Stamping Ground: Investigating the Walkability of Rhodes University students in Makhanda, South Africa

by

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Abstract

Walkability is an important research topic in the Global South where many people in urban settlements walk because of transport poverty. University students are a subset of the urban population in Makhanda who experience transport poverty and largely rely on walking to navigate the city. The purpose of this study is to measure and spatially analyse walkability and walking patterns in the student community of Makhanda, South Africa. This study has a specific focus on students who reside in the Rhodes University campus, Central Business District (Central), Sunnyside, and Westhill. These specific areas were chosen because, in terms of student residents, these are the most densely populated residential areas in the city, but are also the epicentre of student activity. This research intends to explore the existing walkability within these four study sites through a visual survey using common measures of walkability, digital mapping as well as student perceptions of walkability. The quantitative data collected through visual surveys, digital mapping and participatory mapping will be spatially analysed using GIS (Geographic Information Systems). Results show that walking is the main mode of transportation and students do not have affordable alternatives to walking. The Rhodes University campus is the most walkable area with Central being the second, Westhill being the third, and Sunnyside being the least walkable area. Sidewalk conditions (sidewalk presence, evenness and maintenance) and pedestrian safety and security (pedestrian crossings, crime, security features, lighting, the presence of people, and pedestrian visibility) were rated as the most important walkability factors. Additionally, the more walkable roads are mainly found within the Rhodes University campus and Sunnyside while the less walkable roads are mainly found within Central. Furthermore, the epicentre of student activity is focused on the Rhodes University campus during the week and as the week progresses, the epicentre shifts along with a shift in activity. The Rhodes University campus and Central are where students spent most of their time because the main amenities that student use are found within these areas. This research offers insights into walkability that can be directly applied to urban planning and policy-making. Planners should focus their resources on improving walkability, particularly in sidewalk conditions and pedestrian safety and security. By applying the findings of this research, planners can create more conducive, safer, and comfortable walking environments.

Declaration

I declare that this thesis is my own original work. All information and ideas from various authors and other intellectual sources have been fully acknowledged. This thesis has never been published in any form or submitted to another institution in fulfilment of any degree.

Signed: Date:

_____ _____16 January 2025_____

Huresha Padayachee

Author

I certify that the above statement is correct.

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Abbreviations and Acronyms

CPU	Campus Protection Unit
COGTA	Cooperative Governance and Traditional Affairs
DOT	Department of Transport
GIS	Geographic Information Systems
IDP	Integrated Development Plan
NHTS	National Household Travel Survey
NSDF	National Spatial Development and Transformation Framework
NSFAS	National Student Financial Aid Scheme
NEWS	Neighbourhood Environment Walkability Index
NMT	Non-Motorised Transportation
NMTP	Non-Motorised Transportation Policy
SAPS	South African Police Services
SDF	Spatial Development Framework
SPLUMA	Spatial Planning and Land Use Management Act
SDGs	Sustainable Development Goals
WI	Walkability Index

Chapter 1: Introduction

1.1. Introduction and motivation

In many urban environments, walking is an accessible, low-cost and low-energy mode of transport, as compared to vehicles. However, vehicle-based modes of transport have been increasingly encouraged (Carr *et al*., 2011). This, in turn, leads to an increase in physical inactivity amongst urban communities (Carr *et al*., 2011). In light of this increase in physical inactivity and its negative consequences to human health and the economy, the concept of walkability was developed (Carr *et al*., 2011). Walkability is a measure of how friendly and conducive an area is for walking, and is the main aspect in a walkable city (Southworth, 2005). Walkable cities have urban green spaces that not only benefit the environment, but also the physical and mental health of the neighbourhood (Littke, 2015). They promote and encourage health and physical fitness activities, and should be within set distances of pedestrian-centred infrastructure (Brookfield, 2017). Additionally, achievable walkable cities require the re-structuring and re-ordering of urban areas (Talen & Koschinsky, 2013). However, walkability has only been the subject of research within urban planning in recent years (van Heerden, 2018).

Throughout history, the urban development in South Africa was defined by unchecked sprawling (van Heerden, 2018). The two main drivers of this sprawling were the forceful implementation of urban development policies led by the ideas of apartheid, and vehicle-based transportation systems and the resulting infrastructure (van Heerden, 2018). Urban communities today, are now defined by high transportation costs, which brings to light the income inequalities of those that cannot afford vehicle-based transportation on a daily basis. Its importance needs to be highlighted in the Global South, and particularly South Africa as this is where this study is taking place. The Global South, including South Africa, is experiencing rapid urbanisation (Chakwizira *et al*., 2014). Cities are expanding at a fast rate and often with insufficient infrastructure. Walking, and walkability, becomes increasingly important because many people rely on walking as their main mode of transport due to limited access to public transportation or private vehicles (Chakwizira *et al*., 2014). Therefore, improving walkability could improve mobility, safety, and access to essential amenities for a large portion of the population. This study aims to highlight the importance of walkability infrastructure in hopes of bringing change to a space where walking is prominent and needs attention.

While walking is the most common mode of transportation in less developed cities because of the socio-economic differences, it is often not considered as being important (Wigan, 1995). In the Global North, there are usually plans put forward to increase walkability, whereas, in the Global South, individuals are already walking, despite the lack of infrastructure, and planning is almost done as an afterthought (Anciaes *et al*., 2017). Often, individuals in the Global South walk because they do not have a choice as they are in a position of transport poverty (Anciaes *et al*., 2017). Apart from this, there is also a significant lack of literature representing the Global South. There has been an over-reliance on studies representing the Global North while the Global South remains undervalued and misrepresented by literature (Lawhon & Truelove, 2020). Cities in

the Global South as compared to the Global North present their own identities and characteristic problems of walkability, each of which have their own urbanisation dynamics, security issues, sidewalk invasion problems, and poor planning strategies (Arellana *et al*., 2020).

This study places a focus on students residing within Makhanda in the Eastern Cape of South Africa. These students reside in close proximity to the city centre and fall within a low- to middle-income range. While this set up is not typical in South Africa, the Rhodes University campus is located in close proximity to the city centre. This means that many students will choose to reside within walking distances of the university as they lack reliable transportation options. This setting can be contrasted with Memela *et al*. (2022) where a focus was placed on the walking journeys of pedestrians residing within Makanaskop. Makanaskop is a neighbourhood within the township area that is located on the periphery of Makhanda (about 4.5 km from the city centre). The residents of Makanaskop have to travel relatively long distances to get to work and essential amenities (Memela *et al*., 2022).

In 2020, a study was conducted by the National Household Travel Survey (NHTS) under Statistics South Africa, who later revised the study in March of 2022. The study showed that, nationally, more than half (59.4%) of the individuals who attended an educational institution walked all the way while 15.9% use a taxi (Statistics South Africa, 2020). Within the Eastern Cape, 67.6% of individuals walk all the way while 15.1% use a taxi (Statistics South Africa, 2020). It was shown that the main reason students walked was because their education institution was close enough to walk to. The second most common reason was that public transport was too expensive (Statistics South Africa, 2020). A total of 10% of taxi users spent R1-100, 18.5% spent R101-200, and 71.5% spent R200 and more (Statistics South Africa, 2020). The studies done by the NHTS and Statistics South Africa emphasise two important aspects. The first being that the current state of public transport systems in South Africa is costly and dependent on vehicle-based modes of transport (van Heerden, 2017). The second being that a high proportion of South Africans walk to their destinations. With this being said, walking falls under the category of Non-Motorised Transportation (NMT) which encourages public spaces to support low-impact modes of transport (Department of Transport, 2014).

As aforementioned, walkability and walking patterns is a widely understudied topic in the Global South, and within a South African context, there is less than 20 walkability studies in the last 10 years, with none placing a focus on student-based walkability. While this study is the second walkability study based in Makhanda (the first being done by Memela *et al*., 2022), it is not focused on a peripheral township area, but rather on the student walking community in the central areas of the city. With this being said, it is hoped that this study contributes to generating new evidence from a small-sized city to question if the characteristics of the built environment promote walking and are able to be applied to other cities, as found in literature (Arellana *et al*., 2020). A key framework for this study is to bring attention to the perspectives of Southern Urbanism. This study looks to investigate and assess the student walkability and walking patterns within the Rhodes University campus, Central, Sunnyside, and Westhill. Makhanda is a small city located in the Eastern Cape province of South Africa and is home to Rhodes University. The university is situated on the periphery of Central. For

students that live both on the residential campus and within Central, most of the service infrastructure that pertains to their needs are accessible through walking.

1.2. Research aim

To survey and spatially analyse walkability and walking patterns in the student community of Makhanda, South Africa

1.3. Research objectives

1. To survey and spatially analyse the levels of walkability within the Rhodes University campus, Central, Sunnyside, and Westhill

2. To investigate the student perceptions of walkability within the Rhodes University campus, Central, Sunnyside, and Westhill

3. To investigate student walking patterns and walksheds in Makhanda

1.4. Research outline

This section outlines the details of this research project, which consists of eight chapters.

The above first introduction chapter highlighted the importance and relevance of this research and stated the research aims and objectives.

The second literature review chapter will place this research into context and refer to previous studies that will be used to guide this research. The literature review will look at the characteristics and the benefits and challenges of walkability, as well as planning for walkability. Additionally, the literature will focus on investigating walkability using different tools.

The third study area chapter will present the study area that this research focuses on as well as the socio-economic characteristics present in Makhanda.

The fourth methodology chapter will present the multi-methods approach that will be used to inform this study. It will present the methodology matrix and how this study analysed the data.

The fifth, sixth and seventh chapters presents the results of Objective 1 (a spatial analysis of walkability), Objective 2 (student perceptions of walkability), and Objective 3 (student walking patterns and walksheds) respectively.

Finally, this research project will conclude with the eight discussion and conclusion chapter where a discussion of the importance of the findings will be presented along with a conclusion of the importance of this research.

Chapter 2: Literature Review

2.1. Introduction

The previous chapter highlighted why walkability is an important research topic and a relevant topic of discussion. The research aims and objectives of this study was presented and motivated for. This chapter will present the literature review, which will guide this study. The main aim of this study is to measure and spatially analyse walkability and walking patterns in the student community of Makhanda, with specific focus on students who reside on the Rhodes University campus, Central, Sunnyside, and Westhill. By looking at previous research, the aim is to provide an overview of the key arguments surrounding walkability and walking patterns. This will consequently show the gaps that exist in current research. Lastly, this review will discuss the measures used to investigate walkability and walking patterns that will, consequently, inform this study. This review will conclude with a summation of the key arguments and highlight the key takeaways that will be used to guide the research project.

2.2. Walkability and walking patterns

The following section looks at walkability and walking patterns. Firstly, a definition of walkability will be discussed where a definition that will be used for this study will be chosen. Secondly, the characteristics of walkability will be explored. These characteristics will be used to inform the walkability factors that will be used in this study. Thirdly, the benefits and challenges linked to increased walkability will be looked at. This will help contextualise the importance of this research and why walkability is an increasingly important factor to consider. Lastly, this chapter will discuss walkability in the context of New Urbanism and sustainable development. Walkability directly links to urban planning and design, as well as to creating sustainable urban environments. This will allow the reader to visualise the role of walkability in urban planning and the creation of sustainable settlements.

2.2.1. Defining walkability

While literature on the topic of walkability is plentiful, a clear definition of what it is has never been provided. Instead, much of the literature provides a variety of different variables that have been used to produce different definitions (Spoon, 2005). With this being said, at its simplest form, walkability is defined as a qualifier used to describe an area or space that promotes the act of walking (Spoon, 2005). The problem with this definition is that it leaves out a lot of detail as to which environments are designed to successfully promote walking behaviours (Spoon, 2005). By looking at literature on walkability, there seems to be some overlaps in how walkability is defined, specifically looking at walkability factors that influence the quality of the pedestrian environment and the quantity of pedestrians that use that space (Lo, 2009).

This study has chosen to define walkability as a measure of how friendly and conducive an area is for walking (Southwood, 2005). Additionally, Arellana *et al*. (2020) reviewed walkability literature of a total of 67 articles both in the Global North and Global South, and provides a list of walkability measures that should be considered when designing a walkable urban environment. The walkability measures that guide this definition will be used to guide this study. They include, sidewalk conditions, traffic safety and security, comfort levels, and attractiveness. This study has chosen this definition and subsequent walkability measures because it provides a holistic approach to the topic.

2.2.2. Characteristics of walkability

There are four main walkability factors that constitute a walkable city (Arellana *et al*., 2020). These factors have been derived from a hierarchy of walking needs that was originally proposed by Alfonzo (2005).

The first walkability factor is the sidewalk condition which refers to the urban structure conditions and the patterns and characteristics of the present activities (Arellana *et al*., 2020). This includes the length that the sidewalk runs until it ends, the width of the sidewalk, the quality and condition of the sidewalk, the slope and angle of the sidewalk, and the number of vehicles present on the sidewalk (Arellana *et al*., 2020).

The second walkability factor is the traffic, safety and security which refers to the traffic safety, and crime and the intensity of crime being committed (Arellana *et al*., 2020). Traffic safety can be measured by the amount and presence of road signals, speed controllers and other traffic control mechanisms, the number of lanes and crossing times, the flow of traffic, and the speed of the vehicles (Arellana *et al*., 2020). Security can be measured by lighting, crime levels on the roads, and the amount and presence of security cameras (Arellana *et al*., 2020). However, previous studies have shown that more focus was put on assessing traffic safety rather than assessing security. The conclusion was that it could have been a consequence of more studies been done in the Global North perspective, rather than from a Global South perspective (Arellana *et al*., 2020). It was additionally found that this was because perhaps security is not as relevant of an issue in developed countries as it might be in developing countries (Arellana *et al*., 2020).

The third walkability factor is the comfort level which refers to the ease and friendliness of the walking experience (Arellana *et al*., 2020). This includes the attractiveness of the buildings, the weather conditions, the cleanliness of the surrounding areas and of the sidewalks, and the amount and presence of trees and plant life (Arellana *et al*., 2020). Ideally, less conflict is key to the design of a walkable city (Vanderschuren *et al*., 2014). With this being said, there should not be any obstacles on the sidewalks. This includes, benches, street lights, encroachment, and signboards and banners (Pretorius, 2018). These factors are subjective because they depend on individual walking perceptions, preferences, and experiences. What might feel comfortable to one pedestrian, may not necessarily feel the same to another pedestrian.

The fourth walkability factor is the attractiveness which refers to the ability of the pedestrian to socialise and participate in activities while walking or through walking (Arellana *et al*., 2020). Attractiveness is usually

characterised by the proximity of amenities and mixed land-use practices between commercial, residential, and institutional land-use types (Arellana *et al*., 2020). However, attractiveness is subjective to the individual walking. What might be seen as attractive to one pedestrian, may not necessarily be seen as attractive to another pedestrian.

2.2.3. Benefits and challenges linked to increased walkability

The following section outlines the benefits and challenges that have been shown to come about through increasing walkability. These benefits include, physical and mental health, environmental benefits, social cohesion, an increase in accessibility, and sustainable and inclusive environments.

Walking is a form of active commuting (Zijlema *et al*., 2018). Physical inactivity has been regarded as one of the predominant public health problems of this century (Carr *et al*., 2011). In order to combat this and reduce physical inactivity, the concept of walkability was developed (Carr *et al*., 2011). However, modern urban life encourages the use of fossil fuels through the use of cars to travel to work, shops and recreational facilities (Cubukcu, 2013). Before this, cities mainly found in developed countries, were walkable in the sense that they promoted dense development, a mix of land-use practices, and high population densities (Cubukcu, 2013). However, places of employment, shops and recreational facilities are no longer within walking distances. This is because of urban sprawl, single land-use zoning, advancements in technology and the widespread development of industries, along with policies that promote the use of vehicle-based transportation (Cubukcu, 2013). In addition to the cost to human health, this type of human urban lifestyle causes environmental harm and deterioration (Talen & Koschinsky, 2013). Smog from cars pollute the air and warms the atmosphere, and high car ownership causes traffic congestion and increases the risk of damaging road infrastructure (Talen and Koschinsky, 2013).

With these diverse impacts being understood, walkability is encouraged in cities because it helps to improve physical and mental health as well as the quality of the environment (Southworth, 2005). Walking has been shown to reduce stress and anxiety levels (Crone, 2007). Exercise increases the amount of endorphins released which, consequently, improves a person's mood and lowers their stress and anxiety levels (Crone, 2007).

A study done by Avila-Palencia *et al*. (2018) in seven European cities showed that a link between modes of transportation, mental health and social cohesion exists. Similarly, a study conducted in Spain, the Netherlands, Lithuania, and the United Kingdom was done by Zijlema *et al*. (2018). The authors looked at the link between active commuting through open green spaces and mental health. Avila-Palencia *et al*. (2018) found that walking was linked to good self-perceived health, higher vitality, and more frequent contact with family and friends (Avila-Palencia *et al*., 2018). Zijlema *et al*. (2018) found that active commuters had a higher mental health score as compared to non-active commuters (Zijlema *et al*., 2018).

Vegetation and the environment in walkable cities are key factors in creating healthy and active neighbourhoods (Lavelle *et al*., 2016). This is because interacting with nature helps in restoration and reduces

stress and anxiety (Littke, 2015). Walking also acts as a green mode of transport that reduces congestion and has low environmental impacts (Newman & Kenworthy, 1999). Additionally, walking reduces the cost spent on vehicle-based transportation (Merikangas *et al*., 2010). People who own private cars tend to spend more on petrol and people who take public transport tend to spend less on petrol, with the cost of walking being non-existent (Merikangas *et al*., 2010). An increase of public transport usage and a decrease in private vehicle usage means less carbon dioxide being released into the atmosphere, thus allowing for a low environmental impact. Furthermore, public transport is linked to walking as a mode of transport, in the sense that many residents living in cities in the Global South tend to walk to public transportation stops, which will then take them to their intended destination.

Walkability directly contributes to environmental sustainability by promoting walking over vehicle-based transportation (Baobeid *et al*., 2021). This shift reduces greenhouse gas emissions, air pollution, and dependence on non-renewable resources. By focusing on walkable spaces, cities can lower carbon footprints and reduce urban heat islands through green spaces and natural landscapes that encourage walking (Baobeid *et al*., 2021). Additionally, walkable environments often utilise land more efficiently by promoting mixed land use development. This is where residential, commercial, and recreational spaces can coexist (Baobeid *et al*., 2021). This reduces the need for extended travel, which consequently, conserves energy and lessens infrastructure demands (Thornton, 2017).

Furthermore, planning for walkability also encompasses social benefits by creating inclusive, safe, and accessible spaces for diverse groups (Baobeid *et al*., 2021). Walkable neighbourhoods can lead to stronger social ties, improve public health outcomes, and support local businesses, which collectively enhance community resilience (Thornton, 2017). It was found that well-designed walkable environments improve accessibility to essential services like healthcare, schools, and recreation (Thornton, 2017). Easy access to such amenities contributes to higher liveability by ensuring that people can meet their daily needs conveniently (Baobeid *et al*., 2021). Additionally, walkability can reduce traffic accidents and increase safety, as well-designed pedestrian areas tend to be safer (Baobeid *et al*., 2021). Walkable spaces encourage social interactions, which foster a sense of community, enhance social cohesion, and create more vibrant urban areas (Baobeid *et al*., 2021). By not considering walking, countries are not optimising their increased opportunities for public health outcomes, while simultaneously, reducing travel distances and impacts (Thornton, 2017).

A study conducted by Kim *et al*. (2019) showed that a city in South Korea successfully developed their infrastructure to accommodate a walkable city. Initiatives were created that reduced their societal costs, as well as their environmental and health-related problems (Kim *et al*., 2019). Similarly, Eckerson (2014) explored the non-motorised transport policies in Zurich, Switzerland. It was found that if a new parking area were to be built, the same number of parking spaces would be cleared from another area in the city and transformed into public green spaces (Eckerson, 2014). Massingue and Oviedo (2021) and Anciaes *et al*. (2017) look at the disparities in walking conditions in Maputo, Mozambique and Praia, Cabo Verde respectively. Massingue and Oviedo (2021) found that the city faces serious issues of social, physical, and individual inequalities in terms of walking. It was concluded that low-income households are more likely to walk, even in parts of the city

where pedestrian infrastructure is at a minimum (Massingue & Oviedo, 2021). Anciaes *et al*. (2017) concluded that in high-income neighbourhoods, more urbanised areas have the lowest provision of pedestrian space and traffic safety, while less urbanised areas have the lowest accessibility to shops and leisure areas (Anciaes *et al*., 2017). It was further concluded that in low-income neighbourhoods, more urbanised areas have the highest environmental risks, while less urbanised areas have higher slopes, a low provision of pedestrian space, and low accessibility to jobs and public transport (Anciaes *et al*., 2017). These studies highlight the socio-economic and environmental benefits of walkability. Addressing walking disparities, especially in low-income neighbourhoods, can support the economy by reducing costs spent on private vehicles, enhance access for those who are transport poor, while consequently, increasing social cohesion.

While an increase in walkability helps to improve physical and mental health, increase social cohesion, and the quality of the environment, there are also negative effects of increased walkability. The biggest downside of an increase in walkability is the increase in property values (Pivo & Fisher, 2009). The authors looked at the effects of walkability on property values and investment returns in the US, because of its potential social and environmental benefits. The authors found that more walkable areas have higher property values (Pivo & Fisher, 2009). Assessing walkability on a scale of 100 points, an increase of 10 points was shown to increase the property values by 5%-8%, depending on the type of property (Pivo & Fisher, 2009). However, the benefits of walkability far outweigh the negatives. It is important to focus on why walkability is increasingly beneficial to an area because of its physical, mental and environmental effects.

2.2.4. Walkability, New Urbanism and Sustainable Development

Walkability and the benefits outlined above have been linked to urban planning discourse through its relationship to New Urbanism and sustainable development. This section will discuss that link in order to contextualise this study.

New Urbanism is an urban design movement that promotes walkable, mixed-use neighbourhoods as an alternative to sprawling urban development (Cysek-Pawlak & Pabich, 2021). The aim is to create communities that are diverse, accessible, and environmentally sustainable by adapting traditional urban planning principles to modern needs (Cysek-Pawlak & Pabich, 2021). The ideas brought forward by New Urbanism emphasise that walking as a mode of transport is important and should be prioritised (van Heerden, 2018). It is an approach to urban planning and design that has grown to be strongly linked to the process of enhancing and shaping the growth and development of urban environments (Cysek-Pawlak & Pabich, 2021). New Urbanism environments are intent on supporting healthy lifestyles that promote social cohesiveness, with an importance given to the quality of public spaces as well as to creating a sense of community within the neighbourhood (van Heerden, 2018). Furthermore, a basic principle of New Urbanism is supporting an urban design that can achieve the needs of the neighbourhood in an efficient and accessible way (van Heerden, 2018).

Sustainable development is an approach to growth that seeks to meet the needs of the present without compromising the ability of future generations to meet their own needs (van Heerden, 2018). SDGs are an

assortment of 17 interlinked objectives aimed at developing peace and prosperity for the planet and its people for both present and future eras (Thornton, 2017). With this being said, walking is an important factor to achieving a variety of these goals, because of its multi-dimensional nature and contribution to sociable communities, public health initiatives, transport availability, and environmental development, while additionally, being a cost-effective mode of transport (Thornton, 2017). Looking at SDGs are important for promoting walkability because they directly support healthier, sustainable, and inclusive environments that walkability practices align with. They address social, economic and environmental impacts holistically. There are four SDGs that are explicitly linked to walking. These are, Goal 3 which ensures healthy lives and promotes well-being for all at all ages, Goal 9 which builds resilient infrastructure, promotes inclusive and sustainable industrialisation and fosters innovation, Goal 11 which makes cities and human settlements inclusive, safe, resilient and sustainable, and Goal 13 which looks at taking action to combat climate change and its impacts (Thornton, 2017).

The above sections have been discussed in order to define core concepts of walkability and contextualise this study by linking it to urban geography and planning. With an increase in walkability, there are both benefits and challenges. The challenges highlight the need for accessible and sustainable environments which emphasis the direct link walkability has in promoting sustainable development. This study aims to investigate walkability within the student community in Makhanda, highlighting both the benefits and challenges, and how walkability can be improved within Makhanda.

2.3. Planning for a walkable environment

The following section looks at planning for a walkable environment. Firstly, an overview of planning and how it has changed over time will be discussed. Secondly, planning for walkability in South Africa will be explored as this is where this study is being conducted. Lastly, collaborative planning and why it is important to involve stakeholders and the community in urban planning strategies will be looked at.

2.3.1. Planning for walkability

Many urban settlements originally accommodated walking practices. This was because these cities were built before the invention of motor vehicles, and so people relied on walking (van Heerden, 2018). Additionally, these urban settlements had a compact layout with narrow streets, mixed-use areas, and centralised public spaces that promoted walking (van Heerden, 2018). However, with the advancements of vehicle-based modes of transportation during the industrial revolution, urban settlements were increasingly becoming developed for motorisation and not walkability (Pacione, 2005). In the 19th century, movements were starting to develop that sought to revitalise urban growth. Ebenezer Howard, an urban planner, developed the Garden City movement which aimed at creating urban environments that were independent of vehicle-based modes of transportation (van Heerden, 2018). The idea was that urban populations would be decentralised to areas in the primary and regional urban centres (van Heerden, 2018). Through design, the aim of developing Garden Cities was to create

self-sustaining urban areas that were connected to the larger urban environments (Pacione, 2005). A similar development, the City Beautiful movement, was created in the United States of America. The aim of the City Beautiful movement was to beautify cities through design. The development of urban environments would be led by a plan that was to be enforced by the appropriate local authorities (Pacione, 2005).

The 20th century saw a shift in urban planning, in the sense that it become the responsibility of the state (van Heerden, 2018). Urban planning became defined by the development of zoning regulations that focused on issues that needed to be changed in urban environments (Pacione, 2005). Zoning regulations meant that selected areas in the city were reserved for specific land-use practices. This led to urban sprawling which consequently meant weakening urban cores. Such an example can be seen in the development of New Towns (Pacione, 2005). New Towns are defined by four main principles. These include, a population between 20 000 and 60 000 residents, the area should surround other densely populated areas, the area should have large open green space developments, and lastly, the area should avoid the over-consumption of valuable agricultural land (Pacione, 2005). With this being said, the ideas of urban planning today have led to fragmented cities, whether it be physically or socio-economically (van Heerden, 2018). The zoning regulations encouraged the use of vehicle-based modes of transportation and this, therefore, led to a significant decrease in pedestrian infrastructure and a disregard for the walking experience (Pacione, 2005). However, city planners are increasing efforts that lead towards sustainable walkable cities that emphasise the need for low-energy modes of transportation.

Nyamai (2020) looked at the adoption of non-motorised transport in Nairobi, Kenya. The author found that a policy is being implemented which aims at encouraging non-motorised transport (Nyamai, 2020). The policy not only emphasises the equitable and sustainable use of land, but also prioritises the provision of safe non-motorised transport infrastructure (Nyamai, 2020). Similarly, Paglione *et al*. (2024) explored how planners have worked to improve walkability in Barcelona. The city implemented a 15-minute city model which aims to create neighbourhoods where amenities are accessible within a 15-minute walk (Paglione *et al*., 2024). The authors found that improving access to amenities helps reduce reliance on cars, creates a sustainable urban environment, and promotes walking (Paglione *et al*., 2024). Likewise, Kumalasari *et al*. (2022) assessed how Sydney had created a space to improve walkability. Planners created simulations to optimise urban designs that promote comfortable walking environments, highlighting the importance of green spaces and access to amenities (Kumalasari *et al*., 2022).

These studies show that planners are implementing these walkability ideas across the globe, which informs the need for walkability research and urban planning strategies. With the increase in health and environmental problems, and the undeniable benefits walkability and walking can bring about, city planners are wanting to create walkable urban environments. The creation of walkable environments can be directly linked to ideas such as new urbanism and sustainable development. By using the guidelines set out by these ideas, along with involving the community and local stakeholders in the planning process, ideas about what specific walkability needs the city should develop, can be established. This will ensure a more walkable city that pertains to pedestrian safety and comfortability, which will additionally increase access and equity to all pedestrians. This

study is aims to investigate and spatially analysing walkability and walking patterns in the student community of Makhanda, which will could be used to inform planning strategies relating to the development of walkable environments.

2.3.2. Planning for walkability in South Africa

With the release of the National Non-Motorised Policy (NMTP) report, came the prioritisation of the NMT policy. The Department of Transport recognises the value of the NMT policy in addressing transport strategies and aims to increase NMT, especially walking (Department of Transport, 2014). The Department of Transport seeks to do this through regulation (by enforcing the existing road rules), infrastructure (by putting an emphasis on pedestrian-centred developments), transport planning, safety (protection from vehicle-based modes of transport and crime), and funding support (Department of Transport, 2014).

A study done by Bickford (2013) showed that in order for the South African NMT policy to be successful and effective, the government needs to have a better understanding of NMT demands and NMT infrastructure requirements. Additionally, studies done by Labuschagne and Ribbes (2014) criticise the implementation of the NMT policy in South Africa. The authors suggest that the implementation of the policy is ineffective. This being because the South African NMT policy lacks conceptual design thinking principles (Labuschagne & Ribbes, 2014). Principles that can be seen in Universal Design and Complete Streets conceptual models. Such conceptual models have guiding principles. These include, wide sidewalks and pathways, areas for socialising, clearly defined spaces, attenuated acoustic environments because street noise can create stress for the hearing population, places of enclosure, flexibility seating, well-lit and consistent lighting, and the development of green infrastructure and spaces (Hui *et al*., 2018). Furthermore, these design elements emphasis safety, access and mobility, context, liveability, sustainability, visual excellence, and cost-effectiveness (Hui *et al*., 2018).

Wood (2024), Wood (2022a), and Wood (2022b) focus on the important role of context-specific strategies when planning for walkability and public transport in South African cities, particularly in addressing socio-economic and historical challenges. Wood (2024) engages with the concept of walkability in Johannesburg, focusing on its challenges and limitations in the context of urban planning. The author examines how walkability is framed in policy and how the reality on the ground often falls short of these ideals, especially for marginalised communities (Wood, 2024). The findings suggest that walkability in Johannesburg is constrained by spatial inequalities and underdeveloped infrastructure (Wood, 2024). Similarly, Wood (2022a) explores how Johannesburg has attempted to implement walkability through specific infrastructure projects, such as pedestrian bridges and NMT projects. The author uses examples of the Grayston Pedestrian Bridge and the Milpark Pedestrian Bridge and argue that while the efforts are significant, they often overlook deeper socio-economic issues that decrease broader walkability (Wood, 2022a). Likewise, Wood (2022b) looks at the challenges surrounding the implementation of transit-oriented development in South African cities. The author focuses on cities like Johannesburg and Cape Town and highlight that transit-oriented development does not

often deliver equitable outcomes due to its narrow focus on economic efficiency rather than social inclusivity (Wood, 2022b).

It is important to note that walkability is supported both directly and indirectly by South African policies. However, the implementation of these policies in urban environments is where it lacks because of a mix of historical, socio-economic, and infrastructural challenges. While there are on-going efforts to promote walking in South African cities, both broader and more contextual understanding of existing walkability levels, and the needs of various urban communities are still needed.

2.3.3. Collaborative planning

With an increased emphasis being put on proposed policies promoting walkability, this study further draws on collaborative planning. Collaborative planning is a call for urban and city planners and its populations to plan and strategise together (Goldstein, 2009). This is directly linked to planning strategies in the sense that different stakeholders need to be integrated into the planning process to ensure the needs of all parties are addressed, as well as to ensure transparency and trust between the different stakeholders (Goldstein, 2009). This will, in turn, allow for the implementation of projects to run smoothly. The idea of implementing a collaborative planning approach is to utilise the existing power dynamics between different stakeholders (Goldstein, 2009). With the involvement of governmental bodies and business, integrated with the involvement of the public, the implementation process becomes effective (Goldstein, 2009). This study aims to use a spatial analysis that could support collaborative planning as an approach to inform relevant parties as to what built environment attributes and features need to be reworked and/or implemented in order to create a safer, comfortable and accessible environment for pedestrians.

The Makana Municipality Integrated Development Plan (IDP) of 2021-2022 recognises that the main mode of transport used in communities is walking, and they agree that developing the necessary infrastructure is of utmost importance (Makana Local Municipality, 2021). However, the issue lies within the successful implementation of these policies, as in many cases in South Africa. This is in light of the walkability policies and projects, specifically the Corridors of Freedom initiative, that were introduced in the city of Johannesburg that did not take into consideration the actual walking practices of the population (Wood, 2022a). The Corridors of Freedom policy was introduced in efforts to make the city more compact while also making it easier for pedestrians to walk (Wood, 2022a). Furthermore, various other pedestrian initiatives were introduced. This includes, sidewalks and crosswalks, pedestrian-centred land-use and infrastructure design, increased road connectivity, traffic and vehicle restrictions, safety education, vehicle parking policies, and fuel taxes (Wood, 2022a). The city of Johannesburg also made investments in trees, lighting, benches, and security cameras. However, the main investment lied within the proposed pedestrian bridges (Wood, 2022a). After an assessment on the actual usage of the pedestrian bridges was reported, light was shed on the lack of planning and stakeholder involvement that went into creating the initiative. Less than 30% of pedestrians used the bridge and the remaining pedestrians had continued to use the original pathways (Wood, 2022a). To this extent, it

was further suggested that plans should have been made to widen the existing sidewalks and make increased efforts to increase pedestrian safety and public transport ridership (Wood, 2022a).

It is therefore ideal, and advised, that city planners and stakeholders engage in planning strategies so as to not only meet the needs of the community, but to also improve accountability, reduce conflict, and develop social capital and a sense of unity amongst the community (Sager, 2017). This is encouraged by Robinson (2008) who suggests that urban policies should be reworked in order to include the diversity of activities in cities, as well as to support a more inclusive form of urban development. This study aims to take into account the perspective of the walking community, which has proven to be an important basis of collaborative planning. By considering the views of the community directly involved, planning strategies that are catered to the community can be created, thus creating a more conducive, safer and comfortable walking environment.

2.4. Walkability research in context

The following section aims to contextualise walkability research to show the relevance of this study. Firstly, the geographical context will be discussed. This is important because it shows a relative lack of walkability research within a Global South viewpoint, highlighting the importance of this study. Secondly, walkability research in South Africa will be explored. This will further contextualise this study within its geographical and research context. Thirdly, student walking and walkability will be explored. This is important as this study focuses on walkability and walking patterns within the student community. This chapter will conclude by highlighting the gaps in literature that this study aims to fill.

2.4.1. The geographical context of walkability research

Research shows that walkability studies have been disproportionally represented in the Global North compared to the Global South. Adams *et al*. (2014) found that over 70% of walkability studies are focused in the Global North. Most walkability studies are conducted in high-income, urbanised areas, with a significant proportion of them being in North America, Western Europe, Australia, and East Asia (Shields *et al*., 2023). In terms of East Asia, most of the studies focuses on more developed regions, such as Japan, South Korea, and China (Shields *et al*., 2023). On the other hand, only about 30% of walkability studies are focused in the Global South in areas such as Latin America, Africa, and parts of Asia (Adams *et al*., 2014). Walkability studies in Africa are limited and relatively few in numbers, with most of them being conducted in South Africa, Nigeria, Kenya, and Ghana (Shields *et al*., 2023).

The relative absence of literature from the Global South is problematic because in the Global South and less developed cities, walking is the most common mode of transportation (Wigan, 1995). This is because of the socio-economic differences present in these cities (Arellana *et al*., 2020). In the Global North, there are usually plans put forward to increase walkability, whereas, in the Global South, individuals are already walking, despite the lack of infrastructure, and planning is almost done as an afterthought (Anciaes *et al*., 2017). Often,

individuals in the Global South walk because they do not have a choice as they are in a position of transport poverty (Anciaes *et al*., 2017). Understanding the southern context is important and studies in the context of the Global North are not necessarily applicable in other geographical contexts (Lawhon & Truelove, 2020). Furthermore, there is a core-periphery bias in research that has led to a small percentage of literature that focuses on walkability in medium- and small-sized cities (Arellana *et al*., 2020). These settlements have their own contexts, characteristics and manifestations of walkability and walking (Arellana *et al*., 2020). These cities present their own urbanisation dynamics, security issues, sidewalk invasion problems, and poor planning strategies, all of which may not apply to cities in the Global North (Arellana *et al*., 2020). Cities in the Global South tend to differ socially, economically, culturally, and politically from cities that reside in the Global North (Lawhon & Truelove, 2020). Due to these differences, different theories are required to explain concepts and experiences, rather than deducing explanations from existing theories that have a focus on cities in the Global North (Lawhon & Truelove, 2020). It is increasingly important to put an emphasis on understanding the context of where development is taking place (van Heerden, 2018). This is because different areas will require different levels of development. For example, the Global North will require a different level of walkability infrastructure development as compared to the Global South, because of the differences of importance placed on non-motorised transportation in these two areas. Additionally, larger cities such as Cape Town or Johannesburg might require a different level of walkability infrastructure development as compared to smaller cities such as Makhanda, further emphasing the need for place- and context-specific developments. One of the main gaps found in literature that this study aims to address, therefore, is the context-specific research for the Global South and, particularly, South Africa. As established here, there are far fewer studies done in the Global South than the Global North.

2.4.2. Walkability research in South Africa

In 2020, a study was conducted by the NHTS under Statistics South Africa. This study was later revised in March of 2022. The study concluded that, in terms of the travelling methods of scholars, the Eastern Cape was one of four provinces that recorded the highest percentage of scholars who walk to their educational institution with a percentage of 15%. With this being said, the results showed that 76.9% of learners who walked to their educational institution did so because it was close enough to walk to (Statistics South Africa, 2020). The second most common reason was that public transport was too expensive. In terms of the travelling methods of the employed, in the Eastern Cape, 30.3% of workers reported that they walked to work. Of those workers who walked, 72.7% said this is because their place of work is close enough to walk and more than one-tenth (10.5%) of workers said that it was their choice (Statistics South Africa, 2020). The third most common reason was that public transport was too expensive. Additionally, within seven years, all provinces saw a decrease in the percentage of individuals who spent up to 15 minutes or more walking to their place of work after already having used public transport. This was all provinces, except for the Eastern Cape, whose percentage increased from 6.5% in 2013 to 7.9% in 2020 (Statistics South Africa, 2020). Furthermore, travel costs per month for taxi users saw a total increase of R410 from R515 in 2013 to R925 in 2020 (Statistics South Africa, 2020). In

the Eastern Cape, travel cost is the biggest factor influencing a household's choice of mode of travel (with 29%), followed by travel time, flexibility, and reliability (Statistics South Africa, 2020). Based on this, it can be said that walking is a widespread and essential mode of transport in South Africa and the Eastern Cape, driven largely by affordability concerns and the proximity to destinations. Additionally, economic factors play an important role in transportation decisions, with many opting to walk to save on rising public transport costs.

The following studies focus on walkability in South African literature. Additionally, these studies have been grouped according to the disciplinary perspective and context that each study focuses on. With this being said, six studies focus on the relationship between health, walking and walkability of the population in their respective study areas. These studies have examined the relationship between the perceived neighbourhood environment and physical activity, with a particular focus on socio-economic factors and their impact on health outcomes. Wayas *et al*. (2023) explored how perceived neighbourhood walkability correlates with self-reported physical activity and body mass index in South African adolescents. They identified key factors of walkability, including the availability of sidewalks, safety from traffic and crime, and the aesthetic features such as green spaces and lighting. Their findings revealed that adolescents in low-income neighbourhoods had lower perceived walkability, which was associated with reduced physical activity and higher body mass index (Wayas *et al*., 2023). Similarly, Isiagi (2019) studied perceived neighbourhood walkability and physical activity across four urban settings in the Western Cape province, including Langa, Khayelitsha, Pinelands, and Table View. While the study focused on similar walkability attributes, such as safety and infrastructure, it emphasised the socio-economic divide between low-income neighbourhoods (Langa and Khayelitsha) and higher-income areas (Pinelands and Table View). Isiagi (2019) concluded that environmental factors in low-income neighbourhood did not significantly influence physical activity, as physical activity in these areas was often seen as a necessity rather than a leisure activity. This contrasts with the findings of Wayas *et al*. (2023), where lower walkability in low-income areas was linked to reduced physical activity. In a broader context, Malambo *et al*. (2017) examined how built environment attributes influence leisure walking among South African adults. They found that factors such as proximity to local shops, transit stops, aesthetics, and safety from traffic and crime were significantly linked to leisure walking. This study, along with their later work (Malambo *et al*., 2018) showed that neighbourhood safety perceptions from both traffic and crime influenced obesity levels, with those perceiving their neighbourhoods as safer being less likely to be overweight. These studies highlight the importance of built environment factors in promoting or hindering physical activity across different age groups and socio-economic backgrounds. Further studies, such as Kolbe-Alexander *et al*. (2015) have also emphasised how neighbourhood characteristics impact physical activity levels, particularly in elderly South Africans. This study compared Claremont (a higher socio-economic area) and Athlone (a lower socio-economic area) and found that, despite better pedestrian infrastructure in Athlone, Claremont residents reported more physical activity, especially in leisure contexts. The study concluded that the aesthetic quality of the environment might encourage more voluntary physical activity in wealthier areas (Kolbe-Alexander *et al*., 2015). Similarly, Malambo *et al*. (2016) investigated the links between perceived built environment factors and hypertension. They identified that the quality of sidewalks, access to recreational facilities, and the density of residential areas were associated with hypertension, suggesting that certain built environment attributes can

influence health outcomes such as hypertension. Together, these studies suggest that while certain built environment features, such as safety and infrastructure, have a clear link to physical activity and health outcomes, the socio-economic context plays a significant role in shaping how these features are perceived and used. Low-income areas, despite having better infrastructure in some cases, often see physical activity as a necessity, which may not lead to the same health benefits observed in higher-income areas where physical activity is more likely to be engaged in for leisure. The above authors recommended creating walkable neighbourhoods with accessible recreational spaces and sidewalks, addressing perceptions of traffic and crime-related safety, and ensuring consistent maintenance of paths. Additionally, developing connected pathways to facilitate safe and easy navigation, integrating mixed land use developments, designing age-friendly walking paths with benches and shaded areas, and strengthening community policing and lighting.

