catgories of the study area. Respondents from Potchefstroom were generally dissatisfied with the vehicle-pedestrian infrastructure (41.5%) and the safety (66.7%) of the local study area. It is evident that safety is of the highest concern for Potchefstroom respondents, safety had the overall highest percentage. The categories that the local respondents were dissatisfied with will be assessed through the implementation of the preliminary SAWAT to indicate whether there are opportunities for improvement.

6.4 Implementation of the SAWAT characteristics in the local case study

The Potchefstroom respondents were dissatisfied with the safety and vehicle-pedestrian interaction categories relative to their satisfaction levels. These two categories were evaluated in terms of the SAWAT characteristics to illustrate how these characteristics may be used to identify gaps in the pedestrian-friendliness that cause the typical dissatisfaction identified by the Potchefstroom respondents. To observe the study area, a site visit was conducted during the day at lunchtime, between 12:00 and 13:00 and at night between 19:00 and 20:00. Due to the lack of efficient light, pictures were only taken during the day time site visits. Only the safety and vehicle-pedestrian interaction SAWAT characteristics were considered based on the Potchefstroom perception which identified that respondents were dissatisfied with these categories in the study area. The SAWAT characteristics were evaluated by considering the presence of these characteristics within the study area. This explained the reason why the Potchefstroom

respondents were dissatisfied and illustrated how the SAWAT characteristics may be implemented.

6.4.1 Evaluation of study area

The four sections of streets were observed and evaluated according to the SAWAT characteristics. Figure 6-3 displays a section of Meyer Street, Figure 6-4 displays a section of Steve Biko Street, Figure 6-5 displays a section of Borcherds Street and Figure 6-6 displays a section of Hoffman Street. By implementing the preliminary SAWAT, the reason for the dissatisfaction reflected in respondent perceptions may be identified. These SAWAT characteristics that were observed in these sections of streets were indicated by the orange and yellow dots. The yellow dots represented the vehicle-pedestrian interaction characteristics, and the orange dots represented the safety characteristics. If a characteristic was absent or could not be indicated on the figure it was only discussed.

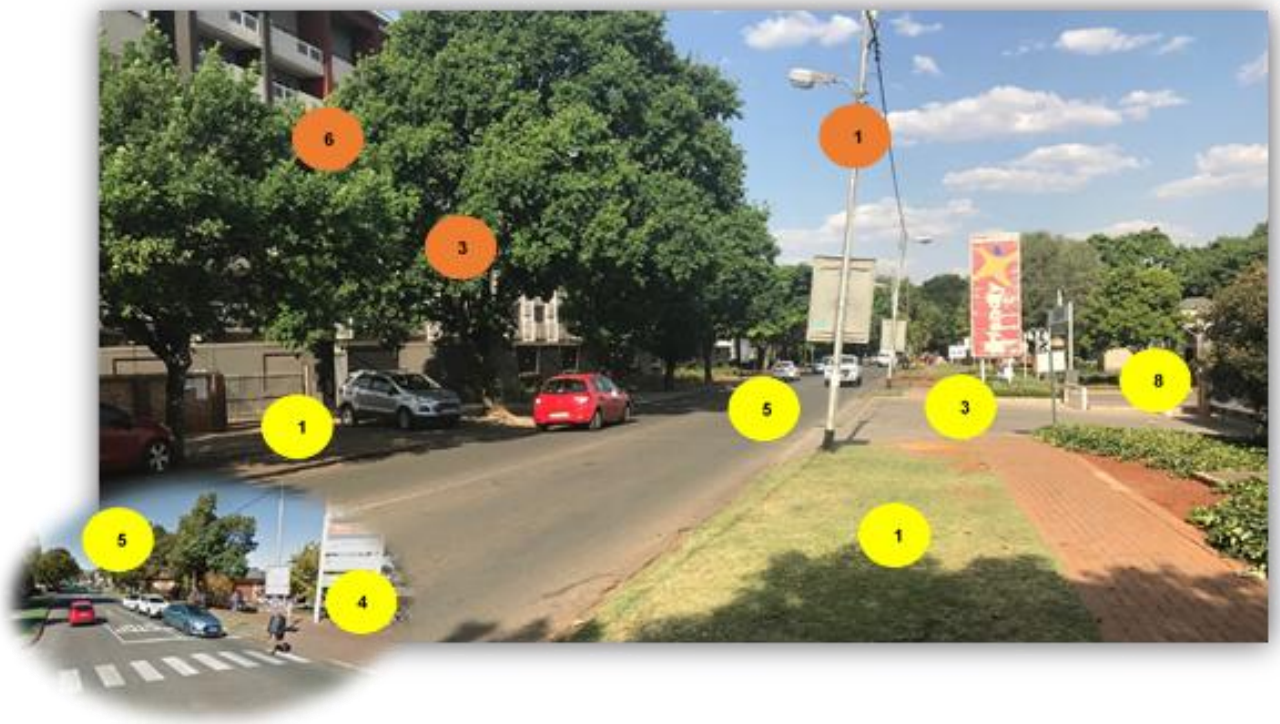


Figure 6-3: Evaluation of Meyer Street section

Source: Own construction (2019)

Vehicle-pedestrian interaction characteristics: A buffer zone of approximately 2m was present on both sides of Meyer Street as indicated by the yellow number one dot as illustrated in Figure 6-3. The road condition appears to be well maintained and does not have a negative impact on the vehicle and pedestrian movement or interaction. There are no visible or dedicated public transportation stop facilities on this section of Meyer Street. Taxis appear to stop in the middle of the road or in the entrance to Cachet Park Shopping Centre indicated by the yellow number three-

dot as illustrated in Figure 6-3. This creates an unsafe interaction between pedestrians and vehicles. There is only one crosswalk on this section of Meyer Street as indicated by the yellow number four dot as illustrated in Figure 6-3. It appears that the lack of crosswalks leads to roads crossings at any part of Meyer street. There is a high traffic volume on the section of street since this is one of the main roads that lead to the NWU campus. The high volume of traffic is pointed out by the yellow number five dot in Figure 6-3. There are no traffic calming techniques used in this section of Meyer Street. There is no visible speed limit designated to this section of the street. There is a parking area indicated by the yellow number eight dot in Figure 6-3, but a parking fee is required.

Safety characteristics: There are street lights present on one side of the street, arranged by one light facing the street and the next facing the pedestrian path as indicated by the orange number one dot in Figure 6-3. The street and pedestrian lights are very dim and spaced far apart. New CCTV surveillance cameras have been installed recently as part of the 'Take back the Bult' project. Police and private security vehicles occasionally pass this area. There are no buffers or barriers along the street except for the trees on one side of the road as indicated by the orange number three-dot in Figure 6-3. The trees are situated far apart from each other, but they provide some form of protection. There are no pedestrian signs on this section of the street. During the day there are numerous "eyes on the street" yet limited buildings facing the road as shown by the orange six dot in Figure 6-3. At night the pedestrian movement reduces dramatically which means there are fewer "eyes on the street" during the night. During the day time site visit there was a general sense of safety, but during the night time site visit the sense of safety diminished.

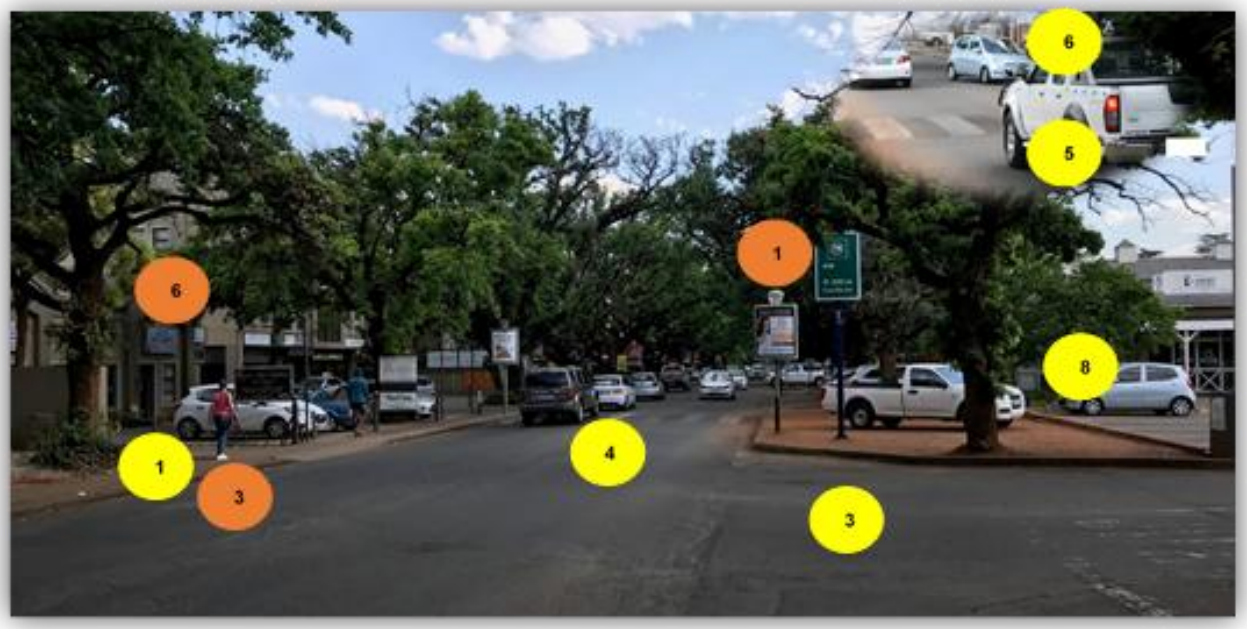


Figure 6-4: Evaluation of Steve Biko Street section

Source: Own construction (2019).

Vehicle-pedestrian interaction characteristics: A buffer zone of approximately 0.2m was present on one side of Steve Biko Street, indicated by the yellow number one dot as illustrated in Figure 6-4. There is no pedestrian path on the other side of Steve Biko Street which means the buffer zone could not be determined. The road condition appears to be well maintained and does not have a negative impact on the vehicle and pedestrian movement or interaction. There are no visible or dedicated public transportation stop facilities in this section of Steve Biko Street. Taxis appear to stop in the middle of the road or in the entrance to Cachet Park Shopping Centre indicated by the yellow number three-dot as illustrated in Figure 6-4. This creates an unsafe interaction between pedestrians and vehicles. There is only one crosswalk on this section of Steve Biko Street as indicated by the yellow number four dot as illustrated in Figure 6-4. There is a high traffic volume on this section of street as there are businesses and restaurants located on both sides of Steve Biko Street. The high volume of traffic is pointed out by the yellow number five dot in Figure 6-4. There is one speed bump in this section of Steve Biko Street. There is no visible speed limit designated to this section of the street. There is a parking area indicated by the yellow number eight dot in Figure 6-4, but a parking fee is required.

Safety characteristics: There are street lights present on both sides of the street as indicated by the orange number one dot in Figure 6-4. The street lights are very dim and spaced far apart which causes several dark areas along the street. New CCTV surveillance cameras have been installed recently as part of the 'Take back the Bult' project. Police and private security vehicles occasionally pass this area. There are no buffers or barriers along the street as indicated by the orange number three dot in Figure 6-4. There are no pedestrian signs on this section of the street. Due to the number of restaurants and business along this section of Steve Biko Street, there are several "eyes on the street" and several buildings facing the road as shown by the orange number six dot in Figure 6-4. At night the pedestrian movement reduces towards the north end of this section of Steve Biko street which means there are fewer eyes on the north end of the street during the night. The southern part of this section of street continues to have more movement due to the restaurants and bars that stay open until late at night. During both site visits there was a general sense of safety to the south end of this section of Steve Biko street. The northern end of this section of Steve Biko street the sense of safety diminished during the dark hours due to lack of movement and limited "eyes on the street".

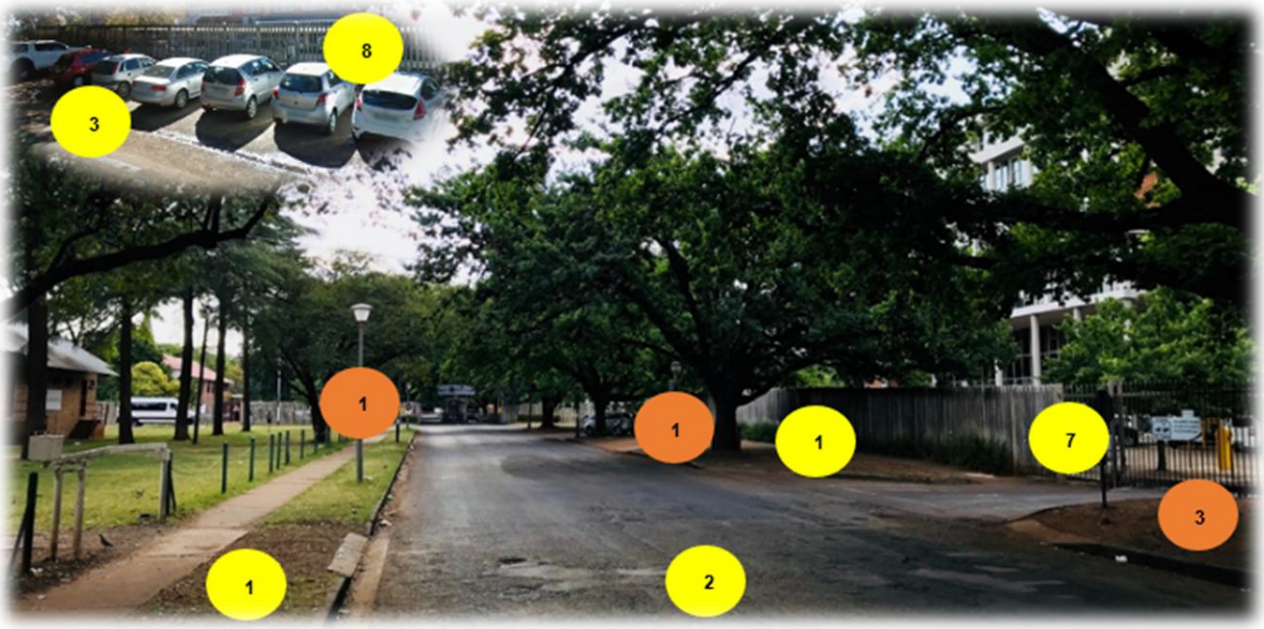


Figure 6-5: Evaluation of Borcherds Street section

Source: Own construction (2019)

Vehicle-pedestrian interaction characteristics: There is a buffer zone of ±1m on the left-hand side of Figure 6-5 and ±5m on the right-hand side of Figure 6-5 indicated by the yellow number one dots. The road condition seems dilapidated in this section of Borcherds Street as indicated by the yellow number two dot. This appears to cause vehicles to veer off to avoid the bad parts of the road, which may increase the chances of interaction between the vehicles and pedestrians. There are no public transportation stops on this section of Borcherds Street. Taxis appear to stop in the middle of the road or on the street side parking indicated by the yellow number three-dot. There are no crosswalks on this section of Borcherds Street. Borcherds Street has the lowest volume of traffic compared to the other three sections. There are no traffic calming techniques used in this section of Borcherds Street. There is no visible speed limit designated to this section of the street. There is a public parking area along one side of the street as indicated by the yellow number eight dot. There is another public parking area to the South of Borcherds Street.