Ten studies focus on assessing the built environment features and urban planning for walkability in their respective study areas. Kruger (2022) conducted a study in Marabastad, Kroonstad, examining walkability factors in urban planning. Key attributes included public transport accessibility, the integration of land uses, and the quality and safety of pedestrian infrastructure. The findings revealed high pedestrian activity driven by the unaffordability of public and private transport, but also noted safety concerns arising from both traffic behaviour and crime, compounded by the lack of mixed land-use practices (Kruger, 2022). This resulted in essential services being beyond convenient walking distances. This concern with pedestrian infrastructure and safety is echoed in van der Walt (2020) and their development of a South African walkability audit tool. This tool evaluates pedestrian infrastructure based on factors such as sidewalk width, condition, and safety features like crossings and lighting. van der Walt (2020) concluded that substantial improvements were needed, including enhanced buffer zones, better maintenance, and safer crossings, to create more pedestrian-friendly environments. These findings align with those of Pretorius (2018), who assessed sidewalk usage in Bloemfontein, revealing that obstructions like encroachments, street furniture, and informal stalls hindered pedestrian mobility and negatively impacted safety and walkability. Pretorius (2018) emphasised the importance of sidewalk width, the absence of obstacles, and safety from traffic as key factors influencing whether pedestrians opted to use sidewalks rather than streets. The relationship between built environment features and pedestrian experiences is also explored in the context of elderly South Africans. Van Der Pas *et al*., (2015) highlighted that the quality of both home and neighbourhood environments, including walkability, safety, and access to services, is directly linked to life satisfaction. This concept of safety and accessibility is similarly discussed by Wasswa (2016), who compared public transport locations in Cape Town and New Delhi. Wasswa (2016) found that road traffic violations and poor pedestrian infrastructure, such as trash-covered walkways, negatively affected the comfort and safety of pedestrians, further limiting their mobility and access to public transport. Research on the specific design features of sidewalks also contributes to this discussion. Vanderschuren *et al*. (2014) identified the minimum sidewalk width as a critical factor, noting that South Africa has a standard 1.2 m width which is inadequate for comfortable pedestrian movement. They recommend a width of at least 1.8 m, with an ideal width of 3 m, to allow for safe passage, especially in areas with high pedestrian traffic. Similarly, Fransolet *et al*. (2016) argued that sidewalks should be free of elevation changes greater than 10 mm over a distance of 1 m, to ensure accessibility for all pedestrians,

including those with disabilities. Further addressing the intersection of urban planning and walkability, Memela *et al*. (2022) examined the pedestrian experience in the Makhanda township, where the lack of infrastructure, poor sidewalk maintenance, and unsafe crossings significantly hindered pedestrian mobility. The study illustrated how inadequate urban planning in lower-income areas can exacerbate issues of safety and accessibility, further limiting the ability of residents to engage in daily activities like walking (Memela *et al*., 2022). In Cape Town, van Heerden (2018) developed a walkability index based on GIS to assess walkability measures such as street connectivity, residential density, and land-use mix. This study incorporated a fourth, context-specific measure that considered walking distances from origin to destination, although it was noted that this measure did not account for environmental factors that influence walking speed. Similarly, Stefanidis and Bartzokas-Tsiompras (2022) applied spatial analysis to identify areas in the city centre of Cape Town that is in need of walkability improvements. Their study emphasises the importance of targeted interventions, such as improving pedestrian crossings and widening sidewalks, in high pedestrian traffic areas, particularly those with higher crime rates and poor accessibility. Together, these studies highlight the multifaceted challenges faced in promoting walkability in South African urban settings. A common theme across these works is the critical need for urban planning that integrates pedestrian needs. The evidence suggests that addressing these concerns is essential not only for improving pedestrian mobility but also for enhancing overall quality of life, particularly in low-income areas where residents rely on walking as a primary mode of transportation. The above authors recommended including mixed land use development to reduce travel distances and encourage pedestrian activity, enhancing pedestrian safety through better street lighting, signage, and traffic calming measures. Additionally, having better connections to public transport to reduce distances between pedestrian amenities and transport stations.

Three studies focus on the role of context-specific strategies when planning for walkability. Wood (2024) critically examines how walkability is framed in policy and its practical implications, particularly for marginalised communities in Johannesburg. The study reveals that while walkability is a key focus in policy discussions, its actualisation is significantly hindered by spatial inequalities and underdeveloped infrastructure, particularly in low-income areas. These structural barriers prevent many communities from accessing the benefits of walkable environments, creating a disconnect between policy intentions and lived realities. Similarly, Wood (2022a) investigates efforts in Johannesburg to enhance walkability through pedestrian bridges and NMT projects. While these initiatives are an important step in promoting pedestrian mobility, Wood argues that they often fail to address the deeper socio-economic issues that undermine broader walkability. The study suggests that these interventions are insufficient, unless they are coupled with efforts to reduce socio-economic disparities. Further extending this analysis, Wood (2022b) examines the implementation of transit-oriented development in Johannesburg and Cape Town. The study emphasises that that transit-oriented development does not often deliver equitable outcomes due to its narrow focus on economic efficiency rather than social inclusivity. These studies by Wood underscore the persistent challenges of achieving equitable walkability and urban development in South Africa. While there have been significant policy and infrastructural efforts, these efforts are often insufficient and do not address the deeper socio-economic and spatial inequalities that continue to hinder access to safe and accessible pedestrian environments.

As discussed in the preceding section, Southern Urbanism highlights a need for studies from a diversity of contexts. It is therefore vital to note the patterns in the research within South African literature. Less than 20 walkability studies have been conducted in South Africa in the last 10 years, with none placing a focus on student-based walkability. With this being said, the three key disciplinary perspectives and context taken by walkability research done in South African include, the relationship between health, walking and walkability, the impact of the built environment and urban planning for walkability, and the role of context-specific strategies when planning for walkability. These studies emphasise that improving walkability in South African cities requires a multi-faceted and holistic approach that addresses infrastructure, safety, urban density, and socio-economic factors. Majority of the studies placed a focus on bigger cities that included both low- and high-income neighbourhoods with studies in Cape Town being the most frequent. The study is increasingly relevant because it is adding to the total number of walkability studies done in the Global South and, more particularly, in South Africa. Additionally, this study places a focus on a smaller city. While this study is the second walkability study based in Makhanda, it is not focused on a peripheral township area, but rather on the student walking community in the central areas of the city. Furthermore, this study is relevant because it aims to address student walkability and walking patterns, a focus previous South African literature did not cover.

2.4.3. Student walking and walkability

University students are a subset of the urban population in Makhanda who experience transport poverty and largely rely on walking to navigate the city. With this being said, this study has chosen to focus on the walkability and walking patterns of the student community in Makhanda. The following are case studies that have placed a focus on campus walkability and student walking. These studies can guide the present research and their findings will be helpful for comparing with those within the context of Makhanda.

Lizárraga *et al*. (2022) examined how perceptions of safety affect university students' walking preferences and overall walking activity in Granada, Spain. Their study found that factors such as crime rates, lighting, and the presence of security features played a key role in influencing students' walking activity, with well-lit streets and safe pedestrian paths being strongly associated with increased walking (Lizárraga *et al*., 2022). Furthermore, female students reported higher concerns about safety and tended to alter their routes or reduce walking, especially at night. This highlights the gendered dimensions of safety perceptions and their impact on walking behaviour. Similarly, Rashidi (2019) analysed safety perceptions at the Middle East Technical University in Turkey, revealing that areas with higher traffic, poor lighting, and inadequate security features were perceived as unsafe and had lower walkability ratings (Rashidi, 2019). This led students to avoid certain areas, particularly after dark, thus reducing overall walking activity. Memon *et al*. (2020) further corroborated these findings by developing a model to assess the relationship between campus safety and walkability at the University of Sindh, Pakistan. Their study emphasised that areas with better lighting, lower traffic volumes, and enhanced security features were rated as more walkable, leading to higher levels of walking activity. This underscores the direct link between safety perceptions and walkability on campus (Memon *et al*., 2020).

The importance of environmental factors, such as lighting, traffic control, and pedestrian infrastructure, was also highlighted by Harun *et al*. (2020), who examined walkability on campus streets in Malaysia. Their study identified street connectivity, sidewalks, pedestrian crossings, and the availability of amenities like benches and shade as critical factors for walkability. Similar findings were reported by Makki *et al*. (2012), who noted that well-connected pathways, safe crossings, and adequate lighting were key determinants of student walking behaviour. Students were more likely to walk when routes were direct, aesthetically pleasing, and provided access to green spaces and shaded areas (Makki *et al*., 2012). In addition to safety and infrastructure, climate also plays a significant role in influencing student walking behaviour. Ramakreshnan *et al*. (2020) explored how environmental features and climate conditions impact student walking behaviour at their campus, revealing that students preferred shaded and cool environments due to the discomfort caused by heat and humidity (Ramakreshnan *et al*., 2020). Green spaces and shaded paths were positively associated with increased walking activity, emphasising the role of environmental comfort in encouraging walking.

Social factors, such as the presence of other people or security patrols, also contribute to safety perceptions and, by extension, walkability. Huang *et al*. (2022) found that students felt safer in well-lit, open, and visible areas, with the presence of others or security patrols, further enhancing feelings of safety. This finding aligns with those of Ford (2013) who assessed the walkability challenges at Wright State University in Ohio, where inadequate pedestrian infrastructure, high traffic volume, and lack of crossings discouraged walking, forcing students to choose other modes of transportation. Further studies have showed that perceptions of safety significantly influence walking patterns. Abeysinghe *et al*. (2023) found that high traffic volumes and poor pedestrian infrastructure in neighbourhoods surrounding university campuses discouraged walking. Similarly, da Silva and da Silva (2020) observed that students who perceived their routes to campus as unsafe, particularly at night or in poorly lit areas, were less likely to walk. These studies emphasise the need for safety measures to encourage walking and improve overall campus walkability. Additionally, Liao *et al*. (2022) highlighted the importance of positive attitudes towards walking in enhancing campus walkability. Their study found that students perceptions of walkability positively influenced their walking experiences, with positive attitudes toward walking further strengthening the benefits of a walkable campus environment (Liao *et al*., 2022). This suggests that beyond physical infrastructure, fostering a culture of walking through education and encouragement can play a significant role in enhancing walkability.

The above studies consistently show that safety perceptions, environmental factors, infrastructure quality, and social elements are crucial to understanding and improving campus walkability. Factors such as crime rates, traffic conditions, lighting, pedestrian infrastructure, and climate significantly impact student walking preferences and behaviours. Ensuring that campuses are designed with these considerations in mind is essential for promoting walking activity and improving overall campus mobility. The above authors recommended ensuring consistent pathway maintenance, installing comprehensive lighting systems, and increasing the presence of security personnel. Additionally, planting more trees, shaded walkways, and fixing barriers such as fencing.

As highlighted in the preceding subsection, there are no research based in South Africa that has a focus on student walkability and walking patterns. This study is important because university students are a subset of the urban population in Makhanda who experience transport poverty and largely rely on walking to navigate the city. The four chosen study areas are the most densely populated student residential areas in the city, but are also the epicentre of student activity. It is therefore important to ensure that the walking infrastructure in those areas are conducive, safe and comfortable for the walking population. This study aims to use the above literature as guidance while aiming to fulfil this gap in research. South Africa has over 25 universities that are located in both metropolitan areas and smaller towns and cities across the country. The findings of this research will help to understand student walking patterns and walkability and can be used for comparison with future studies focused on student communities and spaces.

2.5. Investigating walkability and walking pattens

The following section discusses tools that have been used by other authors to analyse, observe and measure walkability and walking patterns. These tools include, the Neighbourhood Environment Walkability Scale (NEWS) and variations of WI, GIS, perceptions of walkability, and participatory mapping.

2.5.1. Neighbourhood Environment Walkability Scale

The following studies are authors who used the NEWS tool to analyse, observe and measure the walkability of an area. NEWS a type of WI tool. It is a questionnaire that was created and validated in the United States of America (Almeida *et al*., 2021). It is a tool that collects data for assessing the walkability and walking patterns in a selected area (Almeida *et al*., 2021). NEWS assesses the perceived attributes of the neighbourhood environment and has become the most used walkability assessment tool since its first publication (Cerin *et al*., 2013). The questionnaire measures eight walkability attributes using 66 questions. The eight measures of walkability include, residential density, land-use mix, land-use mix access, street connectivity, infrastructure for walking and cycling, aesthetics, traffic safety/hazards, and safety from crime (Almeida *et al*., 2021). The questionnaire has additional questions regarding individual satisfaction with the neighbourhood (Almeida *et al*., 2021). Authors exploring the field of walkability have adapted NEWS to suit their study and would have used some version of it in order to assess walkability and walking patterns.

Leslie *et al*. (2005) conducted a study between two Australian suburbs, Norwood and Hawthorndene, which were selected based on their similarity in weekly household income and resident age, but with distinct differences in walkability. Norwood is a high-walkable suburb while Hawthorndene is a low-walkable suburb. The study found that various measures of walkability, such as mixed land-use practices, street connectivity, sidewalk infrastructure, traffic safety, and accessibility were consistently rated higher by residents in the high-walkable suburb compared to residents in the low-walkable suburbs (Leslie *et al*., 2005). This study highlighted the importance of urban design elements in shaping how residents perceived walkability and suggested that walkability perceptions could vary depending on the specific features of the built environment.

Similarly, Adlakha *et al*. (2016) applied the NEWS tool in Chennai, India and found that the built environment to active commuting were directly connected to the broader socio-ecological systems in the city. Their findings emphasised the constraints faced by urban dwellers, where the built environment posed challenges to walking and other forms of physical activity (Adlakha *et al*., 2016). This study underscores the importance of understanding walkability within the broader socio-economic and cultural contexts, suggesting that walkability perceptions are shaped not only by physical infrastructure but also by the broader socio-ecological factors influencing residents' behaviour. Expanding the application of NEWS to other regions, Adams *et al*. (2009) tested the validity of the tool in San Diego, California. The authors found that active residents tended to have higher perceptions of walkability, with sensitivity analyses revealing that residents with a 20-minute walking threshold had a stronger perception of walkability than those with shorter or longer thresholds (Adams *et al*., 2009). This finding suggests that the relationship between walkability perceptions and physical activity may be influenced by the distance residents are willing to walk, highlighting the significance of proximity to key destinations in shaping walkability experiences. Further extending the global application of NEWS, Oyeyemi *et al*. (2013) assessed the reliability of the tool in Nigeria, finding moderate to high reliability in the results. Their study revealed that high-walkable neighbourhoods were associated with higher residential density, a more diverse land-use mix, better street connectivity, improved traffic safety, and greater perceived safety from crime. However, these neighbourhoods also faced challenges such as lower infrastructure quality and limited facilities for walking and cycling compared to low-walkable areas (Oyeyemi *et al*., 2013). This nuanced result indicated that while higher walkability may correlate with certain urban advantages, challenges remain regarding the quality of infrastructure and safety, which can impact the overall walkability experience. Oyeyemi *et al*. (2017) further explored the application of NEWS across six sub-Saharan African countries (Cameroon, Ghana, Mozambique, Nigeria, South Africa, and Uganda). This study revealed that access to mixed land use and safety were positively associated with transport walking, while proximity to recreational facilities, road connectivity, and infrastructure for walking and cycling were positively associated with leisure walking (Oyeyemi *et al*., 2017). These findings suggest that the specific context of each country plays a critical role in shaping walking behaviours.

The above studies underscore the critical role of urban design in shaping walkability perceptions. They suggest that factors such as mixed land use practices, street connectivity, traffic safety, and infrastructure for walking are central to creating walkable environments. However, they also highlight the complexities involved in assessing walkability, with local socio-economic, cultural, and infrastructural factors influencing how residents perceive and engage with their built environment. The above authors recommended encouraging mixed land use practices, considering the local needs when designing walkable spaces, implementing measures to reduce traffic speed and volume, and improving the quality of sidewalks.

2.5.2. Walkability Index

As mentioned above, authors exploring the field of walkability have adapted NEWS to suit their study and would have used a variation of it to assess walkability and walking patterns. With this being said, the following

studies are authors who used variations of the NEWS tool to analyse, observe and measure the walkability of an area. The National Walkability Index is a standardised tool that was developed in United States of America (Watson *et al*., 2020). It is used to assess and compare walkability across neighbourhoods in the country and provides a score to reflect how walkable an environment is (Watson *et al*., 2020).

Watson *et al*. (2020) conducted a study in the United States of America exploring the relationship between a selected walkability index and both transportation and leisure walking among adults. Their findings showed that areas with high-walkable neighbourhoods exhibited significantly higher levels of walking for both transportation and leisure (Watson *et al*., 2020). This suggests that neighbourhoods with better walkability tend to encourage more walking activity, reinforcing the notion that the built environment plays a crucial role in promoting walking as a mode of transport and physical exercise. A similar approach was taken by Glazier *et al*. (2012) who developed a walkability index for Toronto, Canada. This index was based on variables such as population density, dwelling density, availability of pedestrian-centric facilities, and street connectivity. The walkability index was validated against various outcomes, including physical activity levels, transportation choices, and body weight. The results highlighted that areas with higher walkability scores were associated with increasing walking, cycling, and public transport use, while there were negative associations with car ownership and driving trips (Glazier *et al*., 2012). This study provides further evidence that walkable neighbourhoods are not only conducive to walking but also facilitate the use of alternative, sustainable modes of transport, thereby reducing reliance on cars. Similarly, Rundle *et al*. (2019) developed an index for assessing physical activity across communities in the United States of America. This index aimed to quantify the walkability of neighbourhoods based on built environment features that influence walking for both transportation and health (Rundle *et al*., 2019). Their findings indicated that higher neighbourhood walkability scores were strongly associated with increased walking per week and lower body mass index, emphasising that walkable environments promote physical activity and are linked to improved health outcomes (Rundle *et al*., 2019). Frank *et al*. (2010) also investigated the relationship between walkability and physical activity, specifically focusing on four key walkability measures (net residential density, retail floor area ratio, intersection density, and land use mix). Their study used the Neighbourhood Quality of Life Study, which assesses the built environment and its impact on quality of life, physical activity, and health. Their findings suggested that low density development with separated land uses tend to result in greater traffic congestion, air pollution, and higher risks of physical inactivity, hypertension, and overweight (Frank *et al*., 2010). This highlights the negative health consequences associated with low-walkability environments, reinforcing the importance of mixed land use development and higher density in promoting public health.

The above studies underline the link between walkability and various physical activity outcomes. Walkability indices serve as valuable tools for understanding how built environment factors influence transportation choices and leisure walking, ultimately affecting public health outcomes. These studies suggest that neighbourhoods with higher walkability tend to foster increased physical activity, reduced reliance on cars, and better overall health, emphasising the critical role of urban design in shaping active living environments. The above authors recommended promoting mixed land use practices, and prioritising pedestrian-friendly

infrastructure such as wider sidewalks, traffic calming measures, easier access to amenities, benches, and green spaces.

2.5.3. Geographic Information Systems

The following studies are authors who used GIS to analyse, observe and measure the walkability of an area. According to Maguire (1991), GIS refers to the equipment used in the visualisation, measurement, and analysis of the Earth's features. It is a computer-based system of hardware, software, liveware, and processes designed to support the capture, management, analysis, modelling and display of spatially referenced data (Maguire, 1991). GIS overlaps with disciplines that are connected with physical processes of the Earth or how humans interact with the Earth and with machines (Maguire, 1991). Leslie et al. (2007) further describes GIS as a system that uses databases and software to assess and analyse data by their spatial location. This will reveal additional relationships and trends that may not have been evident on paper or through other conventional methods (Leslie et al., 2007).

Frank *et al*. (2005) in Atlanta, Georgia shows that neighbourhoods with higher walkability scores, driven by better street connectivity and denser residential areas, were associated with higher levels of physical activity. This finding aligns with Telega *et al*. (2021) who, in Kraków, Poland, found that the central part of the city which is characterised by higher walkability, had more accessible pathways for pedestrians. In contrast, the outskirts of the city, marked by lower connectivity and less pedestrian-friendly infrastructure, scored much lower on walkability (Telega *et al*., 2021). Similarly, Owen *et al*. (2007) highlighted that neighbourhoods in Australia with higher residential density and better street layouts led to increased walking for transport, reinforcing the role of urban design in influencing walking behaviours. The concept of connectivity is further explored by Motomura *et al*. (2018) who found that the central areas of Brazil exhibit higher walkability due to better pedestrian infrastructure and more intersections. Their study also suggested that some peripheral, isolated areas could be transformed into more walkable spaces through the creation of mixed-use hubs (Motomura *et al*., 2018).

D'Orso and Migliore (2020) assessed pedestrian access to railway stations in Palermo, Italy using GIS to evaluate the condition of pedestrian paths. Their study revealed that urban planners had not adequately addressed pedestrian needs, leading to poor pedestrian environments and hindered access to transportation hubs (D'Orso and Migliore, 2020). This emphasises the need for urban planners to prioritise pedestrian infrastructure to ensure safe and efficient movement, particularly around key transportation nodes. Rahman *et al*. (2023) further explored the relationship between pedestrian infrastructure and walking behaviours in Khulna, Bangladesh. Their study revealed that well-maintained sidewalks and compact urban areas significantly increased walking, while broader roadways, which allowed for more motorised vehicles, reduced walking (Rahman *et al*., 2023). This highlights the importance of creating pedestrian-centric spaces and reducing car dominance to encourage active transportation. Additionally, they found that longer travel

distances and higher travel costs deterred walking, suggesting that accessibility to essential services and amenities within walking distances is a key factor for promoting physical activity (Rahman *et al*., 2023).

Mu and Lao (2022) in their study of the Zijingang East Campus at Zhejiang University in China, found that walkability scores varied significantly depending on the proximity of key facilities. While shopping facilities had high walkability scores due to their close proximity to dormitories, educational facilities scored lower because of longer travel distances (Mu and Lao, 2022). This suggests that the spatial arrangement of services and facilities within a community directly affects the walkability of that area, and that the specific needs of different populations should be considered when planning walkable spaces. Tarek *et al*. (2021) in Cairo, Egypt used GIS to assess environmental indicators affecting walkability. They found that pedestrian satisfaction was closely linked to the quality of pedestrian infrastructure, local context, and built environment factors. This emphasises the need for tailored solutions that address the unique challenges and opportunities of different urban contexts to improve walkability and ensure that pedestrian needs are met.

The above studies show the important role of urban design in shaping walking behaviours and improving public health outcomes. High walkability is associated with increased physical activity, greater use of active transportation modes, and reduced dependency on cars. The above authors recommended enhancing walkability by ensuring mixed land use spaces are accessible and connected, and ensuring better sidewalks, more pedestrian crossings and signals, lighting, and green spaces.

2.5.4. Perceptions of walking

The following studies are authors who have focused on analysing walkability and walking patterns through interviews and survey questionnaires in order to understand perceptions of walking.

Gebel *et al*. (2011) found that in Australia, residents' negative perceptions of walkability were associated with lower walking rates, even in neighbourhoods with objectively high walkability. This highlights the important role that perceptions play in shaping behaviour, emphasising the environmental factors alone may not be sufficient to encourage physical activity without positive perceptions of walkability (Gebel *et al*., 2011). Similarly, Duncan *et al*. (2016) observed in Paris that neighbourhoods designed with walkability in mind correlate with increased walking among residents. They argued that fostering walkable environments could directly contribute to higher levels of neighbourhood physical activity, underscoring the importance of both physical design and subjective perceptions in promoting walking behaviour (Duncan *et al*., 2016). Further emphasising the role of subjective experiences, Hung *et al*. (2010) conducted a walkability survey in Hong Kong, where participant satisfaction with pedestrian facilities varied. More than half of the participants expressed satisfaction, but those who were dissatisfied highlighted specific areas for improvement, such as better street lighting, wider and more weather-proof pathways, and safer crossings (Hung *et al*., 2010). These findings show that even in relatively walkable environments, perception-based factors like safety and convenience remain critical in determining the quality of walking experiences. In Lisbon, Moura *et al*. (2017) extended this understanding by considering how walkability is perceived differently among various pedestrian

groups including, children, seniors, and people with disabilities. Their research showed that distinct groups faced unique barriers, such as uneven sidewalks or insufficient safe crossings, thus revealing that walkability is not a one-size-fits-all concept. Similarly, Scorza *et al*. (2021) explored the potential of citizen participation in improving walkability in Potenza, Italy. By organising workshops and focus groups, they gathered both qualitative and quantitative data on community perceptions of walkability. The study found that community involvement led to greater awareness of walkability issues and fostered collective efforts toward safer crossings, improved lighting, and enhanced public spaces. This participatory approach echoes the findings of Moura *et al*. (2017), reinforcing the idea that engaging with residents can enhance the relevance and effectiveness of walkability interventions. In Africa, Okyere *et al*. (2023) investigated walkable city planning in several cities, focusing on local conditions and challenges. Their study identified key barriers to walkability, such as inadequate infrastructure, limited public transport, and socio-economic factors that influence pedestrian safety (Okyere *et al*., 2023). These findings emphasise that walkability issues are not only related to the built environment but also to broader socio-economic contexts that must be addressed in urban planning processes. Battista and Manaugh (2019) and Villaveces *et al*. (2012) both contributed to the understanding of how pedestrians perceive walkability through qualitative research methods. Battista and Manaugh (2019) used qualitative GIS techniques to explore how personal experiences shape perceptions of walkability, with factors such as amenities, safety concerns, and aesthetics playing significant roles. Villaveces *et al*. (2012) focused on pedestrian perceptions of safety in Cali, Colombia and found that street design, lighting, and surveillance significantly influenced perceptions of safety, which in turn impacted walking behaviour. Both studies highlight the importance of environmental design in shaping the perceived safety and attractiveness of walking routes. The above studies show that walkability is a multi-faceted concept influenced not only by physical infrastructure but also by individual perceptions, socio-economic contexts, and participatory planning approaches. The studies underscore the importance of considering diverse perspectives in urban planning, as well as the potential for improving public health and physical activity levels through targeted interventions that address both the objective and perceived aspects of walkability. The above authors recommended improving perceptions of walking through public education and awareness campaigns, and context-specific solutions in developing walkable spaces that also cater to community needs. Additionally, improving pedestrian crossings, traffic calming measures, better lighting, wider sidewalks, better community policing and the creation of more public green spaces.

Lee and Dean (2018) focused on urban seniors in Toronto, investigating how factors like proximity to amenities, sidewalk conditions, and safety influenced walking behaviours. Their findings revealed that these environmental determinants are crucial for seniors, who are particularly sensitive to walkability issues due to mobility limitations and safety concerns (Lee and Dean, 2018). Alidoust *et al*. (2018) expanded this focus by examining how perceived neighbourhood walkability affected the social life of older individuals. Their mixed methods approach showed that higher perceived walkability not only encouraged physical activity but also positively impacted social interactions and community engagement, suggesting that walkable environments contribute to both physical and social well-being in aging populations (Alidoust *et al*., 2018). Similarly, Mehta (2008) explored how pedestrian comfort, street design, and perceptions of walkability influenced behaviour in

urban areas. The author highlighted the strong connection between the physical attributed of streets and overall pedestrian satisfaction. This theme was echoed in Van Cauwenberg *et al*. (2012) who employed walk-along interviews to explore how infrastructure, safety, and social interactions shape transportation-related walking behaviours. The role of environmental design in shaping perceptions of walking is further emphasised in Whitfield *et al*. (2019) who examined the influence of environmental factors such as access to parks, traffic conditions, and neighbourhood aesthetics on walking behaviours among both urban and rural residents. The study revealed that these factors significantly affect walking habits, with urban residents particularly attuned to the aesthetic quality of their neighbourhoods and access to green spaces (Whitfield *et al*., 2019). This finding resonates with Vine *et al*. (2012) who highlighted the significance of safety, accessibility, and the presence of green spaces for older residents in high-density inner-city areas in Australia. In the United Kingdom, Kelly *et al*. (2011) compared objective measures, subjective perceptions, and composite indices to assess walkability. Their findings emphasised that subjective perceptions often capture nuances in walkability that objective measures miss, thereby highlighting the importance of considering both the physical and perceptions of walkability when planning pedestrian environments. This aligns with Whybrow *et al*. (2021) who found that individuals often choose neighbourhoods with higher walkability levels for the perceived health and lifestyle benefits. Their qualitative interviews revealed that people actively seek out walkable areas that align with their values of health and well-being, further showing the important role of perception in walking behaviour. Clark *et al*. (2010) explored the perspectives of key stakeholders involved in developing walking neighbourhoods, emphasising the need for collaborative approaches in urban planning to overcome barriers to creating walkable environments. The study found that stakeholders recognised the importance of walkable neighbourhoods for public health, but identified challenges such as funding, political will, and infrastructure limitations (Clark *et al*., 2010).

The above studies underscore that walkability is not simply a matter of physical infrastructure but also involves the perceptions, preferences, and social dynamics of individuals. The integration of walkability into urban planning has significant implications for promoting physical activity, fostering social interaction, and improving overall health. Furthermore, the involvement of community members and stakeholders in the planning process is essential for ensuring that walkable environments meet the needs of diverse populations. The above authors recommended improving lighting, adding pedestrian crosswalks, reducing traffic speeds in residential areas, wider sidewalks, and more green spaces. Additionally, collaborating between urban planners and community members to create a walkable environment that caters to the needs of the people.

2.5.5. Participatory mapping

The following studies are authors who have focused on analysing walkability and walking patterns through participatory mapping exercises. Participatory mapping is a powerful tool that not only captures the walking patterns and walksheds, but also supports and encourages community engagement and informed decision-making practices in urban planning. An analyse of walking patterns and walksheds offers insight into their

behaviours, needs, and challenges, all of which is important for urban planning and improving walking infrastructure. This insight will help create a more conducive, safer and comfortable walking environment.

Roper *et al*. (2024) developed a participatory mapping approach to capture perceptions of walkability in Sydney, Australia. Through workshops and online surveys, residents mapped areas they considered more or less walkable, with the spatial data analysed using GIS tools. They study found significant variations in walkability perceptions based on demographic factors such as age and mobility, with key barriers identified as poor infrastructure, safety concerns, and inadequate amenities (Roper *et al*., 2024). The authors emphasised the effectiveness of participatory mapping in revealing community-specific needs, suggesting that local knowledge can inform more tailored urban planning interventions. Similarly, Saadi *et al*. (2021) employed participatory mapping in Brussels, where residents highlighted safety and infrastructure as critical issues, particularly poorly maintained sidewalks and insufficient lighting. These findings echo Roper *et al*. (2024) in showing that safety concerns are a common theme among residents, influencing their perceptions of walkability. Aditya (2010) examined the usability challenges of participatory in South Yogyakarta in Indonesia, where participants interacted with digital mapping platforms to pinpoint infrastructure issues. Aditya (2010) identified several barriers, including technical difficulties for participants unfamiliar with the tools, the challenge of expressing complex spatial information, and insufficient feedback from planners. These challenges underline the importance of ensuring accessibility and user-friendliness in participatory mapping processes. Similarly, Shields and Osorio (2017) developed a participatory approach in Canada. They identified key issues such as inadequate pedestrian pathways, safety concerns, and limited public transport, echoing common barriers found in other studies. The role of subjective perspectives in shaping walkability is also highlighted in Fancello *et al*. (2020) who applied subjective value theory in Italy. The authors found that perceptions of safety, aesthetics, and social interactions were significant determinants of walkability. Participants valued well-maintained green spaces and safe pedestrian crossings, emphasising the subjective nature of walkability and how individual values influence the perception of urban environments (Fancello *et al*., 2020). The aligns with the findings of Pak and Ag-ukrikul (2017) who conducted participatory workshops in Brussels and found that issues like insufficient lighting, poor sidewalk conditions, and a lack of green spaces were significant barriers to walkability. The relationship between the built environment and social capital in shaping walkability perceptions is explored by Rogers *et al*. (2012) in Durham, USA. Their study found that communities with stronger social capital had better perceptions of their built environment and higher sustainability. This suggest that social capital, including community networks and civic engagement, plays a role in shaping how residents perceive walkability (Rogers *et al*., 2012). This idea of social capital as an influencing factor was echoed in Roper *et al*. (2024) where variations in walkability perceptions were linked to demographic factors.

The above studies show the value of participatory approaches, revealing common barriers such as safety concerns, inadequate infrastructure, and the lack of green spaces. While participatory mapping is an effective tool for understanding local knowledge, challenges such as technical barriers highlight the importance of designing accessible and inclusive mapping processes. Additionally, the subjective nature of walkability

underscores the importance of considering both the physical environment and perceptions when planning walkable cities. The above authors recommended incorporating community feedback into urban planning to better reflect local needs and perceptions, creating walking routes that connect people to community hubs, and creating more accessible public spaces.

2.6. Conclusion

The aim of this study is to investigate and spatially analyse walkability and walking patterns of the student community in Makhanda, South Africa. The above studies look at the importance of analysing, observing and measuring walkability and walking patterns, which align with the research objectives of this study.

This review commenced with a look at walkability and walking patterns. Firstly, a definition of walkability was discussed and chosen to guide this study. Secondly, the characteristics of walkability was explored. These characteristics will be used to inform the walkability factors that will be used in this study. Thirdly, the benefits and challenges linked to increased walkability were looked at. This helps contextualise the importance of this research and why walkability is an increasingly important factor to consider. Lastly, walkability in the context of New Urbanism and sustainable development was discussed. Walkability directly links to urban planning and design, as well as to creating sustainable urban environments. This highlights the role of walkability in urban planning and the creation of sustainable settlements.

This review then looked at planning for a walkable environment. Firstly, an overview of planning and how it has changed over time was discussed. Secondly, planning for walkability in South Africa was explored as this is where this study is being conducted. Lastly, collaborative planning and why it is important to involve stakeholders and the community in urban planning strategies was discussed.

This review then went on to contextualise walkability research and show the relevance of this study. Consequently, the gaps in literature that this study aims to fill were presented. Firstly, the geographical context was discussed. This is important because it shows a relative lack of walkability research within a Global South viewpoint, highlighting the importance of this study. Less than 20 walkability studies have been conducted in South Africa in the last 10 years, with none placing a focus on student-based walkability. The study is increasingly relevant because it is adding to the total number of walkability studies done in the Global South and, more particularly, in South Africa. Additionally, this study places a focus on a smaller city. Secondly, walkability research in South Africa was explored. This further contextualised this study within its geographical and research context. Thirdly, student walking and walkability was explored. This is important as this study focuses on walkability and walking patterns within the student community. South Africa has over 25 universities that are located in both metropolitan areas and smaller towns and cities across the country. The findings of this research will help to understand student walking patterns and walkability in Makhanda, and can be used for comparison with future studies focused on student communities and spaces.

Lastly, this review discussed the tools that have been used by other authors to analyse, observe and measure walkability and walking patterns. These tools include, NEWS and variations of WI, GIS, perceptions of walkability, and participatory mapping. These methods will be used to guide this study and will be further discussed in Chapter 4. Having considered the literature that will be used to inform this study, the following chapter will focus on presenting the study area that this research focuses on.

Chapter 3: Study Area

3.1. Introduction

The previous chapter highlighted walkability and walking patterns in previous literature as well as the importance of measuring and spatially analysing walkability, which align with the research objectives of this study. This chapter will present the study area that this research focuses on. This chapter will, commence with a discussion of the research location. Following this, the physical geography aspects of Makhanda will be discussed. Third, the built environment aspects of the study area will be explored. Fourth, the governance and availability of transport will be investigated. Lastly, the socio-economic characteristics will be discussed.

3.2. The location of Makhanda

Makhanda (formerly known as Grahamstown) is situated within the Eastern Cape province in South Africa. It is located 127 km north-west of Gqeberha (formerly known as Port Elizabeth) and 158 km west of East London. It is located at 33.3181^{o} S and 26.4764^{o} E on a map and has an elevation of 580 m above sea level. Makhanda falls within the Makana Local Municipality, which is one of seven local municipalities in the Sarah Baartman District Municipality in the Eastern Cape (Makana Municipality IDP, 2023). The city was originally established in 1812 by Colonel John Graham as a base for the British Settlers (MacLennan, 2021). However, in 2018, it was renamed to Makhanda to honour amaXhosa warrior Makhanda (also known as Nxele), whose heroics included an attack on the British base (MacLennan, 2021). Figure 3.2.1 shows a map representing Makhanda, with the yellow polygon showing Makhanda East and the blue polygon showing Makhanda West. Makhanda has been separated into the East and West sides because of its socio-economic differences and, more specifically, because this study will be focusing on the western side of the city. This is because a significant percentage of the student population resides within the western part of Makhanda as opposed to the eastern part. The inset map shows the location of Makhanda within the Eastern Cape province.

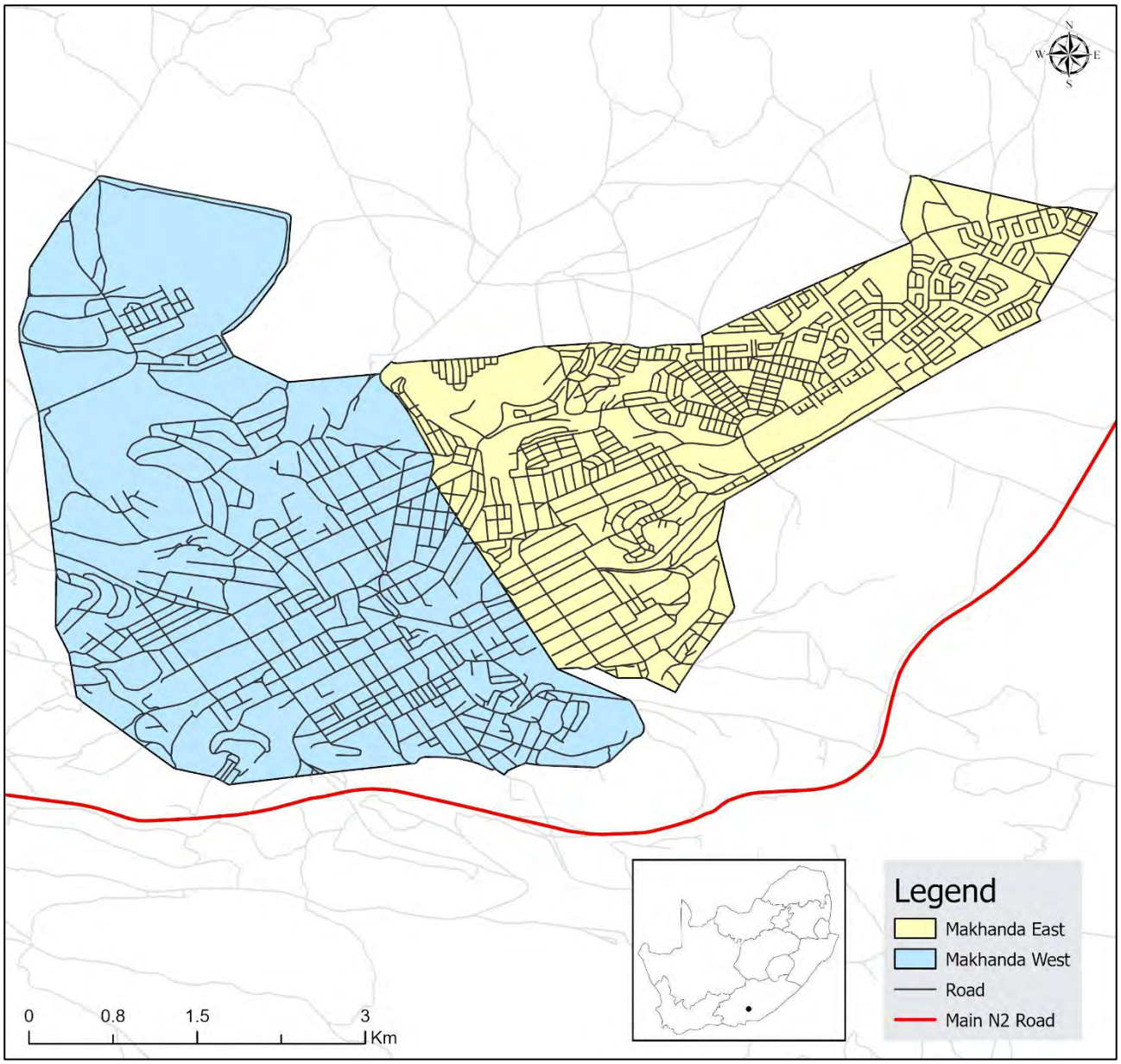

Figure 3.2.1. *The city of Makhanda located in the Eastern Cape province, South Africa.*

3.3. The physical geography of Makhanda

Makhanda has a subtropical climate which means it has warm summers and cool winters. In terms of rainfall, Makhanda has a fairly even distribution of rainfall throughout the year, with the southern portion of the city receiving the highest rainfall (Makana Municipality IDP, 2023). The mean precipitation averages at about 680 mm each year (Makana Municipality IDP, 2023). Figure 3.3.1 shows the average monthly precipitation in Makhanda. This includes rain, snow and hail. It can be seen that Makhanda receives the most amount of rainfall during the summer months. The city receives the least amount of rainfall during the winter months.

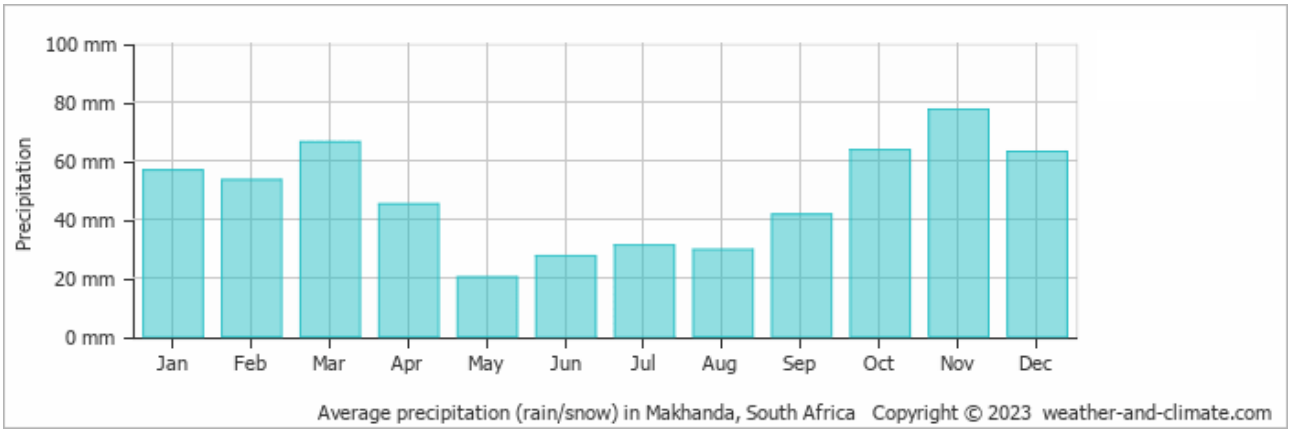

Figure 3.3.1. *Average monthly precipitation for the city of Makhanda. Adapted from Weather and Climate (2023).*

In terms of temperatures, summer temperatures in Makhanda range from an average of 15ºC to 26ºC (Makana Municipality IDP, 2023). Winter temperatures range from an average of 4ºC to 18ºC (Makana Municipality IDP, 2023). Figure 3.3.2 shows the average temperature in Makhanda. It can be seen that the highest temperatures are experienced in January and February, while the lowest temperatures are experienced in June and July.

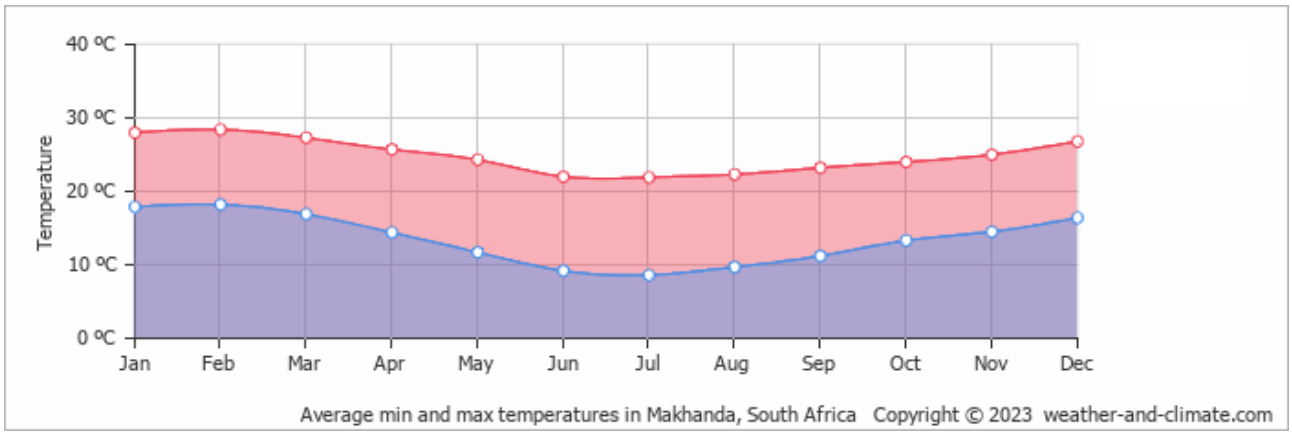

Figure 3.3.2. *Average temperature for the city of Makhanda. Adapted from Weather and Climate (2023).*

It is also important to note the hourly temperature experienced in Makhanda. This is because studies have shown that there is a strong link between walkability and walking experiences (Liao *et al*., 2022; Keat *et al*., 2016; Lee & Shepley, 2020). People may feel uncomfortable walking in extreme temperatures, whether it be too hot or too cold. This, in turn, will affect the walking experiences of the walking population. Figure 3.3.3 shows the average hourly temperature in Makhanda. The green colours represents temperature ranges from 7ºC to 18ºC, the yellow colour represents temperature ranges from 18ºC to 24ºC, and the red colour represents temperature ranges from 24ºC to 35ºC. The Southern Hemisphere experiences summer from December to February and winter from June to August. With this being said, we can see a vast range of temperature differences between the two seasons with summer experiencing high temperatures (ranges from 18ºC to 35ºC) and winter experiencing low temperatures (ranges from 7º to 24ºC). There is a full range of temperature

differences experienced throughout the entire day with the early mornings and late evenings experiencing low temperatures and the afternoons experiencing comfortable to extreme warmth. This directly affects the walking experiences of pedestrians depending on the times of day they choose to walk versus the times of day they have to walk. If we consider the student community, there will be certain times of day students have to walk in order to attend lectures and/or other university commitments.

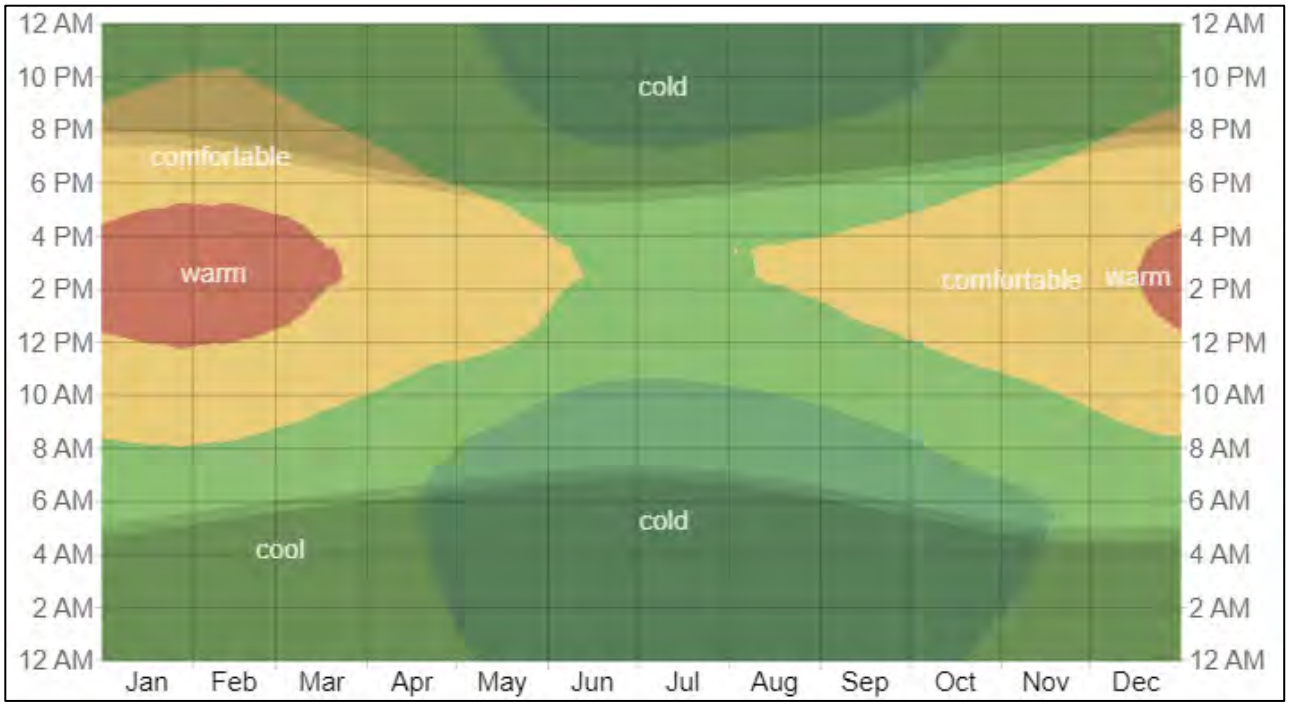

Figure 3.3.3. *Average hourly temperature for the city of Makhanda. Adapted from Weather Spark (2019).*

3.4. The human geography of Makhanda

As of 2023, and based on the present age-gender structure and fertility, mortality and migration rates, the Makana Local Municipality projected a population growth average rate of 2.1% per annum (Makana Municipality IDP, 2023). The population is projected to increase from 91 200 in 2021 to 96 600 in 2026 (Makana Municipality IDP, 2023).

Makhanda is characterised by its post-apartheid layout (Irvine, 2021). With this being said, the western part of Makhanda consists of mainly middle- to higher-income neighbourhoods, whereas the eastern part of Makhanda consists of mainly lower-income neighbourhoods. The urban sprawl in the eastern parts of the city is also more prominent as compared to the western parts of the city (Irvine, 2021). Makhanda is largely segregated, both residentially as well as socio-economically, and it can be seen that Makhanda West is more developed as compared to Makhanda East (Irvine, 2021). This can be seen in the differences in service delivery and infrastructure between the two areas. The delineation of the two sides of Makhanda in Figure 3.2.1 is to visually show how the differences in distance that pedestrians that reside in Makhanda East versus Makhanda West have to walk in order to use the main amenities found in Central. Pedestrians that reside in Makhanda East have to walk a much further distance to reach Central as compared to pedestrians residing in Makhanda West.

It should also be noted that because of the socio-economic differences of the two areas, one relies much more on public transport as a mode of transportation then the other. According to Irvine *et al*. (2022), some residents in Makhanda East use public transportation daily for travelling as they cannot afford their own person vehicles. Apart from this, residents in Makhanda East often walk to their destination, not as a means of leisure, but because they are transport poor.

Makhanda West is also characterised by its distinct neighbourhoods. This study looks at four of those neighbourhoods. The Rhodes University campus is characterised by its student community, with most of the students residing in on-campus residences. Additionally, the proximity of the university to different amenities enhances the student experience (Rhodes University, 2024). Central is home to a vibrant hub of cultural and economic activity. It is characterised by its mixed land use practices and middle-income residents (Irvine, 2021). Due to the high density in Central, the accommodation found in this part of the city is mainly apartment blocks. However, because of urban decay and infrastructure maintenance issues, the overall appeal and functionality has been negatively impacted (Irvine, 2021). Sunnyside and Westhill are residential areas home to middle- to upper-income residents. The accommodation in these areas are away from the hustle and bustle in the central parts of the city and range from modern apartments to traditional houses. Additionally, many of the residents in Sunnyside and Westhill provide affordable student accommodation.

In terms of walkability, Makhanda West hosts more paved walkways, more functioning street lights, as well as more trees and murals. This is vastly different in Makhanda East, which is home to less, if many, paved walkways, almost no functioning street lights (instead, mast lights have been implemented in the area to function as street lights), and less, if any, trees and murals. With this being said, and even though there is an ongoing urban sprawl, Makhanda has not yet decentralized (Irvine, 2021). This means that a lot of the main amenities and places of employment are located at the centre of the city (Irvine, 2021). This further emphasises the inequalities that are rooted in the current spatial planning practices of housing and amenities, and the issues of accessibility (Irvine, 2021).

3.5. Governance in Makhanda

The Makana Municipality is a local municipality which governs the city of Makhanda and surrounding areas in the Eastern Cape. The Makana Municipality shows dysfunctionality in its planning and governance, and has allowed the infrastructure of the city to worsen over the years to the point of which basic services cannot be supplied to its community (Hoefnagels *et al*., 2023).

One such issue that the Makana Municipality faced is its failure to successfully address the needs of the pedestrian community. The provision and maintenance of roads is the responsibility of the municipality, however, assessments have shown that primary transport routes are in need of sidewalks and walkways (Makana Local Municipality, 2019). Despite walking being one of the main modes of transportation in the city, there is a significant lack of suitable pedestrian infrastructure. Additionally, where sidewalks and walkways are present, they are more often than not in poor condition (Makana Local Municipality, 2019).

Residents of Makhanda have also expressed their views on the service delivery that the municipality offers, with many residents highlighting the issues of potholes and dysfunctional street lights (Mjekula, 2024). Residents have noted that they have never seen the municipality coming to their area for inspections, and feel that the government does not do anything for them (Mjekula, 2024).

This lack of responsiveness, reflects a broader inefficiency in the allocation of resources and the development of policies that truly serve the interests of the public (Memela *et al*., 2022; Dlongolo *et al*., 2024). This was further emphasised in 2023, when the Cooperative Governance and Traditional Affairs (COGTA) minister, Thandi Nkadimang, took back more than R21 million that had been reserved for infrastructure because the Makana Municipality failed to spend it (Dyongman, 2023).

3.6. Transport availability in Makhanda

Transport infrastructure was utilised, during apartheid, as a physical barrier to spatially segregate various racial communities (van Heerden, 2018). Infrastructure for transportation in South Africa was created to restrict connectivity rather than to increase it. However, transport policies in the post-apartheid era aimed at connecting and integrating cities (van Heerden, 2018). The Spatial Planning and Land Use Management Act (SPLUMA) of 2013, which places a strong importance on the concepts of spatial justice, sustainability and resilience, regulates urban planning in South Africa (Republic of South Africa, 2013). Each level of government, including local authorities, are required under SPLUMA, to create Spatial Development Frameworks (SDFs) as part of their Integrated Development Plans (IDPs). This involves both the municipality and the community in planning strategies that find the best solutions towards sustainable development (Republic of South Africa, 2013). There are ten guiding principles that formulate SPLUMA. The aim of these principles resides in spatial justice, spatial sustainability, efficiency, spatial resilience, and lastly, good administration. With this being said, SPLUMA was created to resolve the fragmented and unequal planning systems that were a cause of apartheid. The aim is to do this by spatial transformation, and by social and economic inclusion (Republic of South Africa, 2013). This will allow for equal access, by all populations, to the services, amenities and opportunities that organised, functioning areas offer. This is further emphasised by involving different levels of government and stakeholders in the planning processes that address sustainable spatial development patterns. This is directly linked to walkability and walking practices because the built environment in which a pedestrian walks, is as a consequence of spatial planning. Therefore, it is important to enforce adequate and appropriate planning strategies at the beginning to ensure a safe, comfortable and accessible walking environment.

The National Spatial Development and Transformation Framework (NSDF) strives to develop urban regions that support change, innovation and multi-dimensional economic development (Department of Rural Development and Land Reform, 2018). The NSDF aims to reach these goals through densification, diversification and quality public place-making, as well as through the provision and use of effective public transport and non-motorised bicycle lanes and walkways (Department of Rural Development and Land

Reform, 2018). Furthermore, the NSDF states that the three levels of government (national, provincial and local) should be involved in the planning processes. This is to ensure that plans are co-ordinated and consistent (Department of Rural Development and Land Reform, 2018). In terms of transport and communications infrastructure networks, the NSDF has four aims. The first being, an investment in maintaining, strengthening and expanding connectivity (Department of Rural Development and Land Reform, 2018). This is to ensure the development of a strong transport and communications network between urban and rural areas. The second being, an increase in people-focused infrastructure (Department of Rural Development and Land Reform, 2018). This looks at upgrading the existing infrastructure to cater for the increase in population densities and intensities, developing infrastructure networks in former neglected areas, and developing quality public spaces, pedestrian walkways and efficient, cost-effective and safe public transport systems (Department of Rural Development and Land Reform, 2018). The third being, an upgrade of the existing municipal service infrastructure. The fourth being, an increase in the investments of infrastructure needed for renewable energy practices, agriculture, tourism and entertainment focused economic growth, and lastly, innovation and knowledge-creation (Department of Rural Development and Land Reform, 2018). The NSDF looks to implement these aims into non-motorised transportation planning by the year 2050. The aim is to emphasis and prioritise urban areas that are dominant users of walking practices, as well users of public transport and cycling.

The National Department of Transport (DOT) are in charge meeting citizen mobility, and in order to address the issues of walkability, the DOT has developed the NMTP. The recommendations put forth by the NMTP offer standards for promoting public areas that encourage the already existing act of walking (Department of Transport, 2014). The National government sets the policy, legislation and guidelines that the provincial and local governments follow. However, the provincial and local governments have more say in the implementation of the NMT policy (Department of Transport, 2014). The provincial NMT policy focuses on providing direction for NMT initiative planning. The policy outlines each phase of the planning process, from stakeholder identification to NMT infrastructure maintenance (Department of Transport, 2014). The policy outlines the guiding principles that NMT projects should aim to reach. These principles include, designing facilities appropriately, integrating transportation, ensuring safety, enhancing accessibility, sustainability, and promoting the development of NMT infrastructure through institutional change (Department of Transport, 2014). A study done by Labuschagne and Ribbens (2014) highlight the importance of integrating NMT into transport planning initiatives. The authors suggest that there is an increasing need to provide well-designed NMT systems from communities to other existing public transportation systems (Labuschagne & Ribbens, 2014). Additionally, NMT infrastructure should be provided in instances where NMT is the main mode of transport. The authors concluded by emphasising the importance of inclusiveness in the implementation, monitoring, and evaluation processes of such initiatives (Labuschagne & Ribbens, 2014).

A large number of Makhanda's residents travel by foot. This is because Makhanda has no formal public transport systems, instead the privately-owned minibus taxis are considered to be public transportation systems (Memela *et al*., 2022). These are usually standard motor vehicles that accommodate three to four people. It is

important to note that these privately-owned minibus taxis are under the taxi association. With this being said, as of 2023, a one-way trip in Makhanda costs R15 (Memela *et al*., 2022). However, these taxis only cover the Makhanda East area and do not serve the Makhanda West area which is not ideal as majority of the student population resides in Makhanda West (Rhodes University Digest of Statistics, 2022). Makhanda does have privately-owned taxis that take residents around the city. These are usually standard motor vehicles that seat three to four people. However, these privately-owned taxi services can be costly with prices ranging from R30 and above per person, per trip. These taxi services are also different from e-hailing services (which are not available in Makhanda), like Uber, such that they do not use an app. Rather, residents have to call the taxi services to get transportation. With this being said, residents who cannot afford a privately-owned vehicle or a privately-owned taxi rely on walking or on the minibus taxis (Memela *et al*., 2022). The municipality continues to support vehicle-based modes of transportation. This is despite the fact that majority of the residents in Makhanda walk, as well as there being limited access to public transport (Memela *et al*., 2022). This further brings about the need to assess whether or not the walkability of the city adheres to the needs of its population and will, additionally, give direction for planning strategies. It is important to note whether walking routes around the four study areas are conducive, safe and comfortable for the walking population.

3.7. Rhodes University and its students

The purpose of this study is to survey and spatially analyse walkability and walking patterns in the student community of Makhanda. This study places a specific focus on students who reside on the Rhodes University campus, Central, Sunnyside, and Westhill (the areas on the campus periphery). These specific areas were chosen because, in terms of student residents, these are the most densely populated residential areas in the city, but are also the epicentre of student activity. Figure 3.7.1 shows the four study areas within Makhanda West.

Since the focus of this study is on the student population, it is important to understand and discuss the socio-economic characteristics of students at Rhodes University.

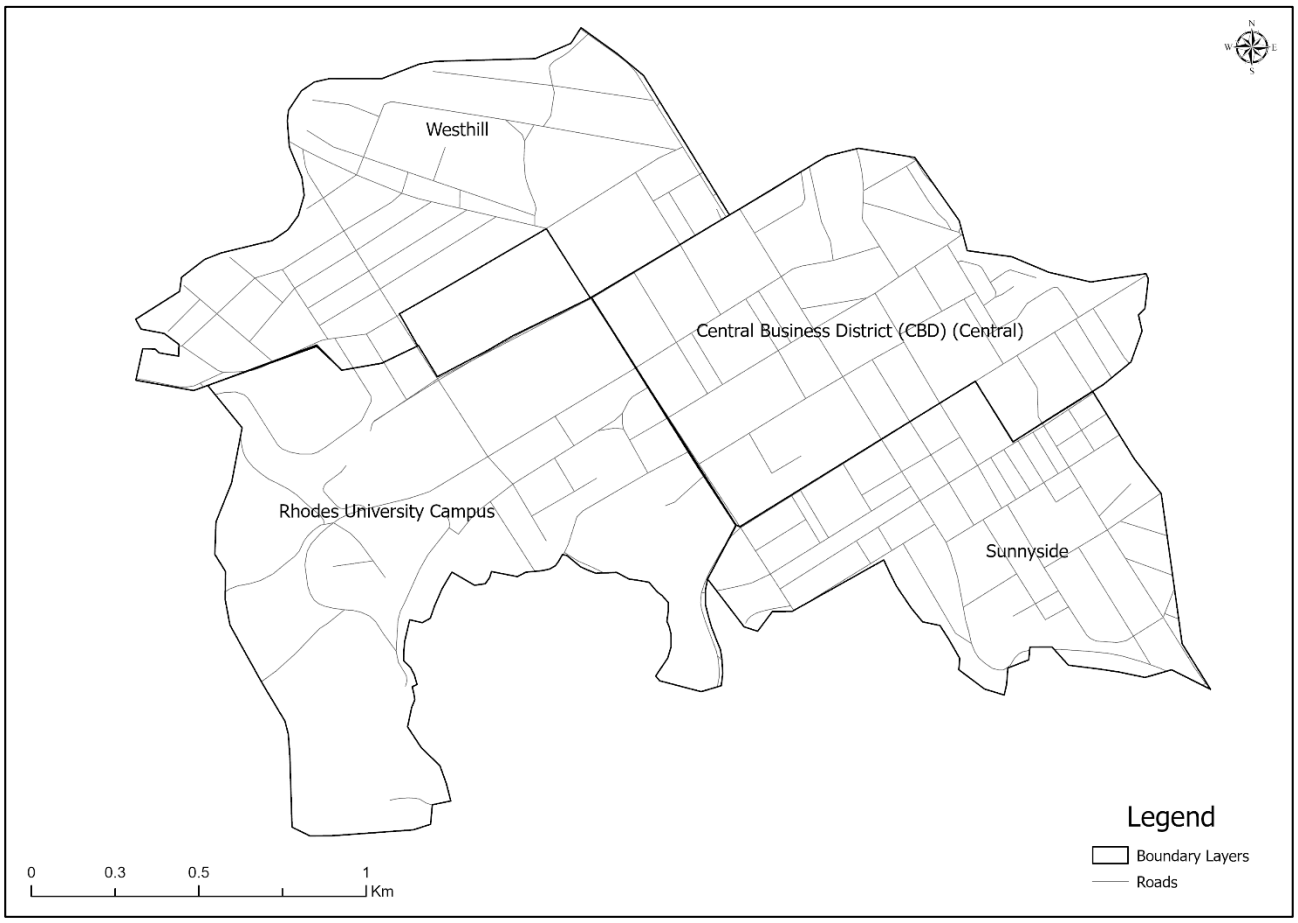

Figure 3.7.1. *The four study areas located within Makhanda West that this research will focus on.*

Rhodes University consists of 35 different academic departments with six faculties, and is located within the western part of Makhanda, alongside the western boundary of Central. In 2024, there was a total of 8 410 registered students at Rhodes University. Of these students, 6 064 were undergraduate students and 2 346 were postgraduate students (Rhodes University, 2024).

The average tuition fees for 2023 was R57 707 (Rhodes University Digest of Statistics, 2023). This is an increase per annum of 5%. With this being said, the average residence fees for 2023 was R80 445 (Rhodes University Digest of Statistics, 2023). The National Student Financial Aid Scheme (NSFAS) is a government agency that provides financial aid to South African students from low-income families (Jadhav, 2024). In 2024, just under half of the registered students at Rhodes University received funding from NSFAS, and over half of these students relied on NSFAS to pay for their student accommodation (Jadhav, 2024). The living allowance for NSFAS students is R16 500 per year which is R1 375 per month (Jadhav, 2024).

As mentioned above, students who receive NSFAS funding come from low-income households. This means that these students are more likely to face financial constraints, which include limited access to private vehicles and even public transport (which can prove to be expensive in the long run). Additionally, with a living

allowance of R1 375 per month, students have a limited budget. Therefore, walking is a more affordable and viable mode of transport for students.

Many NSFAS students live in either on- or off-campus residences. The off-campus residences are required to be within set walking distances of the university (Campus Africa, 2022). With this being said, this study is important because it aims to assess whether or not the walking infrastructure is conducive, safe and comfortable for the pedestrian population. Students should be able to walk to and from campus, and the surrounding areas while feeling safe and comfortable.

Rhodes University is a residential university. The total number of students in residence for the year 2023 was 3 845, which is 45.72% of total students (Rhodes University Digest of Statistics, 2024). The university tries to offer as many first-year students a place in residences as they can, however, it has become increasingly difficult as returning students are starting to stay longer in residence (Rhodes University Digest of Statistics, 2013). To combat this and to accommodate the increasing number of students attending the university, a number of new residences have been built. This has consequently increased the percentage of first years in residences (Rhodes University Digest of Statistics, 2013). Apart from this, it is also difficult for families to meet the financial requirement of being housed in a residence system (Rhodes University Digest of Statistics, 2013). There are a number of off-campus accommodation available for students who, do not want to or cannot afford to, stay in residence.

Before this growth within the university, architects spent time planning how they envisioned the university to look. From the period between 1904-2016, student enrolments had doubled, and this paved the way for infrastructural expansions within the university (Maylam, 2018). Rhodes University had commissioned an architect and town planner in 1975 to create a framework for the spatial development of the university. The aim was to create a more pedestrian-friendly campus, while simultaneously, planning for the increased number of cars (Maylam, 2018). While plans, such as creating quads, turning spaces into parking lots, and construction of new buildings were proposed, many of the recommended plans were not implemented. Once such example is the construction of two buildings on the Drostdy lawn in front of the main administration building (Maylam, 2018). As of 2024, the university has a lot of green spaces that students can use as a place of socialisation or relaxation.

With the expansion of academic buildings on campus, there were also plans to expand the residential accommodation for students. The availability of off-campus accommodation in town proved to be insufficient, given the increasing student enrolments and the increasing demand for accommodation (Maylam, 2018). Within 1904-2016, eight additional student residences came into operation (Maylam, 2018). These expansions also meant that the university is not as compact as it used to be. It has expanded from being a small liberal arts college to being a university campus with much larger academic and residential facilities, green spaces, and specialised buildings (Maylam, 2018). It has changed into a larger, more diverse university that catered to the changing needs of its academic community.

Today, the university has put plans forward to create a more walkable and safe space for students. The Blue Route on campus expands the entirety of Prince Alfred Street and is part of an initiative to enhance campus walkability and accessibility, particularly within a growing campus. The Blue Route is designed within safety as its main priority and is well-lit and has visible security patrolling throughout the day. Figure 3.7.2 shows the before (a) and after (b) of the construction of a paved pathway on campus. The pathway (a desire path) was created by students over years of walking, as a shorter way to get to the Drostdy Arch from Artillery Road and vice versa. The university decided to make it a more formal pathway by paving it. Additionally, the university has also installed solar and high mast lighting around campus. These lights are connected to generators allowing for lighting to still be present during power outages and/or loadshedding. It shows that the university is prioritising walkability on campus and aims to create a more safe and comfortable space for students. It should also be noted that both these upgrades in walking infrastructure was done after data collection and analysis.

Figure 3.7.2.a. *Before the paved pathway (desire path) was constructed*

Figure 3.7.2.b. *After the paved pathway (desire path) was constructed*

3.8. Conclusion

This chapter presented the study area that this research focuses on. This chapter commenced with a discussion of the research location. The city is divided into two areas, Makhanda East and Makhanda West. These areas are characterised by its socio-economic differences where Makhanda West is more developed than Makhanda East. Following this, the physical geography aspects of Makhanda were discussed. Makhanda is characterised by a subtropical climate, with warm summers and cool winters. This seasonal variation, along with hourly temperature fluctuations, influence the comfort and safety of the pedestrian community. Third, the built environment aspects of the study area were explored. Makhanda West hosts better walkability infrastructure, such as paved walkways and functional street lighting, compared to Makhanda East, which faces issues of urban sprawl, lack of infrastructure, and poor service delivery. Fourth, the governance and availability of transport was investigated. Despite walking being a primary mode of transport for residents within Makhanda, the walking infrastructure often falls short in providing safe and accessible walking routes. Furthermore, there is a clear lack of reliable formal public transport options, which exacerbates the reliance on walking, especially

for students and lower-income residents who cannot afford private transport. Lastly, the socio-economic characteristics were discussed. The university campus has made efforts to improve walkability on campus through initiatives such as the Blue Route, which aims to enhance safety and accessibility. These efforts reflect a broader need to improve walkability across the city.

The socio-economic divide, inadequate infrastructure, and lack of cohesive planning in Makhanda present challenges for walkability. However, the focus on the student population and the recent improvements in campus infrastructure show a growing recognition of the importance of walkability. Further attention to pedestrian-friendly designs, better governance, and addressing the needs of the population is important for creating a more safe, comfortable and accessible walking environment.

Chapter 4: Methodology

4.1. Introduction

The previous chapter highlighted the study area and the socio-economic and environmental aspects pertaining to walkability in Makhanda. This chapter will present the methodology that was used to inform this study. This chapter will, commence with a discussion of the research onion. Following this, the walkability indexes that were used in this study will be explored. Afterwards, the methods used to inform the spatial analyse, semi-structured interview schedules, and participatory mapping exercise will be discussed. This chapter will conclude with a summation of the methods used in this study.

4.2. Research Onion

The research onion was created by Saunders *et al*. (2007) and it shows the different stages that should be covered and addressed when developing a research methodology that is effective. This research onion is adaptable and can be applied to most types of research methodologies (Bryman, 2012). Figure 4.2.1 shows the research onion that has informed the methodology of this study.

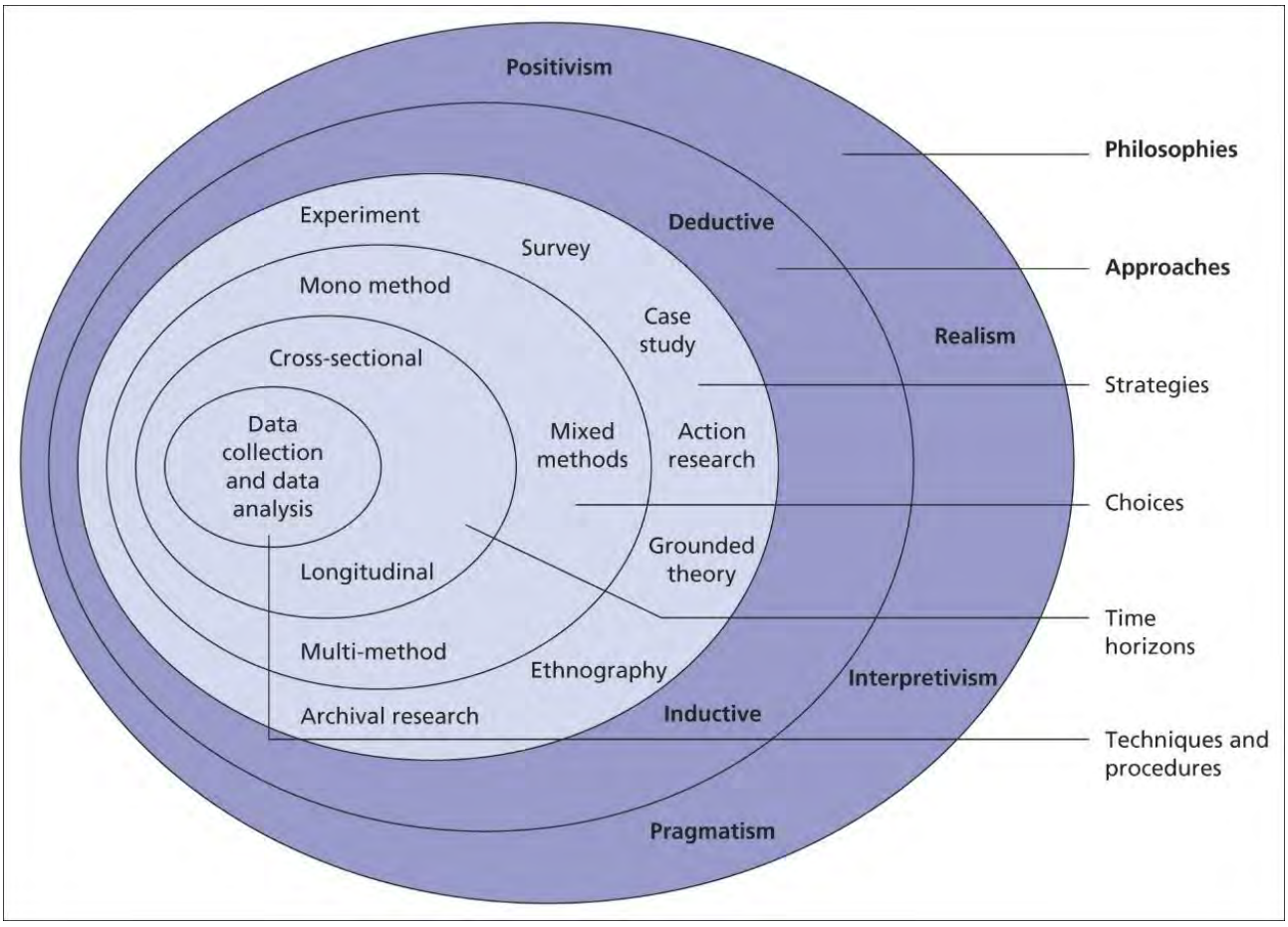

Figure 4.2.1. *The Research Onion. Adapted from Saunders* et al. *(2007).*

The first outer most layer looks at the research philosophy. A research philosophy refers to the set of belief systems that revolves around the nature of the reality that is been investigated and/or assessed (Bryman, 2012). The assumptions that are created and established by a research philosophy provides the justification for how the research will be undertaken (Flick, 2011). Additionally, the methodology should be characterised and informed by the nature of the phenomena being observed. There are two types of philosophical approaches used in this study. The first philosophy is positivism, which suggests that knowledge is primarily derived from empirical evidence and observation. It emphasizes the importance of scientific methods and establishes a basis for knowledge that is grounded in experience and experimentation. This study is based on positivism because it looked at observing the built environment and the existing infrastructure pertaining to walkability within the four study areas. It aimed at understanding what infrastructure exists, where it exists, and how its abundance or scarcity affected the walking population. The second philosophy is interpretivism, which puts an emphasis on understanding the meanings and experiences that individuals assign to the social world. This study is based on interpretivism because it looked at the walking perceptions and experiences of individuals. These perceptions and experiences are unique and subjective to each individual.

The second layer looks at the research approaches. The research onion refers to two types of research approaches. These include, deductive reasoning and inductive reasoning. The deductive approach refers to when the hypothesis is based upon an already existing theory that then forms the basis of the current research project which tests the pre-existing theory (Silverman, 2021). The inductive approach is when observations form the starting point of the research project, in which patterns or trends are then looked for in the data (Beiske, 2007). This study has taken a deductive reasoning approach where conclusions about walkability were made based on existing theories that are applied to the place- and context-specific areas of the four study areas being looked at.

The third layer looks at the research strategies. The research strategy refers to how the researcher aims to carry out the research (Saunders *et al*., 2007). There are two types of strategies used in this study. The first strategy is an action research strategy where action and research are combined to solve real-world problems. This study looked at involving urban planners to improve walkability within the four study areas, based on feedback from participants, as well as from observational data collected. The second strategy is an archival research strategy where secondary data sources are used to inform the study.

The fourth layer looks at the research choices. The research onion refers to three different research choices. These include, the mono-method, the mixed-methods, and the multi-methods. The mono-method refers to the use of one research approach in the study (Saunders *et al*., 2007). The mixed-methods refers to the use of two or more research approaches in the study (Saunders *et al*., 2007). The multi-methods refers to the use of a wider selection of research approaches in the study (Bryman, 2012). The main difference between mixed-methods and multi-methods is that the mixed-methods involves a combined methodology where the outcome is a single dataset (Flick, 2011). On the other hand, the multi-methods involve separate segments of the research. Each segment produces a dataset that is then analysed and discussed (Flick, 2011). This study used a multi-methods approach. Different datasets were created to analyse different walkability factors, however,

at the end of the study, a single dataset showing which areas are more walkable versus less walkable, was created. This study used different methods of measuring walkability and walking patterns. This includes, a survey and spatial analysis, semi-structured interviews, and participatory mapping.

The fifth layer is the time horizons. This refers to the frame of time that the research project is intended for completion (Saunders *et al*., 2007). The cross-sectional time horizon refers to an already established timeline, in which the data should be collected (Flick, 2011). A longitudinal time horizon refers to the collection of data on a repeated basis over an extended period of time (Saunders *et al*., 2007). This study adopted a cross-sectional time horizon framework.

The sixth inner most layer looks at the research techniques and procedures. The methodology used in the data collection and data analysis processes directly contribute to the reliability and validity of the research project (Saunders *et al*., 2007). Data can be collected from primary and/or secondary sources and analysed using qualitative and/or quantitative methods (Saunders *et al*., 2007). This study used both primary and secondary data and this data was analysed using both qualitative and quantitative methods.

There are two types of methodological approaches that are aligned with this study. The first, and main, methodology is behaviourism (Kitchin & Tate, 2013). Behaviourism acknowledges that human action is determined through thought and processing of information (Kitchin & Tate, 2013). It aims to explain and understand the decision-making processes of people (Kitchin & Tate, 2013). Furthermore, behavioural geography attempts to understand and explain human actions in space and place by looking at it on an individual level (Montello, 2018). It suggests that humans perform certain actions because of what they believe in (Montello, 2018). This methodology can be linked to this study because this study aimed at understanding the thought and decision-making processes that lead individuals to walk and their choice of route to take. The second methodology is phenomenology (Kitchin & Tate, 2013). Phenomenology refers to the acknowledgement of actions taken by individuals (Kitchin & Tate, 2013). It focuses on understanding individuals, their actions and the meaning of their decisions based on the environment they are surrounded by (Kitchin & Tate, 2013). Phenomenology as a methodological approach is, to some extent, unavoidable because this study looked at the current built environment. These factors are important because it is linked to walking perceptions and experiences of individuals. With this being said, this methodology can be linked to this study because this study aimed to investigate and access the built environment of the four study areas and, consequently, how that affects the walkability and walking practices of individuals within the student community. Like behaviourism, it looks at understanding why individuals take the routes that they take and the factors that influence them to take those specific routes as compared to other routes.

4.3. Methodology matrix

According to Arellana *et al*. (2020), there are four distinct factors of walkability that characterise a walkable city. The first factor is sidewalk condition which refers to the urban structure conditions and the patterns and characteristics of the present activities (Arellana *et al*., 2020). Sidewalk condition looks the length of that the

sidewalk runs until it ends, the width of the sidewalk, the quality and condition of the sidewalk, the slope and the angle of the sidewalk, and the number of vehicles present on the sidewalk. In South Africa, the proposed and accepted minimum sidewalk width is 1.8 m, with the ideal sidewalk width being 3 m (Vanderschuren *et al*., 2014). Additionally, an important factor of a good sidewalk is the avoidance of gaps or changes in elevation (Fransolet *et al*., 2016). This is because sudden changes in the elevation of a sidewalk can cause difficulties for pedestrians, especially for pedestrians with disabilities. Due to this, is has been recommended that sidewalks should not change in elevation by more than 10 mm over a distance of 1 m (Vanderschuren *et al*., 2014). The second factor is the traffic, safety and security which refers to the traffic safety, crime and the intensity of crime being committed (Arellana *et al*., 2020). Traffic safety can be measured by the amount and presence of road signals, speed controllers and other traffic control mechanisms, the number of lanes and crossing times, the flow of traffic, and the speed of the vehicles (Arellana *et al*., 2020). Security can be measured by lighting, crime levels on the roads, and the amount and presence of security cameras (Arellana *et al*., 2020). The third factor is the comfort level which refers to the ease and friendliness of the walking experience (Arellana *et al*., 2020). This includes the attractiveness of the buildings, the weather conditions, the cleanliness of the surrounding areas and of the sidewalks, and the amount and presence of trees and plant life (Arellana *et al*., 2020). These factors are subjective to individual walking experiences and contribute to the conduciveness of the walking experience. Another factor to consider when talking about the comfort level of walking, are the obstacles that may be present on the sidewalk that interfere with pedestrian walking journeys. Ideally, less conflict is key to the design on a walkable city (Vanderschuren *et al*., 2014). The fourth factor is the attractiveness which refers to the ability of the pedestrian to socialise and participant in activities while walking (Arellana *et al*., 2020). This includes accessibility to public transport and the development and presence of green spaces which promote attractiveness, as well as socialisation (Arellana *et al*., 2020). This study is to take these factors into consideration when conducting the walkability infrastructure analysis, along with the proposed walkability measures as defined in Table 2.

Table 1 is a summary of the methodology matrix that guided the data collection, data analysis, data interpretation, and data presentation of this study. This table will be referred to in each methodology discussion. It includes the research objectives proposed in Chapter 1.3.

Table 1. *Summary of the methodology used in this study.*

	Data analysis	**Data interpretation**	**Data presentation**
Objective 1	Survey and spatial analysis	Quantitative and qualitative	Maps, tables and discussions
Objective 2	Student and key informant interviews	Quantitative and qualitative	Maps, tables and discussions
Objective 3	Participatory mapping	Quantitative and qualitative	Maps, tables and discussions

4.4. NEWS and Walkability Indexes

As can be seen in Table 1, in order to fulfil the aim of Objective 1, a survey and spatial analysis of the Rhodes University campus, Central, Sunnyside, and Westhill was done. A walkability index is a tool that is used to collect data for assessing and analysing the walkability and walking patterns in an area. The tool consists of numerous different walkability variables and is adaptable to the area being investigated. This analysis was done so that an assessment could be made as to whether the existing infrastructure within the four study areas were sufficient enough to ensure a conducive, safe and comfortable walking experience. Previous authors have looked at walkability variables within the scope of pedestrian infrastructure, neighbourhood features, connectivity, safety and security, and green spaces. Within pedestrian infrastructure, previous studies (van der Walt, 2020; Wasswa, 2016; Van Der Pas, 2015) have looked at the sidewalk quality and condition in regards to width, surface material and continuity, pedestrian crossings in regards to the availability and safety of marking crossings and traffic signals, and traffic safety features in regards to presence of lighting, visibility at intersections, and traffic calming measures. Within neighbourhood features, previous studies (Harun *et* al., 2020; Abeysinghe *et al*., 2023; Ford, 2013) have looked at access to amenities in regards to proximity to essential services and recreational areas, and land-use mix. Within connectivity, previous studies (Malambo *et al*., 2016; van Heerden, 2018; Leslie *et al*., 2005; Oyeyemi *et al*., 2013) have looked at street connectivity in regards to density of intersections, directness of routes, and accessibility to public transport, and walking routes in regards to the quality and connectivity of paths leading to public transport stops and key destinations. Within safety and security, previous studies (Memon *et al*., 2020; Rundle *et al*., 2019) have looked at perceived safety in regards to safety from traffic and crime, and environmental quality in regards to noise levels, air quality, and overall safety of the walking environment. Within green spaces, previous studies (Wayas *et al*., 2023; Malambo *et al*., 2017; Ramakreshnan *et al*., 2020; Makki *et al*., 2012) have looked at public green spaces in regards to the accessibility and quality of parks and recreational facilities that contribute to livability and walkability.