Safety characteristics: There are street lights present on both sides of the street as indicated by the orange number one dot in Figure 6-5. The street lights are very dim and spaced far apart which causes several dark areas along the street. New CCTV surveillance cameras have been installed recently as part of the 'Take back the Bult' project. Police and private security vehicles occasionally pass this area. The only buffer present in this section of Borcherds street is the large buffer zone which creates a space between the pedestrians and the vehicles, indicated by the orange number three-dot in Figure 6-5. The trees also act as some form of protection but are very limited as they are spaced far apart. There are no pedestrian signs on this section of the street.

During both site visit there was a general sense of safety to the south end of this section of Steve Biko street. The northern end of this section of Steve Biko street the sense of safety diminished during the dark hours. There are very few “eyes on this street” and limited buildings facing the road. This section of Borcherds street did not feel safe during the day time site visit and even less so during the night site visit.

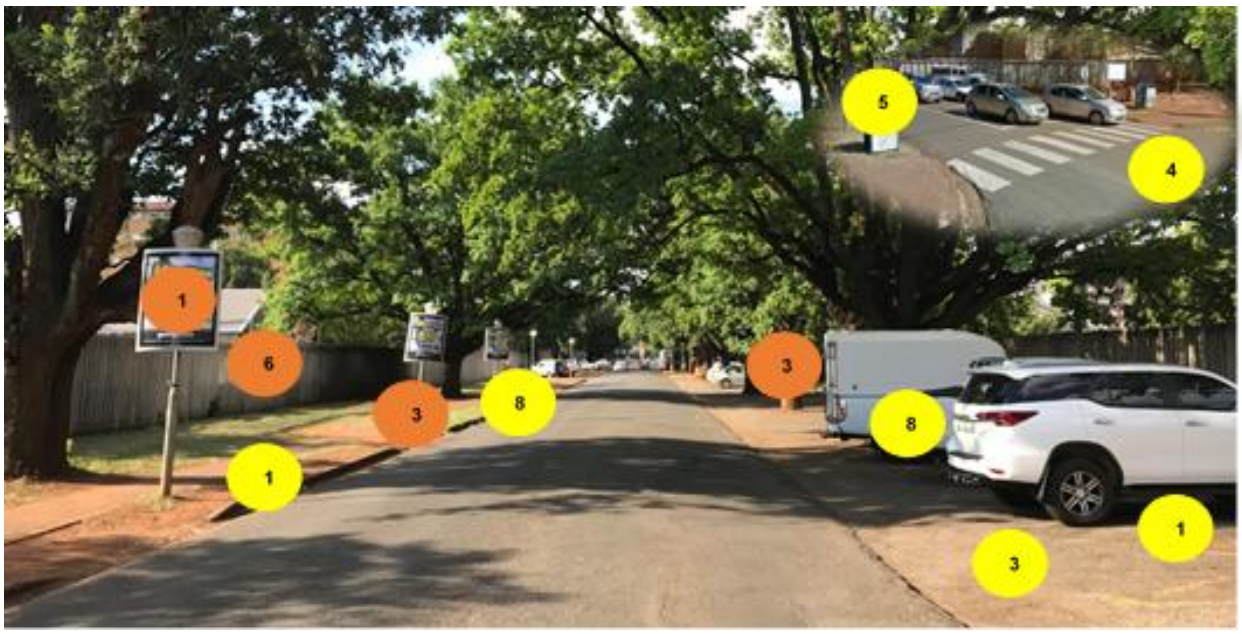


Figure 6-6: Evaluation of Hoffman Street section

Source: Own construction (2019)

Vehicle-pedestrian interaction characteristics: There is a buffer zone of ±1m on the left-hand side of Figure 6-6 and ±5m on the right-hand side of Figure 6-6 indicated by the yellow number one dots. The road condition appears to be well maintained and does not have a negative impact on the vehicle and pedestrian movement or interaction. There are no public transportation stops on this section of Hoffman Street. Taxis appear to stop in the middle of the road or on the street side parking indicated by the yellow number three dot. There is only one crosswalk on this section of Hoffman Street as indicated by the yellow number four dot. There is a high traffic volume on Hoffman Street, as it leads directly into the main gate of the NWU campus. There are no traffic calming techniques used in this section of Hoffman Street. There is no visible speed limit designated to this section of the street. There is street side parking along one side of Hoffman Street indicated by the yellow number eight dot.

Safety characteristics: There are street lights present on both sides of the street as indicated by the orange number one dot in Figure 6-6. Where there are streets light on the right-hand side of the road, there are no street lights on the left-hand side of the road and the same is true for the alternative which means there are areas with minimum lighting. The street lights are spaced closer

together than the other sections, but they are also dim. New CCTV surveillance cameras have been installed recently as part of the 'Take back the Bult' project. The street lights, trees and space created by the street side parking act as buffers or barriers indicated by the orange number three dot in Figure 6-6, other than these there are no other buffers or barriers. There are no pedestrian signs on this section of the street. During the day there are numerous "eyes on the street" yet very few buildings facing the road as shown by the orange number six dot in Figure 6-6. At night the pedestrian movement reduces which means there are fewer "eyes on the street". During the day time site visit, there was a general sense of safety, but during the night time site visit the sense of safety reduced.

6.4.2 Implementing the SAWAT characteristics in local context: A reflection of the role and impact of the SAWAT characteristics for planning walkability

The evaluation of the study area was done through the observation of the SAWAT characteristics. If the section of street did not contain a certain characteristic, it was identified as a major opportunity for improvement. If there were only indications or limited amounts of the characteristic, it was identified as a minor opportunity for improvement. If the characteristic was present and effective, it was said to have no opportunity for improvement. Table 6-1 indicates the SAWAT characteristics observed to evaluate the pedestrian-friendliness of the study area. It provides a priority of implementation, namely priority A, priority B and priority C. The opportunities for improvement of the local study area that were identified by the SAWAT characteristics are illustrated in Table 6-1.

Table 6- 1: Opportunities for improvement identified by the SAWAT characteristics

	Walkability and sidewalk design Characteristics	Priority (A, B or C)	Presence of characteristics - summary	Opportunity identified: No opportunity - ✓✓ (Effective) Minor opportunity- ✓✖ Major opportunity - ✖✖
Vehicle-pedestrian interactions				
1	Buffer zone	**B**	Buffer zone present- effective on both sides of the street.	Meyer Street: ✓✓
			Buffer zone present - smaller than the suggested dimensions.	Steve Biko Street: ✓✖
			Buffer zone present – effective on one side and smaller than the suggested dimensions on the other side.	Borcherds Street: ✓✖

			Buffer zone present – effective on one side and smaller than the suggested dimensions on the other side.	Hoffman Street: ✓✖
2	Road condition	B	Road conditions appear adequate.	Meyer Street: ✓✓
			Road conditions appear adequate.	Steve Biko Street: ✓✓
			Road conditions appear to be run-down.	Borcherds Street ✓✖
			Road conditions seem adequate.	Hoffman Street: ✓✓
3	Public transport stops	B	No public transportations stop.	Meyer Street: ✖✖
			No public transportations stop.	Steve Biko Street: ✖✖
			No public transportations stop.	Hoffman Street: ✖✖
			No public transportations stop.	Borcherds Street: ✖✖
4	Crosswalks	B	Only one crosswalk at the intersection.	Meyer Street: ✓✖
			Only one crosswalk in the middle of the section.	Steve Biko Street: ✓✖
			No crosswalks.	Borcherds Street: ✖✖
			Only one crosswalk at the intersection.	Hoffman Street: ✓✖
5	Traffic volume	B	Medium to high traffic volume.	Meyer Street: ✓✖
			Medium to high traffic volume.	Steve Biko Street: ✓✖
			Relatively low traffic volume.	Borcherds Street: ✓✓

Source: Own construction (2019).

			Medium to high traffic volume.	Hoffman Street: ✓✖
6	Traffic calming	B	No traffic calming techniques.	Meyer Street: ✖✖
			One speed bump present.	Steve Biko Street: ✓✖
			No traffic calming techniques.	Borcherds Street: ✖✖
			No traffic calming techniques.	Hoffman Street: ✖✖
7	Speed limit	C	No speed limits indicated.	Meyer Street: ✖✖
			No speed limits indicated.	Steve Biko Street: ✖✖
			No speed limits indicated.	Borcherds Street: ✖✖
			No speed limits indicated.	Hoffman Street: ✖✖
8	Parking areas	C	Parking available - parking fee required.	Meyer Street: ✓✖
			Parking available - parking fee required.	Steve Biko Street: ✓✖
			Parking alongside to road.	Borcherds Street: ✓✓
			Parking alongside to road.	Hoffman Street: ✓✓
Safety				
1	Lighting	A	Lights on one side of the street, not over pedestrian paths.	Meyer Street: ✓✖
			Dim lights dispersed on both sides.	Steve Biko Street: ✓✖
			Dim lights dispersed on both sides.	Borcherds Street: ✓✖
			Dim lights dispersed on both sides.	Hoffman Street: ✓✖

2	Surveillance	A	CCTV cameras can be seen on certain sections of this street	Meyer Street: ✓✖
			CCTV cameras can be seen on certain sections of this street	Steve Biko Street: ✓✖
			CCTV cameras can be seen on certain sections of this street	Hoffman Street: ✓✖
			CCTV cameras can be seen on certain sections of this street	Borcherds Street: ✓✖
3	Barriers/Buffers	A	Dispersed trees and lamp posts and space between paths act as some form of buffer or barrier.	Meyer Street: ✓✖
			Dispersed lamp posts act as some form of buffer or barrier.	Steve Biko Street: ✓✖
			Dispersed trees and lamp posts act as some form of buffer or barrier.	Borcherds Street: ✓✖
			Dispersed trees and lamp posts act as some form of buffer or barrier.	Hoffman Street: ✓✖
4	Pedestrian signs	A	No pedestrian signs.	Meyer Street: ✖✖
			No pedestrian signs.	Steve Biko Street: ✖✖
			No pedestrian signs.	Borcherds Street: ✖✖
			No pedestrian signs.	Hoffman Street: ✖✖
5	Sense of safety	B	Perceived safety during the day, but not at night.	Meyer Street: ✓✖
			Perceived safety during the day, but not at night.	Steve Biko Street: ✓✖
			Lacks a perceived sense of safety	Borcherds Street: ✖✖
			Perceived safety during the day, but not at night.	Hoffman Street: ✓✖

6	"Eyes on the street"/ Building fronts facing the street	C	Meyers Street has "eyes on the street" during the day, but few "eyes on the street" during the night and few buildings facing the road.	Meyer Street: ✓✖
			Steve Biko has "eyes on the street" and buildings facing the road.	Steve Biko Street: ✓✓
			Borcherds Street has few "eyes on the street" and almost no buildings facing the road.	Borcherds Street: ✖✖
			Hoffman Street has "eyes on the street" during the day, but few "eyes on the street" during the night and few buildings facing the road.	Hoffman Street: ✓✖

Table 6-2 illustrates the opportunities for improvment identified in the study area through the observation of the SAWAT characteristics. Fourteen characteristics from the two categories were used to evaluate the case study area. In Meyer Street, five major opportunities for improvement, seven minor opportunities for improvement and two effective characteristics were identified. In Steve Biko Street, three major opportunities for improvement, nine minor opportunities for improvement and two effective characteristics were identified. In Hoffman Street, four major opportunities for improvement, eight minor opportunities for improvement and two effective characteristics were identified. Borcherds street had the most opportunities for improvement, including seven major opportunities, six minor opportunities and one effective characteristic present. Overall, the study area indicated several opportunities for improvement which may explain why the Potchefstroom respondents indicated that they were dissatisfied with these walkability and sidewalk design characteristics categories. This illustrates the value of the SAWAT to identify opportunities for improvement and contribute to the creation of pedestrian-friendly spaces.

6.5 Conclusion of Chapter 6

This chapter illustrated how the SAWAT characteristics might be implemented to evaluate two of the five categories reported as unsatisfactory by the Potchefstroom respondents. Furthermore, this chapter demonstrated how stakeholder input can be used and incorporated for context. By observing and evaluating the study area according to the SAWAT characteristics, opportunities

for improvement were identified. Several minor and major opportunities for improvement were identified in all four street sections which may explain the dissatisfaction indicated by the Potchefstroom respondents. The SAWAT characteristics may be used to evaluate the pedestrian-friendliness of any space and are not only limited the identification of gaps but can also be used to recognise opportunities. This chapter illustrates that providing a checklist makes it easier for the user of the audit tool to identify opportunities for improvement. In the next chapter research conclusions are drawn in line with the research objectives. In the recommendation chapter the SAWAT characteristics will be used to suggest methods of improving the opportunities identified in this chapter. Furthermore, suggestions on how it may be improved from a planning perspective will be discussed in the recommendations Chapter.

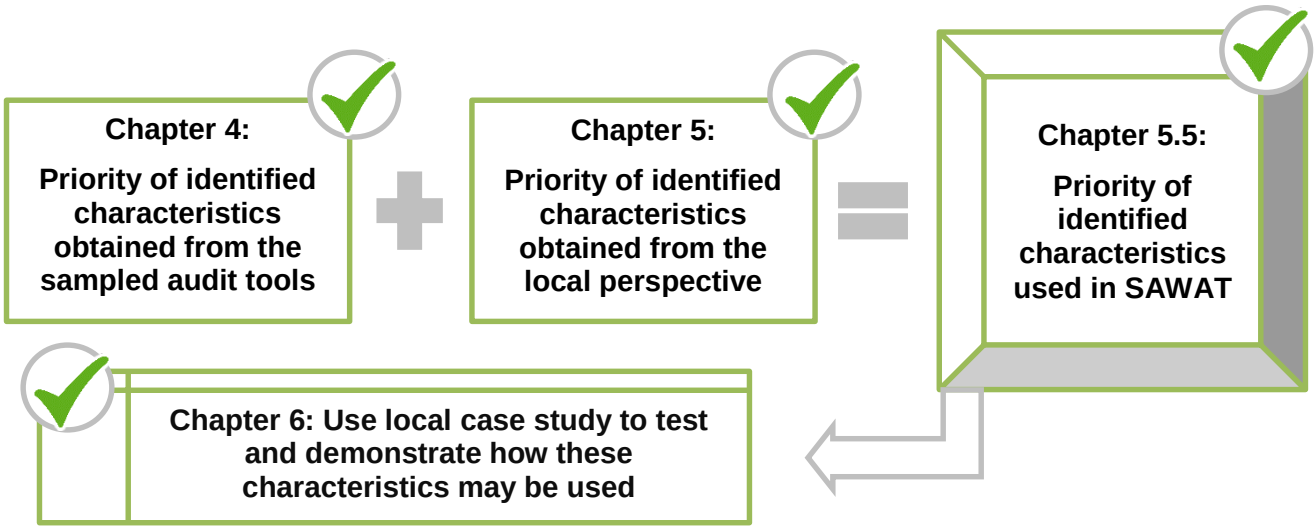


Figure 6- 7:The structure of the empirical section

Source: Own construction (2019).

CHAPTER 7: CONCLUSIONS

This chapter presents the research conclusions drawn in line with the research objectives stated in Chapter 1, based on the literature review and empirical investigation captured in the preceding chapters.

7.1 Conclusion 1: Walkability, sidewalks and pedestrian-friendly spaces could be enhanced from a spatial planning perspective.

Walkability is a notion that is used to measure the level to which a neighbourhood or community accommodates the movement of pedestrians in the area. Walkability is a multidimensional concept entailing various characteristics that allows an area to support walking as a mode of transport without the use of automobiles (see Chapter 2.1). These characteristics were sorted in five categories which include, design, infrastructure, vehicle-pedestrian interaction, safety and aesthetics (see Chapter 3.1). Pedestrian-friendly spaces are areas with high levels of walkability and well-designed sidewalks that support active living. Pedestrian-friendly spaces are challenged by car-orientated built environments which have led to a high level of physical inactivity on an international level. Pedestrian-friendly spaces foster active living, active transportation and provide individuals with transportation equity (see Chapter 2.3). Sidewalks are a consequential part of pedestrian-friendly spaces as individuals make use of sidewalks daily and nearly every trip begins and ends on sidewalks. Sidewalks act as a diverse public space, which provides pedestrian-friendly spaces with several functions. These functions include social, economic and transportations functions (see Chapter 2.4.2). Pedestrian-friendly spaces are often undervalued, especially from a spatial planning perspective (see Chapter 2.3.1). Pedestrian-friendly communities have numerous benefits (see Chapter 2.2). These benefits are listed in Table 7-1.

Table 7- 1: Benefits of a pedestrian-friendly space

Environmental benfits	Transportation benefits	Economic benefits	Safety benefits	Social benefits
• Less dependent on vehicles • Low environmental impact • Lower levels of pollution • Less water run-off	• Less traffic • Lower maintenance costs • Supports public transportation network	• Lower transportation • related costs • Higher retail values • Promotes economic opportunities	• A greater sense of safety • Fewer traffic fatalities	• A greater sense of community • Enhances social capital • Integration between members of the community • Community cohesion

Source: Own construction (2019) based on Chapter 2.3.

The consideration of walkability and sidewalk design characteristics could positively impact the spatial arrangement of cities. A spatial arrangement that supports walkability may connect segregated and scattered cities and provide individuals with greater access to social and economic opportunities. The consideration of such characteristics may not only impact the appearance of cities, but the way cities are experienced. Pedestrian-friendly spaces may cater for large numbers of pedestrians all over South African cities. These spaces may allow pedestrians to reduce their dependency on cars whilst meeting their daily needs and running their day-to-day errands. This pedestrian-friendly compact spatial arrangement supports a key aspect of a South African spatial planning principle, which is the notion of densification.

It appears that there have been attempts to address walkability in South Africa through certain legislation and policies. The South African NMT Facility Guideline Manual was designed to guide the planning of walkability in South Africa. The NMT Manual, however, is not integrated with the town planning laws and policies. There is limited integration between the NMT policy and the town planning laws and policies which might indicate why there is an inadequate manifestation of the NMT manual. In terms of spatial planning, this means there is a lack of pedestrian-friendly spaces. When a town planning application is motivated by the private sector and considered by the public sector, SPLUMA and LUPA are often considered as well as the Municipal SDF and By-laws. If the NMT manual is not integrated with these policies and legislation, there will be limited regulation and implementation of pedestrian friendly-spaces. No guidelines like the NMT Manual or tools like the proposed SAWAT is considered during any land use applications.

7.2 Conclusion 2: Walkability and sidewalk design characteristics from existing international and local walkability audit tools present overlapping characteristics that serve as best practices to inform the local approach to a SAWAT.

Six existing walkability audit tools, namely SPACES, SWAT, MAPS, ANC, 7C's and PEAT were sampled to determine which of the walkability and sidewalk design characteristics identified in Chapter 3 were predominantly used in these audit tools (see Chapter 4). These characteristics were grouped under design, infrastructure, vehicle-pedestrian interaction, safety and aesthetics as identified in Chapter 3. These characteristics identified in the six existing tools were all used to inform the SAWAT along with the input of the local South African perspective. Figure 7-1 is an example of how the characteristics from the audit tools were used to inform the SAWAT.

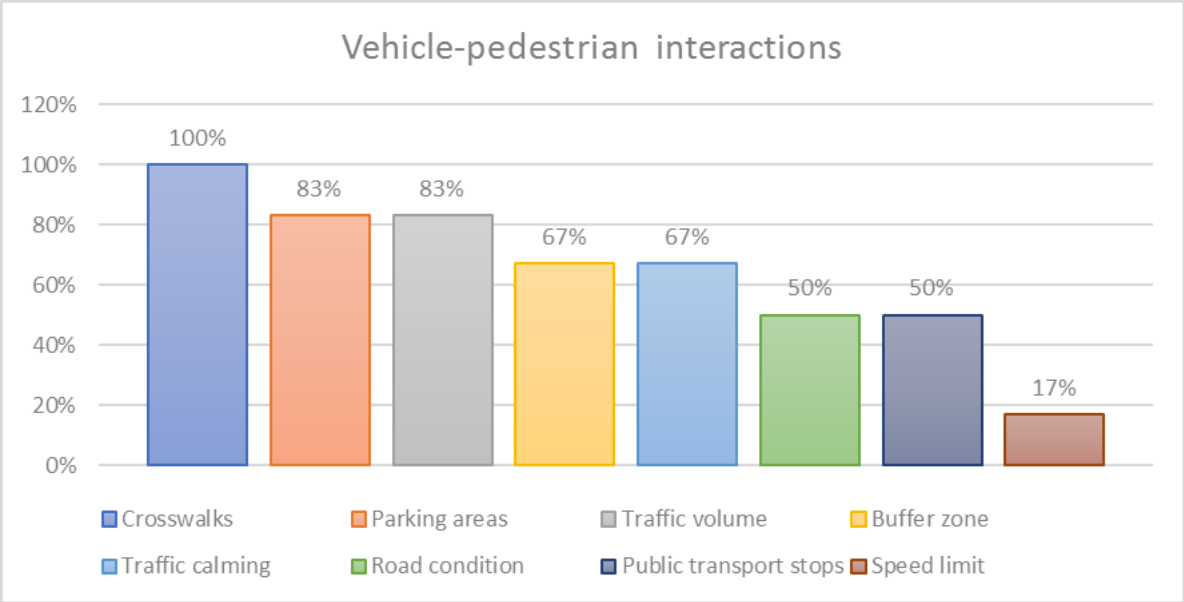


Figure 7- 1: Occurrence of vehicle-pedestrian interaction characteristics

Source: Own construction (2019).

Figure 7-1 demonstrates the occurrence of the following walkability and sidewalk design characteristics that are grouped under vehicle-pedestrian interactions in the six existing tools. It illustrates that crosswalks, as a walkability and sidewalk design characteristic, was found in all the six existing tools (100%). This indicates that crosswalks should be considered as an important part of creating pedestrian-friendly spaces. The crosswalk characteristic will, therefore, have a higher priority in the SAWAT as the alignment of these existing tools indicated the importance of considering this characteristic. In contrast, the speed limit as a walkability and sidewalk design characteristic was only found in 17% of the existing audit tools (see Chapter 4.3). The assumption is therefore made that the speed limit, as a walkability and sidewalk design characteristic is less important which means it's likely to lower the priority in the SAWAT.

The evaluation of walkability audit tools from different countries provides a wider perspective of the characteristics to be implemented or to measure walkability and pedestrian-friendliness of an area. Using existing walkability audit tools provides insight into established characteristics and qualities that have been tested and utilised effectively in creating pedestrian-friendly spaces. This assisted to identify the priorities of key walkability and sidewalk design characteristics that informed the SAWAT. The walkability audit tools from each country included various characteristics that contribute to a pedestrian-friendly space, and the importance of these characteristics may depend on the area and differ accordingly. Each walkability or sidewalk design characteristic has a unique contribution to the creation of a pedestrian-friendly space and contribute individually or collectively to support walkability and create a sense of community.

7.3 Conclusion 3: Context-based considerations are crucial when identifying the walkability and sidewalk design characteristics used in the SAWAT.

While it is essential to use existing walkability audit tools, it is important to ensure that the SAWAT is context-based. Therefore, to further inform the SAWAT priorities, the local perspective on the walkability and sidewalk design characteristics were important to identify the needs of a sample from the SA community in addition to the sampled walkability audit tools. The local perspective on the walkability and sidewalk design characteristics identified in Chapter 3 was captured by means of a structured e- questionnaire to determine which characteristics are considered important to increase walkability and the pedestrian-friendliness of an area.

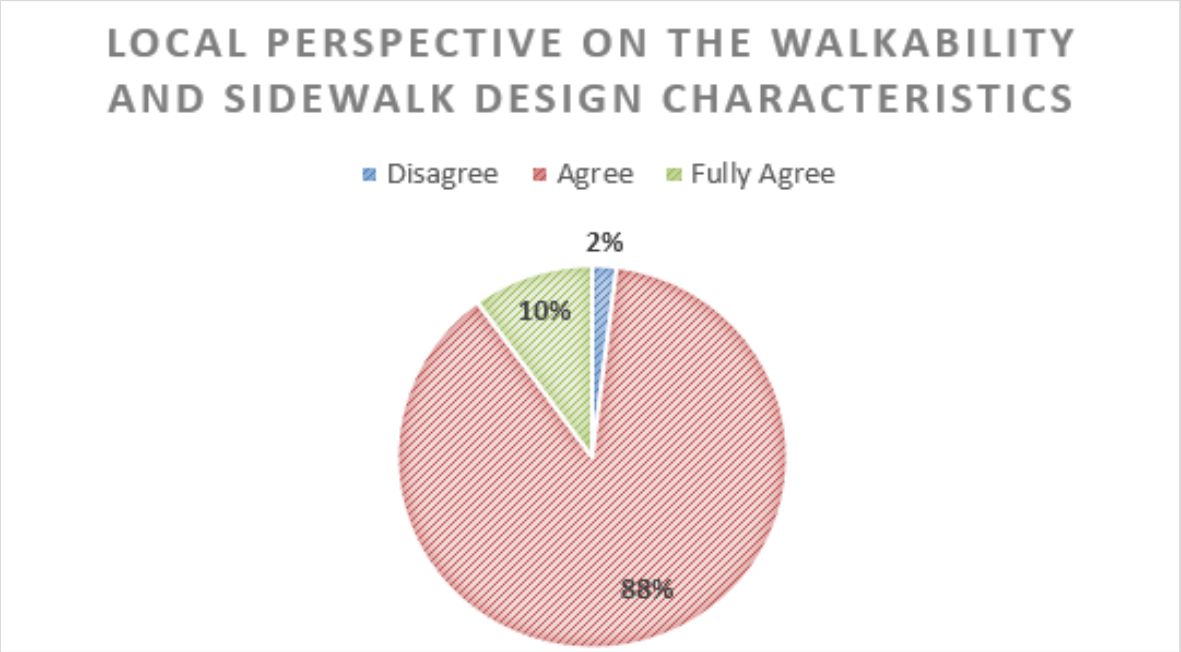


Figure 7- 2: The importance of the walkability and sidewalk design characteristics in the local context

Source: Own construction (2019).