Table 2 shows the types of walkability variables that were used in this study. They consist of five categories which include, diversity of amenities, sidewalk conditions, pedestrian safety and security, sidewalk connectivity, and comfort levels.

These walkability variables have been chosen based on studies that have been adapted in the Global North and the Global South, as well as in South Africa. They have been adapted to suit the place- and context-specific study area in Makhanda. While cities in the Global North have different walkability conditions as compared to cities in the Global South, the walkability factors used to assess the built environment are consist throughout previous walkability studies both in the Global North, Global South, and in a Southern African context. Hence, this study has used similar walkability variables as those in previous South African walkability studies (Wayas *et al*., 2023; Isiagi *et al*., 2019; Malambo *et al*., 2017; Kruger, 2022; Van Der Pas *et al*., 2015).

This study is looking at the built environment within the four study areas, as well as the perceived walking perceptions pertaining to the existing walking infrastructure. Additionally, it should be noted that this study had adapted a sidewalk connectivity analysis approach as opposed to a street connectivity analysis approach

as used by previous studies. The presence of sidewalks adds to a space being more walkable and pedestrians should have access to a sidewalk. Thus, this study placed an importance on the sidewalk network as opposed to a street network. With this being said, the walkability variables chosen for this study links with the objectives of the study.

Table 2. *The walkability variables that are to be used to inform this study. Adapted from Maghelal and Capp (2011).*

Category	**Walkability variables**
Diversity of Amenities	
Sidewalk Conditions	• Sidewalk presence • Sidewalk width • Continuity and coverage • Sidewalk condition • Slope • Encroachment
Pedestrian Safety and Security	• Traffic calming measures • Visibility of markings • Traffic volume • Lighting • Security personnel • CCTV surveillance cameras • Pedestrian visibility • Bushes/vacant land • Hazards • General activity levels • Crimes and intensity of crime
Comfort Levels	• Attractiveness • Cleanliness • Odor • Noise • Dumping • Litter • General maintenance • Trees • Benches
Sidewalk Connectivity	

This study looked to create a walkability index, based on the five categories used, to conclude which of the four study areas are more versus less walkable. A rating system framework was developed based on previous studies (Telega, 2021, Leslie *et al*., 2007). This study has chosen to rate each walkability variable on a scale of 0-10, with 0-3 being poor, 4-6 being sufficient, and 7-10 being good. Table 3 shows what each category looks at in terms of poor, sufficient and good.

Table 3. *The proposed walkability index rating system framework used in this study.*

Category	Poor (0-3)	Sufficient (4-6)	Good (7-10)
Diversity of Amenities	Very few amenities, mostly residential	Some amenities, but not varied	A wide range of amenities within walking distance
Sidewalk Conditions	Broken, narrow, non-existent sidewalks	Moderate sidewalks, uneven with some maintenance issues	Well-maintained, wide and continuous sidewalks
Pedestrian Safety and Security	High traffic speeds, few traffic calming measures, high crime rates	Moderate traffic speeds, some traffic calming measures, moderate crime rates	Low traffic speeds, ample traffic calming measures, low crimes rates
Comfort Levels	Unpleasant environment, noise, pollution, lack of shade	Fairly comfortable but lacks some amenities such as green spaces	Inviting environment with seating, shade, greenery
Sidewalk Connectivity	Isolated sidewalks with many dead ends	Some connections but still a few barriers	Highly interconnected sidewalks with direct routes

Once each walkability variable was rated and given a score of 0 to 10, weights were assigned to each variable based on the student perceptions of walkability. Different variables were ranked as being more important than others and based on their importance, an assigned weight was given to them. This, in turn, changed the overall score for each variable. After the assigned weights were been given to each variable and the total score was summed up, the scores were normalised to create a final index score. This final score was expressed as a percentage. In order to normalise the scores, the formula below was used. This formula is a generalised mathematical formula for normalising datasets, however, variations of this formulas were used by previous authors (Moura *et al*., 2017; Stefanidis and Bartzokas-Tsiompras, 2022).

$$Normalised\ score = \left(\frac{Raw\ score}{Maximum\ possible\ score}\right) \times 100$$

A table was then created to show the output of the assigned weight (in percentages) for each walkability factor based on their importance as defined by student perceptions. The percentages given to each walkability factor is subjective and based on data from the likert scale students were asked to fill in during the student interviews.

4.5. Geographic Information Systems

4.5.1. Diversity analysis

A general diversity analysis was done for this study within the four study areas. The map was created using Google Earth Pro and ArcGIS Pro. The location of each of the amenities was found using a satellite image in Google Earth Pro. Once the location of the amenities was found, a map layout was created in ArcGIS Pro. A point was created for each of the amenities and the symbology was changed according to the type of amenity it is. Additionally, a kernel density map showing the general diversity of amenities was created and clipped to the study area. The data has been interpreted using both qualitative and quantitative data interpretation methods. Furthermore, the outcome of this analysis has been presented as a map as well as in the form of a discussion.

A student station diversity analysis was done for this study. It represents the diversity of amenities within the four study areas that were visited by the 60 students interviewed in the student interviews. These amenities are based on the places that the interviewed students go to throughout their walking journey. Additionally, a kernel density map showing the student station diversity of amenities was created and clipped to the study area. The map was created using the same techniques used above for the diversity analysis map. The data has been interpreted using both qualitative and quantitative data interpretation methods. Furthermore, the outcome of this analysis has been presented as a map as well as in the form of a discussion.

4.5.2. Sidewalk condition, pedestrian safety and security, and comfort levels

Data was collected using an observational survey of each of the roads (a total of 109 roads) in the four study areas. The observational survey can be seen in Appendix A. The roads were visited and notes and pictures were taken in regards to the existing walkability infrastructure pertaining to sidewalk condition, pedestrian safety and security, and comfort levels. Notes on the existing infrastructure were taken using Survey123 while the pictures were taken using a phone camera. Furthermore, GPS points of speed humps and pedestrian crossings were taken using Survey123, in order to analyse the traffic calming measures within the four study areas. In order to assess whether the sidewalk widths follow the recommended guidelines, a measurement wheel was used to measure the sidewalk widths.

A total of 10 maps, 17 graphs, and 6 collages were created to fulfil this objective. The data was exported as an Excel file from Survey123 and cleaned in Excel while the maps were created using ArcGIS Pro. The first step in creating the following maps was to digitise each of the observed roads by creating a new line feature class in ArcGIS Pro. A line was then created for each of the roads. However, the traffic calming measures map is an exception because points were used instead of lines. Once this was done, and depending on the categories for each of the walkability variables, a symbology and colour scheme was created for each map that clustered each road into the relevant categories. For the sidewalk presence data, a brown, yellow and orange colour scheme was used. For data that showed good, fair and poor categories, a green, red and blue colour scheme was used. For data that showed whether a variable was present or not (either yes or no in the case of evenness,

overgrown vegetation, encroachment, and hazards), an orange and blue colour scheme was used. For the slope data, an orange, green and brown colour scheme was used. For data that showed high, medium and low categories, a red, peach and blue colour scheme was used.

Maps were made for both sidewalk conditions and pedestrian safety and security. In terms of sidewalk conditions, 6 maps were made. These maps include, sidewalk presence, continuity and coverage, sidewalk condition (evenness), sidewalk condition (overgrown vegetation), slope, and encroachment. In terms of pedestrian safety and security, 4 maps were created. These maps include, traffic calming measures, visibility of pedestrian crossings, traffic volume, and lighting.

Graphs were made for both sidewalk conditions, and pedestrian safety and security. In terms of sidewalk conditions, 2 graphs were made. The first graph shows the sidewalk width and the second graph shows the verge width. In terms of pedestrian safety and security, 4 graphs were made. The graphs showed crime and the intensities of crime being committed. The data was provided by the South African Police Services (SAPS) in Makhanda and showed crime data for the year 2022. The first step was to sort through the data and take out the irrelevant information. For this study, the relevant information included the day of the week and the time that the crime occurred, as well as in which area it occurred in. Once this data was sorted through, three bar graphs and one line graph were created. The first bar graph shows the frequency of crime occurrences during the week. The second bar graph shows the frequency of crime occurrences in the four different study areas. The third bar graph shows the frequency of crime occurrences during each month. The line graph shows the frequency of crime occurrences during each hour.

Collages were made for sidewalk conditions, pedestrian safety and security, and comfort levels. The images taken were put together in PowerPoint. In terms of sidewalk conditions, 2 collages were made. These included, sidewalk condition and encroachment. In terms of pedestrian safety and security, 3 collages were made. These included, visibility of markings, pedestrian visibility and bushes/vacant land, and hazards. In term of comfort levels, 2 collages were made. These include, attractiveness and cleanliness.

It should be noted that not all of the walkability variables were presented visually by a map, graph and/or collage. This was because it proved to be better represented solely as a discussion, as the use of a visual aid would have added no value to the discussion. The data has been interpreted using qualitative data interpretation methods. Furthermore, the outcome of this analysis has been presented in the form of maps, collages showcasing images of the different walkability variables, and a discussion.

4.5.3 Sidewalk connectivity analysis

A sidewalk connectivity analysis was done for this study within the four study areas. The points of intersection are represented by the blue dots. The map was created using ArcGIS Pro. The sidewalk presence data layer that was created when analysing the built environment features was used for this analysis. Once this was done, points were created on the line intersection. The unsplit lines tool was used on the line layer to merge the endpoints so that they do not count as intersections. The input feature was the sidewalk presence layer. Once

this was done, an unsplit line layer was created. The next step was to use the unsplit line layer as the input feature for the intersect tool with the output type being a point. Once the tool was run, the output feature created points for every intersection in the sidewalk network. Additionally, a kernel density map showing the sidewalk connectivity was created and clipped to the study area. The data has been interpreted using both qualitative and quantitative data interpretation methods. Furthermore, the outcome of this analysis has been presented as a map as well as in the form of a discussion.

4.6. Sampling methods

The sample size and population are the number of respondents taking part in the study, which have been sampled to try and answer questions (Bryman, 2012). This study adopted two sampling methods and had a sample size and population of two groups. These included, students and key informants (who will be identified later in this section).

Non-probability sampling methods are when participants are sampled based on their judgment rather than being randomly selected (Bryman, 2012). This sampling method was used because this study aimed to interview people who: a. are registered students, b. walk as their primary mode of transport and c. resides in one of the four study areas. Furthermore, a snowball sampling method was used to find more students who fall within the above conditions. Snowball sampling is a non-probability sampling method that involves asking participants to recommend other potential participants (Bryman, 2012).

The sample size consisted of a minimum of 60 students with 20 each students each that reside within Rhodes University campus and Central, and 10 students each that reside within Sunnyside and Westhill. Of the 60 student interviews, 42 (70%) were female respondents, 16 (26.7%) were male respondents, and 2 (3.3%) were non-binary respondents. Furthermore, 51 (85%) were black respondents, 7 (11.7%) were white respondents, 0 (0%) were Indian respondents, and 2 (3.3%) were coloured respondents.

The key informants were selected purposively because on their experience and expertise, and the understanding of walkability and walking patterns that they can provide to the study. Four out of the original six key informants were interviewed. They were identified from Rhodes University which includes the Infrastructure and Operations Division and Campus Protection Unit (CPU), SAPS, local security companies which include Hi-Tec and Smhart, and the Makana Local Municipality Planning Department.

4.7. Semi-structured interviews

As can be seen in Table 1, in order to fulfil the aim of Objective 3, semi-structured interviews with students and key informants were done. The interview schedule for the students can be seen in Appendix B. The interview schedule for the key informants can be seen in Appendixes D, E, and F.

Students were interviewed using a semi-structured interview schedule with the aim of understanding their experiences and perceptions of walkability within the study area, as well as understanding their walking patterns and the decision-making process relating to their choice of trajectory. Using the semi-structured interview, insights into their main mode of transport and reasons for walking were gained. Additionally, students were able to give options based their opinions of which walkability factors they feel are important, and add or reduce walkability. Furthermore, an A3 Grahamstown map showing the road network of Makhanda was printed out and given to students. This was used to gain an understanding into which roads students feel are more versus less walkable and what walkability factors played a role in the routes they took. The students were also asked for recommendations on how to ensure these spaces become more walkable. Students were also asked to fill in a likert scale. A list of walkability variables were given and students were asked to rate their importance in their walking activity or choice of route.

For the purpose of this study, the term key informant is defined as the employees and/or representatives of the company and/or institution. Key informants were interviewed using a semi-structured interview schedule with the aim of understanding what measures already exist and have been put in place to ensure a safe, accessible and comfortable walking environment, as well as some of the existing challenges to walkability. Furthermore, the aim was to explore whether the opinions of the key informants aligned with the lived walking experiences of the students. Of the six key informants identified, the key informants that have been interviewed include, the Rhodes University CPU, the Makana Municipal Planner, Hi-Tec and Smhart. The Rhodes University Infrastructure and Operations Division and SAPS were not interviewed because of communication difficulties. Using the semi-structured interview, insights into important walkability factors and factors that add or reduce walkability were gained. Additionally, the key informants spoke about which areas and roads they feel are more walkable versus less walkable and the challenges faced in these areas.

4.7.1. Perceptions of walking

The data for this objective has been interpreted using both qualitative and quantitative data interpretation methods. Furthermore, the outcome of this analysis has been presented as a map, graphs, tables as well as in the form of a discussion. Data to analyse the perceptions of walkability was done by using a likert scale. Students were asked to give opinions based on their experiences in terms of which walkability factors they thought were important as well as which walkability factors they thought both added and reduced walkability. These walkability variables were rated from strongly disagree to strongly agree. The outputs of this data have been represented using four graphs. The first step was to sort through the data and extract the relevant information for each of the walkability factors and variables within those factors. The first graph shows a summary of the student rated walkability variables within the factors of sidewalk conditions, pedestrian safety and security, and comfort levels. The following three graphs show a more in-depth analyse of how students rated each of the walkability variables within the categories of sidewalk conditions, pedestrian safety and security, and comfort levels. A map showing the more versus less walkable roads as perceived by the students was done. The road data layer used in previous objectives was already created and digitised. For this objective,

the roads that students perceived as being more versus less walkable were selected and extracted. Once this was done, a symbology and colour scheme was created where green represented the more walkable roads and red represented the less walkable roads. A table was created to show the student recommendations on how to improve walkability. This data was sorted through and put into categories based on what students said during the interviews. The recommendations that were recurring and were brought up the most during the interviews by each student has been bolded. The key informant interviews were integrated into the presentation of the above results.

4.7.2. Ethical considerations

This study investigated human perceptions and experiences with the environment. This meant that ethical clearance was required in order to conduct the interviews. Ethical clearance was obtained from Rhodes University and the approved ethical clearance form can be seen in Appendix G. This study involved data collection on students and how they perceive space. Additionally, participants mapped out their daily walking journey throughout the week. This information is personal and sensitive, and participants may feel unsafe if this information was revealed. The informed consent forms for students (Appendix H) and key informants (Appendix I) were given to participants to sign before the interview began. The aim was to ensure that the participants understood the nature and purpose of the research, as well as what is to be expected from them.

4.8. Participatory mapping in time and space

As can be seen in Table 1, in order to fulfil the aim of Objective 2, an assessment of the student walking patterns and walksheds of the Rhodes University campus, Central, Sunnyside, and Westhill through participatory mapping methods was done. Previous walkability studies have suggested that participatory mapping is important in assessing the walking patterns of individuals (Roper *et al*., 2024; Aditya, 2010; Saadi *et al*., 2021; Fancello *et al*., 2020). This is in light of the relationship between walking trajectories and walking experiences. Participatory mapping is a process that visualises the relationship between people and space by using maps (Emmel, 2008). It is a valuable tool for capturing complex, localised perspectives on walkability and fosters engagement by involving community members directly in the data collection process. It helps raise awareness of walkability issues, which also gives residents a voice in urban planning and influencing positive changes (Emmel, 2008). Participatory mapping provides context-specific insights, by capturing local knowledge and specific challenges that vary widely between neighbourhoods and demographic groups. It emphasises that walkability is not only a physical infrastructure issue, but that it also relates to social dynamics (Emmel, 2008). By understanding the walking patterns and walksheds taken by individuals, urban planners and policymakers can begin to understand which roads are used more than others and focus on improving the built environment in those areas to create a more conducive, safe and comfortable walking environment for all pedestrians. With this being said, participatory mapping allows for visual representations of these walking patterns and walksheds, making is easier to understand these patterns and trends.

Data was collected during the student interviews. An A3 Grahamstown map showing the road network of Makhanda was printed out and given to students. Students then mapped out their daily individual trajectories for the week, from their stations to their non-home stations. The participatory mapping exercise schedule and map can be seen in Appendix C. This included, a typical weekday (Monday to Thursday), a typical Friday, a typical Saturday, and a typical Sunday. The reason Monday to Thursday, and Friday have been divided as separate days of the week is because students tend to have a different Friday afternoon schedule as compared to the rest of the week. This will affect the overall walking patterns and walkshed, and this study wants to take this into consideration. Once the daily individual trajectories for all 60 students were mapped out, they were then digitised using Google Earth Pro and ArcGIS Pro. A line was created for each trajectory for each day of the week, with different colours used for each of the four times. These lines were created in Google Earth Pro as it provided a more accurate road network. The dataset was then saved as a KML layer where it was exported onto ArcGIS Pro. The KML layer was then converted to a shapefile to allow the located, shape and attributes of the dataset to be stored correctly, and to be easily accessible in one location. A walkshed was then created using the line dataset for each of the four study areas. A polygon around the student trajectories was created using ArcGIS Pro where the symbology was changed to match the symbology used for the line dataset. These series of lines and polygons show the walking patterns and walksheds in time and space for each of the four study areas. A total of 8 maps were created with 4 showing student walking patterns and 4 showing student walksheds. The data has been interpreted using both qualitative and quantitative data interpretation methods. Furthermore, the outcome of this analysis has been presented as in the form of maps, as well as in the form of a discussion.

4.9. Desktop analysis

4.9.1. Walking distances from stations to main amenities

The distance from stations to non-home stations play an important role in walkability. The closer amenities are, the more likely people are to walk. A table was created to show the maximum and minimum walking distances from student stations in each study area to a central point. The central point used is the Rhodes University Drostdy Arch at the front of the university as this is seen at the entrance to the university. This central point was chosen as it is the university is the common amenity that all students go to. The walking distances were measured using the measuring tool in ArcGIS Pro, and was measured in kilometres. The maximum point included residents that were stationed at the furthest possible distance to the central point, for each study area. The minimum point included residents that were stationed at the closest possible distance to the central point. The data has been interpreted using both qualitative and quantitative data interpretation methods. Furthermore, the outcome of these analyses has been presented as in the form of a table, as well as in the form of a discussion.

4.9.2. Walking patterns in the intensity of routes used

Measuring the intensity of the routes used by students is an important factor to consider when measuring walkability because it shows which roads are being used more than other roads. This can inform policy makers, urban planners and the government in creating a more conducive, safe and comfortable space for the pedestrian community. An Excel Spreadsheet was created with all the roads used by the students. The roads were ten categorised to most versus least used. Once this was done, five categories of intensity were used to represent the routes used by students. The line dataset used for the participatory maps was used to create the intensity of routes used map. The categories included, 0-9 (least intensely used), 10-19, 20-29, 30-39, and 40-49 (most intensely used). The symbology was changed to suit the five categories. The range of colours go from cool (blue: lowest intensity) to hot (red: highest intensity). The student-based diversity of amenities kernel density map that was previously created was placed underneath the intensity of routes used map to offer a more in-depth analysis. A table was created to show the main roads that are the most intensely used by the students within each of the four study areas. This table was created to show which roads need improvement and should be prioritised when walkability infrastructure is upgraded. This data was created using an Excel Spreadsheet. The data has been interpreted using both qualitative and quantitative data interpretation methods. Furthermore, the outcome of these analyses has been presented as in the form of a table, as well as in the form of a discussion.

4.10. Conclusion

This chapter highlighted the methodology that has been used in this study. This chapter commenced with a discussion of the research onion. This study is based on positivism where it seeks to understand what walkability infrastructure exists, where it exists, and how its abundance or scarcity affects the walkability population. Additionally, this study adopts a deductive reasoning approach where conclusions about walkability are made based on existing theories that are applied to the place- and context-specific areas of the four study areas being looked at. There are two types of strategies used in this study. The first strategy is an action research strategy where action and research are combined to solve real-world problems. The second strategy is an archival research strategy where secondary data sources are used to inform the study. This study uses a multi-methods approach. Different datasets were created to analyse different walkability factors, however, at the end of the study, a single dataset showing which areas are more walkable versus less walkable, was created. Furthermore, this study adopted a cross-sectional time horizon framework. Lastly, this study takes both a behaviourism and phenomenology approach.

This study has three main objectives. Objective 1 looks to survey and spatially analyse the levels of walkability within the Rhodes University campus, Central, Sunnyside, and Westhill. This will be done by investigating the walkability using a WI through observation, as well as conducting a diversity and sidewalk connectivity analyse of the student walkability and walking patterns. The walkability factors chosen for this study include, sidewalk condition, pedestrian safety and security, comfort level, and attractiveness. These walkability factors offer a comprehensive foundation for measuring and spatially analysing walkability and walking patterns in Makhanda. Sidewalk conditions includes aspects relating to width, surface quality and connectivity, all of

which plays an important role in making walking routes conducive, safe and comfortable. Traffic safety and security is highlighted as especially significant in a Global South context, where security is often a critical concern. This factor is important in considering how visible security and functional street lighting can influence willingness to walk. Comfort level includes aspects relating to cleanliness, shade, benches, and the presence or absence of obstacles. These all play an important role in providing a comfortable walking experience. Attractiveness relates to how well urban spaces support social interaction and accessibility to green spaces, mixed land use practices, and public transport. These aspects are important in making walking more appealing to the community.

Objective 2 looks at investigating the student perceptions, walking patterns and walksheds within the four study areas. This will be done by conducting semi-structured student and key informant interviews. Participatory mapping is a valuable tool for capturing complex, localised perspectives on walkability. It provides context-specific insights, by capturing local knowledge and specific challenges that vary widely between neighbourhoods and demographic groups. By highlighting the context-specific needs and community preferences, urban planners and policymakers can prioritise infrastructure improvements that align with resident needs.

Objective 3 looks at investigating student walking patterns and walksheds in Makhanda through participatory mapping. This will be done through participatory mapping exercises with the interviewed students to show a time-space analyse of walking patterns. This study aims to combine Objective 1 and Objective 2 to measure walkability and give each of the four study areas a rating of how walkable it is, as well to identify issues that would need improving. The aim of Objective 3 is to further identify the issues, as well as to identify specific streets that need focus in planning. An analyse of walking patterns and walksheds offers insight into walking behaviours, needs, and challenges, all of which is important for urban planning and improving walking infrastructure. This will, in turn, help create a more conducive, safer and comfortable walking environment.

Having considered the methodology that has been used to inform this study, the following three chapters will focus on presenting the results. The next chapter will look at a survey and spatial analysis of the levels of walkability within the four study areas.

Chapter 5: Results - A Spatial Analysis of Walkability

5.1. Introduction

This chapter presents the results of Objective 1, which aims to survey and spatially analyse the levels of walkability within the Rhodes University campus, Central, Sunnyside, and Westhill. The chapter will, commence with a presentation of the diversity of amenities found within the four study areas. This is important to note in order to understand what types of amenities are located where, as well as which ones are of importance to the student community. Following this, the sidewalk conditions will be discussed. Third, pedestrian safety and security will be explored. Fourth, the comfort level pertaining to walkability will be discussed. A series of walkability variables for each of these three walkability factors will be shown with a summary of which areas are more versus less walkable for each of them. Lastly, the sidewalk connectivity within the four study areas will be presented. Students often take the shortest route to get to their destination. It is, therefore, important to note which routes pedestrians might prefer as it bypasses each other. This chapter will conclude with a summation of the key arguments presented in terms of the walkability measures discussed within the chapter. Additionally, a presentation of which areas are more versus less walkable will be summarised.

5.2. Diversity of amenities

A diversity of amenities is done in order to understand what types of amenities are located within the four study areas. Makhanda is a very diverse city in terms of its amenities, and so a diversity of amenities analysis is done in order to understand the different types of amenities that are found within the four study areas. This analysis shows where the most and the least amount of amenities are located, as well as what type of land-use practices are dominate in each study area. This is so that an analysis can be made showing which streets contain different amenities that might be of importance to the community and whether they are within set walking distances.

Figure 5.2.1 is a diversity of amenities map within the four study areas. This is a general amenities map showing the different types of amenities within the four study areas. Land-use practices are characterised between commercial, residential, and institutional land-use types. This includes small businesses, schools, coffee shops, and street vendors. On the Rhodes University campus, the main land-use types are residential and institutional. In the CBD, the main land-use types are residential and commercial. In the Westhill area, the main land-use type is residential. In the Sunnyside area, the main land-use type is residential and commercial.

Each symbol in Figure 5.2.1 represents a different cluster of amenities. Amenities are mainly clustered within the Rhodes University campus and Central areas. Accommodation, information, labs, lecture theatres, libraries, sports complexes, and sports fields can mainly be found within the Rhodes University campus, while museums, bars, coffee shops, pharmacies, places of worship, restaurants, schools, security, and shopping centres can mainly be found within Central. Sunnyside and Westhill are residential areas as compared to the commercial

areas of the Rhodes University campus and Central. With this being said, there are far fewer amenities found within Sunnyside and Westhill.

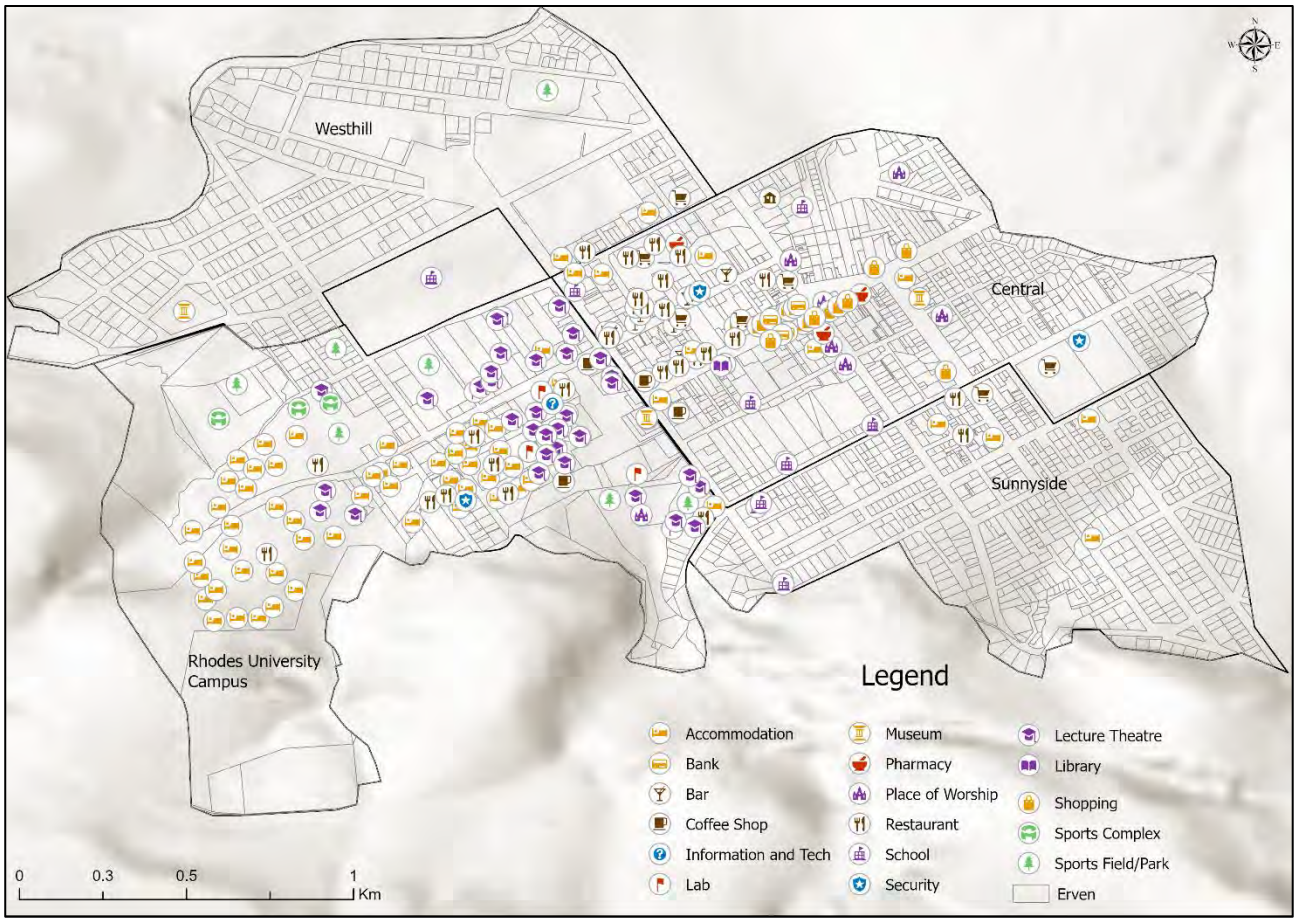

Figure 5.2.1. *A general diversity of amenities within the four study areas.*

Figure 5.2.2 is a kernel density map of the general diversity of amenities within the four study areas. The grey colour represents areas of low density. The light purple represents areas of medium density where the amenities are spread out and not as clustered. The dark purple represents areas of high density where the amenities are clustered and less spread out.

As can be seen by both Figure 5.2.1 and Figure 5.2.2, there is a high concentration of amenities within the Rhodes University campus and Central. Moreover, the high concentration of amenities is within lower campus in the case of Rhodes University, and within the extent of African Street, Somerset Street, New Street, and High Street in the case of Central. This is because of the amount of student accommodation and lecture theatres found within the Rhodes University campus. Additionally, there is a shopping centre and shops along the streets located within the western part of Central (African Street, Somerset Street, New Street, and High Street) which is frequented by the student population.

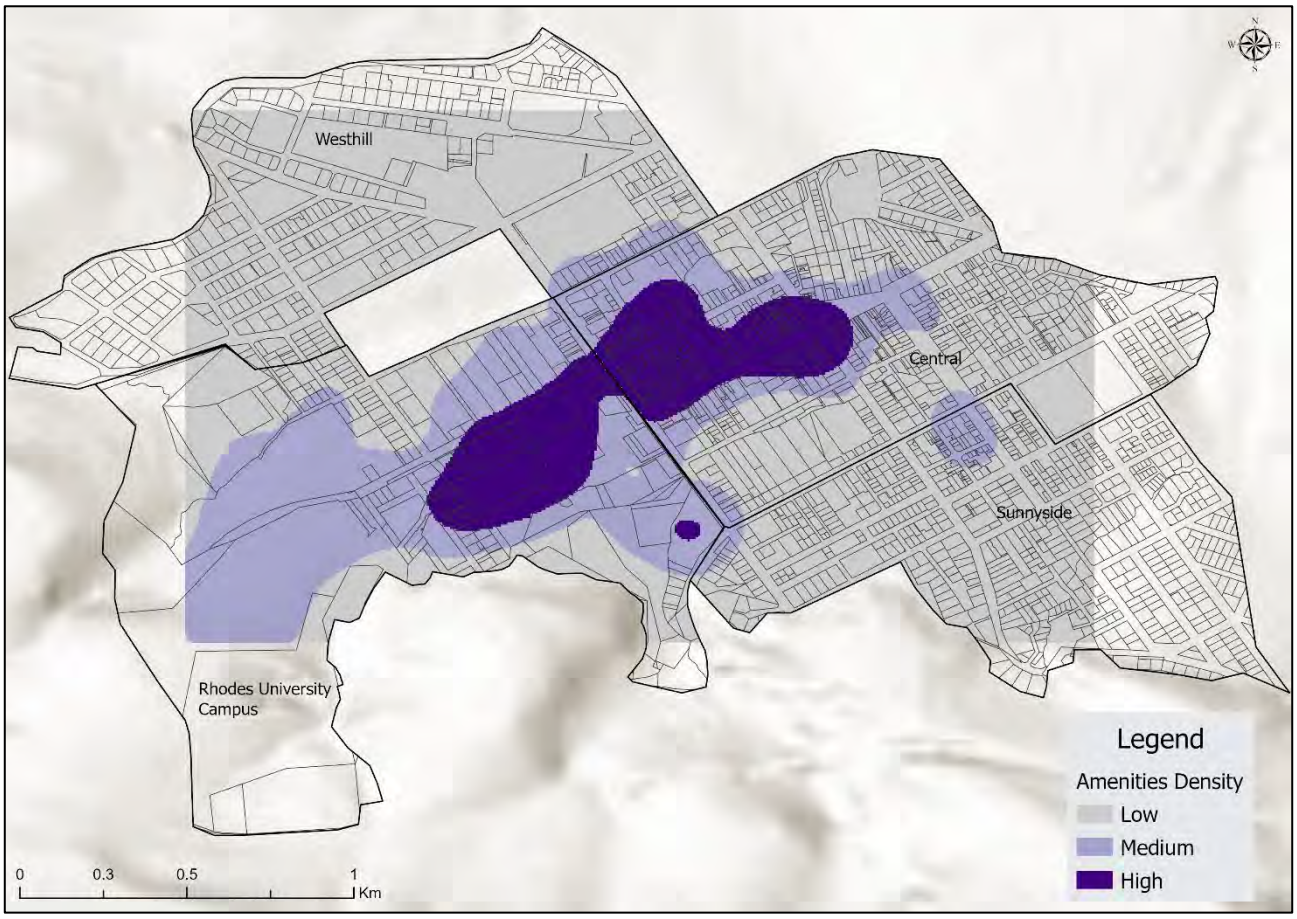

Figure 5.2.2. *The general amenities density within the four study areas.*

5.3. Sidewalk conditions

The second walkability factor that will be presented is the sidewalk condition. Sidewalk condition refers to the urban structure conditions and the patterns and characteristics of the present activities. This includes the presence of the sidewalk, the width of the sidewalk, the continuity and coverage of the sidewalk, the quality and condition of the sidewalk, the slope and angle of the sidewalk, and the presence of encroachment on the sidewalk.

In terms of the sidewalk presence, Figure 5.3.1 is a map representing the sidewalk presence within the four study areas. The roads where the sidewalk is present on both sides (one sidewalk on each side of the road) are represented by a brown line. The roads where the sidewalk is present on one side are represented by a yellow line. The roads that have no sidewalk are represented by an orange line.

Of the 109 roads, 55 had sidewalks (50.46%) while 54 (49.54%) did not have sidewalks. Additionally, 74 (43.12%) had a sidewalk on one side of the road while 35 (48.62%) had sidewalks on both sides of the road. On the Rhodes University campus, the roads are dominated by sidewalks present on one side of the road and no sidewalks present. The main roads (Artillery Street, and Lucas Avenue) that students use to walk onto campus, have sidewalks present on one side of the road. However, Prince Alfred Street has sidewalks on both sides of the road. In Central, the roads are dominated by sidewalks present on both sides of the road. The roads that have either one sidewalk present or no sidewalk present are located on the eastern side of Central. The

main roads (African Street, New Street, High Street, and Huntly Street) that students use to walk onto campus, have sidewalks present on both sides of the road. In the Westhill area, the roads are a mix of sidewalks present on one side of the road and no sidewalks present. Three of the main roads (Worcester Street, Cradock Road, and Milner Street) running through Westhill have sidewalks on both sides of the road. In the Sunnyside area, the roads are a mix of both sidewalks present on both sides of the road and no sidewalks present. The roads that have sidewalks present on both sides of the road are located on the northern side of Sunnyside, close to Central. The roads that have no sidewalks present are located on the southern part of Sunnyside that consists mainly of residential buildings. With this being said, the Rhodes University campus, Central, and the northern parts of Sunnyside are more walkable areas, in terms of sidewalk presence.

Figure 5.3.1. *The sidewalk presence within the four study areas.*

A sidewalk is a path or walkway that is usually found alongside a road. It is designed for pedestrians to walk on and is typically raised slightly above the road level. Figure 5.3.2 shows the average sidewalk widths for the left and right side of the road for each of the study areas, along with the South African sidewalk width standards. With this being said, the Rhodes University campus and the Westhill area are the more walkable areas, in terms of sidewalk width.

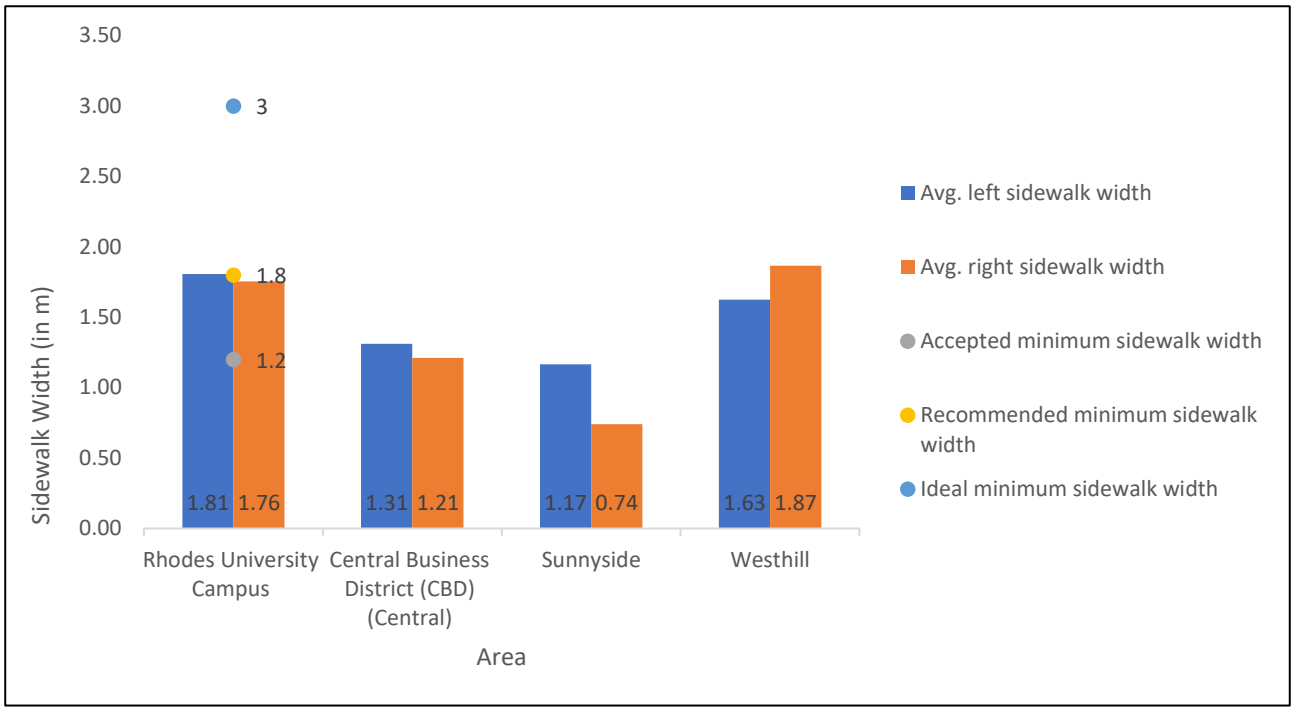

Figure 5.3.2. *The average sidewalk widths for the left and right side of the road for each of the study areas, along with the South African sidewalk width standards.*

A verge is the strip of land that is found between the road and the sidewalk and/or another boundary. It is important to measure the verge and note where it occurs because often when sidewalks are not present, students will either walk on the verge or on the road. Figure 5.3.3 shows the average verge width for the left and right side of the road for each of the four study areas.

Of the 109 roads, 78 (71.56%) did not have overgrown verges while 31 (28.44%) did have overgrown verges. The majority of the verges that are not overgrown are within Central and Sunnyside. The majority of the overgrown verges are within Central, Sunnyside, and Westhill. With this being said, the Rhodes University campus, Central, and the Sunnyside area are the more walkable areas, in terms of verge width.

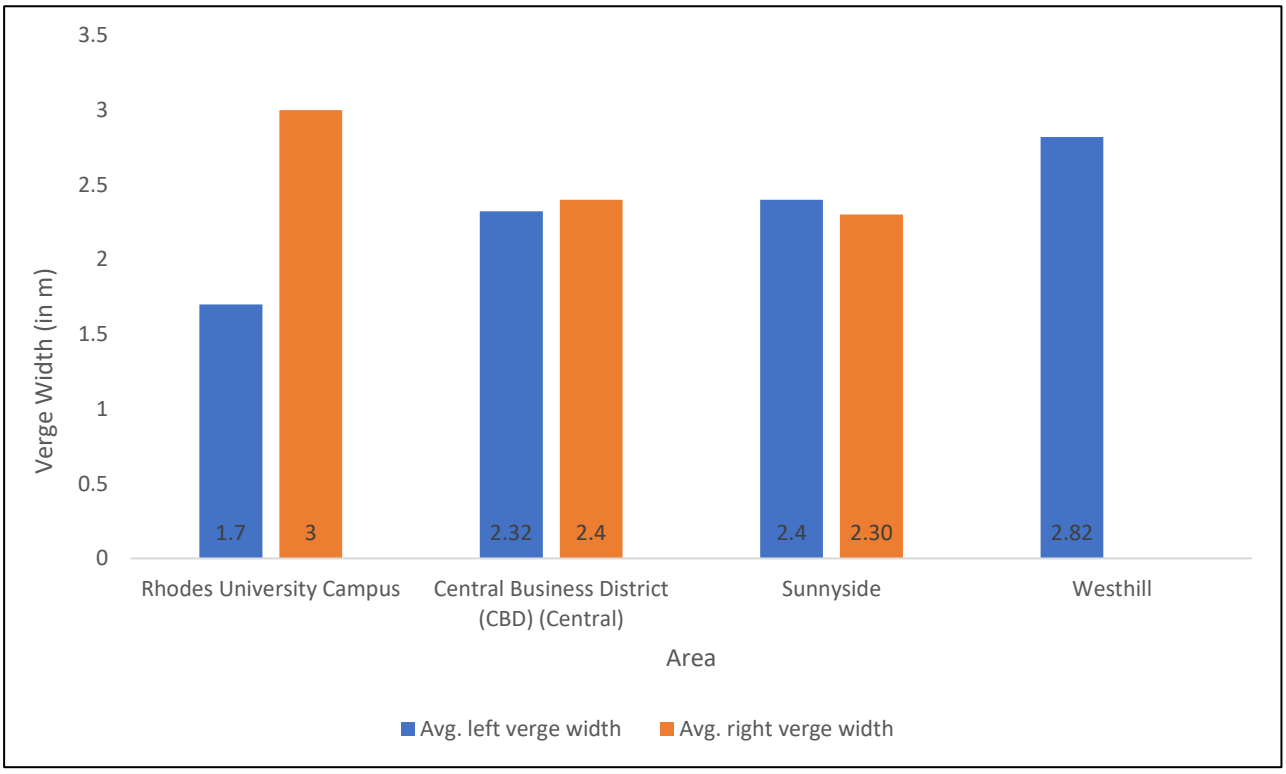

Figure 5.3.3. *The average verge width for the left and right side of the road for each of the four study areas.*

In terms of continuity and coverage, Figure 5.3.4 is a map representing the continuity and coverage of the sidewalk within the four study areas. The roads that have good continuity and coverage are represented by a green line. The roads that have fair continuity and coverage are represented by a red line. The roads that have poor continuity and coverage are represented by a blue line. The roads that did not have sidewalks have not been shown. This is because they would not be able to show any continuity and coverage data as the sidewalk does not exist. When the term "good" is used, it is referring to when the sidewalk continues and covers the entire length of the road being walked on. When the term "fair" is used, it is referring to when the sidewalk abruptly stops along the road and does not cover the entirety of the road. When the term "poor" is used, it is referring to when the sidewalk stops for a significant length of the road and is discontinuous for most of the road.