As illustrated by Figure 7-2, the results indicated that 10% of the characteristics were fully agreed to be important, 88% of the characteristics agreed to be important and 2% of the characteristics disagreed to be important to increase the walkability of an area (see Chapter 5.1). The results obtained from the local perspective were then used to inform the priorities of the characteristics included in the SAWAT. The four characteristics (10%), namely, path maintenance, sense of safety, sidewalk infrastructure and tree presence that were fully agreed to be important by the local perspective to increase the walkability of an area is likely to have a higher priority (priority A or B) in the SAWAT. Similarly, the 36 characteristics (88%) that were agreed to be important by the local perspective to increase the walkability of an area will be likely to have a medium priority

(priority B or C) in the SAWAT. The one characteristic (2%) that was disagreed to be important by the local perspective to increase the walkability of an area will be of lower priority (priority C) in the SAWAT (see Table 5-3).

Obtaining the local perspective through the structured e-questionnaire does not only illustrate the local context and what characteristics are thought to important to increase the walkability of an area but, it provides insight into the current situation of the walkability in South African cities and towns. The fact that the local perspective fully agreed to 10% and agreed to 88% of the characteristics that would improve the walkability of an area may indicate that there is a great need for pedestrian-friendly spaces. If the respondents were satisfied with the walkability of their cities or towns then fewer characteristics might be needed to improve the walkability of the area. For this reason, the high percentages may indicate that there is a significant need for a planning intervention to improve the spatial planning of communities to support walkability and pedestrian friendly-spaces. Furthermore, listing these characteristics to South African respondents allowed the communities to recognise what will improve their cities and experiences.

Each town, city and country has different environments and needs which is why a context-based walkability audit tool is essential. The top five walkability and sidewalk design characteristics identified by the local South African respondent's included the presence of trees, sidewalk infrastructure, sense of safety, path maintenance and better path lights in this respective order (see Chapter 5.4). The presence of trees and sidewalk infrastructure were perceived to be the most important walkability and sidewalk design characteristics according to the local perspective and found in all the sampled audit tools (see Chapter 4.3). This may indicate that certain walkability and sidewalk design characteristics remain important regardless of the country or geographic location of an area. Maintained sidewalk and path lights were perceived to be important characteristics according to the local perspective and found in 83% of the sampled audit tools. This might indicate that certain walkability and sidewalk design characteristics may be expected or seen as a standard practice in some countries but seen as a luxury or rarity in other countries. Sense of safety is perceived to be the third most important walkability and sidewalk design characteristic according to the local perspective but was only found in 33% of the sampled audit tools. This may indicate that safety is a greater concern in countries like South Africa compared to the origins of the sampled audit tools.

From this study, it is evident that it is essential to gain the local perspective of an area as not all countries or cities have the same challenges and needs. Therefore the desired walkability and sidewalk design characteristics that are needed to improve the walkability or pedestrian friendliness may differ according to the location of the study area.

7.4 Conclusion 4: The proposed SAWAT has the potential to contribute to the planning of pedestrian-friendly spaces in the local context, based on the preliminary implementation results.

To establish a platform to illustrate how the SAWAT characteristics may be used to contribute to the planning of pedestrian-friendly spaces, the dissatisfaction of the Potchefstroom respondents was identified in terms of the walkability and pedestrian-friendliness of the local case study area. The Potchefstroom respondents indicated that two of the five walkability and sidewalk design categories (see Chapter 3) are dissatisfactory, namely safety and vehicle-pedestrian interaction. By using the preliminary SAWAT as a guideline, the reasons for the dissatisfaction of the Potchefstroom respondents could be identified. The vehicle-pedestrian interaction and safety of the study area was evaluated by identifying the opportunities for improvement by observing the characteristics in the preliminary SAWAT. Suggestions and proposals on how to improve the identified opportunities for improvement in the local case study are provided in recommendations Chapter (see Chapter 8.4) through the utilisation of the knowledge gained in Chapter 3 in terms of each of the SAWAT characteristics (see Chapter 3).

This study identified that there was scope for improvement in the local case study area. By using the preliminary SAWAT as a framework to identify which characteristics were required to improve the walkability and pedestrian-friendliness of the area, opportunities for improvement were identified. This study considered the dissatisfaction of the Potchefstroom respondents as a practical demonstration of how the SAWAT characteristics may be employed to evaluate an area. Not only can the SAWAT characteristics be used to identify gaps but also opportunities. The preliminary SAWAT also identifies useful characteristics, which may encourage relevant professionals and authorities to maintain or implement these characteristics in other areas. By implementing the preliminary SAWAT in the study area it is evident that this tool may be used not only for the design and layout of new developments but also to enhance or revitalise an established built environment. Table 6.1 illustrates the potential for the SAWAT to contribute to the planning of pedestrian-friendly spaces, in the local context, by identifying opportunities for improvement.

7.5 Conclusion 5: The planning of pedestrian-friendly spaces can be enhanced by means of a South African Walkability Audit Tool (SAWAT)

The SAWAT was informed by the review of existing audit tools and the perspective of the SA community on significant walkability and sidewalk design characteristics. The walkability and sidewalk design characteristics were arranged in priority according to the occurrence of the characteristics in the sampled audit tools and the value of the characteristics to the local perspective. The SAWAT was further informed by the knowledge obtained in the literature review

with regards to the details and specifics of each walkability and sidewalk design characteristic that is needed to create pedestrian-friendly spaces. The SAWAT may be used as a framework for the evaluation or implementation of pedestrian-friendly spaces in both new and existing developments.

If there is no framework for the identification of a pedestrian-friendly space, it is difficult to identify the missing characteristics and qualities in such a space. In addition, through the employment of the SAWAT in the local case study, it was recognised that without a framework which indicates what characteristics should be included in a pedestrian-friendly space, professionals and relevant authorities, that are involved in the spatial planning and operation of new developments, have nothing to guide the implementation, preservation or protection of pedestrian-friendly spaces. The proposed SAWAT will be presented in the following recommendations chapter (Chapter 8).

CHAPTER 8: PLANNING RECOMMENDATIONS

In Chapter 7, the conclusions drawn through this research were captured. Chapter 8 builds upon the conclusions drawn and presents specific planning recommendations to inform the planning of walkability. The recommendations are captured in line with the research aims identified in Chapter 1. This chapter further identifies the contribution made by this research to the planning profession, in terms of the proposed SAWAT for the local environment. The proposed SAWAT will be presented in this chapter as a final recommendation and contribution made by this MSc study.

8.1 Recommendation 1: Walkability, sidewalks and pedestrian-friendly spaces should be prioritised within spatial planning approaches

Walkability and sidewalk design characteristics contribute to the development of pedestrian-friendly spaces. Walkability and sidewalk design characteristics should form an integral part of future planning and development of cities. Due to the multiple benefits of walking, walkability as a concept should be taken more seriously by planners and developers as it can largely benefit society. Cities, towns and rural areas that are walkable promote economic mobility to people who cannot afford other forms of transportation. Any concept like walkability that could enhance the country's economy should be considered as important. Planning for walkability and sidewalk design form a big part of the spatial character of a city. Towns should be planned as diverse public spaces and improvements should be made accordingly. Sidewalks should allow pedestrians to walk comfortably and safely through the implementation of planning and design guidelines. The design should follow specific regulations and guidelines to monitor sidewalks' quality and features, including buffers and crosswalks.

Related to the findings of this study, it will be necessary to upgrade pedestrian infrastructure in an attempt to offer pedestrian-friendly spaces. Planners should use their professional positions to urge the government and municipal offices to consider the development of pedestrian-friendly spaces, as its benefits: health, environmental, economic, and social and transportation outweigh the cost of redesigning or implementing walkability and sidewalk design characteristics (see Chapter 2.3). Pedestrian-friendly spaces should be implemented in SA to accommodate a large number of pedestrians. Pedestrian-friendly spaces should be implemented to allow individuals to easily navigate an area safely and efficiently. To encourage active transportation, it is important to plan for pedestrian-friendly spaces as they do not only cater for individuals who do not have cars but also encourage people with cars to walk more often. Pedestrian-friendly spaces as an undervalued concept should be reconsidered in the sphere of planning and development.

Policies such as the NMT policy have the potential to create higher levels of walkability and increase the number of pedestrian friendly-spaces. The efficient implementation of such policies and guidelines should, therefore, be considered. It is therefore imperative to integrate policies such as the NMT policy and the SAWAT with town planning legislation to allow the manifestation of pedestrian-friendly spaces. The town planning profession regulates and controls the use of land and the spatial planning of towns and cities which makes it an integral discipline to encourage the implementation of NMT related policies. Such policies should be integrated with SPLUMA, LUPA, IDPs, SDFs and Municipal By-laws to ensure that walkability and pedestrian-friendly spaces are implemented in and around developments as these laws and frameworks guide spatial planning of South African towns and cities. Furthermore, policies like the NMT should be revised and updated by supportive documents such as the SAWAT. By observing the benefits of pedestrian-friendly spaces in Table 7-1 (see chapter 2.3) it is evident that the issue of walkability should be prioritised to a point where this matter is actively considered by decision-makers.

8.2 Recommendation 2: A SAWAT should be informed by existing audit tools and the local perspective

It is essential to observe the walkability and sidewalk design characteristics found in existing walkability audit tools, as it provides a reliable foundation for the identification and prioritisation of the characteristics included in the SAWAT. The identification of the most prominent characteristics used in the six existing walkability audit tools (see Chapter 4.2) establishes that these characteristics have a significant contribution to a pedestrian-friendly environment. These characteristics are therefore expected to significantly improve the walkability of South African cities and towns if it was to be implemented. Despite the different needs and requirements in each country, the prominent characteristics (see Chapter 4.2) present in each of the six audit tools from different countries, indicates the fundamental role of such characteristics in a pedestrian-friendly environment. In certain countries, the same characteristic might be perceived differently as the requirements or regulations may vary. Sidewalk infrastructure in a developed country might mean asphalt for recreational purposes, cobblestones for inner-city or cement surface in neighbourhoods wherein another country gravel sidewalk with necessary dimensions and other relevant features such public transportation stops might be sufficient.

Therefore, developing and employing an audit tool like the SAWAT that is specific to SA is essential. Including the perspective of a community is of great value as with the SAWAT, it confirmed the priorities of some of the characteristics identified by the audit tools and identified the needs of the South African community. According to the sampled existing audit tools the safety characteristics such as lighting and surveillance were included in 83% and 50% of existing tools,

respectively, however, safety was one of the main concerns identified by the Potchefstroom respondents in the case study area. Safety in one country might mean that lighting is sufficient and that surveillance in addition to local police presence is of no need. In South Africa, safety is a major concern, which means surveillance cameras or additional measures are needed to increase the sense of safety. Moreover, just as requirements of countries might differ so can areas where people live in SA such as rural areas, informal settlements or even gated communities influence specific needs concerning walkability and design characteristics. Gaining the perspective of the local communities can, therefore, guide the priority of implementation or upgrade according to the needs identified. The SAWAT may act as n basis for evaluating the pedestrian friendliness of an area. To further define and prioritise these characteristics, the local perspective of an area can add value and should be combined with the SAWAT which means active public participation is recommended.

8.3 Recommendation 3: The proposed SAWAT could be used by Planners to identify the opportunities for improvement within local case studies

The value of the SAWAT can also be observed in the implementation of the SAWAT characteristics within the local context. The SAWAT characteristics were employed to identify the opportunities for improvement in the Potchefstroom case study. By considering the role of each SAWAT characteristic (see Chapter 3), suggestions were made to enhance the identified opportunities for improvement in each of the four street sections as indicated in Table 6.1 (see Chapter 6.4). Table 8-1 subsequently illustrates the recommendations on how to improve the pedestrian friendliness of the area in terms of the SAWAT characteristics in the vehicle-pedestrian interactions and the safety categories. This provides an understanding of how the characteristics in the SAWAT may be utilised.

Table 8-1: Employing the SAWAT characteristics to address identified opportunities for improvement

Walkability and sidewalk design characteristics		Priority (A, B or C)	Opportunity identified: No opportunity - ✓✓ (Effective) Minor opportunity- ✓✖ Major opportunity- ✖✖	Recommendations to enhance the identified opportunities for improvement through the employment of SAWAT
Vehicle-pedestrian interactions				
1	Buffer zone	**B**	Meyer Street: ✓✓	Adequate buffer zones (2m).
			Steve Biko Street: ✓✖	Increase the buffer zone to at least 0.6m where there is no road reserve (see Chapter 3.2.3).

			Borcherds Street: ✓✖	Increase the buffer zone to at least 1.2m-1.5m where there is a road reserve. The alternative side has an adequate buffer zone (5m) (see Chapter 3.2.3).
			Hoffman Street: ✓✖	Increase the buffer zone to at least 1.2m-1.5m where there is a road reserve. The alternative side has an adequate buffer zone (5m) (see Chapter 3.2.3).
2	Road condition	**B**	Meyer Street: ✓✓	Adequate road condition.
			Steve Biko Street: ✓✓	Adequate road condition
			Borcherds Street ✓✖	Maintain road and repaint surface to improve delineation pedestrian of related uses (see Chapter 3.2.3).
			Hoffman Street: ✓✓	Adequate road condition.
3	Public transport stops	**B**	Meyer Street: ✖✖	Add public transportation stops if there is no public transport stop within 300m (see Chapter 3.2.3).
			Steve Biko Street: ✖✖	
			Hoffman Street: ✖✖	
			Borcherds Street: ✖✖	
4	Crosswalks	**B**	Meyer Street: ✓✖	Crosswalks must be found every 50-100m (see Chapter 3.2.3) – Add one more crosswalk.
			Steve Biko Street: ✓✖	Crosswalks must be found every 50-100m (see Chapter 3.2.3) - Add one more crosswalk.

			Borcherds Street: ✖✖	Crosswalks must be found every 50-100m (see Chapter 3.2.3) - Add at least one, preferably two crosswalks.
			Hoffman Street: ✓✖	Crosswalks must be found every 50-100m (see Chapter 3.2.3) - Add one more crosswalk.
5	Traffic volume	**B**	Meyer Street: ✓✖	Reduce traffic volume or implement more of the other vehicle-pedestrian interaction related walkability and sidewalk design characteristics as it may help pedestrians interact better with high traffic volumes (see Chapter 3.2.3).
			Steve Biko Street: ✓✖	Reduce traffic volume or implement more of the other vehicle-pedestrian interaction related walkability and sidewalk design characteristics as it may help pedestrians interact better with high traffic volumes (see Chapter 3.2.3).
			Borcherds Street: ✓✓	No gap identified.
			Hoffman Street: ✓✖	Reduce traffic volume or implement more of the other vehicle-pedestrian interaction related walkability and sidewalk design characteristics as it may help pedestrians interact better with high traffic volumes (see Chapter 3.2.3).

6	Traffic calming	B	Meyer Street: ✖✖	Implement traffic calming infrastructure i.e. speed humps, chockers, narrowing of streets, elevated crosswalks, coarse paving, traffic diverters, landscaping or roundabouts (see Chapter 3.2.3).
			Steve Biko Street: ✓✖	Add one additional traffic calming technique if it is possible
			Borcherds Street: ✖✖	Add traffic calming infrastructure as mentioned above in Meyer street (see Chapter 3.2.3).
			Hoffman Street: ✖✖	Add traffic calming infrastructure as mentioned above in Meyer street (see Chapter 3.2.3).
7	Speed limit	B	Meyer Street: ✖✖	Speed limit signs ought to be implemented to create awareness of the speed limit as this should increase awareness of speeding and allow for a safer walking environment (see Chapter 3.2.3).
			Steve Biko Street: ✖✖	
			Borcherds Street: ✖✖	
			Hoffman Street: ✖✖	
8	Parking areas	C	Meyer Street: ✓✖	Encourage the implementation of free and effective parking areas (see Chapter 3.2.3).
			Steve Biko Street: ✓✖	Encourage the implementation of free and effective parking areas (see Chapter 3.2.3).
			Borcherds Street: ✓✓	Parking areas available.
			Hoffman Street: ✓✓	Parking areas available.
Safety				

1	Lighting	B	Meyer Street: ✓✖	Lights should service the pedestrian paths and not only the roads (see Chapter 3.2.4).
			Steve Biko Street: ✓✖	Better quality lights should be implemented, separated by less space (see Chapter 3.2.4).
			Borcherds Street: ✓✖	Better quality lights should be implemented, separated by less space. Lights should service the pedestrian paths and not only the roads (see Chapter 3.2.4).
			Hoffman Street: ✓✖	Better quality lights should be implemented, separated by less space. Lights should service the pedestrian paths and not only the roads (see Chapter 3.2.4).
2	Surveillance	B	Meyer Street: ✓✖	Some cameras have been installed on specific points on these streets. Increase surveillance should be implemented in all four sections. Path surveillance may include additional cameras, security stops, security patrol, gated or boomed communities (see Chapter 3.2.4).
			Steve Biko Street: ✓✖	
			Hoffman Street: ✓✖	
			Borcherds Street: ✓✖	
3	Barriers/Buffers	B	Meyer Street: ✓✖	Implement additional barriers/buffers to separate pedestrian from moving traffic, i.e. additional trees, plants, street furniture (see Chapter 3.2.4).
			Steve Biko Street: ✓✖	Implement barriers/buffers to separate pedestrian from moving traffic as mentioned above in Meyer street (see Chapter 3.2.4).

			Borcherds Street: ✓✖	Implement barriers/buffers to separate pedestrian from moving traffic as mentioned above in Meyer street (see Chapter 3.2.4).
			Hoffman Street: ✓✖	Implement barriers/buffers to separate pedestrian from moving traffic as mentioned above in Meyer street (see Chapter 3.2.4).
4	Pedestrian signs	**B**	Meyer Street: ✖✖	Pedestrian signs should be implemented in all sections to guide the movement of pedestrians Building fronts should be built towards the street
			Steve Biko Street: ✖✖	
			Borcherds Street: ✖✖	
			Hoffman Street: ✖✖	
5	Sense of safety	**B**	Meyer Street: ✓✖	By implementing more of the other safety-related walkability and sidewalk design characteristics, it may help create a sense of safety in this area (see Chapter 3.2.4).
			Steve Biko Street: ✓✖	By implementing more of the other safety-related walkability and sidewalk design characteristics, it may help create a sense of safety in this area (see Chapter 3.2.4).
			Borcherds Street: ✖✖	By implementing more of the other safety-related walkability and sidewalk design characteristics, it may help create a sense of safety in this area (see Chapter 3.2.4).
			Hoffman Street: ✓✖	By implementing more of the other safety-related walkability and sidewalk design characteristics, it may help create a sense of safety in this area (see Chapter 3.2.4).

6	"Eyes on the street"/ Building fronts facing the street	C	Meyer Street: ✓✖	New developments should allow a clear view of the road (see Chapter 3.2.4). Trimming the trees on this section of the street might allow better view of the street.
			Steve Biko Street: ✓✓	Sufficient "eyes on the streets" and building fronts facing the sidewalks (see Chapter 3.2.4).
			Borcherds Street: ✖✖	Building fronts should be built towards the street (see Chapter 3.2.4).
			Hoffman Street: ✓✖	Building fronts should be built towards the street (see Chapter 3.2.4).

Source: Own construction (2019).

Table 8-1 illustrates how the tool may be used to address the opportunities for improvement identified by the SAWAT. The SAWAT can be seen as an audit tool that is reliable in assessing the pedestrian-friendliness of an area that may be beneficial to professionals and community members due to the simplicity of its format, categorised items, familiar terminology and short length. Furthermore, this tool requires limited training to generate consistent results. The tool can be used as a checklist and can assist in identifying targets for change in towns and cities, which will lead community awareness and encourages the improvement of areas to increase walkability.

8.4 Recommendation 4: The planning of pedestrian-friendly spaces should be supported by a comprehensive South African Walkability Audit Tool (SAWAT)

Based on the literature review and empirical investigation, a South African Walkability Audit Tool to guide the planning of pedestrian-friendly spaces is created. The use of leading walkability and sidewalk design characteristics (see Chapter 3) from various studies and research papers are recommended for the SAWAT. Existing walkability audit tools and the insight of the local South Africa perspective through public participation was necessary to accurately inform the priority of the characteristics included in the SAWAT. It is recommended that the SAWAT is used as a framework with which the relevant professionals, authorities of communities may guide the planning of pedestrian-friendly spaces. The recommendations in Table 8-2 are based on data collected in the literature review and the priorities obtained from the empirical investigation. The SAWAT may be used by the relevant user to evaluate an area by referring to the recommendations provided in Table 8-2, which sets the standard for each walkability and sidewalk design characteristic.

Table 8- 2: **Final proposed South African Walkability Tool (SAWAT)**

Walkability and sidewalk design characteristics	***Recommendations (See Chapter 3)***	***Priority (A, B or C)***
Design		
Mixed land uses	**Encourage mixed land uses;** Develop areas with mixed land uses as this motivates agglomeration advantages, which encourages walking. Business uses near residential areas encourage walkability.	**B**
Layout accessibility	**Implement efficient layout designs;** Grid pattern layouts are encouraged as they are the most pedestrian-friendly layout. An efficient layout design is characterised by well connect origins and destinations with many through routes	**B**
Residential density	**Increase residential density;** Support infill development to combat urban sprawl. Communities that are denser and less dependent on vehicles encourage walking as a mode of transportation to reach desired destinations.	**C**
Street connectivity	**Encourage well-connected streets;** Communities with more four-way intersections are encouraged as this provides a greater range of path choices. Well-connected streets with several intersections provide easy access to destinations and decrease travel distance.	**C**
Infrastructure		
Sidewalk infrastructure	**Implement sidewalk infrastructure;** Implement sidewalks where there is a road reserve provided. Sidewalks delineate suitable places for people to walk and provide areas for the ease of other modes of transport. Good quality sidewalk infrastructure allows for higher levels of walkability.	**A**
Path maintenance	**Maintain paths;** Ensure effective and working paths with no form of cracks or irregularities. Avoid badly maintained sidewalks as this may decrease levels of walkability dramatically.	**A**

Path obstructions	**Ensure paths are kept clear;** No obstructions should interfere with the right of way of pedestrians. Implement strict policies that prevent any form of obstruction to the movement of pedestrians, i.e. parked cars, rubbish skips, mailboxes, newspaper vending machines and utility poles.	**B**
Path slope	**Avoid steep path slopes;** Gradient of path: Road with gradient <5% = Max 5% Road with gradient >5% = Road gradient	**B**
Path surface	**Implement quality path surfaces;** Implement slip resistant, firm and stable path surfaces. A high level of drainage to prevent puddles and slippery surfaces. Avoid any form of surface that may increase fear of falling.	**B**
Public recreational facility	**Provide recreational facilities:** Implement recreational facilities that are fully or partially pedestrian orientated. Recreational facilities should be implemented as they may act as a node for walkability and encourage additional people to walk and therefore contribute to the creation of pedestrian-friendly space.	**B**
Path continuity	**Plan for continuous paths;** Path continuity is the extent of linkage of pedestrian networks between the essential origins and destinations in a neighbourhood or development. Implement continual and complete path networks throughout developments.	**B**
Path width	**Widen sidewalks;** Where it is possible, the recommended width of a sidewalk is between 1.5 to 2.0m. Sidewalks in the business centre should be 2.5 – 3.5m.	**B**
Path on both sides	**Encourage paths on both sides of the street;** Ensure the implementation of paths on both sides of a street where possible. This allows greater connectivity and a sense of safety as pedestrians may face oncoming traffic which allows individuals to be more aware of the traffic movement. Having sidewalks on both sides of higher-order roads are therefore highly recommended.	**C**

Path directness	**Plan for direct paths;** Paths should be planned to directly link key locations as far as possible. Direct paths support an efficient pedestrian-friendly space.	**C**
Special needs zones	**Ensure accessibility for people with disabilities;** Ensure wheelchair accessibility is implemented throughout the pedestrian network. Appropriate ramps, handles, bars and path surfaces are essential for catering for individuals with disabilities.	**C**
Vehicle-pedestrian interactions		
Buffer zone	**Encourage and implement buffer zones;** Implement a 0.6m buffer zone where there is no road reserve, 1.2 -1.5m in the case of road reserve and 3m where there is enough space.	**B**
Road condition	**Maintain roads;** Maintain roads and road markings. Road markings allow pedestrian and vehicles to know where they can go and where they should not go. Collisions involving pedestrians may be reduced by improving road conditions.	**B**
Public transport stops	**Implement public transport stops at regular intervals;** Implement public transport stops at 300m intervals and railway stations at 500m inside cities. Public transport allows people to walk to and from public transportation stops which means it also encourages walking.	**B**
Crosswalks	**Implement crosswalks;** A street crossing should be found every 50 – 100m in pedestrian-friendly spaces.	**B**
Traffic volume	**Evaluate traffic volume and plan accordingly;** Reduce traffic volume where possible or implement more of the other vehicle-pedestrian interaction characteristics to accommodate pedestrians in a high traffic volume area.	**B**
Traffic calming	**Implement and manage traffic calming techniques;** Implement traffic calming techniques to reduce dangers of vehicle traffic using speed humps, mini traffic circles, raised crosswalks, chokers, chicanes or road closure.	**B**
Speed limit	**Implement and enforce applicable speed limits;**	**C**