Of the 109 roads, 9 (8.26%) had good continuity and coverage, 24 (38.53%) had fair continuity and coverage, and 76 (69.72%) had poor continuity and coverage. On Rhodes University campus, the roads are dominated by good continuity and coverage. The main road (Prince Alfred Street) that runs from the beginning of the Rhodes University campus to the residences at the end of the road, has fair continuity and coverage. It should be noted, however, that the first half of Prince Alfred Street (from the beginning to just west of South Street) has fair continuity and coverage while the second half of Prince Alfred Street (just west of South Street to the end of Prince Alfred Street) has good continuity and coverage. In Central, the roads are dominated by fair continuity and coverage, with two of the main roads (Somerset Street and Beaufort Street) having good continuity and coverage. It should be noted, however, that the first half of Beaufort Street (from the Somerset intersection until Hill Street) has good continuity and coverage while the second half of Beaufort Street (from

Hill Street until the end of Beaufort Street) has fair continuity and coverage. In the Sunnyside area, the roads are dominated by both fair and good continuity and coverage. It was also noted that the sidewalk condition is better around educational institutions, specifically around Beaufort Street, Hill Street and Worcester Street. The location of these educational institutions can be seen in Figure 5.2.1 and are represented by the school symbology. In the Westhill area, the roads are dominated by poor continuity and coverage, with three of the main roads (Cradock Road, Worcester Street, and Milner Street) having fair continuity and coverage. It should be noted, however, that the first half of Worcester Street (from the Mather-Pike Street intersection until Cradock Road) has good continuity and coverage while the second half of Worcester Street (from Cradock Road until the end of Worcester Street) has fair continuity and coverage. With this being said, the Rhodes University campus, the eastern parts of Central, and the southern parts of Westhill are the more walkable areas, in terms of continuity and coverage.

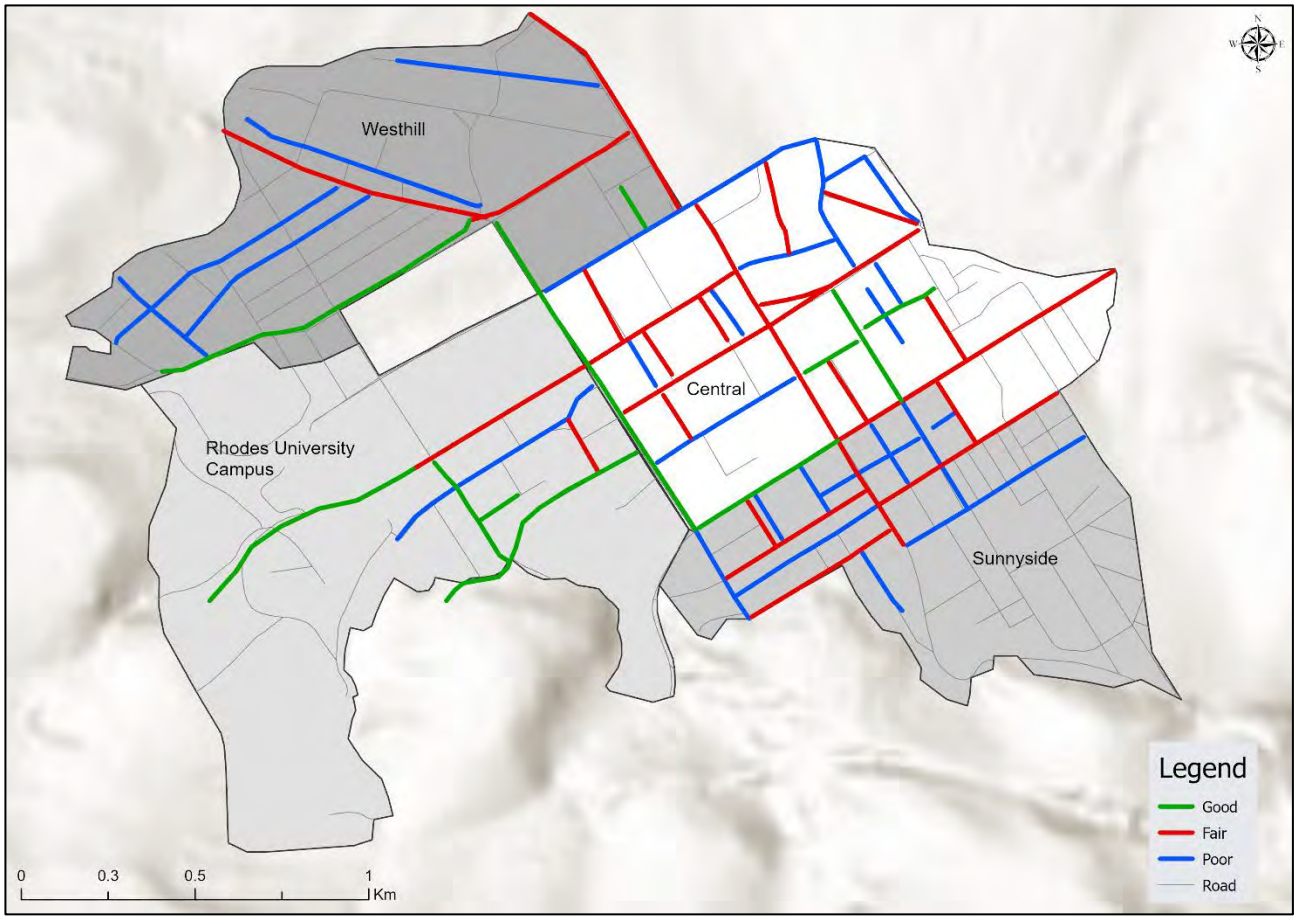

Figure 5.3.4. *The continuity and coverage within the four study areas.*

In terms of sidewalk condition, Figure 5.3.5 is a map representing the evenness within the four study areas. The roads with even sidewalks are represented by an orange line. The roads with uneven sidewalks are represented by a blue line. Evenness was measured by whether or not there were bumps, breakages, and overall unevenness of the sidewalk.

Of the 109 roads, 59 (45.87%) have even sidewalks while 50 (59.13%) have uneven sidewalks. On the Rhodes University campus, the roads are a mix of both even and uneven sidewalks. In Central, the roads are dominated by uneven sidewalks. In the Sunnyside area, the roads are a mix of both even and uneven sidewalks. The even sidewalks are mainly located on the southern part of Sunnyside, whereas the uneven sidewalks are located on the northern part of Sunnyside. In the Westhill area, the roads are dominated by even sidewalks. With this being said, the southern parts of Sunnyside and the Westhill area are the more walkable areas, in terms of sidewalk condition (evenness).

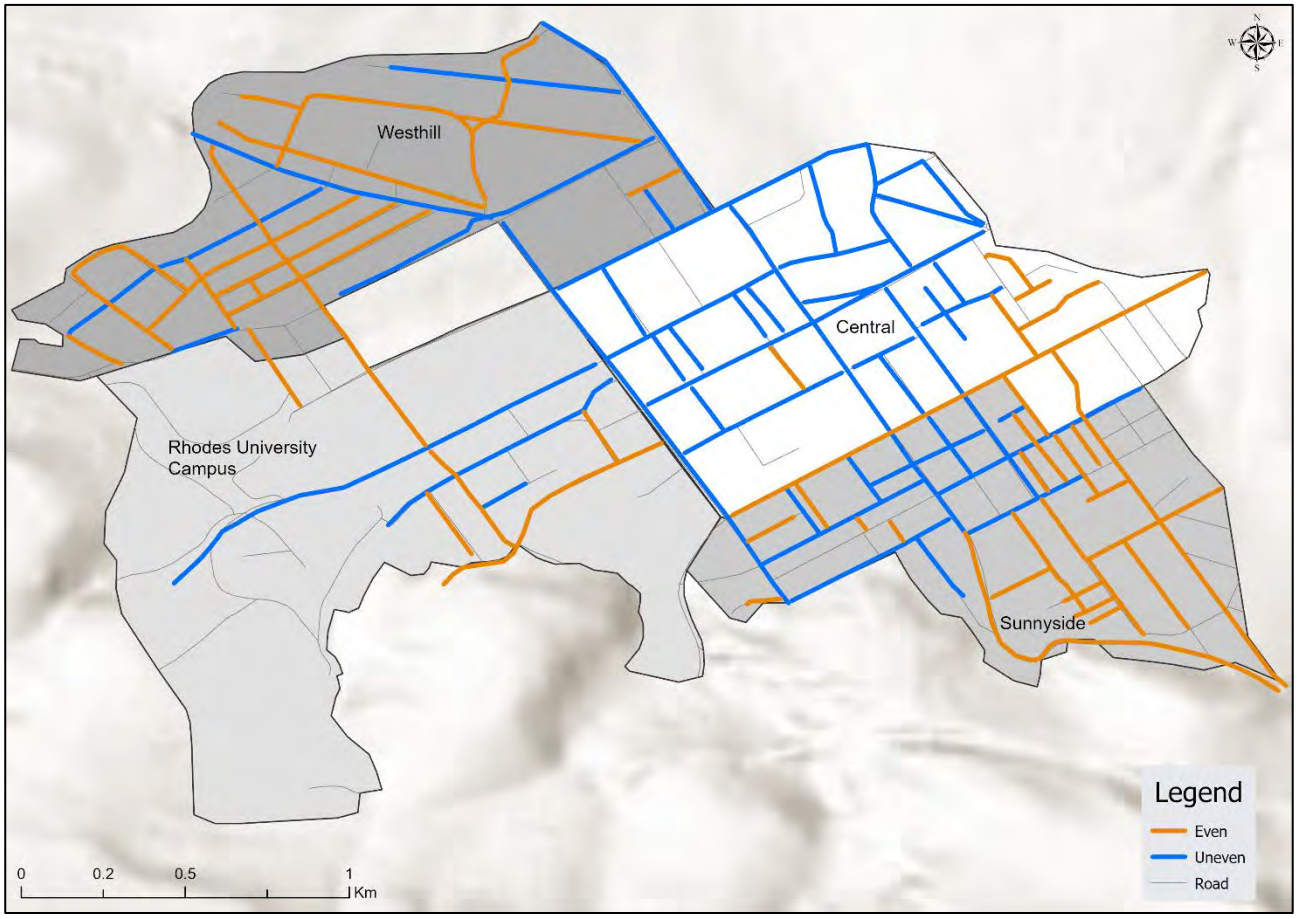

Figure 5.3.5. *The sidewalk condition (evenness) within the four study areas.*

Figure 5.3.6 is a map representing the overgrowth of vegetation on the sidewalk within the four study areas. The roads that did not have overgrown vegetation on the sidewalks are represented by an orange line. The roads that did have overgrown vegetation on the sidewalks are represented by a blue line. Overgrowth was measured by whether or not there was overgrown vegetation on the sidewalk that would have disrupted the walking experience.

Of the 109 roads, 73 (66.97%) did not have overgrown vegetation while 36 (33.03%) did have overgrown vegetation. On the Rhodes University campus, the roads are dominated by sidewalks that are not overgrown. In Central, the roads are a mix of both overgrown and not overgrown sidewalks. In the Sunnyside area, the roads are a mix of both overgrown and not overgrown sidewalks. The overgrown sidewalks are mainly located

on the southern part of Sunnyside, whereas the sidewalks that are not overgrown are located on the northern part of Sunnyside. In the Westhill area, the roads are dominated by sidewalks that are not overgrown. The only overgrown sidewalk present is on Cradock Road. With this being said, the Rhodes University campus, the southern parts of Sunnyside, and the Westhill area are the more walkable areas, in terms of sidewalk condition (overgrowth).

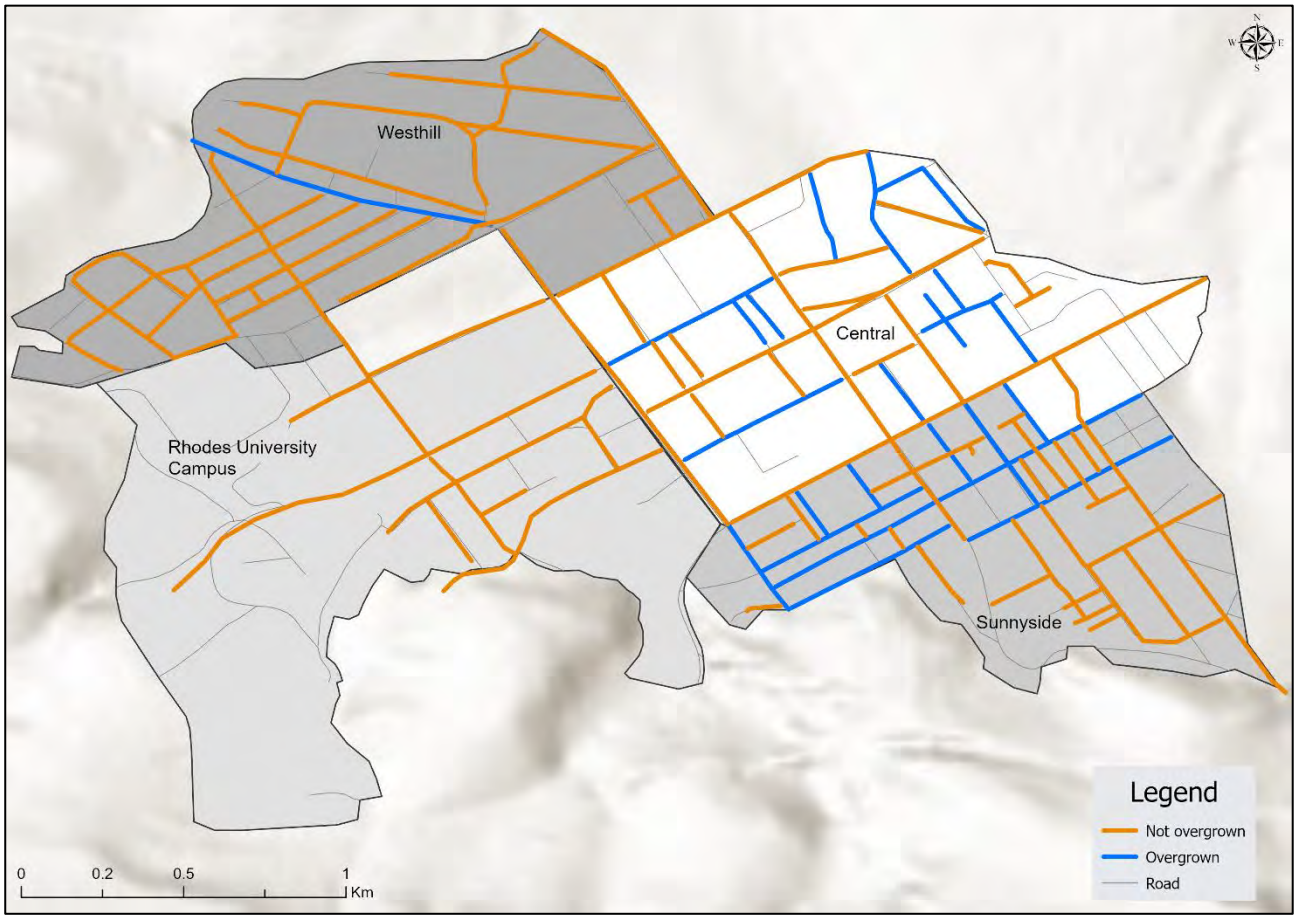

Figure 5.3.6. *The sidewalk condition (overgrown vegetation) within the four study areas.*

In terms of overall sidewalk condition, Figure 5.3.7a, Figure 5.3.7b and Figure 5.3.7c are examples of the terms "good," "fair" and "poor" sidewalk condition within each of the four study areas. When the term "good" is used, it is referring to when the sidewalk is in good condition and does not have uneven and overgrown sidewalks. When the term "fair" is used, it is referring to when the sidewalk is uneven and has slightly overgrown vegetation, but not to the extent of disrupting the overall walking experience. When the term "poor" is used, it is referring to when the sidewalk has many bumps and breakages, and has overgrown vegetation that disrupts the walking experience.

Of the 109 roads, 17 (15.6%) had a good sidewalk condition, 30 (27.52%) had a fair sidewalk condition, and 62 (56.88%) had a poor sidewalk condition. Overgrown vegetation and uneven sidewalks are the dominating sidewalk conditions within the four study areas. The majority of the roads that have good sidewalk conditions are within the Rhodes University campus. The majority of the roads that have fair sidewalk conditions are within Central and Sunnyside. The majority of the roads that have poor sidewalk conditions are within Central,

Sunnyside and Westhill. With this being said, the Rhodes University campus is the more walkable area, in terms of overall sidewalk conditions.

Figure 5.3.7a. *An illustration showing good sidewalk condition within the four study areas.*

Figure 5.3.7b. *An illustration showing fair sidewalk condition within the four study areas.*

Figure 5.3.7c. *An illustration showing poor sidewalk condition within the four study areas.*

In terms of the slope of the sidewalks, Figure 5.3.8 is a map representing the slope of the roads in the four study areas. The roads with a gentle slope are represented by an orange line. The roads with a flat slope are represented by a green line. The roads with a steep slope are represented by a brown line. When the term "flat" is used, it is referring to when the slopes have no angle to them. When the term "gentle" is used, it is referring to when the slopes have a slight angle to them, but not so much that it is strenuous to walk on. When the term "steep" is used, it is referring to when the slopes have a steep angle to them that requires strenuous effort to walk on.

Of the 109 roads, 64 (58.72%) had gentle slopes, 25 (22.93%) had flat slopes, and 20 (18.35%) had steep slopes. The elevation within the four study areas ranges from 529 m to 546 m with the elevation increasing towards the outskirts of the boundaries. The majority of the gentle slopes are within Central, Sunnyside and Westhill. The majority of the flat slopes are within Central and Sunnyside. The majority of the steep slopes are within Rhodes University and Sunnyside. With this being said, Central, Sunnyside and Westhill are the more walkable areas, in terms of slope.

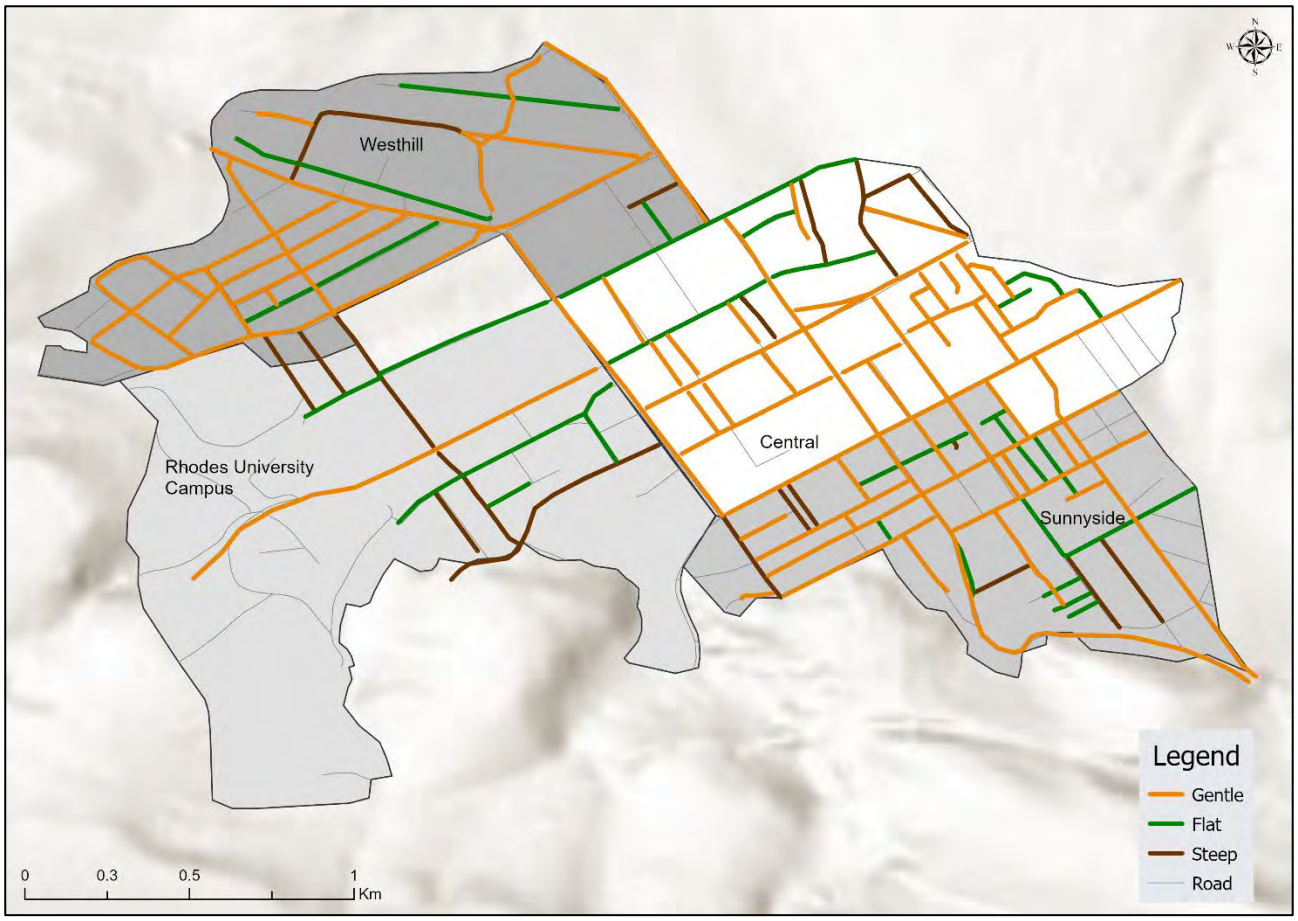

Figure 5.3.8. *The slope within the four study areas.*

In terms of encroachment, Figure 5.3.9 is a map representing encroachment within the four study areas. The roads that have encroachment are represented by an orange line. The roads that do not have encroachment are represented by a blue line. Figure 5.3.10 is an example of encroachment on the sidewalks within the four study areas. For this study, encroachment was defined as the presence of objects on the sidewalk that would disrupt the continuous flow of walking and the overall walking experience. Objects include, vehicles, banners, cardboard advertisements, electricity boxes, construction material, and street vendors.

Of the 109 roads, 66 (60.55%) did have encroachments on the sidewalks while 43 (39.45%) did not have encroachments on the sidewalks. Encroachment was mainly found within Central. Central is an economic and business hub. Furthermore, a lot of the encroachment found on the sidewalk was as a result of banners, cardboard advertisements and street vendors. With this being said, the southern parts of the Rhodes University campus and the Westhill area are the more walkable areas, in terms of encroachment.

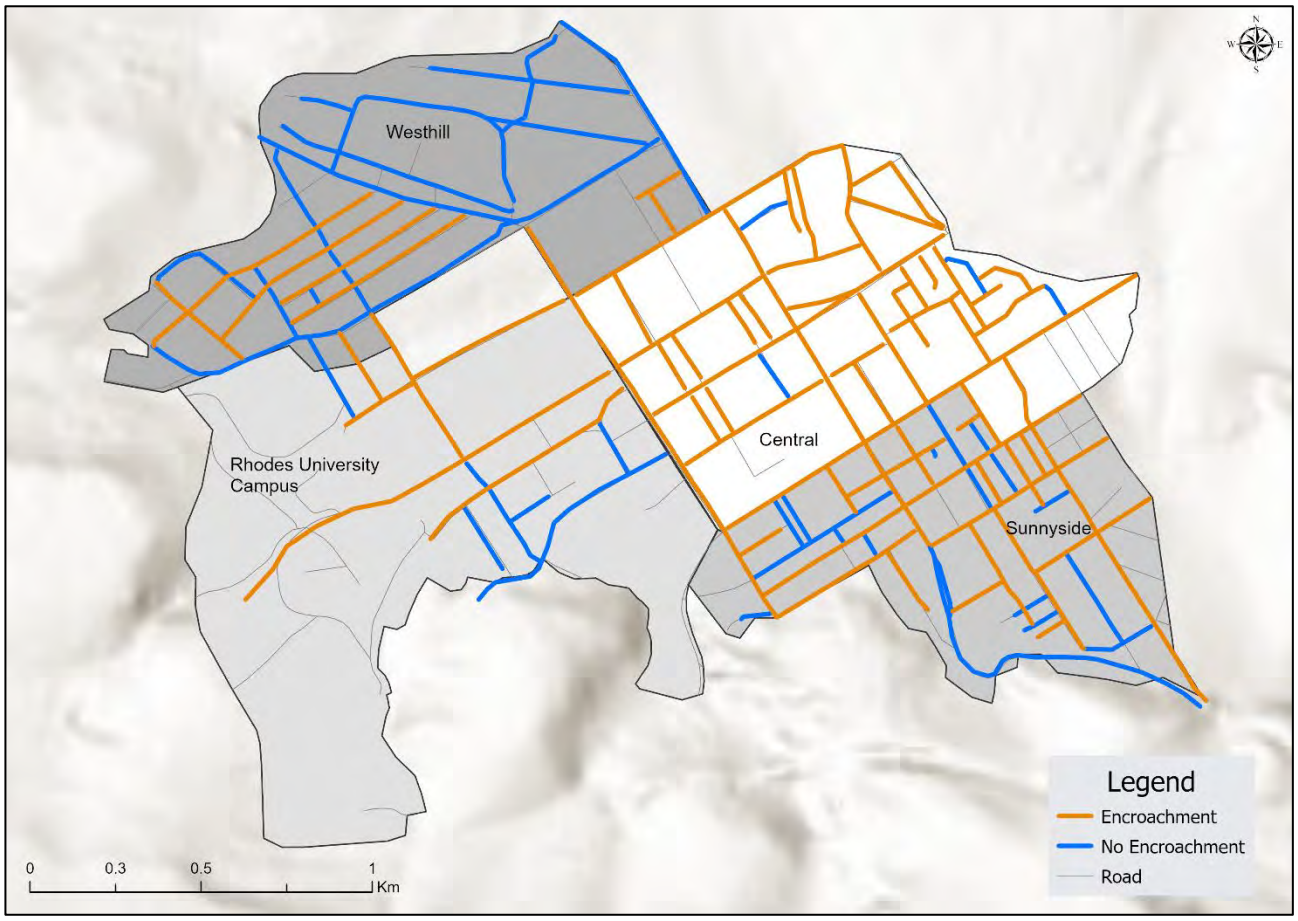

Figure 5.3.9. *Encroachment within the four study areas.*

Figure 5.3.10. *An illustration showing the presence of encroachment within the four study areas.*

5.4. Pedestrian safety and security

The third walkability factor that will be presented is the pedestrian safety and security within the four study areas. Pedestrian safety and security refers to the traffic safety, crime and the intensity of crime being committed. This includes the presence of traffic calming measures, the volume of traffic, the lighting, and the safety and security features present.

In terms of traffic calming measures, Figure 5.4.1 is a map representing the number and presence of speed humps, pedestrian crossing, and pedestrian crossings with speed humps within the four study areas. The speed humps are represented by the green squares. The pedestrian crossings are represented by the orange circles. The pedestrian crossings with speed humps are represented by the blue triangles. Schools within the area have also been shown and are represented by the purple school symbol.

Of the 109 roads, 86 (78.9%) did not have any traffic calming measures while 23 (21.1%) did have traffic calming measures. This consisted of speed humps. In terms of signals and signages, 1 road had a working signal/sign while the other 108 roads did not have any signals/signs and/or did not have working signals/signs. Of the 109 roads, 79 (72.48%) had 0 crosswalks/zebra crossings, 14 (12.84%) had 1 crosswalk/zebra crossing, 4 (3.67%) had 2 crosswalks/zebra crossings, 4 (3.67%) had 3 crosswalks/zebra crossings, and 8 (7.34%) had more than 4 crosswalks/zebra crossings. It should be noted that traffic calming measures are a lot more abundant on roads that have schools located near them. On the Rhodes University campus, the roads are dominated by speed humps. The main road (Prince Alfred Street) has a higher presence of all three types of traffic calming measures as opposed to the other roads which mainly consist of speed humps. In Central, the roads are dominated by pedestrian crossings. Somerset Street has a much higher presence of pedestrian crossings as opposed to the other roads. In the Sunnyside area, the traffic calming measures are mainly located on the western side of Sunnyside near the schools. In the Westhill area, the roads are dominated by pedestrian crossings with speed humps. The pedestrian crossing with speed humps are mainly located on the central part of Westhill. With this being said, the Rhodes University campus and eastern parts of Central are the more walkable areas, in terms of traffic calming measures.

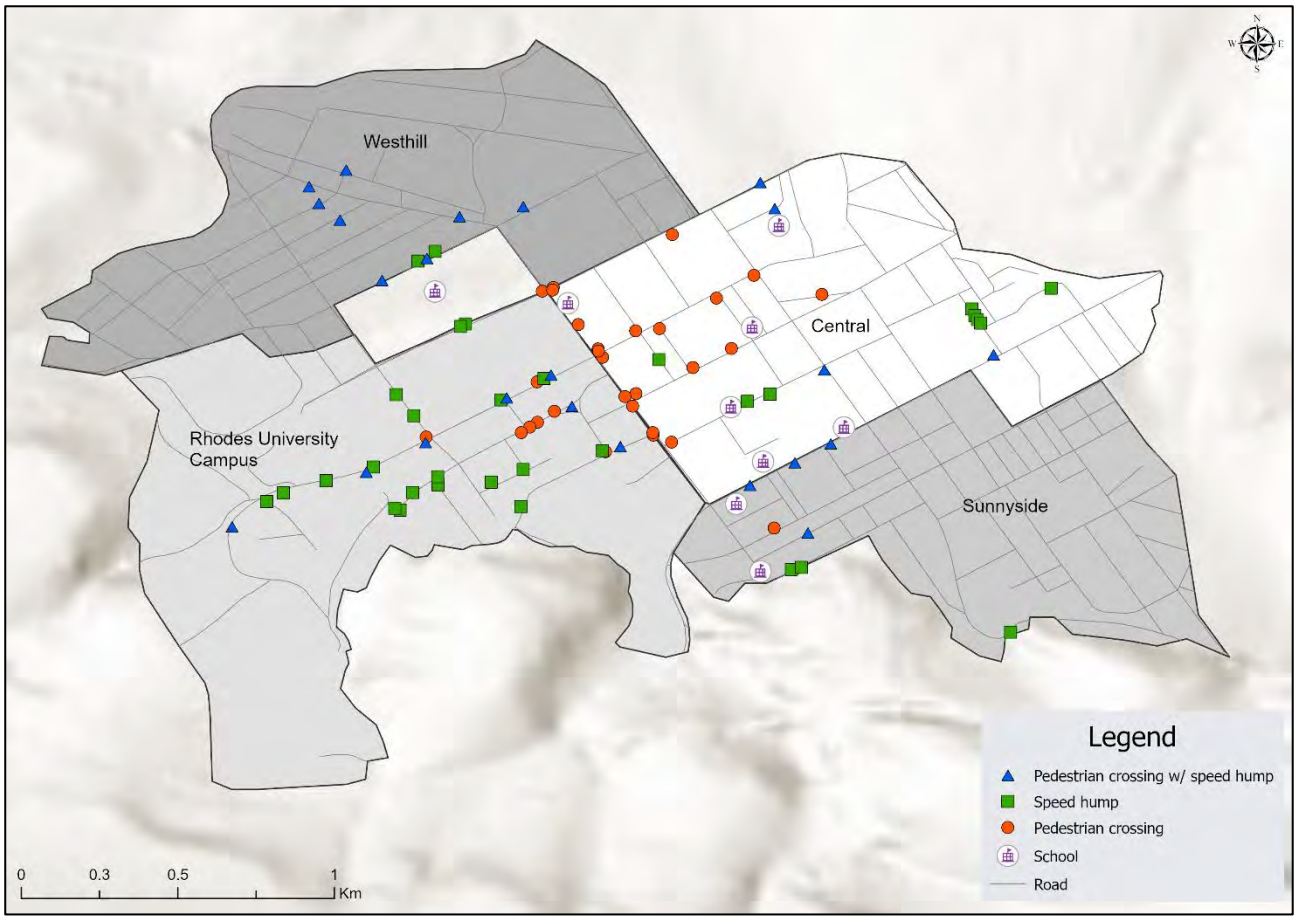

Figure 5.4.1. *The traffic calming measures within the four study areas.*

In terms of visibility of markings, Figure 5.4.2 is a map representing the visibility of pedestrian crossings within the four study areas. The roads with high visibility are represented by a red line. The roads with medium visibility are represented by a peach line. The roads with low visibility are represented with a blue line. When the term "high" is used, it is referring to when the visibility of markings is bright, clear, has been maintained, and can be seen from afar. When the term "medium" is used, it is referring to when the visibility of markings is visible but unclear and is fading thus not being able to see from afar. When the term "low" is used, it is referring to when the visibility of markings is barely existent and cannot be seen until the pedestrian and/or driver is in front on the crosswalk/zebra crossing. Figure 5.4.3a shows an example of "high" visibility within the four study areas. Figure 5.4.3b shows an example of "medium" visibility within the four study areas. Figure 5.4.3c shows an example of "low" visibility within the four study areas.

Of the 109 roads, 15 (13.76%) had a high visibility of markings, 8 (7.34%) had a medium visibility of markings, and 86 (78.9%) has a low visibility of markings. The majority of the roads with a high visibility of markings are within Central and Westhill. The majority of the roads with a medium visibility of markings are within Central. The majority of the roads with a low visibility of markings are within Central, Sunnyside and Westhill. With this being said, the eastern parts of Central and the Westhill area are the more walkable areas, in terms of visibility of markings.

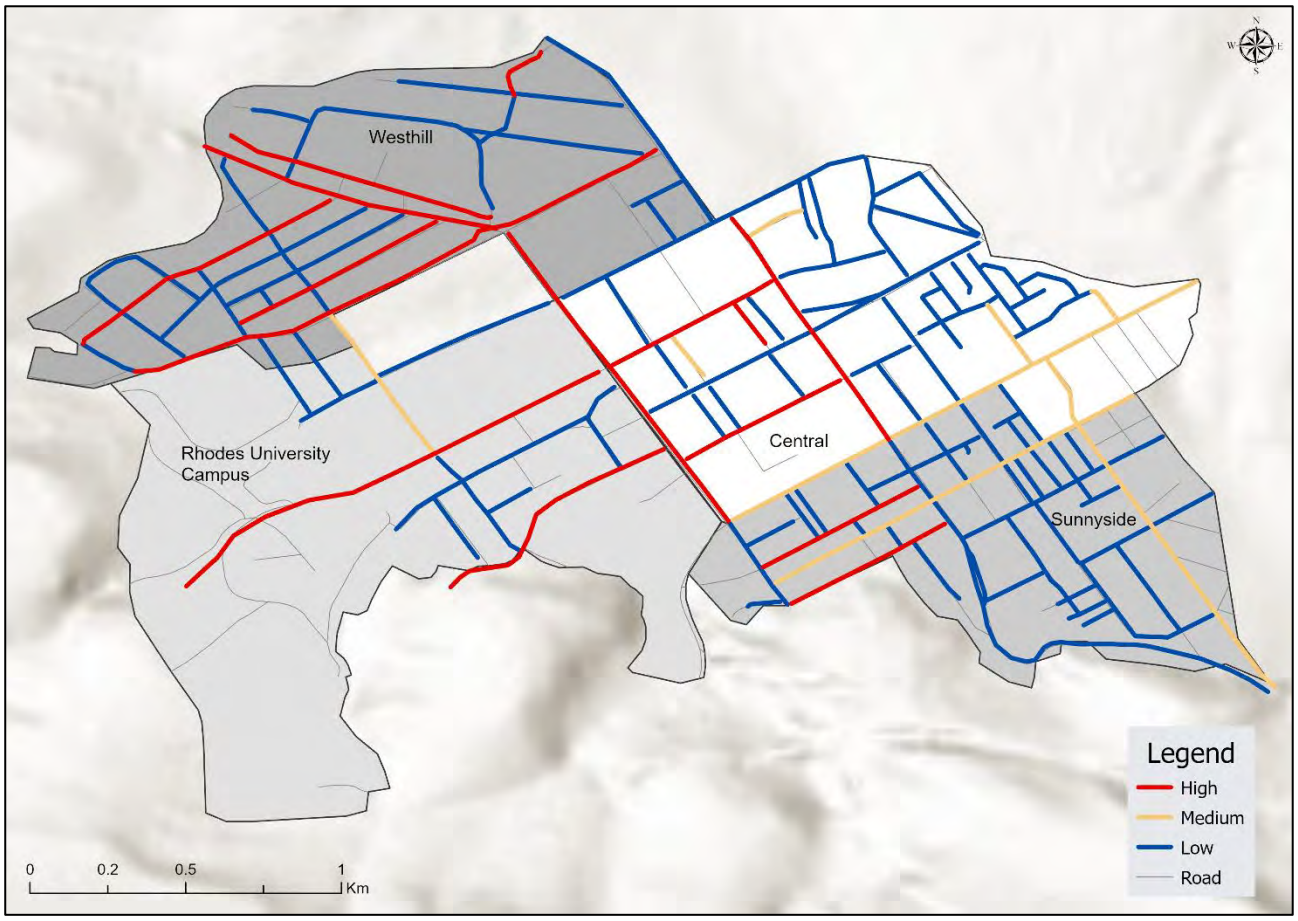

Figure 5.4.2. *The visibility of pedestrian crossings within the four study areas.*

Figure 5.4.3a. *An illustration showing good visibility of markings within the four study areas.*

Figure 5.4.3b. *An illustration showing fair visibility of markings within the four study areas.*

Figure 5.4.3c. *An illustration showing poor visibility of markings within the four study areas.*

In terms of the traffic volume, Figure 5.4.4 is a map representing the traffic volume within the four study areas. The roads that have a high traffic volume are represented by a red line. The roads that have a medium traffic volume are represented by a peach line. The roads that have a low traffic volume are represented by a blue line. It should be noted that the traffic volume in the four different study areas were taken at different times of the day. This is because data collection was done on different days at different times. This discrepancy would thus affect the results shown in terms of traffic volume that was seen on a road on a specific time and day. With this being said, when the term "high" is used, it is referring to when more than 10 cars are seen driving on a road within ± 5 minutes. When the term "medium" is used, it is referring to when 5-10 cars are seen driving on a road within ± 5 minutes. When the term "low" is used, it is referring to when <5 cars are seen driving on a road within ± 5 minutes.

Of the 109 roads, 15 (13.76%) had high traffic volume, 26 (23.85%) had medium traffic volume, and 68 (62.39%) had low traffic volume. On Rhodes University campus, the roads are dominated by medium traffic volume. The main road (Prince Alfred Street) that runs from the beginning of the Rhodes University campus to the residences at the end of the road has high traffic volume and this is because of the university vehicles, public transportation and student vehicles that are consistently travelling up and down the road. This is also because this road connects to majority of the secondary roads on campus. In Central, the roads are a mix of both high and medium traffic volume. In the Sunnyside area, the roads are a mix of both medium and low traffic volume. This is the same case for roads in the Westhill area. This can be attested to the fact that these areas are largely residential areas and would not have a constant high flow of traffic throughout the day. It should be noted that low traffic volume can be linked to a lack of pedestrian and traffic safety features. In the areas with low traffic volume (Sunnyside and Westhill), there is a lack of pedestrian safety features. This includes, pedestrian crossings, speed humps, low visibility of markings, lighting, and CCTV surveillance cameras. With this being said, the Rhodes University campus, the southern parts of the Sunnyside area, and the Westhill area are the more walkable areas, in terms of traffic volume.