	Speed limits should be reduced from 60km/h to 40km/h in areas with a high number of pedestrians. Additionally, speed limits need to be indicated on traffic signs to increase awareness of speed limits.	
Parking areas	**Ensure efficiently placed parking areas;** Increase centrally located parking areas which encourage individuals to walk around in that area to complete their errands. Discourage unnecessarily large parking areas. Encourage on-street parking as this increases the buffer between the road and the sidewalk and it also reduces the speed that vehicles travel.	**C**
Safety		
Lighting	**Implement streets and pedestrian lights:** Lights should be provided on roads and pedestrian paths. Light posts should be positioned to allow that coverage of the entire area to avoid dark areas.	**B**
Surveillance	**Ensure implementation and presence of surveillance;** Cameras, security stops, security patrol, gated or boomed communities.	**B**
Barriers/Buffers	**Implement barriers that separate pedestrians from road traffic;** Wooden or metal barriers, hedges, plants, trees, street furniture or street parking may act as barriers and be used to separate pedestrian and vehicles.	**B**
Pedestrian signs	**Increase and promote the use of pedestrian signs;** Regulate road signs according to the Road Traffic Signs Manual and the National Road Traffic Regulations – Department of transport. Signs allow individuals to navigate the pedestrian space with confidence. Traffic signs allow vehicles to be more aware of pedestrian movement.	**B**
Sense of safety	**Encourage an environment that is safe and comfortable;** Increase and regulate the other safety-related characteristics to increase the general sense of safety. Safety plays a significant role in how individuals respond to the built environment.	**B**

“Eyes on the street”/ Building fronts	**Encourage house fronts and buildings to face the streets;** Encourage the development of buildings that face the street to increase the number of “eyes on the street”. “Eyes on the street” could increase the perceived safety of pedestrians.	**C**
Aesthetics		
Tree Presence	**Plant trees along paths;** Encourage the planting of trees on the street side. Trees add to the aesthetic character of an area. Trees also provide shade, act as barriers and provide some protection from the rain.	**A**
Cleanliness	**Clean pedestrian spaces:** Areas with pedestrian movements should be kept clean. Cleanliness improves a sense of place and a sense of safety. Implement bins and rubbish removals.	**B**
Architectural variety	**Encourage creative architecture and set guidelines** ; Set architectural guidelines to add to the sense of place and aesthetic beauty of architecture can play a role in the amount that people may want to walk in a specific area.	**B**
Aesthetically pleasing scenery	**Ensure pleasant scenery and views within pedestrian spaces;** Well-designed green streets, park landscapes, greenery and seaside views. Pleasant scenery encourages the use of pedestrian spaces. Protect heritage buildings and heritage streetscapes.	**B**
Public open spaces	**Implement sustainable public open spaces;** Provide communal areas where individuals may partake in physical activity. Incorporate open public spaces as key component of a pedestrian-friendly space. Prevent overcrowded or empty public spaces to avoid negative impacts on the walkable environment.	**B**
Fewer abandoned buildings	**Reduce and manage abandoned buildings;** Remove or renovate abandoned buildings as they often associated with crime. Abandoned buildings should be avoided to encourage a pedestrian-friendly environment.	**B**
Public seating	**Implement benches for public seating;**	**B**

	Provide benches as resting places. Benches may benefit people that are unfit to walk long distances and accommodate people that want to sit and enjoy the surroundings.	
Greenery	**Provide point, line and surface greenery;** Point greenery may be found in forms of shrubs or blocks of lawn next to pavilions or benches. Line greenery or shrubs in the form of trees and other plants are usually found along both sides of a sidewalk, and this helps guide pedestrians. Surface greenery is generally in the form of flowerbeds or a tract of meadows located between buildings or in a central green area which often acts as a central attraction.	**B**
Garden maintenance	**Maintain Gardens;** Encourage and regulate the maintenance of gardens. Promote the use of sustainable gardening techniques that require minimal usage of water. Gardens contribute to the aesthetic character of an area.	**B**
Vacant lot	**Reduce vacant lots;** Encourage infill development to prevent vacant lots which may be related to danger. Vacant lots may reduce the aesthetic character of an area. Infill development also combats urban sprawl.	**B**
Water fountains	**Implement water fountains along paths;** Implement water fountains along pedestrian paths to encourage walking. This contributes to a pedestrian-friendly environment.	**B**
Public art	**Encourage public art;** The implementation of art into an environment provides a sense of excitement, community and a place people can enjoy social networking.	**B**

Source: Own construction (2019).

The prioritisation of the characteristics included in the SAWAT allows for an implementation to take place in phases. Phased implementations are cost-effective and provide more time for detailed planning. First, implement the basic infrastructure identified in the SAWAT which is the priority A characteristics. These include sidewalk infrastructure, well-maintained sidewalks and trees for shade and protection. The basic sidewalk infrastructure needs to be implemented first and needs to be well maintained. The implementation of trees allows for protection from weather

elements, provides a barrier between the cars and pedestrians and adds to the aesthetics of the surroundings. This provides a solid foundation for pedestrian-friendly spaces which should be strengthened by the lower priority characteristics. Allow for certain situations where a lower priority characteristic may need to be implemented to accommodate or support a higher-order characteristic.

The SAWAT can be used to guide the planning of pedestrian-friendly spaces by either enhancing existing spaces or implementing the identified characteristics in new developments. The SAWAT may be used as a supportive document or tool that forms part existing documents such as the NMT policy which will further strengthen these policies. The SAWAT may be used by town planners, other professionals and community members to assist in the creation and practical implementation of pedestrian friendly spaces. It would be of great value to implement SAWAT in different locations, based on stakeholder inputs, such as informal settlements, rural areas, residential areas, gated communities and inner-city areas to ensure the inclusion of all walkability and sidewalk design characteristics and the applicability in all settings. The local perspective provided in the study may not necessarily represent all of SA but provides a foundation for practical implementation and allows for enhancements to be made. The SAWAT could be further defined as local SAWATs to accommodate smaller communities with specific needs. Such local SAWATs would need a strong stakeholder engagement process.

8.5 Recommendation 5: More research is needed to refine the pilot research and inform future planning of walkable cities, especially in the local context

The SAWAT provides a priority with which the characteristics should be tested and implemented accordingly. The design, vehicle-pedestrian interaction and safety characteristics do not contain priority A characteristics. Safety is a big concern in SA and should be considered intently. This was confirmed by the local case study where the Potchefstroom respondent's biggest concern was safety and vehicle-pedestrian interaction. Design characteristics should also be further refined to ensure effective priorities that address the design of segregated and isolated SA towns and cities. Future research should further define these priorities to ensure the effective implementation of this tool.

The immediate achievement of walkable cities in South Africa, where the current urban and rural morphology is dominated by urban sprawl and geographic segregation, is a challenging task. Several steps will have to follow with patience and persistence. Such steps should include: Firstly, the walkability of South African cities and towns need to be evaluated and assessed individually to develop and enhance policies and supportive documents like the SAWAT that addresses such issues. Secondly, these policies and tools need to be integrated with town planning legislation as

these laws control land uses and shape South African towns and cities. Thirdly, town planners, urban designers, transport planners, engineers and professions alike should work together to explore creative solutions or research existing models to address the issue of walkability. Fourth, the involvement of local communities through public participation and education in the planning process is essential. A focus on pedestrian-friendly spaces and walkable cities will revolutionise the way we live in rudimentary ways, benefiting the natural environment, social relations and human health. A tool such as the SAWAT could play a critical role in the future planning of South African cities.

BIBLIOGRAPHY

AARP (Advanced Sidewalks and Streets Toolkit. Advanced Sidewalks and Streets Toolkit). 2011. http://www.aarp.org/content/dam/aarp/livable-communities/plan/assessments/advancedstreets-and-sidewalks-toolkit-2011-aarp.pdf Date of access: 13 Jun. 2018

Adkins, A., Dill, J., Luhr, G. and Neal, M., 2012. Unpacking walkability: Testing the influence of urban design features on perceptions of walking environment attractiveness. Journal of Urban Design, 17(4), pp.499-510.

Adkins, A., Dill, J., Luhr, G. and Neal, M., 2012. Unpacking walkability: Testing the influence of urban design features on perceptions of walking environment attractiveness. Journal of Urban Design, 17(4):499-510.

Aghaabbasi, M., Moeinaddini, M., Shah, M.Z. and Asadi-Shekari, Z. 2017. A new assessment model to evaluate the microscale sidewalk design factors at the neighbourhood level. Journal of Transport & Health, 5:97-112.

Aghaabbasi, M., Moeinaddini, M., Shah, M.Z., Asadi-Shekari, Z. and Kermani, M.A., 2018. Evaluating the capability of walkability audit tools for assessing sidewalks. Sustainable cities and society, 37:475-484.

Albers, P.N., Wright, C. and Olwoch, J., 2010. Developing a South African pedestrian environment assessment tool: Tshwane case study. South African Journal of Science, 106(9-10):1-8.

Arrive Alive. 2017. Pedestrian Safety in South Africa. https://www.arrivealive.co.za/Pedestrian-Safety-Advice Date of access 8 Sep. 2017.

Asadi-Shekari, Z., Moeinaddini, M. and Zaly Shah, M. 2013. Disabled Pedestrian Level of Service Method for Evaluating and Promoting Inclusive Walking Facilities on Urban Streets. Journal of Transportation Engineering. 139 (2): 181-192.

Asadi-Shekari, Z., Moeinaddini, M. and Zaly Shah, M. 2014. A pedestrian level of service method for evaluating and promoting walking facilities on campusstreets. Land Use Policy. 38: 175-193.

Astell-Burt, T., Feng, X., & Kolt, G.S. 2015. Identification of the impact of crime on physical activity depends upon neighbourhood scale: multilevel evidence from 203,883 Australians. Health & Place, 31:120–123.

Bedimo-Rung, A.L., Mowen, A.J., & Cohen, D.A. 2005. The significance of parks to physical activity and public health: A conceptual model. American Journal of Preventive Medicine, 28(2):159–168.

Bicycle Federation of America Campaign to Make America Walkable, 1998. Creating Walkable Communities. A guide for local governments.

Brownson, R.C., Hoehner, C.M., Day, K., Forsyth, A. and Sallis, J.F., 2009. Measuring the built environment for physical activity: state of the science. American journal of preventive medicine, 36(4):99-123.

Brownson, R.C., Housemann, R.A., Brown, D.R., Jackson-Thompson, J., King, & A.C., Malone, B.R. 2000. Promoting physical activity in rural communities: Walking trail access, use, and effects. American Journal of Preventive Medicine, 18(3):235–241.

Cain, K.L., Millstein, R.A. and Geremia, C.M., 2012. Microscale Audit of Pedestrian Streetscapes (MAPS): Data Collection & Scoring Manual. University California San Diego. Available for download at: http://sallis. ucsd. edu/Documents/Measures_documents/MAPS% 20Manual_v1_010713. pdf

Cao, X., Mokhtarian, P.L. and Handy, S.L., 2009. Examining the impacts of residential self-selection on travel behaviour: a focus on empirical findings. Transport reviews, 29(3):359-395

Carver, A., Timperio, A., & Crawford, D. 2008. Playing it safe: The influence of neighbourhood safety on children's physical activity. A review. Health & Place, 14(2):217–227.

Cerin, E., Saelens, B.E., Sallis, J.F. and Frank, L.D., 2006. Neighborhood Environment Walkability Scale: validity and development of a short form. Medicine & Science in Sports & Exercise, 38(9):682-1691.

Chatman, D.G., 2009. Residential choice, the built environment, and nonwork travel: evidence using new data and methods. Environment and Planning A, 41(5)

Claris, S. and Scopelliti, D., 2016. Cities alive: towards a walking world.

Clarke, L., 2012. Building Capitalism (Routledge Revivals): Historical Change and the Labour Process in the Production of Built Environment. Routledge.

Cohen, D.A., Ashwood, J.S., Scott, M.M., Overton, A., Evenson, K.R., Staten, L.K., *et al*. 2006. Public parks and physical activity among adolescent girls. Pediatrics, 118(5):1381–1389.

Cohen, D.A., Marsh, T., Williamson, S., Derose, K.P., Martinez, H., Setodji, C., *et al*. 2010. Parks and physical activity: Why are some parks used more than others? Preventive Medicine, 50(1):9–12.

Constitution of the Republic of South Africa, 1996

Corazza, M.V., Di Mascio, P. and Moretti, L., 2016. Managing sidewalk pavement maintenance: A case study to increase pedestrian safety. Journal of Traffic and Transportation Engineering (English Edition), 3(3):203-214.

Cortright, J., 2009. Walking the walk: How walkability raises home values in US cities.

Deacon, L.A., 2013. Planning Sidewalks: Implications of Regulating Sidewalk Space in the East Village.

Department of Housing (South Africa). 2005. Guidelines for human settlement planning and design 2005. Pretoria.

Department of Transport (Australia). 2011. Walkability Audit Tool. Western Australia.

Department of Transport (South Africa). 2003. Pedestrian and Bicycle Facility Guidelines. Pretoria.

Department of Transport (South Africa). 2014. NMT facility guidelines. Pretoria

Department of Transport (South Africa). 2018. Sate of Road Safety Report. Pretoria.

Devlin, A., Frank, L. and VanLoon, J., 2009. Physical activity and transportation benefits of walkable approaches to community design in British Columbia. Prepared for British Columbia Recreation and Parks Association.

Edwards, P. and Tsouros, A.D., 2006. Promoting physical activity and active living in urban environments: the role of local governments. WHO Regional Office Europe.

Emery, J., Crump, C. and Bors, P., 2003. Reliability and validity of two instruments designed to assess the walking and bicycling suitability of sidewalks and roads. American Journal of Health Promotion, 18(1):38-46.

Estabrooks, P.A.,Lee, R.E., & Gyurcsik, N.C. 2004. “Resources for Physical Activity Participation: Does Availability and Accessibility Differ by Neighborhood Socioeconomic Status?” Annals of Behavioral Medicine 25:100–104

Ewing, R., 2005. Can the physical environment determine physical activity levels? Exercise and sport sciences reviews, 33(2):69-75.