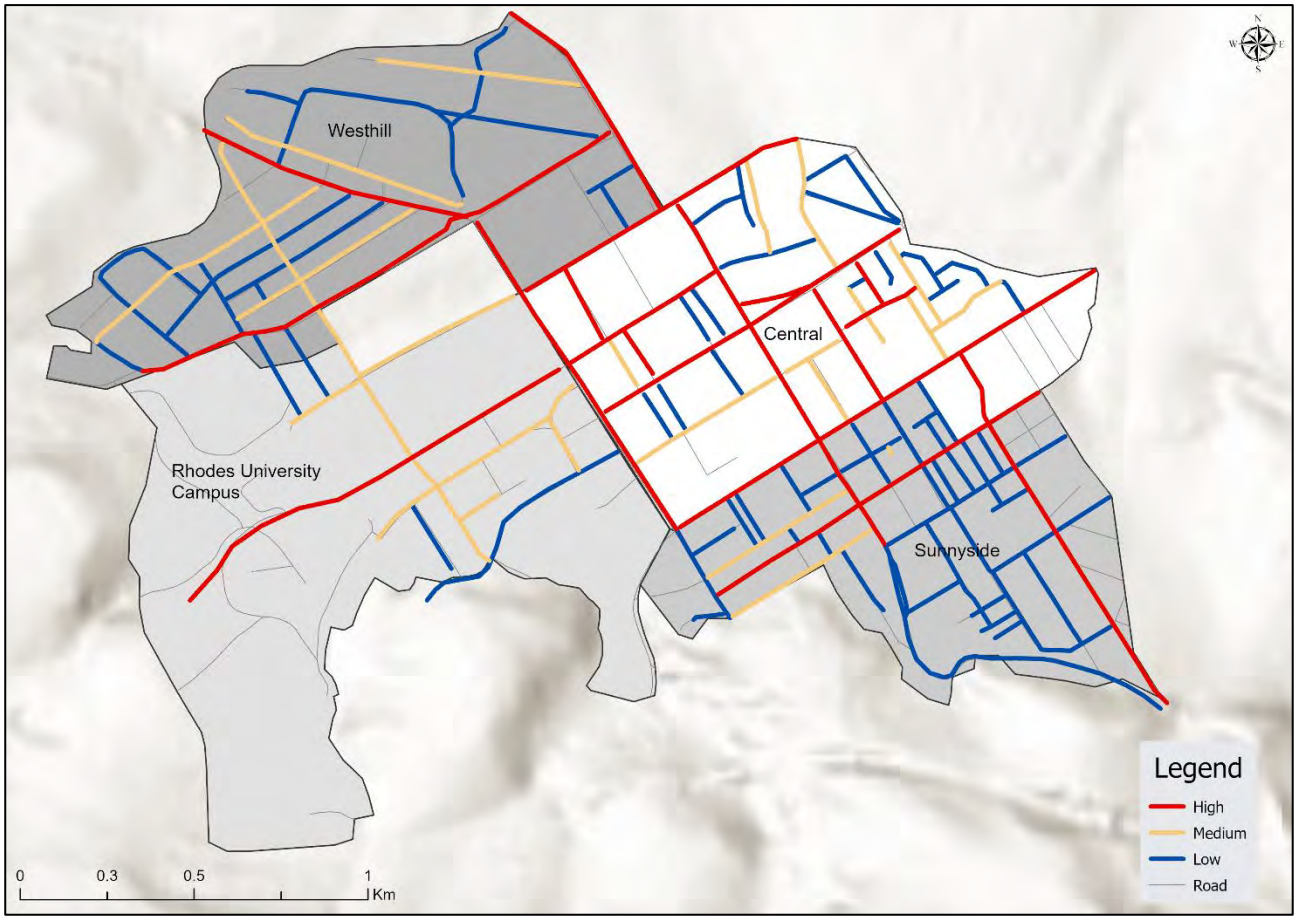

Figure 5.4.4. *The traffic volume within the four study areas.*

In terms of lighting, Figure 5.4.5 is a map representing the lighting within the four study areas. The roads with good lighting are represented by a green line. The roads with fair lighting are represented by a red line. The

roads with poor lighting are represented by a blue line. When the term “good” is used, it is referring to when all the lighting along a road is working at night and lights up the entirety of the road. When the term “fair” is used, it is referring to when some but not all of the lighting along a road is working at night. This means that parts of the road are lit up but not the entirety of the road. When the term “poor” is used, it is referring to when none of the lighting along a road is working at night. This means that the road is dark and unsafe.

Of the 109 roads, 10 (9.17%) has good lighting, 4 (3.67%) has fair lighting, and 95 (87.16%) has poor lighting. The four study areas are dominated by poor lighting with the only area having good lighting being on the Rhodes University campus. It should be noted that after lighting data was collected, the Rhodes University campus installed solar and high mast lighting in certain parts of the campus. This lighting project consists of 13, 20 m mast lights as well as 254 upgraded lights along Prince Alfred Street. These lights are connected to generators allowing for lighting to still be present during power outages and/or loadshedding. With this being said, the Rhodes University campus is the more walkable area, in terms of lighting.

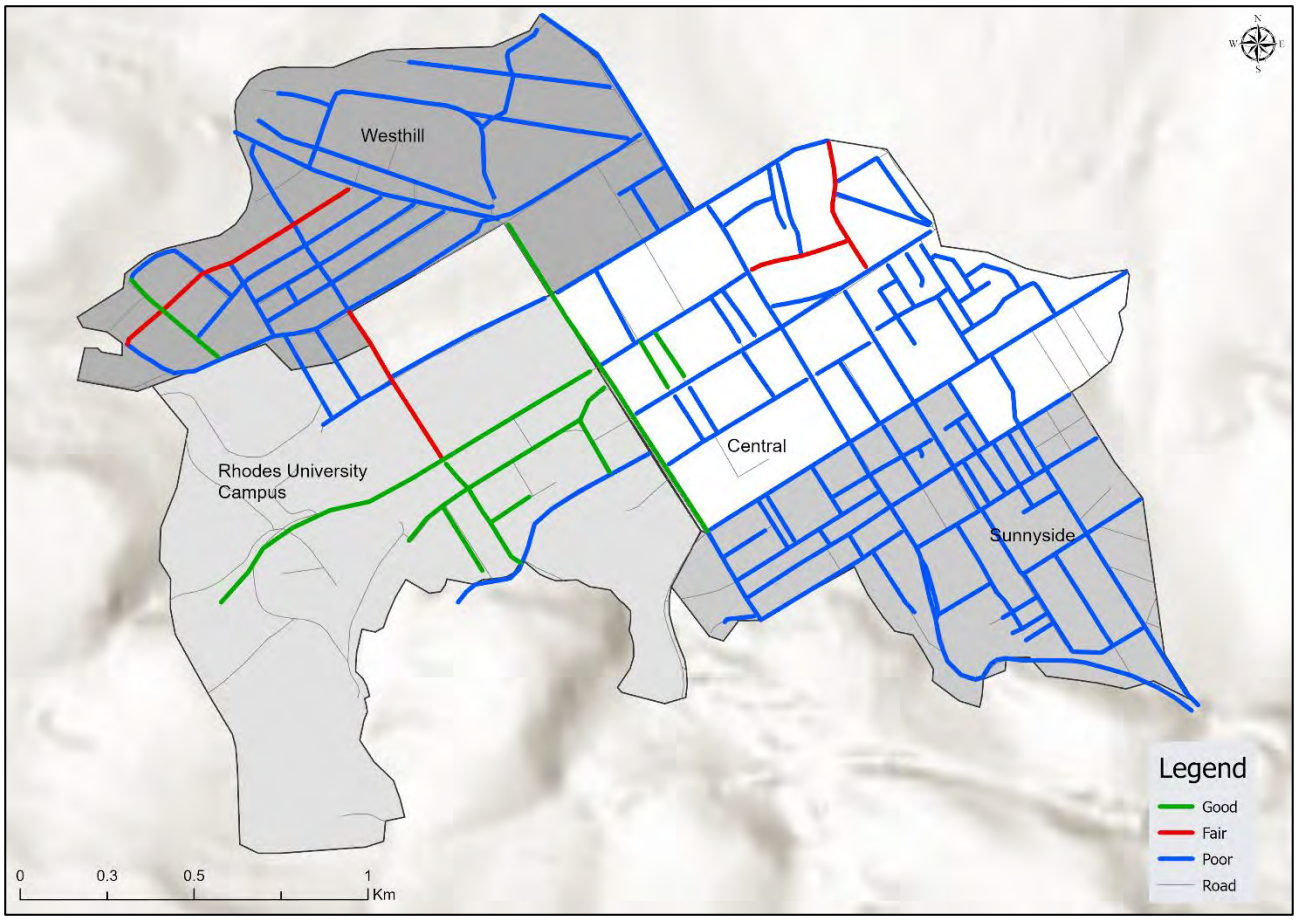

Figure 5.4.5. *The lighting within the four study areas.*

In terms of the safety and security features present, seven different factors will be focused on. This includes security personnel, CCTV surveillance cameras, pedestrian visibility, the presence of bushes/vacant land, hazards, the general activity levels, and the overall crimes and intensity of crime within the four study areas.

In terms of security personnel, it should be noted that security personnel have been defined as SAPS, Hi-Tec and Smhart officers that are patrolling the area. Of the 109 roads, 69 (63.3%) did have security personnel patrolling around while 40 (36.7%) did not have security personnel patrolling around. The majority of the security personnel are within Sunnyside and Westhill. However, it should be noted that the Rhodes University campus does have campus protection (CPU) and Hi-Tec security personnel patrolling the campus. With this being said, the Rhodes University campus, Sunnyside and Westhill are the more walkable areas, in terms of security personnel.

In terms of CCTV surveillance cameras, of the 109 roads, 12 (11.01%) did have CCTV surveillance cameras while 97 (79.19%) roads did not have CCTV surveillance cameras. The majority of the CCTV surveillance is within Rhodes University. With this being said, the Rhodes University campus is the more walkable area, in terms of CCTV surveillance cameras.

In terms of pedestrian visibility and bushes/vacant land, Figure 5.4.6a shows an example of "good" pedestrian visibility within the four study areas. Figure 5.4.6b shows an example of "fair" pedestrian visibility within the four study areas. Figure 5.4.6c shows an example of "poor" pedestrian visibility within the four study areas. Pedestrian visibility refers to whether or not the pedestrian can clearly see in front of them without having obstructions in their line of view, as well as whether or not there are bushes/vacant land in the area that can hide a possible attacker. With this being said, when the terms "good" is used, it is referring to when the pedestrian has a clear line of view in front of them. When the term "fair" is used, it is referring to when the pedestrian has a fairly clear line of view in front of them. This means that there are bushes/vacant land present, but not expansive enough to hide a possible attacker. When the term "poor" is used, it is referring to when the pedestrian does not have a clear line of view in front of them and is prone to a possible attack because of obstructions in the way.

In terms of pedestrian visibility, of the 109 roads, 40 (36.7%) had good pedestrian visibility, 50 (45.87%) had fair pedestrian visibility, and 19 (17.43%) had poor pedestrian visibility. The majority of the good pedestrian visibility are within Westhill and Sunnyside. The majority of the fair pedestrian visibility are within Central and Sunnyside. The majority of the poor pedestrian visibility are within Central. With this being said, the southern and northern parts of Sunnyside and the Westhill area are the more walkable areas, in terms of pedestrian visibility.

In terms of bushes/vacant land, of the 109 roads, 39 (35.78%) did have bushes/vacant land while 70 (64.22%) did not have bushes/vacant land. The majority of the bushes/vacant land are within the eastern parts of Central and the western parts of Sunnyside. With this being said, the Rhodes University campus, the western parts of Central, the eastern parts of Sunnyside, and Westhill are the more walkable areas, in terms of bushes/vacant land.

Figure 5.4.6a. *An illustration showing good pedestrian visibility/bushes and vacant land within the four study areas.*

Figure 5.4.6b. *An illustration showing fair pedestrian visibility/bushes and vacant land within the four study areas.*

Figure 5.4.6c. *An illustration showing poor pedestrian visibility/bushes and vacant land within the four study areas.*

In terms of hazards, Figure 5.4.7 is an example of hazards present on the sidewalks within the four study areas. For this study, hazards included trenches on the sidewalks, open manhole covers, water-logged potholes on the sidewalks, and debris consisting of bricks and stones left on the sidewalks. Of the 109 roads, 45 (41.28%) did have hazards on the sidewalks while 64 (58.72%) did not have hazards on the sidewalks. Hazards were mainly found within Central and the northern parts of Sunnyside. With this being said, the Rhodes University campus and the Westhill area are the more walkable areas, in terms of hazards.

Figure 5.4.7. *An illustration showing the presence of hazards within the four study areas.*

In terms of the general activity levels, this refers to how busy a road is in terms of people activity. It should be noted that the general activity levels in the four study areas were taken at different times of the day. This is because data collection was done on different days at different times. This discrepancy would thus affect the results shown in terms of general activity levels that was seen on a road on a specific time and day. Of the 109 roads, 12 (11.01%) had high general activity levels, 29 (26.61%) had medium general activity levels, and 68 (62.39%) had low general activity levels. The majority of the high activity are within Central. The majority of the medium activity are within Central, Sunnyside and Westhill. The majority of the low activity are within Central, Sunnyside and Westhill. With this being said, the eastern parts of Central, Sunnyside and Westhill are the more walkable areas, in terms of general activity levels.

In terms of the crime and intensity levels, four different categories have been taken into consideration. These include, the day of the week, the suburb, the month, and the time of day. Within each of these, crimes include, attempted murder, culpable homicide, robbery aggravating, public violence, rape, sexual assault, crimen injuria (injury to person's dignity), child abuse, kidnapping, abduction, assault, burglary, theft, shoplifting, arson, and malicious damage to property. It is important to note that this data shows the repeated crime cases within Makhanda for the year 2022.

Figure 5.4.8 is a graph representing the frequency of crime occurrence during the week. It can be seen that Friday has the most amount of crime occurrences and Sunday has the least amount of crime occurrences. Overall, the middle of the week towards the end of the week is when crimes happen the most.

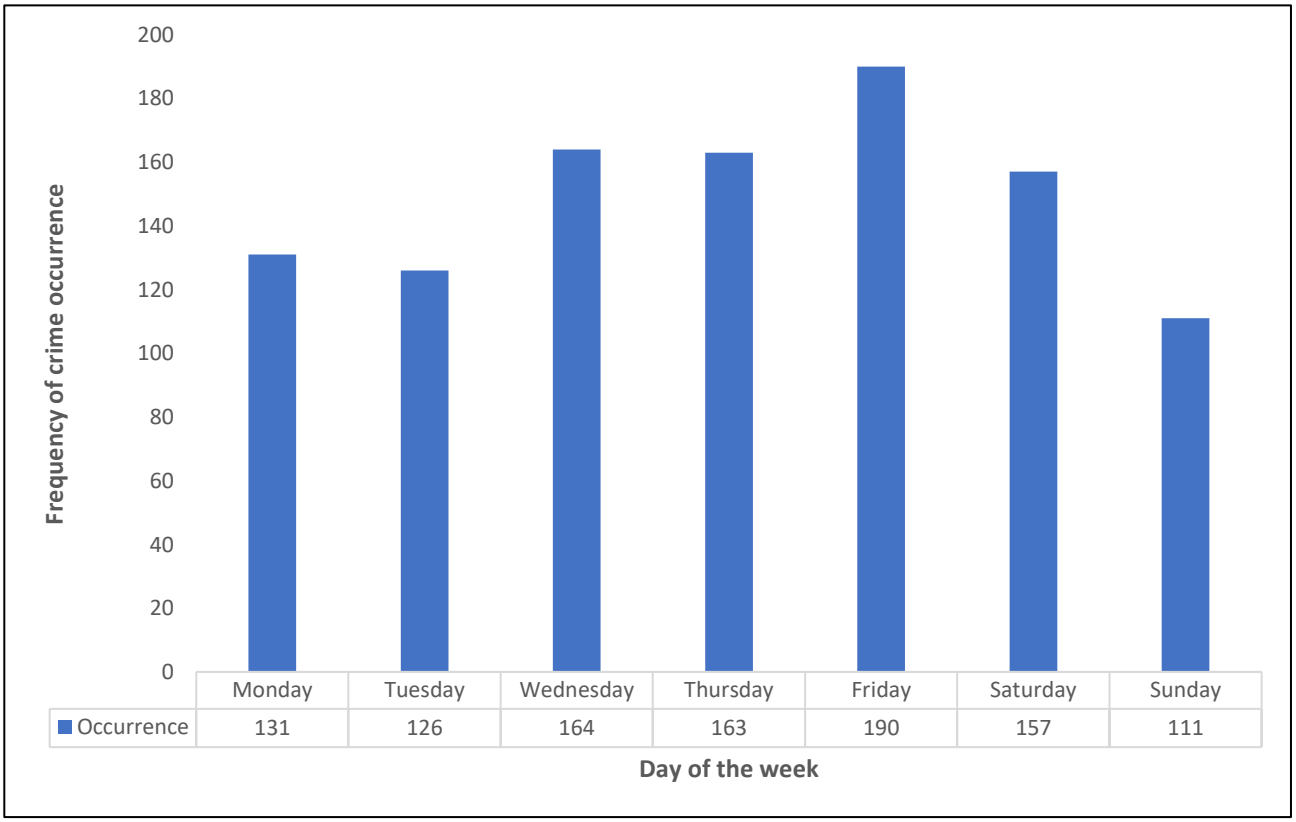

Figure 5.4.8. *The frequency of crime occurrences during the week in Makhanda for the year 2022.*

Figure 5.4.9 is a graph representing the frequency of crime occurrences in each of the four study areas. It can be seen that the most amount of crime occurs in Central and the least amount of crime occurs on the Rhodes University campus. Sunnyside and Westhill have similar intensity of crime occurrences as opposed to the other suburbs.

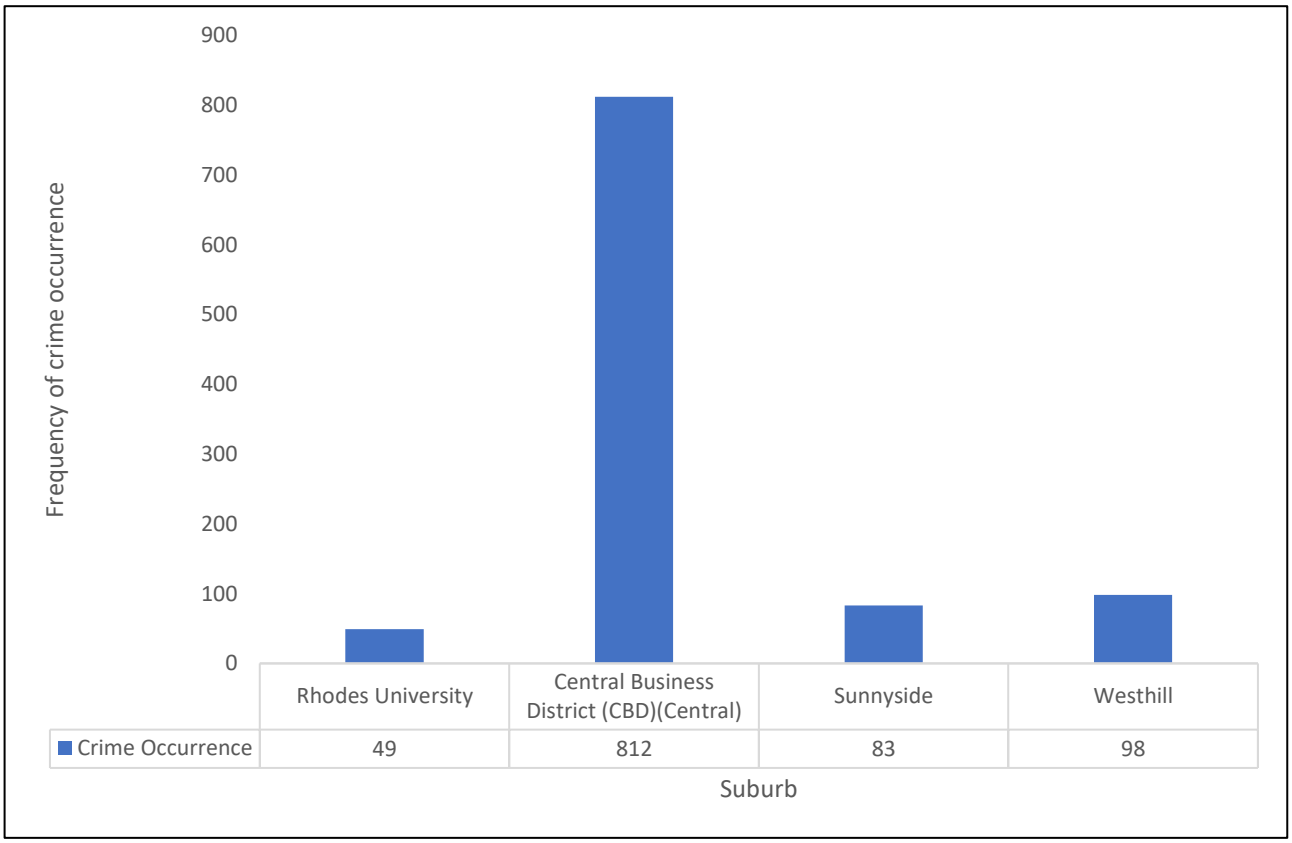

Figure 5.4.9. *The frequency of crime occurrences in the four different study areas in Makhanda for the year 2022.*

Figure 5.4.10 is a graph representing the frequency of crime occurrences for each month. It can be seen that the most amount of crime occurs in April and the least amount of crime occurs in January. There is an overall high intensity of crime in each month, especially in the second half of the year from August through to December. It should also be noted that crimes whose case was opened up in month A and expanded into a different month before the case was closed (month B) have been categorised as month A (the month in which the case was opened up).

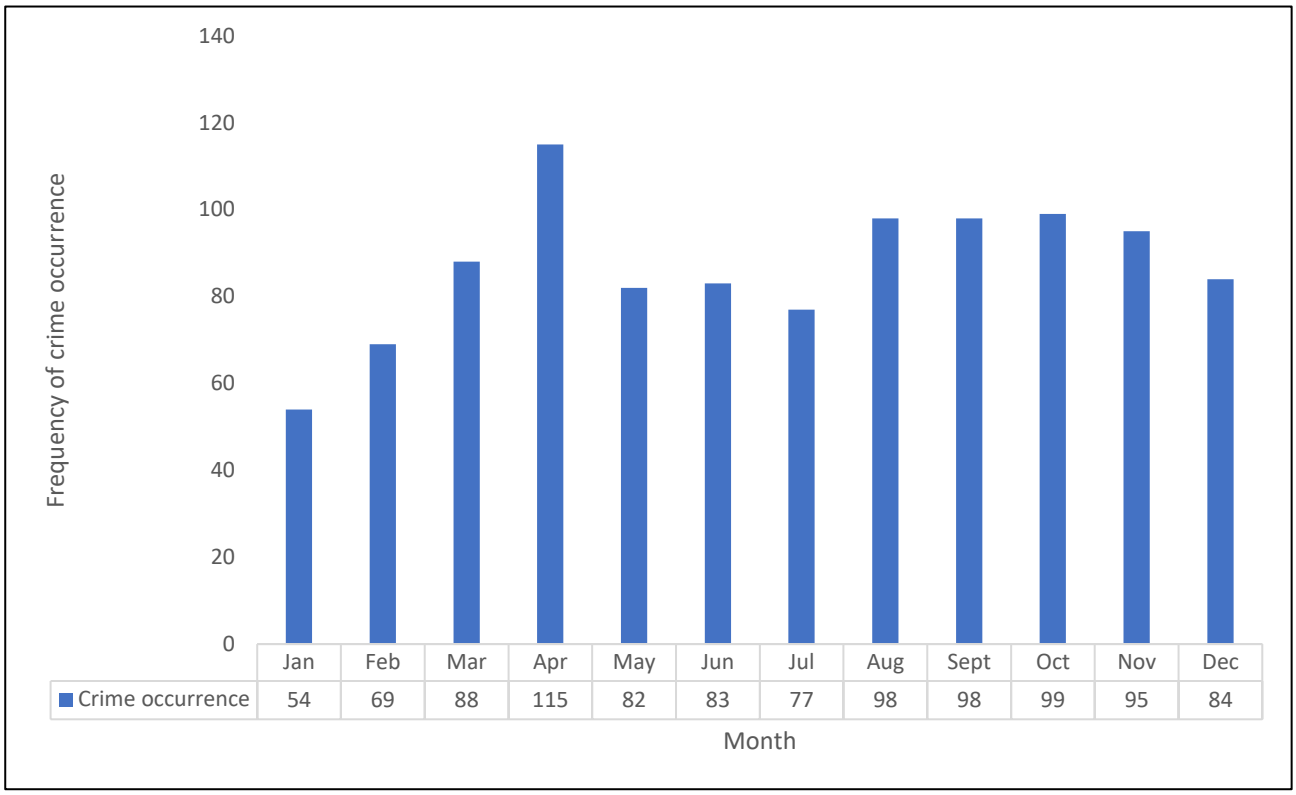

Figure 5.4.10. *The frequency of crime occurrences during each month in Makhanda for the year 2022.*

Figure 5.4.11 is a graph representing the frequency of crime occurrences for each month. It can be seen that the most amount of crime occurs during 13:00 with similar intensities occurring during 16:00 and 17:00. The least amount of crime occurs during 5:00.

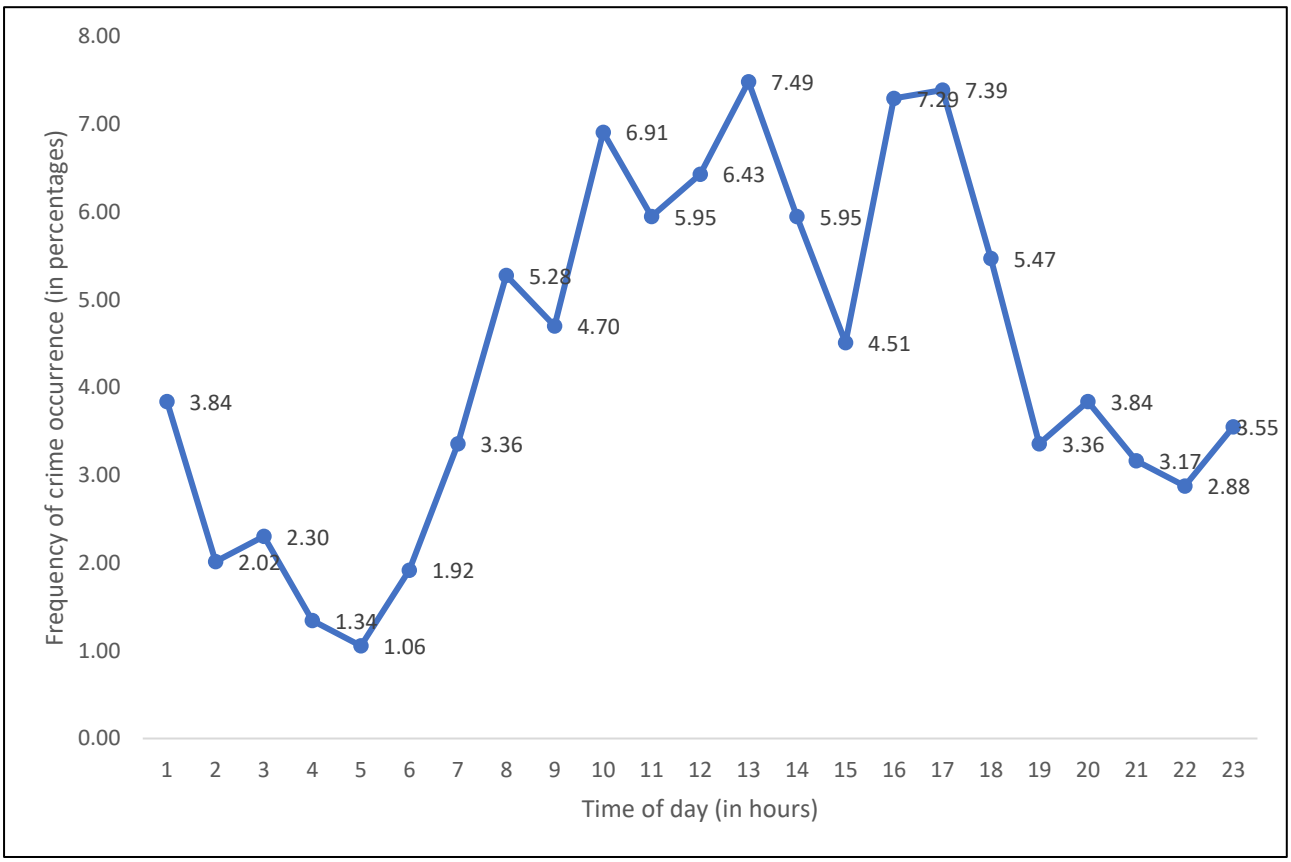

Figure 5.4.11. *The frequency of crime occurrences (shown as percentages) during each hour in Makhanda for the year 2022.*

With this being said, Sunday to Tuesday are when crime happens the least with the Rhodes University campus experiencing the least amount of crime. Furthermore, January to July are when crime happens the least with the least crime occurrences happening from 19:00 to 8:00.

Based on the seven safety and security features presented (security personnel, CCTV surveillance cameras, pedestrian visibility, bushes/vacant land, hazards, general activity levels, and the overall crimes and intensity of crimes), it can be concluded that the Rhodes University campus, Sunnyside and Westhill are the more walkable areas.

5.5. Comfort level

The fourth walkability factor that will be presented is the comfort levels. Comfort levels refers to the ease and friendliness of the walking experience. This includes the attractiveness of the surrounding environment, the cleanliness of the surrounding environment and of the sidewalks, the amount and presence of trees and plant life, and the presence of benches. It should be noted that these factors are subjective to individual walking experiences and contribute to the conduciveness of the walking experience.

In terms of the attractiveness of the buildings, Figure 5.5.1a shows an example of "good" attractiveness within the four study areas. Figure 5.5.1b shows an example of "fair" attractiveness within the four study areas. Figure

5.5.1c shows an example of “poor” attractiveness within the four study areas. when the term “good” is used, it is referring to when there are many trees along the road, there is no litter on the sidewalk, and the walls have paintings on it making it an overall pleasant walking experience. When the term “fair” is used, it is referring to when there are a couple of trees along the road, the sidewalk is not completely clean and has some litter along it, and the walls do not have paintings on it. When the term “poor” is used, it is referring to when there are no trees along the road, there is litter on the road, and the walls do not have paintings on it. It should be noted that attractiveness is subjective to the individual walking. What might be seen as attractive to one pedestrian, may not necessarily be seen as attractive to another pedestrian.

Of the 109 roads, 38 (34.86%) had good visual attractiveness, 45 (41.28%) had fair visual attractiveness, and 26 (23.85%) had poor visual attractiveness. The majority of the good attractiveness are within Sunnyside and Westhill. The majority of the fair attractiveness are within Central and Sunnyside. The majority of the poor attractiveness are within Central. With this being said, Sunnyside and Westhill are the more walkable areas, in terms of attractiveness of buildings.

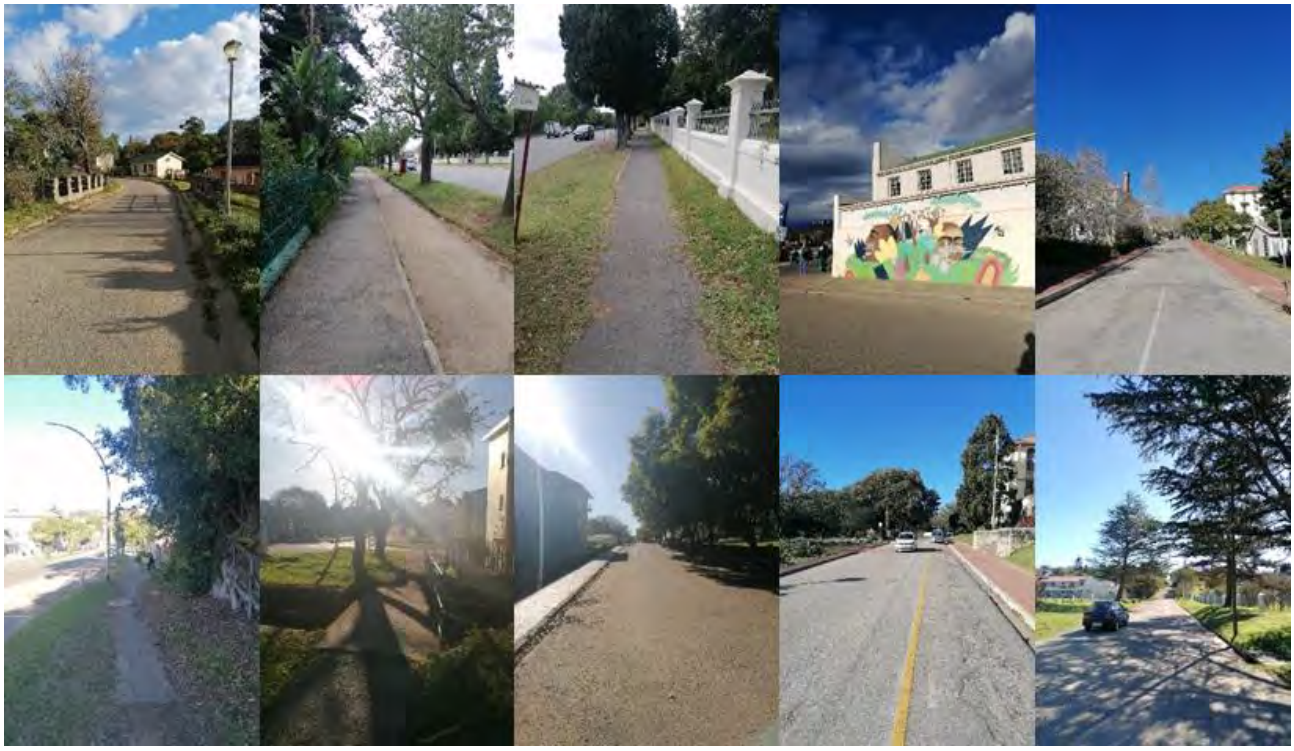

Figure 5.5.1a. *An illustration showing good attractiveness within the four study areas.*

Figure 5.5.1b. *An illustration showing fair attractiveness within the four study areas.*

Figure 5.5.1c. *An illustration showing poor attractiveness within the four study areas.*

In terms of the cleanliness of the environment, Figure 5.5.2a shows an example of "good" cleanliness within the four study areas. Figure 5.5.2b shows an example of "fair" cleanliness within the four study areas. Figure 5.5.2c shows an example of "poor" cleanliness within the four study areas. Cleanliness has been broken down

into seven factors. This includes, odor, noise, dumping, litter, the general maintenance, the amount and presence of trees, and the presence of benches.

Figure 5.5.2a. *An illustration showing good cleanliness within the four study areas.*

Figure 5.5.2b. *An illustration showing fair cleanliness within the four study areas.*

Figure 5.5.2c. *An illustration showing poor cleanliness within the four study areas.*

In terms of odor, of the 109 roads, 8 (7.34%) did have an odor or smell along the road while 101 (92.66%) had no odor or smell along the road. The majority of the odor is within Central and Sunnyside. With this being said, the Rhodes University campus and Westhill are the more walkable areas, in terms of odor.

In terms of noise, of the 109 roads, 9 (8.26%) were noisy while 100 (91.74%) were not noisy. The majority of the noise is within Central and Sunnyside. With this being said, the Rhodes University campus and Westhill are the more walkable areas, in terms of noise.

In terms of dumping, of the 109 roads, 23 (21.1%) did have dumping along the sidewalks while 86 (78.9%) did not have dumping along the sidewalks. The majority of the dumping is within Central and Sunnyside. With this being said, the Rhodes University campus and Westhill are the more walkable areas, in terms of dumping.

In terms of litter, of the 109 roads, 49 (44.95%) did have litter along the sidewalks while 60 (55.05%) did not have litter along the sidewalks. The majority of the litter are within Central and Sunnyside. With this being said, the Rhodes University campus and Westhill are the more walkable areas, in terms of litter.

General maintenance refers to how well-kept the sidewalks are. It looks at the cleanliness of the sidewalks and whether or not the grass is frequently cut. When the term “good” is used, it is referring to a clean and well-kept environment. When the term “fair” is used, it is referring to a relatively clean and well-kept environment. This means that there is some litter along the sidewalk but not so much as to be justified as a mess, and the grass is slightly overgrown. When the term “poor” is used, it is referring to an unclean and overgrown environment. Of the 109 roads, 55 (50.46%) had good general maintenance, 27 (24.77%) had fair general maintenance, and 27 (24.77%) had poor general maintenance. The majority of the good maintenance are within Sunnyside and Westhill. The majority of the fair maintenance are within Central and Sunnyside. The majority of the poor maintenance are within Central. With this being said, Sunnyside and Westhill are the more walkable areas, in terms of general maintenance.

In terms of the amount and presence of trees and plant life, when the term “many” is used, it is referring to > 5 trees along the road. When the term “few” is used, it is referring to 1-5 trees along the road. When the term “none” is used, it is referring to when there are no trees along a road. Of the 109 roads, 38 (34.86%) had many trees along the road, 44 (40.37%) had a few trees along the road, and 27 (24.77%) did not have any trees along the road. The majority of the “many” trees are within Sunnyside and Westhill. The majority of the “few” trees are within Central and Sunnyside. The majority of the “no” trees are within Central. With this being said, Sunnyside and Westhill are the more walkable areas, in terms of the presence of trees.

In terms of the presence of benches, of the 109 roads, 3 (2.75%) had benches along the sidewalks while 106 (97.25%) had no benches along the sidewalks while. Central had three benches (along Somerset Street and Beaufort Street) while Westhill (along Milner Street) had one bench. With this being said, Central and Westhill are the more walkable areas, in terms of the presence of benches.

Based on the seven cleanliness factors presented (odor, noise, dumping, litter, the general maintenance, the amount and presence of trees, and the presence of benches), it can be concluded that the Rhodes University campus, Sunnyside and Westhill are the more walkable areas.

5.6. Sidewalk connectivity

A sidewalk connectivity analysis is done so that an analysis can be made on which areas have a greater presence of intersecting sidewalks. This is important as it shows the density of the intersections as well as which routes pedestrians might prefer as it bypasses each other, thus allowing for a shorter travel distance.

Figure 5.6.1 shows a map of the sidewalk connectivity within the four study areas. Each point represents an intersection between roads. The sidewalk presence is represented by the brown colour while the points of connectivity are represented by the blue dots.

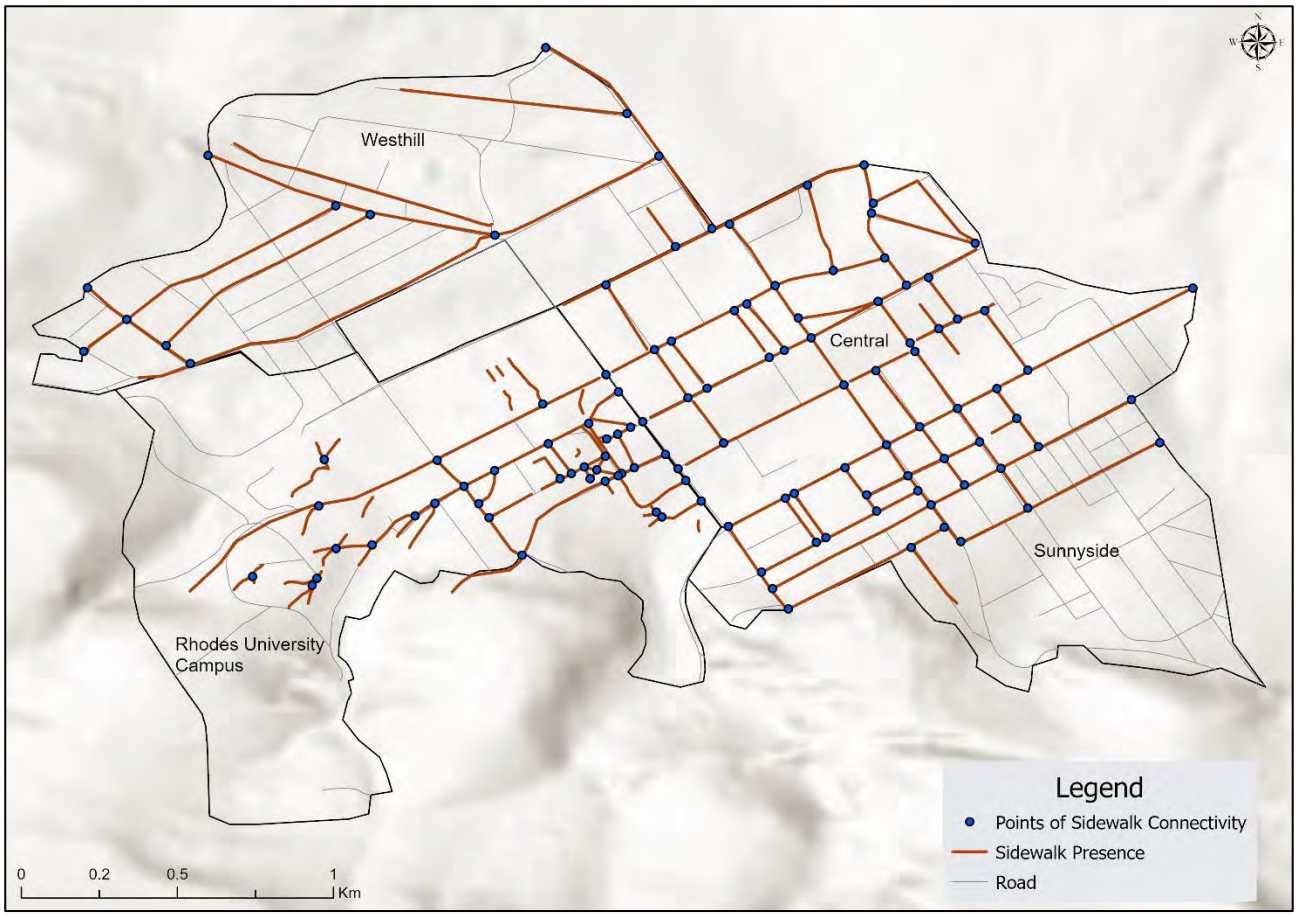

Figure 5.6.1. *The sidewalk connectivity within the four study areas.*

Figure 5.6.2 shows a kernel density map of the sidewalk connectivity within the four study areas. The grey colour represents areas of low density. The light purple represents areas of medium density. The dark purple represents areas of high density.

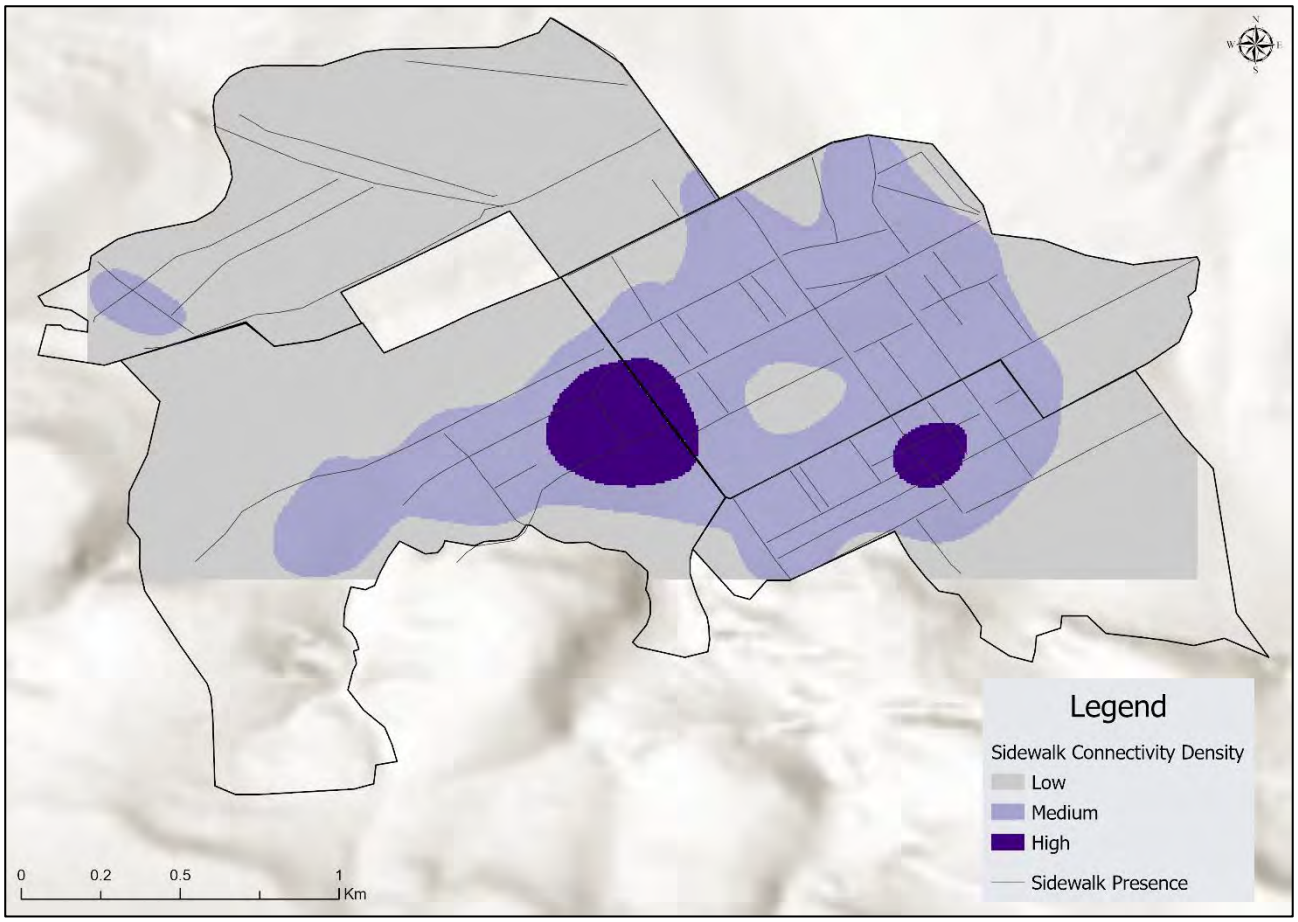

Figure 5.6.2. *The sidewalk connectivity density within the four study areas.*

As can be seen by Figure 5.6.1 and Figure 5.6.2, there is a high concentration of sidewalk connectivity within the eastern parts of the Rhodes University campus and Sunnyside. There is a medium concentration of sidewalk connectivity within the western parts of the Rhodes University campus, Central, Sunnyside, and the western part of Westhill. There is a low concentration of sidewalk connectivity within Westhill. With that being said, the Rhodes University campus, Central, and Sunnyside are the more walkable areas, in terms of sidewalk connectivity.

5.7. Proposed walkability index

This following chapter is presentation of which areas are more versus less walkable, based on these walkability factors discussed above. Table 4 shows the walkability index created for this study. This study has chosen to rate each walkability variable on a scale of 0-10, with 0-3 being poor, 4-6 being sufficient, and 7-10 being good. It should be noted that these scores are as a result of a spatial analysis of the existing walking infrastructure and does not include student perceptions of walkability. Different variables were ranked as being more important than others and based on their importance, an assigned weight will be given to them. Once this assigned weight is added to the index, the overall score will change for each variable.

The Rhodes University campus is the most walkable area (70.71%). The second most walkable area is Westhill (60%). The third most walkable area is Sunnyside (52.5%). Central is the least walkable area (52.14%). On the Rhodes University campus, the highest scores were found in the diversity of amenities, sidewalk width, continuity and coverage, sidewalk condition, traffic calming measures, lighting, security personnel, general activity levels, crimes and intensity of crime, attractiveness, cleanliness, odor, noise, dumping, and litter. The lowest scores were found in the presence of sidewalks, slope, visibility of markings, pedestrian visibility, and benches. In Central, the highest scores were found in the diversity of amenities, presence of sidewalk, slope, traffic calming measures, and sidewalk connectivity. The lowest scores were found in encroachment, visibility of markings, traffic volume, lighting, security personnel, CCTV surveillance cameras, hazards, crimes and intensity of crimes, and benches. In the Sunnyside area, the highest scores were found in slope, traffic volume, security personnel, odor, noise, general maintenance, and trees. The lowest scores were found in the diversity of amenities, continuity and coverage, encroachment, traffic calming measures, visibility of markings, lighting, CCTV surveillance cameras, bushes/vacant lant, crimes and intensity of crimes, and benches. In the Westhill area, the highest scores were found in the sidewalk width, slope, encroachment, pedestrian visibility, cleanliness, odor, noise, dumping, litter, general maintenance, and trees. The lowest scores were found in the diversity of amenities, presence of sidewalk, traffic calming measures, lighting, CCTV surveillance cameras, bushes/vacant land, crimes and intensity of crime, benches, and sidewalk connectivity. The most common issues that all four study areas face and have low walkability scores in are benches and visibility of markings. The Rhodes University campus has a significantly higher walkability score as compared to the other three study areas and, thus, does not have many common issues. The most common issues that Central, Sunnyside, and Westhill face are continuity and coverage, sidewalk condition, encroachment, lighting, CCTV surveillance cameras, bushes/vacant land, hazards, general activity levels, and crimes and intensity of crimes. There are some issues that arise solely within the residential areas of Sunnyside and Westhill. These include, the diversity of amenities, presence of sidewalks, and traffic calming measures. To conclude, the most change and/or improvement in infrastructure needs to happen within the category of pedestrian safety and security.

Table 4. *The proposed walkability index used in this study.*

	Rhodes University Campus	Central Business District (Central)	Sunnyside	Westhill
Diversity of Amenities	8	9	2	1
Sidewalk Conditions				
Presence of Sidewalk	3	8	5	3
Sidewalk Width	9	7	6	8
Continuity and Coverage	8	6	4	5
Sidewalk Condition	8	5	6	7
Slope	4	9	8	9
Encroachment	5	1	3	8
Pedestrian Safety and Security				
Traffic Calming Measures	10	8	3	3
Visibility of Markings	2	4	3	5
Traffic Volume	6	4	8	7
Lighting	9	2	1	0
Security Personnel	9	4	8	7
CCTV Surveillance Cameras	7	1	1	1
Pedestrian Visibility	3	5	6	8
Bushes/Vacant Land	7	5	3	3
Hazards	7	3	5	6
General Activity Levels	8	6	7	6
Crimes and Intensity of Crime	8	2	3	4
Comfort Level				
Attractiveness	8	6	7	7
Cleanliness	8	5	6	8
Odor	10	7	8	10
Noise	10	7	8	10
Dumping	10	5	7	10
Litter	10	5	7	10
General Maintenance	7	6	8	9
Trees	7	6	8	9
Benches	0	1	0	1
Sidewalk Connectivity	7	9	6	3
TOTAL SCORE	**198**	**146**	**147**	**168**
NORMALISED SCORE (%)	**70.71%**	**52.14%**	**52.5%**	**60%**

5.8. Conclusion

This chapter highlighted the results of Objective 1, which was a survey and spatial analysis of the levels of walkability within the Rhodes University campus, Central, Sunnyside, and Westhill. This chapter commenced with a presentation of the diversity of amenities found within the four study areas. The Rhodes University campus and Central are characterised by high concentrations of amenities, particularly in the lower parts of campus and along African Street, Somerset Street, New Street, and High Street. This is where a mix of student accommodation, lecture theatres, shopping centres, cafes, and restaurants are concentrated. In contrast to this, Sunnyside and Westhill are primarily residential with fewer amenities.

In terms of sidewalk presence, the Rhodes University campus, Central and northern parts of Sunnyside are the most walkable. Sidewalk width is generally more favourable on the Rhodes University campus and Westhill, while verge width is better within the Rhodes University campus, Central and Sunnyside. When assessing continuity and coverage, the Rhodes University campus, eastern parts of Central, and southern parts of Westhill are the most walkable. Sidewalk conditions (evenness) are generally better in the southern parts of Sunnyside and Westhill whereas sidewalk conditions (overgrowth) are better within the Rhodes University campus, southern parts of Sunnyside and Westhill. The overall sidewalk condition shows that the Rhodes University campus is the most walkable. The slope of sidewalks is mostly gentle and flat in Central, Sunnyside and Westhill, making these areas more walkable. Encroachment is most prevalent in Central due to street vendors and advertising materials, whereas the southern parts of the Rhodes University campus and Westhill experience less obstructions.

Traffic calming measures are more prevalent around schools, with the Rhodes University campus and Central being the most walkable. However, a significant portion of roads across all areas lack basic safety features like traffic signals and pedestrian crossings. In terms of visibility of markings, the eastern parts of Central and the Westhill area are the more walkable areas. Traffic volume is less high on the Rhodes University campus, southern parts of Sunnyside and Westhill. Lighting is poor throughout all four study areas, but the Rhodes University campus has generally good lighting. The Rhodes University campus is the most walkable when it comes to CCTV surveillance cameras. In terms of pedestrian visibility, the southern and northern parts of Sunnyside and Westhill are more walkable while in terms of bushes/vacant land, the Rhodes University campus, western parts of Central, eastern parts of Sunnyside and Westhill are more walkable. The Rhodes University campus and Westhill has less hazards compared to the other study areas. When assessing general activity levels, the eastern parts of Central, Sunnyside and Westhill are the most walkable areas. Crime and intensity levels show that the middle of the week towards the end of the week is when the most amount of crime occurs. Additionally, April is when most crime occurs with an overall high intensity from August to December. Furthermore, the most amount of crime occurs during 13:00, 16:00 and 17:00. The overall safety and security shows that the Rhodes University campus, Sunnyside and Westhill is the most walkable area.

In terms of attractiveness, Sunnyside and Westhill are the most walkable areas while Central has the least attractive roads. When assessing cleanliness which include odor, noise, dumping, litter, general maintenance, and amount and presence of trees and benches, it was found that the Rhodes University campus, Sunnyside and Westhill are the most walkable areas.

The eastern parts of the Rhodes University campus and Sunnyside exhibit a high concentration of sidewalk connectivity, making these areas more walkable.

Lastly, a presentation of which areas are more versus less walkable was summarised. The Rhodes University campus emerged as the most walkable area (70.71%), followed by Westhill (60%), Sunnyside (52.5%), with Central being the least walkable area (52.14%). The study concludes that significant infrastructure improvements are required in pedestrian safety and security. Having considered a survey and spatial analysis of the levels of walkability within the four study areas, the next chapter will focus on investigating the student perceptions of walkability.

Chapter 6: Results - Student Perceptions of Walkability

6.1. Introduction

The previous chapter highlighted the results of Objective 1, which looked at a survey and spatial analysis of the levels of walkability within the Rhodes University campus, Central, Sunnyside, and Westhill. This chapter will present the results of Objective 2, which is to investigate the student perceptions of walkability in the four study areas. This will be supplemented with key informants (the Rhodes University Campus Protection Unit, the Makana Municipality Planner, Hi-Tec Security, Smhart Security, and the Crime Policing Forum) where they discuss student safety issues and their responses to it. This chapter will, commence with a presentation of the reasons for walking. It is important to note why students walk and what their main reasons for walking is. This is because motivations for walking influences how, when, and where people choose to walk. Following this, the perceptions of walkability will be explored. This informs the study as to how students feel about the walking infrastructure and whether it is conducive, safe and comfortable. Furthermore, the study gains insight on their walking experiences and which walkability factors should be prioritised for improvement. Thirdly, the more versus less perceived walkable spaces will be looked at. This is important as these areas are where students walk the most. Therefore, these areas should be prioritised when walking infrastructure changes are made. Fourth, a discussion of the student recommendations to improve walkability will be done. Changes should not be made without consulting the community it directly involves and when changes are done, they should cater to the community. It is, therefore, important to note these recommendations as they are coming from the walking community themselves. Lastly, the key informant responses to safety and security will be explored. It is important to note whether people in power have the same viewpoints as they community and what measures that have and will be putting in place to make a safer walking environment. This chapter will conclude with a summation of the key arguments presented in terms of the student perceptions of walkability within the chapter. Additionally, a presentation of an updated version of the proposed walkability index will be looked at, having taken into account student perceptions of which walkability variables are considered as more important than others.

6.2. Reasons for walking

Of the 60 students, 57 (95%) students use walking as their main made of transport, because it is their only option. These students also walk because their main amenities are within close proximity to where they reside. They tend to only use public transport or cab services if they have a lot of groceries to carry or if it is late at night.

Additionally, students were asked to indicate if they walked for utility, physical exercise or leisure purposes. All 60 students walk for utility purposes. In addition, 17 (28.33%) students stated that they walk for physical exercise, and 31 (51.67%) students did so for leisure purposes.

6.3. Perceptions of walkability

Students were asked to note whether any of the proposed walkability factors played a role in the routes they take as part of their walking journey. The results showed that 50 (83.33%) students said that walkability factors did play a role in the routes they take, while the rest did not consider walkability as a factor in their decision-making.

When asked whether any of the walkability factors played a role in their choice of residential location, 26 (43.33%) students said that walkability factors played a minor role in their choice of residential location, while the remaining 34 (56.67%) students said that walkability factors did not play any role. The main walkability factor that students noted was the proximity and time it takes to reach their destination. Students prefer to live close to their main amenities because they have to walk. Apart from this, students also mentioned safety as a role. Students prefer to live in areas in which they perceive as being relatively safe because of visible security and the presence of people.

Students were asked to give opinions based on their experiences in terms of which walkability factors they thought were important as well as which walkability factors they thought both added and reduced walkability. For the purpose of these results, these walkability factors were categorised into three walkability measures. These walkability measures include, sidewalk condition, pedestrian safety and security, and comfort levels.

Students rated walkability variables and their importance in their walking activity or choice of route. These walkability variables were rated on a likert scale from strongly disagree to strongly agree. The likert scale can be seen in Appendix B. Figure 6.3.1 is a graph representing the average of the student ratings. None of the students gave ratings of strongly disagree and disagree to any of the walkability variables. Students rated sidewalk conditions and pedestrian safety and security as being the most important walkability variables, while comfort levels have almost similar ratings of neutral, agree and strongly agree, respectively. However, it is important to note that pedestrian safety and security is by far the most important walkability factor, with 54 (90%) of students strongly agreeing.

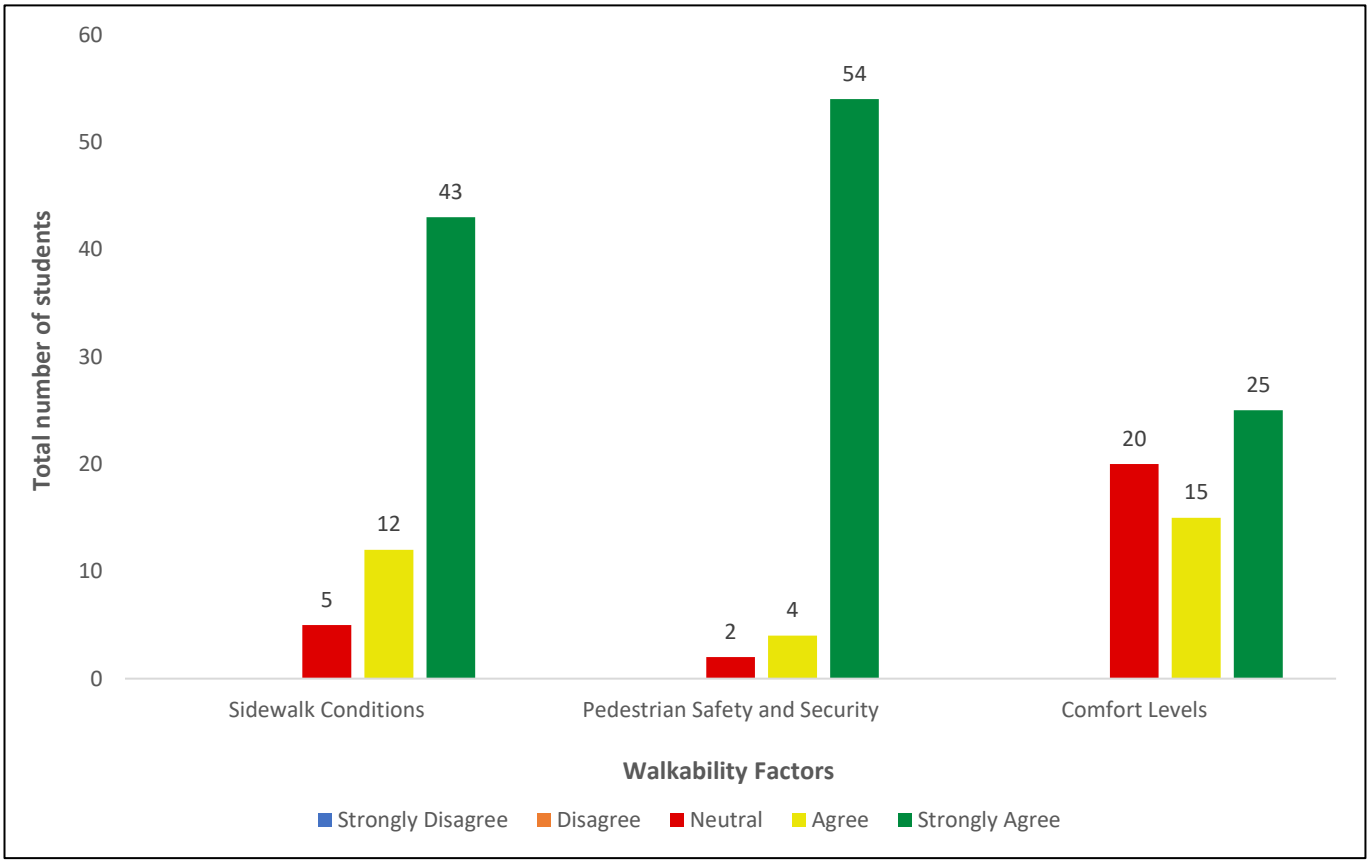

Figure 6.3.1. *An average of the student rated walkability variables according to their importance in their walking activity or choice of route.*

The first factor is the sidewalk condition. Figure 6.3.2 shows the student rated walkability variables for this factor. The results showed that 5 (8.33%) were neutral, 12 (20%) agreed and 43 (71.67%) strongly agreed to the importance of this factor (Figure 6.3.1). The most important walkability factors in this category for students are the presence (80% strongly agreed), evenness (68.33% strongly agreed), and maintenance of the sidewalks (70% strongly agreed). This is because students have to walk on the road when there is not a sidewalk and that poses a safety issue. Students also find that where the sidewalk is in poor condition and has too many bumps and breakages in the paved sidewalks, they have to either walk on the road or risk being uncomfortable with the uneven and damaged sidewalks which makes their walking experience unpleasant. The least important walkability factors are the width of the sidewalk, barriers on the sidewalk and slope. Students also mentioned that the road condition is an important factor because of the lack of sidewalk presence in smaller roads and in residential areas. To summarise, these factors were highly ranked overall, with above 50% of students strongly agreeing. This can also be seen in the average rating for sidewalk conditions (71.67%) in Figure 6.3.1.

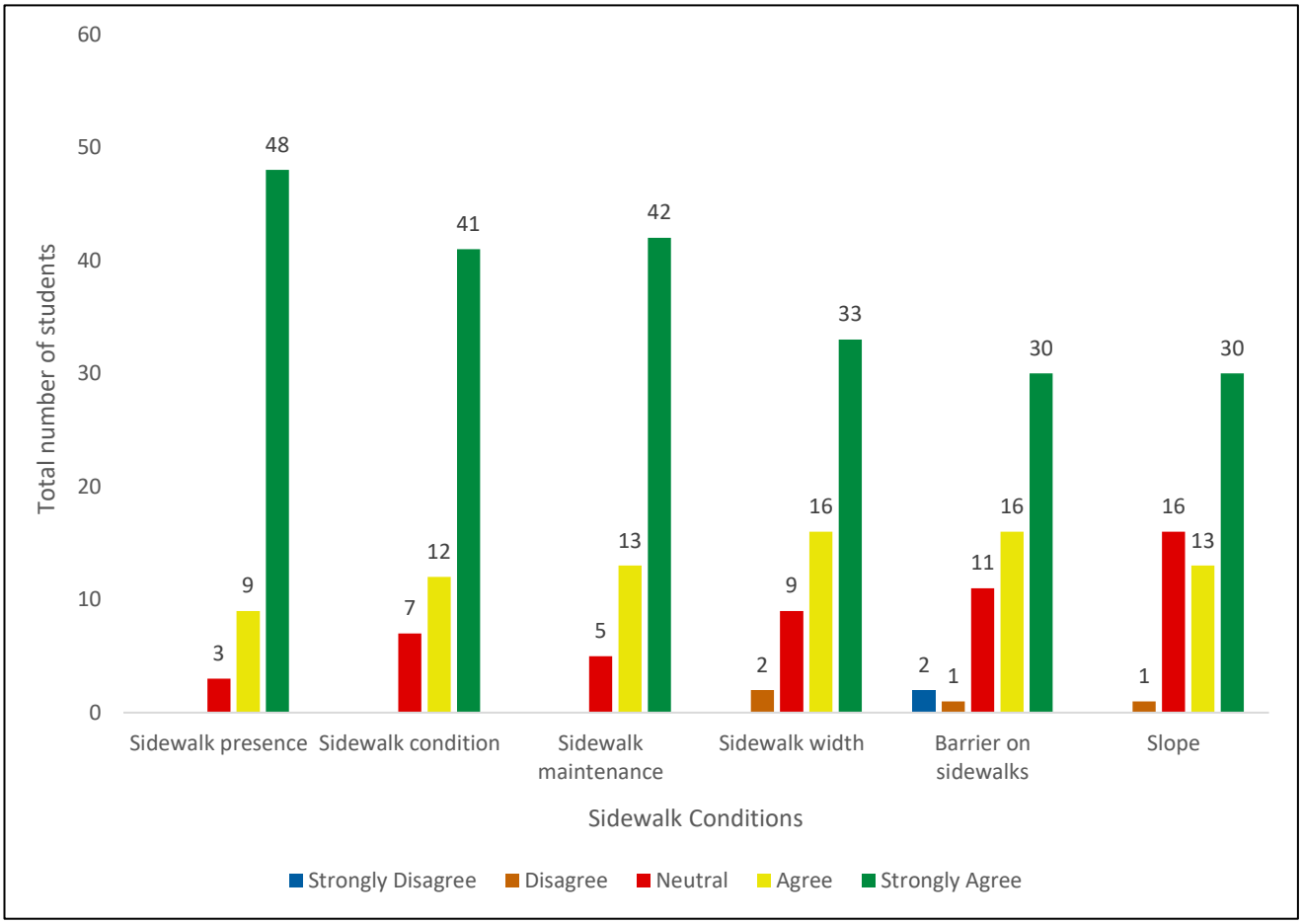

Figure 6.3.2. *Student rated walkability variables in terms of sidewalk conditions, according to their importance in their walking activity or choice of route.*

The second factor is pedestrian safety and security. Figure 6.3.3 shows the student rated walkability variables for this factor. The results showed that 2 (3.33%) were neutral, 4 (6.67%) agreed, and 54 (90%) strongly agreed to the importance of this factor (Figure 6.3.1). The most important walkability factors in this category for students are the pedestrian crossings (63.33% strongly agreed), crime (95% strongly agreed), security features (73.33% strongly agreed), lighting (96.67% strongly agreed), the presence of people (63.33% strongly agreed), and pedestrian visibility (80% strongly agreed). Students felt that the lack of pedestrian crossings combined with inconsiderate drivers made it difficult and unsafe to cross the road and they had to often wait extended periods of time before they could move. With the lack of lighting, students noted that there are no working street lights mainly within Central, Sunnyside, and Westhill. Due to this, students feel unsafe walking at night because they cannot see the roads clearly nor what it is front of them. Furthermore, with an increase in crime rates and a lack of security features outside of campus combined with a lack of lighting, student feel unsafe at night more so than they do during the day when it is bright outside. This is because students are more vulnerable at night because they are unable to see. Additionally, students said that pedestrian visibility is important because of the increased crime incidences that have been occurring. When there is a lack of lighting and a lack of visible security, the opportunity for crime to occur increases. In terms of the presence of people, students expressed that they feel that more people make a road safer, and less people and quiet roads add to a less safe environment. This is because students felt that it depends on what type of people are present on the road. If they feel that the people they see on the road look like other students or working adults, they feel safe, but if

the people they see on the road are homeless and engage in begging, they feel less safe. The least important walkability factors are bushes/vacant land, and traffic safety measures. According to the CPU, safety is a concern on the Rhodes University campus, and they use several means to increase safety. In Central, Sunnyside and Westhill, two private security companies (Hi-Tec Security and Smhart Security) operate to support residents and businesses. Both acknowledge that safety while walking is an issue for residents and this needs to be improved. To summarise, these factors were highly ranked overall, with above 50% of students strongly agreeing. This can also be seen in the average rating for pedestrian safety and security (90%) in Figure 6.3.1.

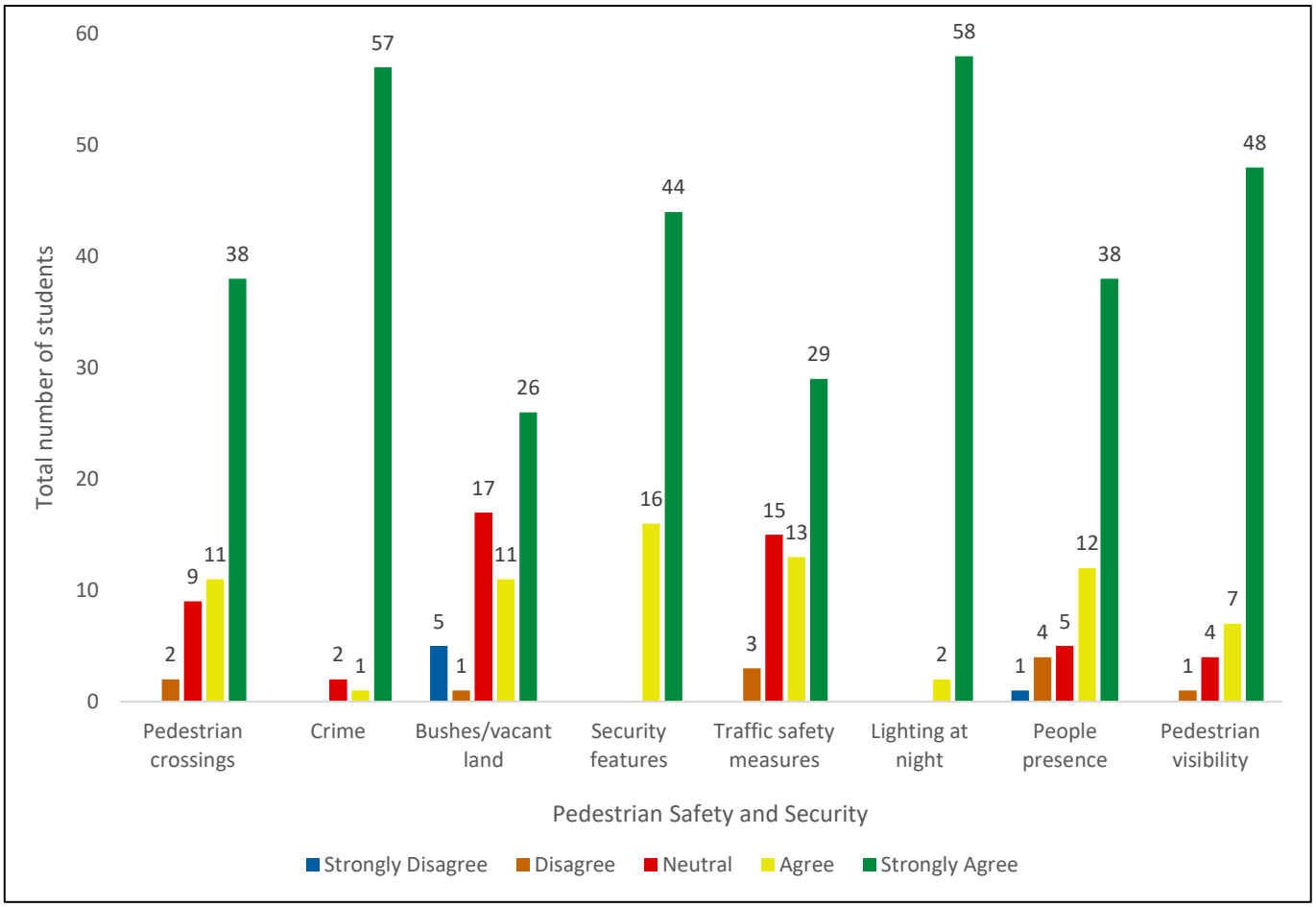

Figure 6.3.3. *Student rated walkability variables in terms of pedestrian safety and security, according to their importance in their walking activity or choice of route.*

The third factor is comfort levels. Figure 6.3.4 shows the student rated walkability variables for this factor. The results showed that 20 (33.33%) were neutral, 15 (25%) agreed and 25 (41.67%) strongly agreed to the importance of this factor (Figure 6.3.1). The most important walkability factors in this category for students are the distance/proximity it takes to reach their destination (45% strongly agreed), odor/smell of the surrounding environment (45% strongly agreed), and litter/dumping on the sidewalks (65% strongly agreed). Students prefer to travel the shortest distance possible to get to a destination and if the distance is long, students felt less motivated to walk, especially in poor walking infrastructure and unsafe environments. Additionally, students felt that odor from sewerage or potholes filled with dirty, still water, and litter strewn across the sidewalk made their walking journey

less enjoyable. The least important walkability factors are benches, attractiveness of the environment, the weather, and noise levels. As defined by the Makana Municipal Planner, the conditions of the walkability infrastructure are not high, but certain streets are better than others. To summarise, these factors were highly ranked overall, with above 50% of students strongly agreeing. However, this walkability variable is less highly ranked than the other two factors. This can also be seen in the average rating for comfort levels (41.67%) in Figure 6.3.1.

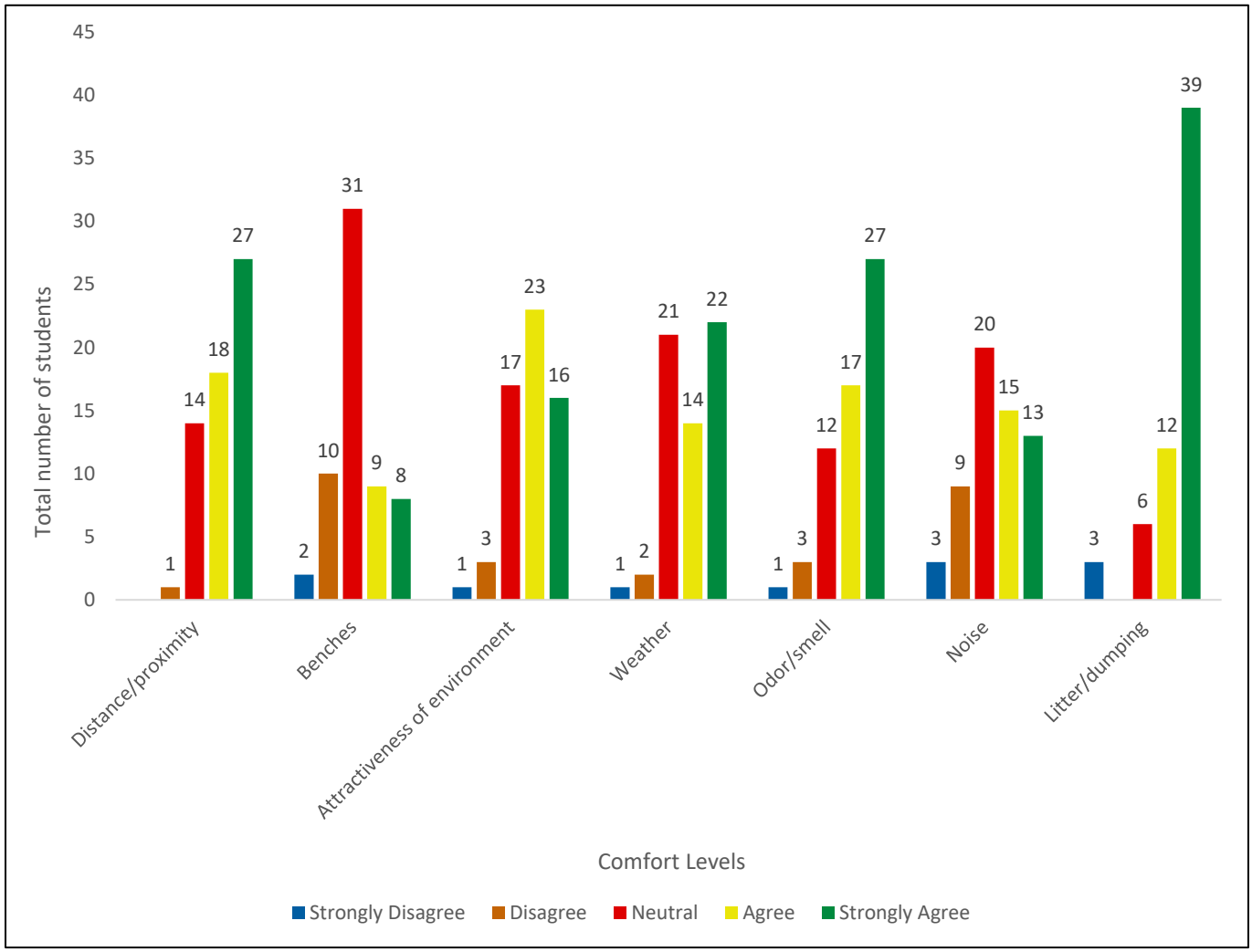

Figure 6.3.4. *Student rated walkability variables in terms of comfort levels, according to their importance in their walking activity or choice of route.*

6.4. More versus less walkable spaces

Figure 6.4.1 is a map representing student perceptions of the more versus less walkable roads as perceived by students. The more walkable roads are mainly found within the Rhodes University campus and Sunnyside while the less walkable roads are mainly found within Central.

The more walkable roads are Worcester Street, Lawrence Street, Donkin Street, Market Street, Croft Street, Prince Alfred Street, New Street, High Street, Somerset Street, Beaufort Street, Hillsview, Constitution Street, Drodsty Road, Lucas Avenue, Milner Street, Rhodes Avenue, Cross Street, South Street, Artillery Road, and the informal

pathways around campus. The common walkability factors that students noted within these roads that they felt made it more walkable are the evenness of the sidewalk and the presence of people. Students also mentioned that the slope played a role. These roads that either gentle or flat slopes that make the walking experience more pleasant. The main roads have visible security and traffic safety measures which students felt added to the feelings of safety and the overall walking experience. Students noted that routes around campus is where they feel the most comfortable because of lighting, visible security and the presence of people.

The less walkable roads are Huntly Street, Scotts Avenue, Hill Street, Warren Street, African Street, Allen Street, Bertram Street, Coles Lane, Anglo-African Street, Glanville Street, and Bartholomew Street. The common walkability factors that students noted within these roads that they felt made it less walkable are the unevenness of the sidewalk, the lack of lighting, the unclean sidewalks, the lack of visible security, and the presence of people.

Students have noted that walkability depends on the time of day because of safety issues at night. Students felt that certain roads were more walkable during the day, but less walkable during the night because of lighting and visible security. These roads include, Hill Street, Somerset Street, Worcester Street, Beaufort Street, New Street, High Street, African Street, Prince Alfred Street, Hill Street, and Scotts Avenue. These roads are the most intensely used roads as can be seen in Chapter 7.4. While students feel that these roads are unsafe, they still walk on it, because they do not have alternative options. Students tend to use the fastest and most convenient roads, and while they do pose safety issues, it gets students to their destination the quickest. Students mentioned that they will sometimes risk their safety, instead of taking a longer route.

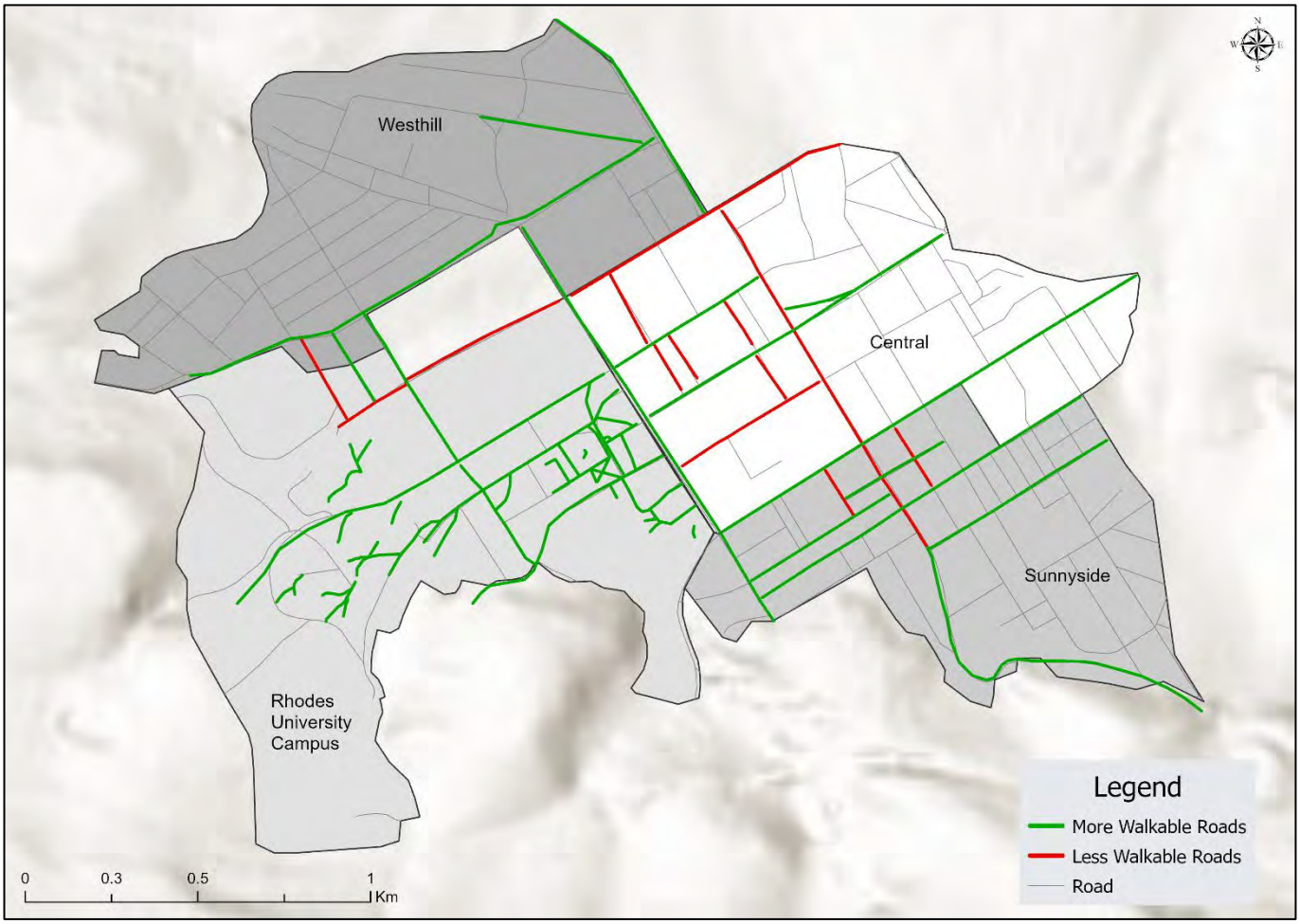

Figure 6.4.1. *The more versus less walkable roads as perceived by students.*

The views of the students align with the views of the key informants. The Blue Route spans the entirety of Prince Alfred Street and students are encouraged to use this route because it is safe, has efficient security features such as CCTV cameras and SOS buttons, and lighting (CPU, 2023). Students are discouraged from using African Street, especially in the early hours of the morning and night because it is not well-lit. They have noted that there have been a few mugging cases and there are no campus patrols in African Street, because it is considered as a public street (CPU, 2023). Additionally, the CPU has no jurisdiction in public streets. They have also discouraged students from walking in isolated areas during the evening because it is unsafe. The Makana Municipal Planner noted that Somerset Street and New Street are more walkable spaces, while the connecting streets such as Scotts Avenue and Allen Street are less walkable spaces and not pedestrian-friendly. This is because the sidewalks are not wide enough and there are no walkability infrastructure in those streets. Certain streets and areas are more walkable than others, and different spaces provoke different feelings in people as they walk into those spaces (Makana Municipal Planner, 2023). In terms of Central, Somerset Street is the most walkable street because it is wide enough for pedestrians and has visible pedestrian markings. Overall Central is walkable, but it depends which street you are walking on. Some streets have wide enough sidewalks, but others have very narrow sidewalks or no sidewalks at all (Makana Municipal Planner, 2023). In terms of Sunnyside, because it is a residential area, it is quieter and because of the quietness, the safety is low. However, the Sunnyside area is more comfortable because there is shading from the trees. In terms of Westhill, the area is safer because of private security, even though it is also a quiet area (Makana Municipal Planner, 2023).