Fearnley, N., Flügel, S. and Ramjerdi, F. 2011. Passengers' valuations of universal design measures in public transport. Research in Transportation Business & Management. 2:83-91

Ferreira, I., Van Der Horst, K., Wendel-Vos, W., Kremers, S., Van Lenthe, F.J. and Brug, J., 2007. Environmental correlates of physical activity in youth–a review and update. Obesity reviews, 8(2):129-154.

Forsyth, A. and Southworth, M., 2008. Cities afoot—Pedestrians, walkability and urban design.

Forsyth, A., 2015. What is a walkable place? The walkability debate in urban design. Urban design international, 20(4):274-292.

Foster, S., Knuiman, M., Hooper, P., Christian, H., & Giles-Corti, B. 2014. Do changes in residents' fear of crime impact their walking? Longitudinal results from RESIDE. Preventive Medicine, 62:161–166.

Foster, S.,Wood, L., Christian, H., Knuiman,M., & Giles-Corti, B. 2013. Planning safer suburbs: Do changes in the built environment influence residents' perceptions of crime risk? Social Science & Medicine (1982), 97:87–94.

Frackelton, A., Grossman, A., Palinginis, E., Castrillon, F., Elango, V. and Guensler, R., 2013. Measuring walkability: Development of an automated sidewalk quality assessment tool. Suburban Sustainability, 1(1):1-4.

Frank, L.D., Schmid, T.L., Sallis, J.F., Chapman, J. and Saelens, B.E., 2005. Linking objectively measured physical activity with objectively measured urban form: findings from SMARTRAQ. American journal of preventive medicine, 28(2):117-125.

Franklin, B.A., 2006. Walking: the undervalued prescription. Preventive cardiology, 9(1):56-59.

Garvin, E., Branas, C., Keddem, S., Sellman, J. and Cannuscio, C., 2013. More than just an eyesore: local insights and solutions on vacant land and urban health. Journal of Urban Health, 90(3):412-426.

Giles-Corti, B., Broomhall, M.H., Knuiman, M., Collins, C., Douglas, K., Ng, K., *et al*. 2005. Increasing walking: how important is distance to, attractiveness, and size of public open space? American Journal of Preventive Medicine, 28(2):169–176.

Google Maps. (2018). Google Maps. Available at: https://www.google.co.za/maps/@-26.6962291,27.0983669,13.88z. Date of access: 28 Oct. 2018.

Greaves, S. and Standen, C., 2019. Active transport perspectives. A Research Agenda for Transport Policy: 60.

Grodach, C., 2011. Art spaces in community and economic development: Connections to neighborhoods, artists, and the cultural economy. Journal of Planning Education and Research, 31(1):74-85.

Grossman, D.C. 2000. The History of Injury Control and the Epidemiology of Child and Adolescent Injuries. Future of Children, 10(1): 23–52

Guide, U.B.D., 2011. National Association of City Transportation Officials. New York, 8.

Handy, S., Cao, X. and Mokhtarian, P.L., 2006. Self-selection in the relationship between the built environment and walking: Empirical evidence from Northern California. Journal of the American Planning Association, 72(1):55-74

Hjorthol, R. 2013. Winter weather — An obstacle to older people's activities? Journal of Transport Geography, 28:186–191.

Hoehner, C.M., Ivy, A., Ramirez, L.K.B., Handy, S. and Brownson, R.C., 2007. Active neighborhood checklist: a user-friendly and reliable tool for assessing activity friendliness. American Journal of Health Promotion, 21(6):534-537.

Inoue, S., Ohya, Y., Odagiri, Y., Takamiya, T., Ishii, K., & Kitabayashi, M. 2010. Association between perceived neighborhood environment and walking among adults in 4 cities in Japan. Journal of Epidemiology, 20(4):277–286.

International Transport Forum, 2017. Road Safety Annual Report 2017. Paris: OECD Publishing: 476 - 483.

Jamal, M., Khasraw, W., Khabat, S. and Mohammed-Amin, R.K., 2017. Investigating and boosting walkability in Sulaimani's mixed-use streets: Jamal Irfan street as a case study. Kurdistan Journal of Applied Research, 2(3):397-409.

Kent, J., Thompson, S.M., and Jalaludin B., 2011. Healthy Built Environments: A review of the literature, Sydney: Healthy Built Environments Program, City Futures Research Centre, UNSW:51

Kochtitzky, C. S. 2011. Vulnerable Populations and the Built Environment.Making Healthy Places. 129-145

Koh, P.P. and Wong, Y.D., 2013. Comparing pedestrians' needs and behaviours in different land use environments. Journal of Transport Geography, 26:43-50.

Komori, M. and Christine, K., 2013. Thematic analysis. Design Research Techniques. http://designresearchtechniques. com/casestudies/thematic-analysis.

Krenichyn, K. 2006. "The only place to go and be in the city": Women talk about exercise, being outdoors, and the meanings of a large urban park. Health & Place, 12(4):631–643.

Kruger, T., Landman, K. and Liebermann, S., 2001. Designing safer places: A manual for crime prevention through planning and design. South African Police Service and the CSIR.

Landis, B. W., Vattikuti, V. R., Ottenberg, R. M., McLeod, D. S. and Guttenplan, M. 2005. Modeling the roadside walking environment: Pedestrian level of service. Transportation Research Record 1773:82-88.

Lau, W.L., & Chan, L.Y. 2003. Commuter exposure to aromatic VOCs in public transportation

Lee, K. & Burney, D., 2011. Active design guidelines promoting physical activity and health in design.

Leyden, K.M. 2003. Social capital and the built environment: the importance of walkable neighborhoods. American journal of public health, 93(9):1546.

Li, F., Fisher, K.J., & Harmer, P. 2005. Improving physical function and blood pressure in older adults through cobblestone mat walking: A randomized trial. Journal of the American Geriatrics Society, 53(8):1305–1312.

Li, X., 2015. Study of Environmental Variables Affecting Walkability: Learning From Main Street in Downtown Fort Worth.

Litman, T. 2004. Economic value of walkability. World Transport Policy & Practice, 10(1):5-14.

Litman, T. 2011. Land use impacts on transport: How land use factors affect travel behaviour

Litman, T. 2017. Economic value of walkability. Victoria Transport Policy Institute.

Litman, T. 2019. Evaluating Active Transport Benefits and Costs. Guide to Valuing Walking and Cycling Improvements and Encouragement Programs. Victoria Transport Policy Institute.

Loon, J.V. and Frank, L., 2011. Urban form relationships with youth physical activity: implications for research and practice. CPL bibliography, 26(3):280-308.

Lopez, R.P., & Hynes, H.P. 2006. Obesity, physical activity, and the urban environment: Public health research needs. Environmental Health: A Global Access Science Source, 5:25.

Loukaitou-Sideris, A. and Ehrenfeucht, R., 2009. Sidewalks: Conflict and negotiation over public space. MIT Press.

Loukaitou-Sideris, A. and Ehrenfeucht, R., 2010. Planning urban sidewalks: Infrastructure, Daily life and Destinations. Journal of Urban Design, 15(4):459-471.

Maas, J., Verheij, R.A., Groenewegen, P.P., De Vries, S. and Spreeuwenberg, P., 2006. Green space, urbanity, and health: how strong is the relation? Journal of epidemiology and community health, 60(7):587-592.

Malambo, P., Kengne, A.P., Lambert, E.V., De Villers, A. and Puoane, T., 2017. Association between perceived built environmental attributes and physical activity among adults in South Africa. BMC public health, 17(1):213.

Marisamynathan, V.P., 2014. Study on pedestrian crossing behavior at signalized intersections. Journal of Traffic and Transportation Engineering (English Edition) 1 (2):103-110.

Mårtensson, F., Boldemann, C., Söderström, M., Blennow, M., Englund, J. -E., & Grahn, P. 2009. Outdoor environmental assessment of attention promoting settings for preschool children. Health & Place, 15(4):1149–1157.

Martin, R. (2017). Walking in Nashville. City lab https://www.citylab.com/transportation/2017/01/walking-in-nashville/512114/ Date of access 9 Jun. 2018.

Mason, P., & Kearns, A. 2012. To what extentmay local crime rates, perceptions of crime and personal safety limit walking in deprived neighbourhoods? Journal of Science and Medicine in Sport, 15(15):219.

Mason, P., Kearns, A. and Livingston, M., 2013. “Safe Going”: the influence of crime rates and perceived crime and safety on walking in deprived neighbourhoods. Social science & medicine, 91:15-24.

McCormack, G.R., & Shiell, A. 2011. In search of causality: A systematic review of the relationship between the built environment and physical activity among adults. International Journal of Behavioral Nutrition and Physical Activity, 8(1):125.

McCormack, G.R., Rock, M., Toohey, A.M., & Hignell, D. 2010. Characteristics of urban parks associated with park use and physical activity: A review of qualitative research. Health & Place, 16(4):712–726.

Mecredy, G., Pickett, W. and Janssen, I., 2011. Street connectivity is negatively associated with physical activity in Canadian youth. International journal of environmental research and public health, 8(8):3333-3350.

Meyers, A.R., Anderson, J.J., Miller, D.R., Shipp, K., & Hoenig, H. 2002. Barriers, facilitators, and access for wheelchair users: Substantive and methodologic lessons from a pilot study of environmental effects. Social Science & Medicine, 55(8):1435–1446.

Millington, C., Thompson, C.W., Rowe, D., Aspinall, P., Fitzsimons, C., Nelson, N., Mutrie, N. and SPARColl—The Scottish Physical Activity Research Collaboration, 2009. Development of the Scottish walkability assessment tool (SWAT). Health & place, 15(2): 474-481.

Minnery, J., 2012. Sidewalks: Conflict and Negotiation over Public Space.

Monteiro, F. B. and Campos, V. B. 2012. A proposal of indicators for evaluation of the urban space for pedestrians and cyclists in access to mass transit station. Procedia-Social and Behavioral Sciences. 54:637-645.

Moura, F., Cambra, P. and Gonçalves, A.B., 2017. Measuring walkability for distinct pedestrian groups with a participatory assessment method: A case study in Lisbon. Landscape and Urban Planning, 157:282-296.

Mytton, O.T., Townsend, N., Rutter, H., & Foster, C. 2012. Green space and physical activity: An observational study using Health Survey for England data. Health & Place, 18(5):1034–1041.

Neckerman, K.M., Lovasi, G.S., Davies, S., Purciel, M., Quinn, J., Feder, E., Raghunath, N., Wasserman, B. and Rundle, A., 2009. Disparities in urban neighborhood conditions: evidence from GIS measures and field observation in New York City. Journal of Public Health Policy, 30(1):264-285.

Ng, E., 2009. Designing high-density cities: for social and environmental sustainability. Routledge.

Norman, G.J., Nutter, S.K., Ryan, S., Sallis, J.F., Calfas, K.J. and Patrick, K., 2006. Community design and access to recreational facilities as correlates of adolescent physical activity and body-mass index. Journal of physical activity and health, 3(1):118-128.

O'Hanlon, J., Scott, M.S. & West, L. 2016. Healthy and complete communities in Delaware: The walkability assessment tool. Institute for Public Administration. http://www.ipa.udel.edu Date of access: 2 Jun. 2018.

Oakes, J.M., Forsyth, A. and Schmitz, K.H., 2007. The effects of neighborhood density and street connectivity on walking behavior: the Twin Cities walking study. Epidemiologic Perspectives & Innovations, 4(1):16.

Owen, N., Humpel, N., Leslie, E., Bauman, A. and Sallis, J.F., 2004. Understanding environmental influences on walking: review and research agenda. American journal of preventive medicine, 27(1):67-76.

Oxford Advance Learner Dictionary. 2011. UK: Oxford University Press

Oyeyemi, A.L., Adegoke, B.O., Oyeyemi, A.Y., Deforche, B., De Bourdeaudhuij, I. and Sallis, J.F., 2012. Environmental factors associated with overweight among adults in Nigeria. International Journal of Behavioral Nutrition and Physical Activity, 9(1):32.

Park, S., 2008. Defining, measuring, and evaluating path walkability, and testing its impacts on transit users' mode choice and walking distance to the station.

Pikora, T., Giles-Corti, B., Bull, F., Jamrozik, K. and Donovan, R., 2003. Developing a framework for assessment of the environmental determinants of walking and cycling. Social science & medicine, 56(8):1693-1703.

Pikora, T., Giles-Corti, B., Bull, F., Knuiman, M., Jamrozik, K. and Donovan, R., 2000. Survey of the Physical Environment in Local Neighbourhoods SPACES Instrument: Observers Manual.

Pucher, J., Dill, J., & Handy, S. 2010. Infrastructure, programs, and policies to increase bicycling: An international review. Preventive Medicine, 50(1):106-125.

Rafiemanzelat, R., Emadi, M.I. & Kamali, A.J. 2017. City sustainability: the influence of walkability on built environments. Transportation research procedia, 24:97-104.

Reyer, M., Fina, S., Siedentop, S. and Schlicht, W., 2014. Walkability is only part of the story: walking for transportation in Stuttgart, Germany. International journal of environmental research and public health, 11(6):5849-5865.

Saelens, B.E., Sallis, J.F., Frank, L.D. 2003. “Environmental Correlates of Walking and Cycling: Findings from the Transportation, Urban Design, and Planning Literatures,” Annals of Behavioral Medicine 25:80–91

Sallis, J.F, Prochaska, J.J & Taylor, W.C. 2000. “A Review of Correlates of Physical Activity of Children and Adolescents,” Medicine and Science in Sports and Exercise 32:963–75.

Sallis, J.F. & Glanz, K., 2006. The role of built environments in physical activity, eating, and obesity in childhood. The future of children. 89-108.

Sallis, J.F., Cerin, E., Conway, T.L., Adams, M.A., Frank, L.D., Pratt, M., Salvo, D., Schipperijn, J., Smith, G., Cain, K.L. and Davey, R., 2016. Physical activity in relation to urban environments in 14 cities worldwide: a cross-sectional study. The Lancet, 387(10034):2207-2217.

Sallis, J.F., Frank, L.D., Saelens, B.E., & Kraft,M.K. 2004. Active transportation and physical activity: Opportunities for collaboration on transportation and public health research. Transportation Research Part A: Policy and Practice, 38(4):249–268.

Shaaban, K., 2019. Assessing Sidewalk and Corridor Walkability in Developing Countries. Sustainability, 11(14):1.

Shamsuddin, S., Hassan, N.R.A. and Bilyamin, S.F.I., 2012. Walkable environment in increasing the liveability of a city. Procedia-Social and Behavioral Sciences, 50:167-178.

Singh, R., 2016. Factors affecting walkability of neighborhoods. Procedia-Social and Behavioral Sciences, 216: 643-654.

Soria, J. and Talavera, R., 2013. Pedestrian Mobility Environments: Defenitions, Evaluation and Prospects. In AESOP-ACSP Joint Congress. Dublin:1

Southworth, M., 2005. Designing the walkable city. Journal of urban planning and development, 131(4):246-257

Stafford, M., Cummins, S., Ellaway, A., Sacker, A., Wiggins, R.D. & Macintyre, S., 2007. Pathways to obesity: identifying local, modifiable determinants of physical activity and diet. Social science & medicine, 65(9):882-1897.

Su, J.G., Winters, M., Nunes, M., & Brauer, M. 2010. Designing a route planner to facilitate and promote cycling in Metro Vancouver, Canada. Transportation Research Part A: Policy and Practice, 44(7):495–505.

Sugiyama, T., Neuhaus, M., Cole, R., Giles-Corti, B. and Owen, N., 2012. Destination and route attributes associated with adults' walking: a review. Medicine and science in sports and exercise, 44(7):1275-1286.

Timperio, A., Veitch, J., & Carver, A. 2015. Safety in numbers: does perceived safety mediate associations between the neighborhood social environment and physical activity among women living in disadvantaged neighborhoods? Preventive Medicine, 74:49–54.

Towers, G., 2013. Introduction to Urban Housing Design. Routledge.

Tran, M.C., 2016. Healthy cities—walkability as a component of health-promoting urban planning and design. Journal of Sustainable Urbanization, Planning and Progress, 1(1).

Tudor-Locke, C.E. and Myers, A.M., 2001. Methodological considerations for researchers and practitioners using pedometers to measure physical (ambulatory) activity. Research quarterly for exercise and sport, 72(1):1-12.

Urban street design guide, 2013. 2nd ed. New York: Island Press: 33-45.

US Department of Transportation. 2009. Design and Engineering manual. District of Columbia

Van Dyck, D., Cerin, E., Conway, T.L., De Bourdeaudhuij, I., Owen & N., Kerr, J. 2013. Perceived neighborhood environmental attributes associated with adults' leisuretime physical activity: Findings from Belgium, Australia and the USA. Health & Place, 19:59–68.

Vosper, S.J. & Mercure, J.F., 2016. Assessing the effectiveness of South Africa's emissions-based purchase tax for private passenger vehicles: A consumer choice modelling approach. Journal of Energy in Southern Africa, 27(4):25-37.

Wang, Y., Chau, C.K., Ng, W.Y. and Leung, T.M., 2016. A review on the effects of physical built environment attributes on enhancing walking and cycling activity levels within residential neighbourhoods. Cities, 50:1-15.

Wicramasinghe, V., Dissanayake, S., 2017. Evaluation of pedestrians’ sidewalk behavior in developing countries. Transportation research procedia, 25:4068-4078.

Wijlhuizen, G.J., Chorus, A.M.J., & Hopman-Rock, M. 2008. Fragility, fear of falling, physical activity and falls among older persons: Some theoretical considerations to interpret mediation. Preventive Medicine, 46(6):612–614.

Winters, M., Brauer, M., Setton, E.M., & Teschke, K. 2010. Built environment influences on healthy transportation choices: Bicycling versus driving. Journal of Urban Health: Bulletin of the New York Academy of Medicine, 87(6):969–993.

World Health Organization, 2010. Global recommendations on physical activity for health. Available: http://apps.who.int/iris/bitstream/10665/44399/1/9789241599979_eng.pdf

World Health Organization, 2010. Global recommendations on physical activity for health.

World Health Organization, 2011. Physical Activity and Adults Recommended levels of physical activity for adults aged 18- 64 years.http://www.who.int/dietphysicalactivity/physical-activity-recommendations-18-64years.pdf?ua=1 Date of access: 6 Jun. 2018

Yee, W.Y., Cameron, P., & Bailey, M. 2006. Road traffic injuries in the elderly. Emergency Medicine Journal, 23(1):42–46.

Zakaria, J. and Ujang, N., 2015. Comfort of walking in the city center of Kuala Lumpur. Procedia-Social and Behavioral Sciences, 170:642-652.

Zamora, T., Alcántara, E., Artacho, M.Á., and Cloquell, V. 2008. Influence of pavement design parameters in safety perception in the elderly. International Journal of Industrial Ergonomics, 38(11–12):992–998.

Zhu, X., Yu, C.Y., Lee, C., Lu, Z. and Mann, G., 2014. A retrospective study on changes in residents' physical activities, social interactions, and neighborhood cohesion after moving to a walkable community. Preventive medicine, 69:93-97.

ANNEXURES A - E-QUESTIONNAIRE

Walkability Study

Walkability generally refers to various features of a city or community that creates an area that is easily accessible by foot (McNally, 2010:)

This questionnaire is part of a masters degree which considers walkabilty from a South Africa perspective.The main research aim is to create a South African walkability audit tool to guide the planning of public sidewalks.

Section One

1. Which city do you currently live in? (Ex: Jhb, Potch, Cpt)

_____

2. Age

Mark only one oval.

<18

25-39

40-60

3. Gender

Mark only one oval.

Female

Male

Other

4. Ethnic group

Mark only one oval.

Black/African

White/Caucasian

Coloured

Indian

Asian

Other

5. Physical Status

Mark only one oval.

Walk daily more than 3km

Walk daily, but less than 3km

Walk weekly approximately 3km

Walk less than 3km a week

Unable to walk

Section Two

Which of following characteristics will have a positive impact on my daily walking behaviour:

SAFETY

6. Better lighting on paths

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

7. Surveillance on paths (i.e. security cameras)

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

8. Houses and buildings facing the streets (eyes on the street)

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

9. Barriers between road and sidewalks (i.e. metal barriers, wooden poles, trees, etc)

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

10. Pedestrians signs (i.e. directions, warnings and instructions)

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

11. Sense of safety (You feel safer walking in this area)

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

INFRASTRUCTURE

12. More sidewalk infrastructure (availability of walking paths)

Mark only one oval.

Fully Agree
Agree
Not sure
Disagree
Strongly Disagree

13. Direct sidewalk paths to location (i.e. Direct Path from your house to shops)

Mark only one oval.

Fully Agree
Agree
Not sure
Disagree
Strongly Disagree

14. Connected sidewalks (continuity all across neighborhood)

Mark only one oval.

Fully Agree
Agree
Not sure
Disagree
Strongly Disagree

15. Different path surfaces to accommodate different forms of physical activity (i.e. running, walking, prams, etc)

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

16. Wider sidewalk

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

17. Less slopes in sidewalk

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

18. Maintained sidewalks

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

19. Less sidewalk obstructions (i.e. rubbish bins, signs

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

20. More recreational activities along sidewalks (i.e. outdoor gym, public art , etc)

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

21. Special needs supportive infrastructure (i.e. wheelchair access, ramps)

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

22. Sidewalks on both sides of the street

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

23. More space between sidewalk and road (Buffer zone)

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

24. More traffic calming infrastructure (i.e. speed humps, lane narrowing, etc)

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

25. More crosswalks to cross the road (i.e. zebra crossings, raised crossings, etc)

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

26. Less parking areas

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

27. Less road traffic (Less busy roads)

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

28. Lower speed limits

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

29. Public transport stops along roads (Bus, train &taxi stops)

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

AESTHETICS

30. Better Scenery (i.e. natural surroundings, cleanliness, etc)

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

31. More public open spaces (i.e. parks and greenery)

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

32. Architectural variety (different building designs i.e. old, modern, traditional, etc)

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

33. Presence of trees (i.e. Trees along paths for shade and aesthetic qualities)

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

34. Garden maintenance (a neighborhood with well maintained gardens)

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

35. More public seating along paths

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

36. More water fountains along paths

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

37. Less abandoned buildings and vacant lots (i.e unsafe feeling)

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

38. More public art (i.e. statues, wall murals, etc)

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

DESIGN

39. Mixed land uses (i.e. shops, restaurants and offices in the same area)

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

40. Higher density of buildings (Shorter walking distances i.e. compact layout)

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

41. Well connected roads (i.e. more intersections, chances to change direction, etc)

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

42. Accessible Layouts (i.e. accessible layouts)

Mark only one oval.

Fully Agree

Agree

Not sure

Disagree

Strongly Disagree

Section Three

Only complete the following if you are familiar with the area below (otherwise please submit your survey):

Area surrounding the cachet park shopping centre

**Picture of study area*

**Picture of Steve Biko Street view*

**Picture of Borcherds Street view*

**Picture of Hoffman Street view*

**Picture of Meyer Street view*

43. Are you satisfied with the overall pedestrian infrastructure in this area?

Mark only one oval.

Satisfied

Not sure

Dissatisfied

44. Are you satisfied with the overall vehicle-pedestrian interaction in this area?

Mark only one oval.

Satisfied

Not sure

Dissatisfied

45. Are you satisfied with the overall safety in this area?

Mark only one oval.

Satisfied

Not sure

Dissatisfied

46. Are you satisfied with the overall aesthetics in this area?

Mark only one oval.

Satisfied

Not sure

Dissatisfied

ANNEXURES B - E-QUESTIONNAIRE RESULTS

	Descriptive Statistics					
		N	Minimum	Maximum	**Mean**	Std. Deviation
SAFETY	Better lighting on paths	115	1	5	**1.50**	0.799
	Surveillance on paths	114	1	5	**1.54**	0.884
	Houses and buildings facing the streets	115	1	4	**1.77**	0.798
	Barriers between road and sidewalks	115	1	5	**1.98**	1.076
	Pedestrians signs	113	1	5	**1.70**	0.854
	Sense of safety	115	1	5	**1.46**	0.787
INFRASTRUCTURE	More sidewalk infrastructure	115	1	3	**1.41**	0.605
	Direct sidewalk paths to location	114	1	4	**1.75**	0.878
	Connected sidewalks	114	1	4	**1.73**	0.744
	Path surfaces	115	1	5	**2.02**	1.009
	Wider sidewalk	115	1	5	**1.90**	1.063
	Less slopes in sidewalk	115	1	5	**2.41**	1.091
	Maintained sidewalks	115	1	5	**1.47**	0.841
	Less sidewalk obstructions	115	1	5	**2.09**	1.174
	More recreational activities along sidewalks	115	1	5	**2.03**	1.092
	Special needs supportive infrastructure	115	1	5	**1.69**	0.882
	Sidewalks on both sides of the street	115	1	5	**1.97**	1.135
VEHICLE-PEDESTRIAN INTERACTION	More space between sidewalk and road	115	1	4	**1.70**	0.794
	More traffic calming infrastructure	115	1	5	**2.41**	1.154
	More crosswalks to cross the road	115	1	5	**1.83**	0.920
	Reduce parking areas	115	1	5	**3.61**	1.023
	Less road traffic	113	1	5	**2.11**	1.047
	Lower speed limits	115	1	5	**2,20**	1.148
	Better road conditions	114	1	5	**2.13**	1.141
	Public transport stops along roads	112	1	5	**1.85**	0.961
AESTHETICS	Aesthetically pleasing cenery	113	1	4	**1.50**	0.746
	More public open spaces	112	1	5	**1.68**	0.922
	Architectural variety	113	1	5	**1.96**	0.981
	Presence of trees	113	1	4	**1.35**	0.550
	Garden maintenance	113	1	5	**1.62**	0.938

	Greenery	112	1	5	**1,82**	0,962
	More public seating along paths	113	1	5	**1.98**	1.000
	More drinking fountains along paths	113	1	5	**2.26**	1.208
	Less abandoned buildings	113	1	5	**1,52**	0,767
	Less vacant lots	113	1	5	**1.52**	0.757
	More public art and pedestrian environment notes	113	1	5	**1.90**	0.991
DESIGN	Better layout accessiblity	113	1	5	**2.32**	1.096
	Mixed land uses	113	1	5	**1.67**	0.829
	Well connected roads	113	1	5	**2.04**	0.910
	Higher density of buildings	113	1	5	**2.32**	1.096

	Dissatisfied	**Not sure**	**Satisfied**
Are you satisfied with the overall design of this area?	26.4%	15.4%	58.2%
Are you satisfied with the overall pedestrian infrastructure in this area?	41.6%	15.7%	42.7%
Are you satisfied with the overall vehicle-pedestrian interaction in this area?	41.5%	22.5%	36%
Are you satisfied with the overall safety in this area?	66.7%	15.5%	17.8%
Are you satisfied with the overall aesthetics in this area?	34.1%	18.2%	47.7%