As noted by Hi-Tec Security, majority of the areas are unsafe, with Oatlands (outside the scope of this study) being one of the safest areas in Makhanda because they have cameras. Similarly, Smhart Security noted that Sunnyside is safe, and while there are no streetlights and sidewalks, it is safe during the day. Smhart Security noted that people need to be aware in Central, especially on upper New Street because of the car guards. While private security companies have done well in trying to prevent crime in Market Square, a lot still needs to be done. Another crime hotspot noted is New Street. Crime on New Street mainly occurs in the early mornings and at night.

6.5. Student recommendations to improve walkability

Students were asked to provide their own recommendations based on their walking experiences. Table 5 shows these recommendations. They have been categorised for easier understanding. The noteworthy recommendations that students have mentioned and that were repeated amongst majority of the students have been highlighted in bold and mainly fall within the pedestrian safety and security category.

Table 5. *Student recommendations on how to improve walkability.*

Category	Student recommendations
Sidewalk connectivity	• Better designation between the sidewalk and road • **Better maintenance of the sidewalks** • **Fixing of potholes on the roads**
Pedestrian safety and security	• **Better lighting** • **More visible security** • **More SOS buttons and CCTV cameras** • More functional safety measures • Better control of pedestrian congestion on the sidewalks • **More traffic lights** • Better use of vacant land and hidden corners • Implementation of solar-powered lights, especially for the night • More traffic control measures • Installation of gates on campus to make it a closed university • Better maintenance of these speed humps and pedestrian crossings • More sheds for security personnel • Better implementation of road rules
Comfort Levels	• Fixing of sewerage issues • Cleaner spaces and better maintenance of these spaces • More green spaces • More bins along the sidewalks • More benches along the sidewalks • More murals on the walls
Transportation	• More efficient public transport • Transportation provided by the university to travel between upper and lower campus • More university transport on campus for off-campus students
Community support	• **Provide on job opportunities for people on the street (street beggars)** • Better consultation between local stakeholders and the community to see what needs fixing and improving • Strengthen governmental bodies in charge

6.6. Rhodes University, Makana municipality and security companies response to safety and security

As noted by the CPU, crime has been a challenge. Car guards tend to commit crimes after hours, and the evenings are especially a problem, because they look for vulnerable students (J. Majotya, personal communication, 6 November, 2023). Due to this, the CPU encourages students to walk in a buddy system of three to four people. It was also noted that the CPU does not have plans to make the campus space more walkable at this stage, and that they might look into this with the municipality because African Street is considered to be a municipal road. The CPU does, however, have cameras on African Street and SOS buttons which they plan to expand to more in the long run. Additionally, there are crime awareness sessions where safety issues are discussed and what they can do to help students (J. Majotya, personal communication, 6 November, 2023). Furthermore, they have installed cameras, SOS panic buttons which are patrolled with the addition of installing intercoms in the works, and they have a WhatsApp line for students that goes directly to the control room. The CPU notes that communication is the solution, and they tell students to not expose their gadgets, however, the onus is on them to apply that advice. It is not all about security, but also about the students feeling safe, and so the CPU has security awareness sessions twice a year for students to attend. In terms of the cameras and SOS buttons, the CPU has a company and service-level agreement with good IT infrastructure units to make sure the cameras are up to standard. The SOS buttons on campus are serviced every second day. The defective SOS buttons are noted and the service provider is notified immediately. In terms of visible security, the CPU is in collaboration with Hi-Tec Security to provide security on campus. In terms of lighting, there is a routine maintenance (J. Majotya, personal communication, 6 November, 2023). Every Sunday, a report is compiled to the Manager of Electrical Infrastructure where they compile a risk assessment report. Additionally, the CPU has a risk mitigation strategy, and part of this strategy is placing high mast lights strategically around campus with these mask lights being connected to generators. Furthermore, the CPU offices are still connected to the Eduroam internet network during loadshedding so that students can still get a hold of them if necessary. They have brought the crime risk down from 80% to 50%, however on campus, they are still striving to stop the lack of lighting. In regards to town, the CPU noted that the infrastructure needs to be looked at because darkness encourages crime and lighting discourages crime. The CPU offices also provide escorting services to on-campus students. They encourage students living on campus to phone CPU to escort them to their residences if they do not feel safe or comfortable. Off-campus students have university transport available to them in the case that they do not want to walk alone at night.

According to Hi-Tec Security, safety plays a big part in walkability and people need to choose which route to take and know their surroundings. This is because there is a bigger opportunity for crime at night. They are implementing SOS buttons and community guards. Apart from this, they have a buzzer app that they want to limit to students only (K. Knoetze, personal communication, 3 November, 2023). Additionally, Hi-Tec Security has an open policy with their contact number, and they are wanting to put more visible security around Makhanda. In terms of this, they have the same amount of patrollers, but they want to redirect them to different areas.

According to Smhart Security, the sidewalks are big enough for people, however they are uneven. Furthermore, there are potholes on the roads, the streetlights are non-existent, and there are a lot of open manhole covers. The interviewee said that they would not personally walk at night because of the lack of lighting, however, they do have response

units patrolling everywhere. As noted by Smhart Security, their response vehicles are placed at certain times around Central and the two residential areas (Sunnyside and Westhill). Smhart Security has patrolling guards as well as standing guards who wait for crime to occur. These standing guards are mainly found where there are open fields and premises (J. Terblanche, personal communication, 2 November, 2023). Smhart Security noted that they have the same amount of standing guards during the day and night, but they have more patrols out during the night.

As noted by the Makana Municipal Planner, walkability is a high priority for the municipality. There is high foot traffic along the roundabout at the end of High Street, but there is no pedestrian infrastructure for pedestrians. It is not easy to maintain the trees along some of the areas because of the livestock that damage it (X. Zondo, personal communication, 4 March, 2024). There is also not a lot of businesses at the end of High Street and this means that the space is not as active as other spaces. If the space was more active, then there may be less crime incidences (X. Zondo, personal communication, 4 March, 2024). The Municipal Planner notes that Makhanda, in general, is facing an infrastructure problem that needs to be addressed.

6.7. Adjusted walkability index with student perceptions

The following chapter is a presentation of an updated version of the proposed walkability index, using student perceptions of the importance of each walkability variable. Table 6 shows the assigned weight given to each of the walkability variables proposed in Chapter 4.3. The decision was taken to assign weights (in percentages) to each factor based on their importance as defined by the students. This assigned weight will affect the overall score for each variable. The sidewalk conditions and pedestrian safety and security were rated as being the most important walkability variables by students. However, pedestrian safety and security was rated higher than sidewalk conditions. Comfort levels were not rated as high, however, there was still an importance placed on this walkability variable with 25 (41.67%) students strongly agreeing to its importance. Diversity of amenities and sidewalk connectivity were weighted evenly as an emphasis on the importance of these walkability variables were not noted by students.

Table 6. *Assigned weight (in percentages) for each walkability factor based on their importance as defined by student perceptions.*

Walkability factor	Assigned weight (in %)
Diversity of Amenities	**5**
Sidewalk Conditions	**35**
Presence of Sidewalk	9
Sidewalk Width	5
Continuity and Coverage	6
Sidewalk Condition	7
Slope	4
Encroachment	4
Pedestrian Safety and Security	**40**
Traffic Calming Measures	2
Visibility of Markings	1
Traffic Volume	1
Lighting	9
Security Personnel	2
CCTV Surveillance Cameras	3
Pedestrian Visibility	5
Bushes/Vacant Land	3
Hazards	1
General Activity Levels	5
Crimes and Intensity of Crime	8
Comfort Level	**15**
Attractiveness	2
Cleanliness	1
Odor	2
Noise	1
Dumping	2
Litter	3
General Maintenance	1
Trees	1
Benches	2
Sidewalk Connectivity	**5**

Table 7 shows the updated walkability index created for this study having taken into account student perceptions of walkability and the weighting of each. The Rhodes University campus is the most walkable area (77.78%). The second most walkable area is Central (58.56%). The third most walkable area is Westhill (56.44%). Sunnyside is the least walkable area (52%). Similar to the findings in Chapter 5.7, the Rhodes University campus is the most walkable area. However, after the assigned weight was added, the narrative shifts with the other three study areas. In the previous walkability index, Westhill was the second most walkable area with Central being the least walkable area. The total score for the Rhodes University campus and Central has increased from 70.71% to 77.78% and from 52.14% to 58.56% respectively. The total score for Sunnyside and Westhill has decreased from 52.5% to 52% and from 60% to 56.44% respectively.

Table 7. *The proposed walkability index with student perceptions.*

	Rhodes University Campus	Central Business District (Central)	Sunnyside	Westhill
Diversity of Amenities	4	4.5	1	0.5
Sidewalk Conditions				
Presence of Sidewalk	2.7	7.2	4.5	2.7
Sidewalk Width	4.5	3.5	3	4
Continuity and Coverage	4.8	3.6	2.4	3
Sidewalk Condition	5.6	3.5	4.2	4.9
Slope	1.6	3.6	3.2	3.6
Encroachment	2	0.4	1.2	3.2
Pedestrian Safety and Security				
Traffic Calming Measures	2	1.6	0.6	0.6
Visibility of Markings	0.2	0.4	0.3	0.5
Traffic Volume	0.6	0.4	0.8	0.7
Lighting	8.1	1.8	0.9	0
Security Personnel	1.8	0.8	1.6	1.4
CCTV Surveillance Cameras	2.1	0.3	0.3	0.3
Pedestrian Visibility	1.5	2.5	3	4
Bushes/Vacant Land	2.1	1.5	0.9	0.9
Hazards	0.7	0.3	0.5	0.6
General Activity Levels	4	3	3.5	3
Crimes and Intensity of Crime	6.4	1.6	2.4	3.2
Comfort Level				
Attractiveness	1.6	1.2	1.4	1.4
Cleanliness	0.8	0.5	0.6	0.8
Odor	2	1.4	1.6	2
Noise	1	0.7	0.8	1
Dumping	2	1	1.4	2
Litter	3	1.5	2.1	3
General Maintenance	0.7	0.6	0.8	0.9
Trees	0.7	0.6	0.8	0.9
Benches	0	0.2	0	0.2
Sidewalk Connectivity	3.5	4.5	3	1.5
TOTAL SCORE	**70**	**52.7**	**46.8**	**50.8**
ADJUSTED SCORE (%)	**77.78%**	**58.56%**	**52%**	**56.44%**

6.8. Conclusion

This chapter highlighted the results of Objective 2, which was to investigate the student perceptions of walkability, along with insight of safety and security from the key informants of the Rhodes University campus, Central, Sunnyside, and Westhill. The chapter commenced with a presentation of the reasons for walking. Following this, the perceptions of walkability was explored. Thirdly, the more versus less walkable spaces was looked at. Fourth, a discussion of the student recommendations to improve walkability was included. Fourth, the key informant responses to safety and security was explored. Lastly, a presentation of an updated version of the proposed walkability index was summarised to conclude this chapter, using student perceptions walkability.

It was found that 95% of student use walking as their main mode of transport. Additionally, all 60 students walk for utility purposes. Results showed that 83.33% of students said that walkability factors did play a role in the routes they take, while the rest did not consider walkability as a factor in their decision-making. Furthermore, 43.33% of students said that walkability factors played a minor role in their choice of residential location, while the remaining students said they walkability factors did not play any role. The main walkability factor that students noted was the proximity and time it takes to reach their destination.

In terms of perceptions of walkability, all factors which included, sidewalk conditions, pedestrian safety and security, and comfort levels, were highly ranked overall. Above 50% of students strongly agreed to the importance of these factors. However, it is important to note that pedestrian safety and security is by far the most important walkability factor, with 54 (90%) of students strongly agreeing. Sidewalk conditions were rated an average of 71.67% and comfort levels (less highly ranked than the other two factors) were rated an average of 41.67%.

The more walkable roads are mainly found within the Rhodes University campus and Sunnyside while the less walkable roads are mainly found within Central. The common walkability factors that students noted within these roads that they felt made it more walkable are the evenness of the sidewalk and the presence of people. Students noted that routes around campus is where they feel the most comfortable because of lighting, visible security and the presence of people. The common walkability factors that students noted within these roads that they felt made it less walkable are the unevenness of the sidewalk, the lack of lighting, the unclean sidewalks, the lack of visible security, and the presence of people. It should be noted that students mentioned that walkability depends on the time of day because of safety issues at night. Students felt that certain roads were more walkable during the day, but less walkable during the night because of lighting and visible security. In light of this, students have given their recommendations on how to improve walkability. The noteworthy recommendations that students have mentioned and that were repeated amongst majority of the students mainly fall within the pedestrian safety and security category. These include, better lighting, more visible security, more SOS buttons and CCTV cameras, and more traffic lights.

All of the key informants agreed that safety is a pressing issue in Makhanda and within the four study areas. However, they do have measures in place to mitigate the effects of crime. The CPU encourages students to walk in a buddy system and in well-lit roads. Additionally, they have SOS buttons and visible security throughout the entire day. Hi-Tec Security and Smhart Security have patrollers out throughout the day and are available to students if they feel unsafe. The Municipal Planner notes that Makhanda, in general, is facing an infrastructure problem that needs to be addressed.

Lastly, a presentation of which areas are more versus less walkable was summarised after taking into account the student perceptions of walkability. The Rhodes University campus emerged as the most walkable area (77.78%), followed by Central (58.56%), Westhill (56.44%), with Sunnyside being the least walkable area (52%). Compared to the proposed walkability index presented in Chapter 5.7, the Rhodes University campus and Central improved in score while Sunnyside and Westhill saw a decrease. Having considered the student perceptions of walkability within the four study areas, the next chapter will focus on investigating the student walking patterns and walksheds in Makhanda.

Chapter 7: Results - Student Walking Patterns and Walksheds

7.1. Introduction

The previous chapter highlighted the results of Objective 2, which was to investigate the student perceptions of walkability, along with insight of safety and security from the key informants of the Rhodes University campus, Central, Sunnyside, and Westhill. The chapter concluded with a presentation of an updated version of the proposed walkability index, having taken into account student perceptions of which walkability variables are considered as more important than others. This chapter presents the results of Objective 3, which is to investigate the student walking patterns and walksheds in Makhanda through participatory mapping methods. This chapter will, commence with a presentation of the student station diversity found within the four study areas. It is important to note the student station diversity because this is where students walk to the most. It will inform the study as to where students spend most of their time, which will inform their walking patterns and walkshed. Following this, a presentation of the student walking patterns and walksheds in time and space will be discussed. It is important to note the student walking patterns and walkshed so that a conclusion can be made as to which roads are used the most and where walking infrastructure improvements should be focused on. Thirdly, the walking distance from residential stations to non-residential stations will be discussed. It is important to note the walking distances because the closer the amenities are, the more likely people are to walk and it is important to note whether these amenities follow walking distance regulations. Lastly, the intensity at which each road is used by the students will be explored. It is important to note the intensity of roads used because it shows which roads are used more than other roads. This, in turn, allows conclusions to be made on which roads should be a priority focus in walking infrastructure improvements.

7.2. Student walking patterns in time and space

The student sample size consisted of 60 students with 20 students each residing within the Rhodes University campus and Central, and 10 students each residing within Sunnyside and Westhill, respectively. Students were asked to engage in a participatory mapping exercise where they mapped their typical walking journeys and trajectories over the week, from their residential stations (within either of the four study areas) to their non-residential stations. This was broken up into four different times which include, a typical weekday (Monday to Thursday), a typical Friday, a typical Saturday, and a typical Sunday. This section will discuss the student station diversity, and the walking patterns and walksheds within each of the four different times and study areas, where it will be compared and contrasted against each other.

Figure 7.2.1 is a map representing the student station diversity within the four study areas that were visited by the 60 students interviewed in the student interviews. These stations are within student trajectories. Each symbol represents a different cluster of stations. Stations are mainly clustered within the Rhodes University campus and Central. This same pattern and clustering can be seen in the general diversity of amenities found in Chapter 5.2.

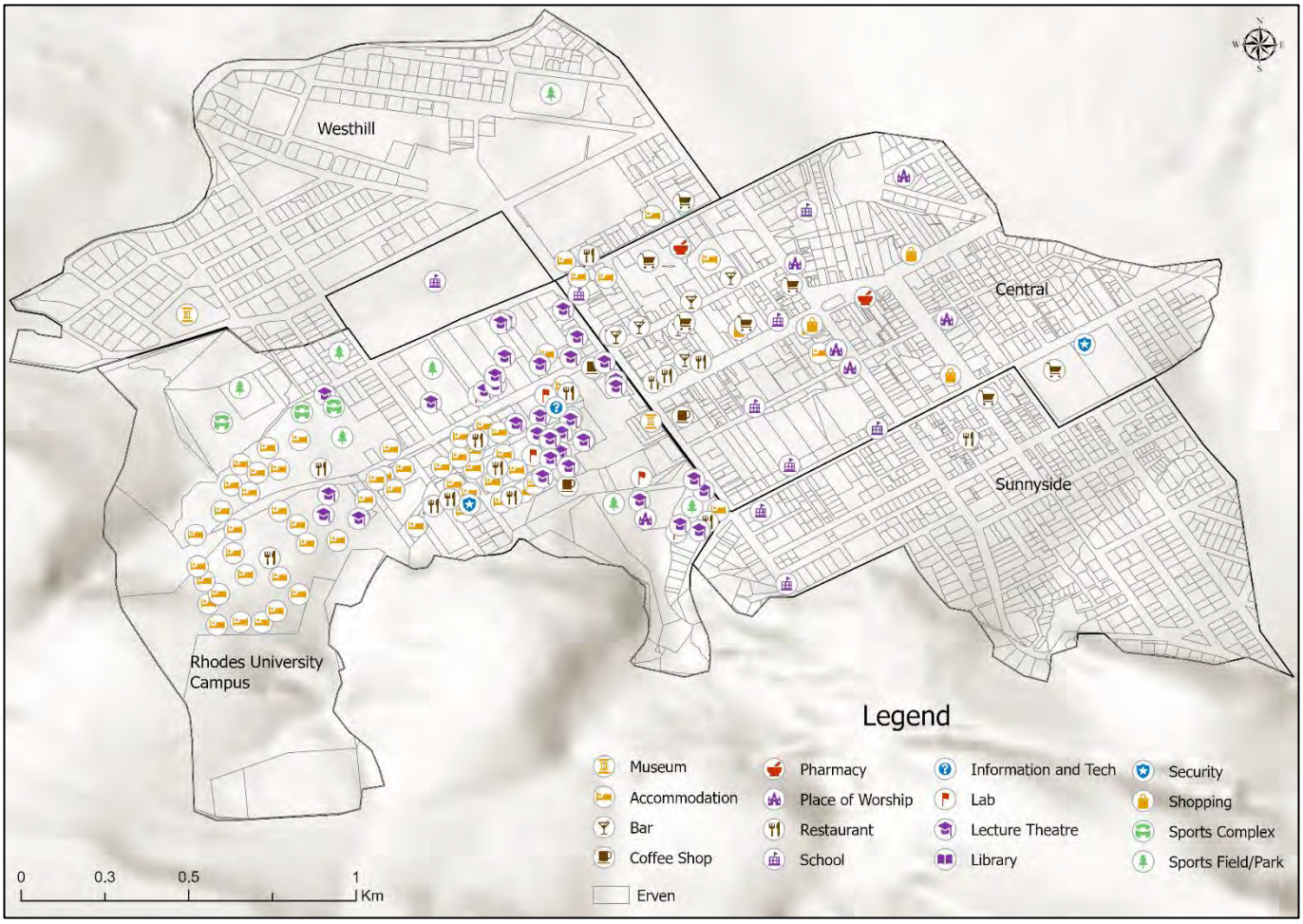

Figure 7.2.1. *The student station diversity within the four study areas.*

Figure 7.2.2 is a kernel density map of the student stations within the four study areas. The grey colour represents areas of low density. The light purple represents areas of medium density where the amenities are spread out and not as clustered. The dark purple represents areas of high density where the amenities are clustered and less spread out.

As can be seen by both Figure 7.2.1 and Figure 7.2.2, the student station diversity narrows down the diversity of amenities to stations that students go to as part of their walking trajectories. The highest concentration of stations visited by the students is within the Rhodes University campus. This is where all trajectories lead. Moreover, the high concentration of amenities is within lower campus where majority of the lecture theatres are located. The overall walkshed of the students are within the Rhodes University campus and Central. This is also where most of the student stations are found. It should be noted that there is a shopping centre and shops along the streets located within the western part of Central (African Street, Somerset Street, New Street, and High Street) which is frequented by the student population. The Westhill and Sunnyside areas do not contain many amenities that students visit often. It should also be noted that there is a shopping centre located within the south eastern parts of Central that is not frequented by the student population. These conclusions are the same conclusions made from the diversity of amenities analysis in Chapter 5.2.

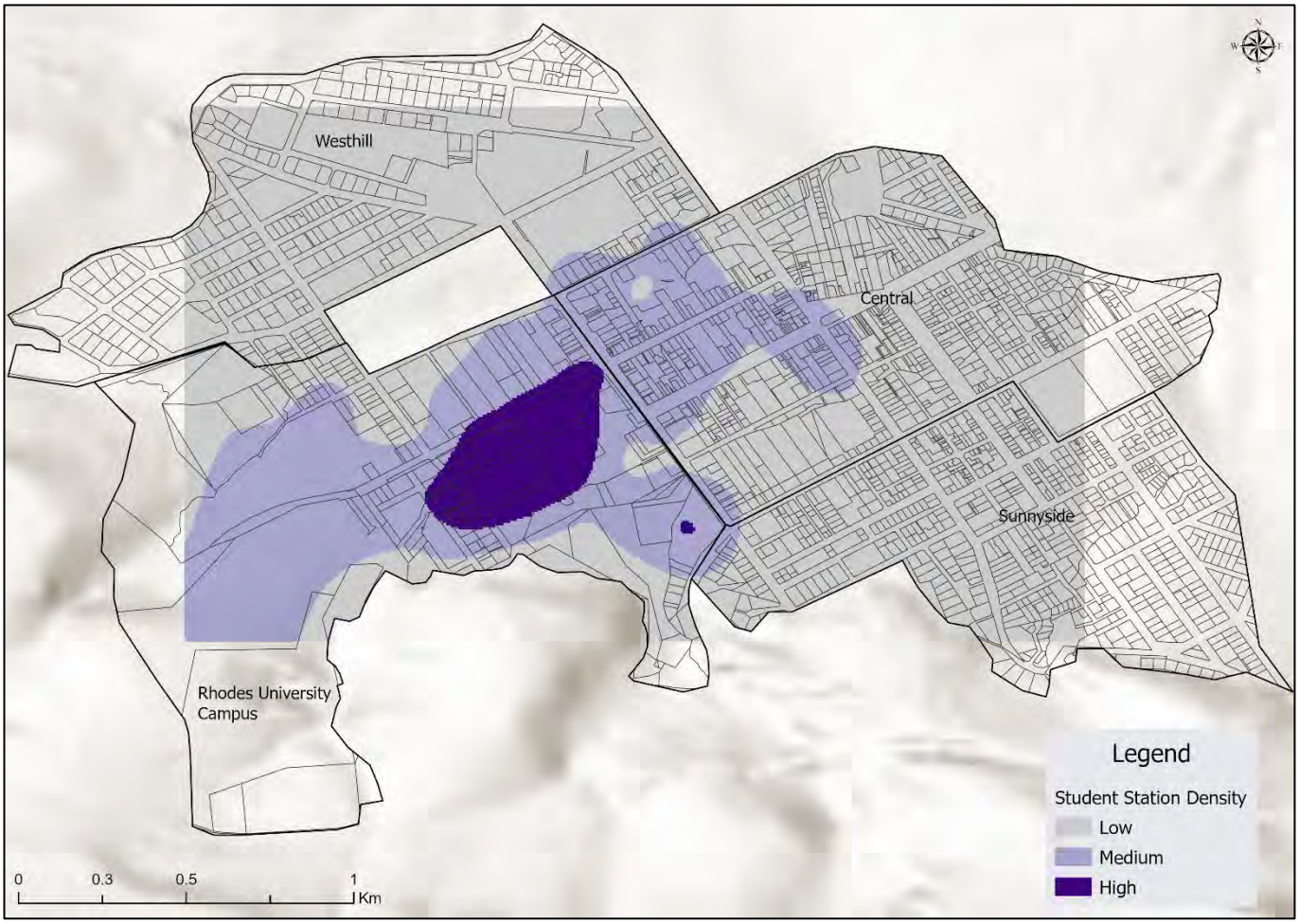

Figure 7.2.2. *The student station density within the four study areas.*

All of the figures below (Figure 7.2.3, Figure 7.2.4, Figure 7.2.5, and Figure 7.2.6) are four different maps representing the walking patterns and walksheds of each of the 60 students stationed within the Rhodes University campus, Central, Sunnyside, and Westhill, respectively. The fifth map for each figure shows the combined walkshed for each day of the week. The trajectories show a typical weekday (Monday to Thursday) (red line and red polygon), a typical Friday (blue line and blue polygon), a typical Saturday (green line and green polygon), and a typical Sunday (yellow line and yellow polygon). The roads that are unused by the students are represented by a grey line. It should be noted that this legend explanation is the same for all of the maps in this section.

The overall walkshed for students on a typical weekday and a typical Friday is within the Rhodes University campus and Central, however, the students whose residential stations are outside these boundaries (Sunnyside and Westhill residents) add to their own walksheds within their respective boundaries. Students with residential stations within the Rhodes University campus and Central walk within the extent of the Rhodes University campus and Central. Students with residential stations within Sunnyside and Westhill walk within the extent of the Rhodes University campus, Central and their respective neighbourhoods. It should be noted that Sunnyside and Westhill residents do not tend to explore much within their neighbourhood, nor do they tend to walk outside the extent of the main roads within each of their neighbourhoods.

In terms of the temporal dimensions of their movements, the Rhodes University campus and Central are the focus areas of student-based activities on a weekday. This is because during the week, students primarily engage in academic activities and access other amenities that are located within these two areas. The walkshed for all the students for a typical Friday widens from their typical weekday trajectories to the northern, eastern, and southern parts of Central along African Street, High Street, Dundas Street, Bathurst Street, Huntly Street, Hill Street and Beaufort Street. There are exceptions to this general pattern, of course, with one or two students venturing further along Worcester Street and outside of the boundary of the study areas in the north eastern direction. The overall walkshed for students on a typical Saturday and Sunday has shifted from focus on the Rhodes University campus and Central, to focus within Central. This is because, during the weekend, students engage less with academic activities and more with non-academic and leisure activities. For students residing on the Rhodes University campus, Sunnyside and Westhill, their trajectories are to and from residential stations and Central, as opposed to being to and from residential stations and campus amenities (lecture theatres and labs) and Central. For Sunnyside residents, the extent of the student walkshed, both increases and decreases where students do not go into the upper campus area, but they go further south into Botanical Gardens. For Westhill residents, the extent of the student walkshed, decreases with students staying within Westhill and part of the Rhodes University campus and Central (African Street, Allen Street and New Street).

There is much less movement of student activity on a Sunday as compared to the rest of the week. During a typical Sunday, the walkshed of the students somewhat increases along Huntly Street and further along New Street. They tend to attend places of worship. For Sunnyside residents, the extent of the student walkshed, decreases significantly where students do not go into Central nearly as much as they would during the rest of the week. For Westhill residents. the extent of the student walkshed, increases where students are within the Rhodes University campus and Central. There are exceptions with this general pattern, of course, with one or two students venturing both further along the Rhodes University campus (Botanical Gardens) and Sunnyside area, as well as outside of the boundary of the study areas in the north eastern direction.

In general, the walkshed for all the students are bounded and do not tend to go outside the extent of the Cathedral located in Central along the intersection between High Street and Hill Street. The students also do not tend to go outside the extent of the intersection between African Street and Hill Street, and Beaufort Street and Hill Street. In essence, the student walkshed size and shape changes as the week progresses and a shift in its epicentre is observed. The reason these trends in the student walking patterns and walksheds are seen, is because on a typical weekday, student activities are mainly academic focused. While this is also true for a typical Friday, students also tend to engage more in non-academic and leisure activities on a Friday than they would during the week. The same is true for a Saturday and Sunday.

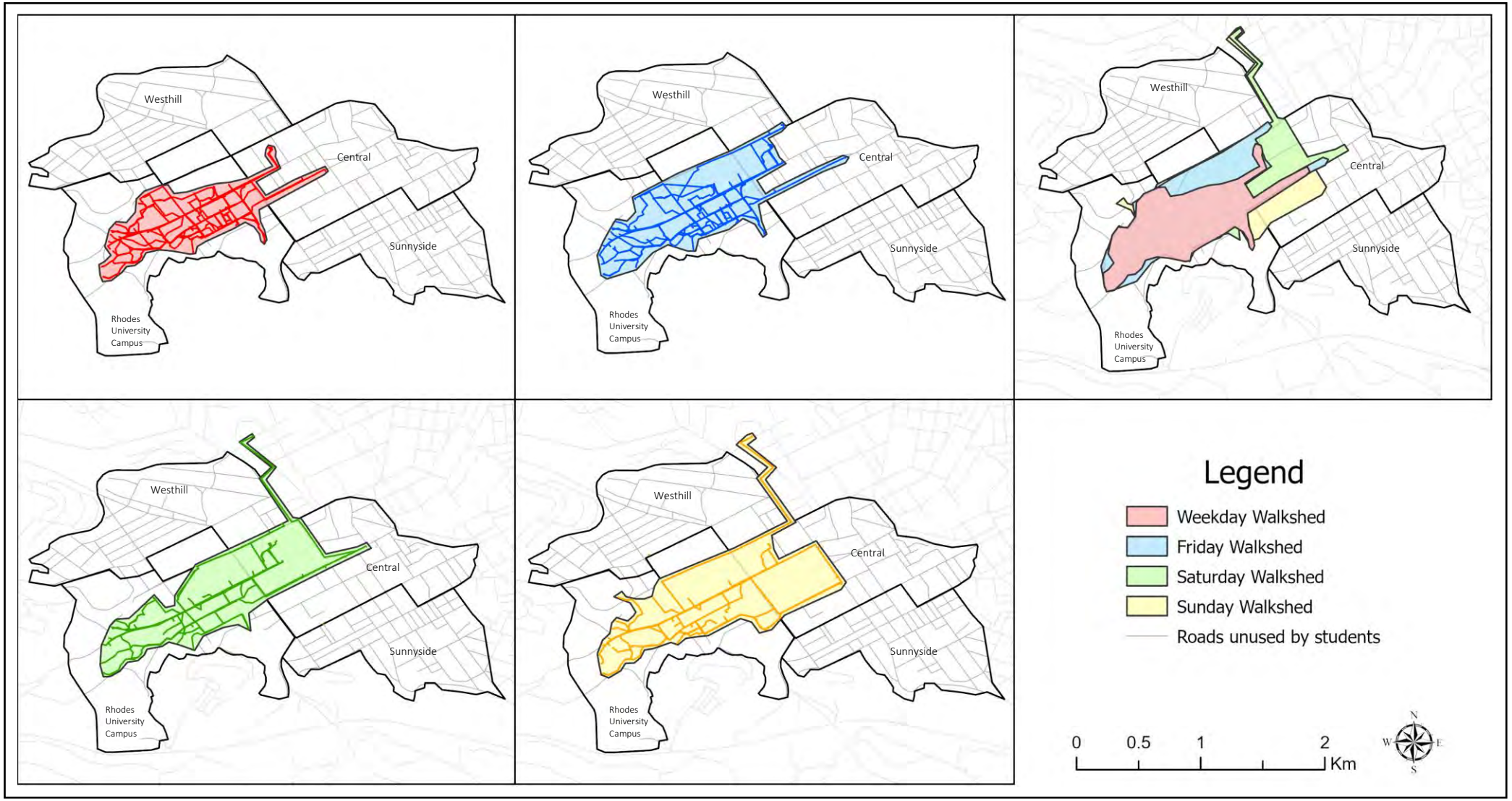

Figure 7.2.3. *The student walkshed for Campus residents at different times of the week.*

Figure 7.2.4. *The student walkshed for Central residents at different times of the week.*

Figure 7.2.5. *The student walksheds for Sunnyside residents at different times of the week.*

Figure 7.2.6. *The student walksheds for Westhill residents at different times of the week.*

7.3. Walking distance from main amenities

The distance from residential stations to non-residential stations play an important role in walkability. The closer amenities are, the more likely people are to walk. NSFAS is a South African government initiative that provides financial support to students going into higher education. This study notes that there are university-specific walking regulations that exists, however, the walking regulations for Rhodes University could not be found, and so the NSFAS regulations will be used. With this being said, according to NSFAS location regulations, student housing that are NSFAS accredited must be within 20 km from campus and should have shops or public facilities nearby (Campus Africa, 2022). Additionally, if the student housing has a walking distance of more than 2 km, the owner of the student housing should provide transportation services (Campus Africa, 2022). With this being said, the maximum walking distance that falls within regulation is 2 km from residential stations to stations on the Rhodes University campus.

Table 8 shows the minimum and maximum walking distances from residential stations in each study area to a central point. The central point used is the Rhodes University Drostdy Arch at the front of the university as this is seen at the entrance to the university. The walking distance has been measured in kilometres. All of the distances between residential stations and non-residential stations within the four study areas comply with NSFAS regulations. Central has the shortest walking distance (an average of 0.27 km) as compared to the residential areas of Sunnyside and Westhill (averages of 0.82 km and 1 km, respectively). The furthest and closest student stations on the Rhodes University campus will clearly be within walking distance (an average of 0.77 km) to the central point as they are in close proximity to the it.

Table 8. *Minimum and maximum walking distances from student stations to a central point (the Rhodes University Drostdy Arch) measured in kilometres.*

	Rhodes University Campus		**Central**		**Sunnyside**		**Westhill**	
	Min	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**
	0.28	1.25	0.08	0.46	0.43	1.2	0.53	1.48
Average	0.77		0.27		0.82		1	

7.4. The intensity of the routes used by students

Measuring the intensity of the routes used by students is an important factor to consider when measuring walkability because it shows which roads are being used more than other roads. This can inform policy makers, urban planners and the government in creating a more conducive, safe and comfortable space for the pedestrian community. By knowing which roads are being used more intensely than others, these institutions can work on ensuring those roads, as well as the other less used roads, are up to standard and have sufficient sidewalks, safety, lighting, and overall proper walking infrastructure. This section will discuss which roads are used more intensely by students than others and why that may be the case.

Figure 7.4.1 is a map representing the intensity of routes used by students within the four study areas. Five categories of intensity were used to represent this where the range of colours go from cool (blue: lowest intensity) to hot (red: highest intensity). The roads that are unused by the students are represented by a grey line. In terms of the student stations kernel density map, the lightest grey colour represents areas of low density. The darker grey represents areas of medium density where the amenities are spread out and not as clustered. The darkest grey represents areas of high density where the amenities are clustered and less spread out.

The least intensely used roads (0-9) are mainly located in Sunnyside and Westhill. There are also some roads in the eastern parts of Central and one road (Gilbert Street) on the Rhodes University campus. The roads within the 10-19 category are within the Rhodes University campus and Central. This is the same for the roads within the 20-29 and 30-39 category. The two most intensely used roads (40-49) are located on the Rhodes University campus and Central. They are Prince Alfred Street and New Street. Based off these results, it can be seen that the walking trajectories of students are mainly focused within the Rhodes University campus and Central. Students do not tend to venture into the two residential areas (Sunnyside and Westhill) nor do they explore the eastern parts of Central past the Cathedral located in Central along the intersection between High Street and Hill Street. Student-based activity is focused on lower campus and on the western parts of Central within African Street, Hill Street and High Street. This pattern can be seen in Chapter 7.2 where the highest concentration of stations visited by the students, and where all trajectories lead, is within the Rhodes University campus.

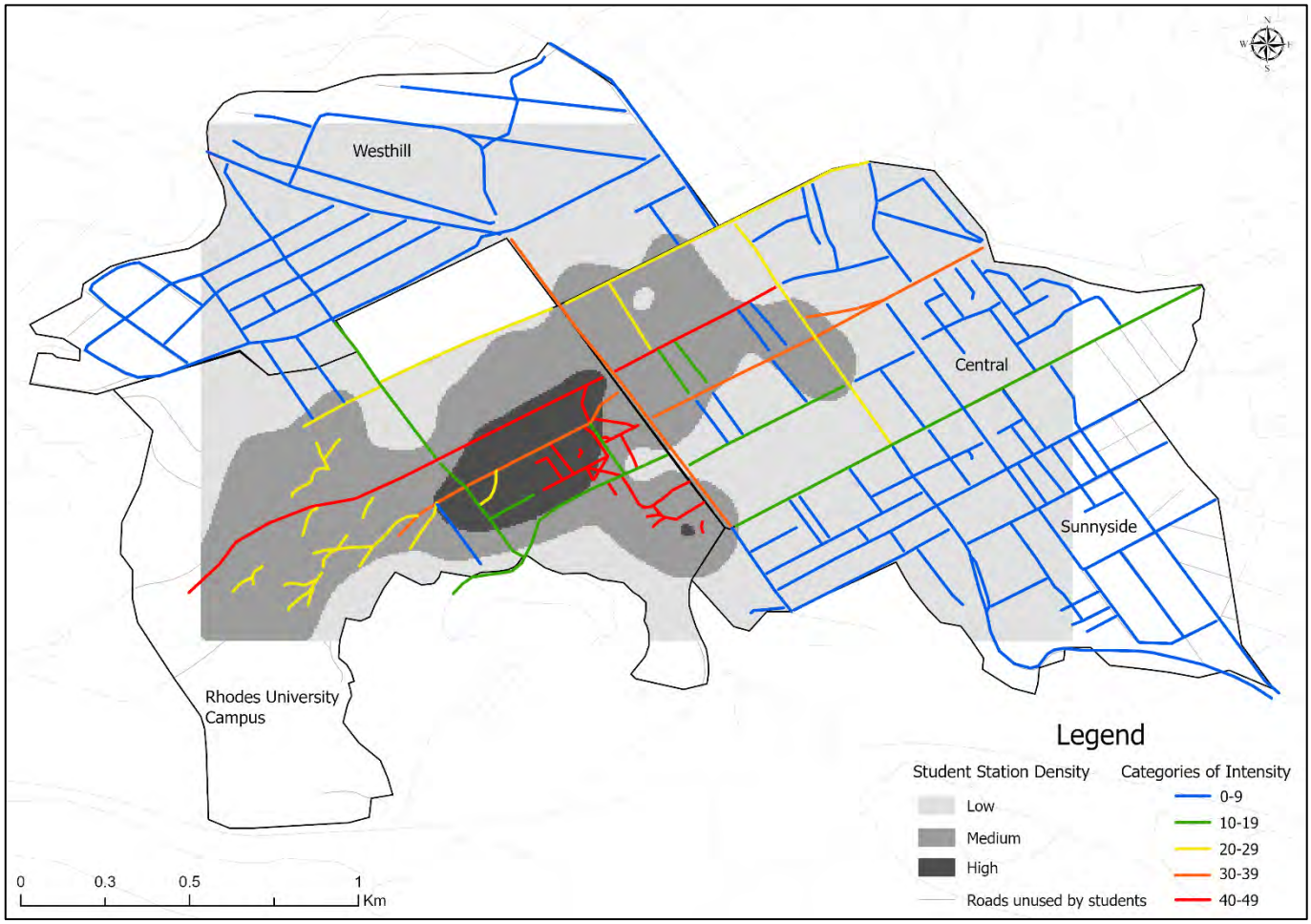

Figure 7.4.1. *The intensity of routes used by students throughout the week within the four study areas using five categories of intensity with a student station density map underneath*

There is a high intensity of roads used within the Rhodes University campus and Central. This should mean that the walking infrastructure within those areas should be conducive, safe and comfortable for pedestrians. However, as seen in Chapter 5.7, this is not the case. There is a low intensity of roads used within Sunnyside and Westhill. The walking infrastructure within these areas, much like those within the Rhodes University campus and Central, are not conducive, safe and comfortable for pedestrians. Table 9 shows the main roads that are used by students within each of the four study areas. These roads are frequented by the walking population. In reference to Table 4 in Chapter 5.7, it can be seen that the walking infrastructure needs improvement within each of the areas that these main roads are located in. While not all walkability factors need improvement, there are important walkability factors within each category that needs improvement (within the category of 0-3).

Table 9. *The main roads used by students within each study.*

	Rhodes University Campus	**Central**	**Sunnyside**	**Westhill**
Main roads	African Street	African Street	Donkin Street	Graham Street
	Artillery Road	Allen Street	Hill Street	Worcester Street
	Drostdy Road	Bathurst Street	Market Street	
	Lucas Avenue	Beaufort Street	Somerset Street	
	Prince Alfred Street	High Street		
	Rhodes Avenue	Hill Street		
	South Street	Huntly Street		
	University Road	Somerset Street		

7.5. Conclusion

This chapter highlighted the results of Objective 3, which was to investigate the student walking patterns and walksheds in Makhanda through participatory mapping methods. This chapter commenced with a presentation of the student walking patterns and walksheds in time and space. Following this, the walking distance from residential stations to non-residential stations was discussed. Lastly, the intensity at which each road is used by the students was explored.

The walkshed of each student on a typical weekday (Monday-Thursday) is within the Rhodes University campus and Central, however, the students that are stationed outside these boundaries (Sunnyside and Westhill residents) add to their own walkshed within their respective boundaries. The walkshed of each student on a typical Friday widens from their typical weekday trajectories to the northern, eastern, and southern parts of Central. The walkshed of each student on a typical Saturday and Sunday has moved from being within the Rhodes University campus and Central, to mainly being within Central. However, there is much less movement of student activity on a Sunday as compared to the rest of the week. The common walking patterns and walksheds for all students can be seen in that the student walkshed does not tend to go beyond the extent of the intersection between High Street and Hill Street, African Street and Hill Street, and Beaufort Street and Hill Street. Additionally, the student walkshed size and shape changes at the week progresses, as well as its epicentre. The epicentre is focused on the Rhodes University campus during the week with lectures and university life being the dominant pull on student's time and activities. As the week progresses, the epicentre shifts with a shift in activity.

In terms of walking distances, all of the distances between residential stations and non-residential stations within the four study areas comply with NSFAS regulations. Central has the shortest walking distance (an average of 0.27 km) as compared to the residential areas of Sunnyside and Westhill (averages of 0.82 km and 1 km, respectively). The student stations on the Rhodes University campus will clearly be within walking distance (an average of 0.77 km) to the central point as they are in close proximity to the it.

Measuring the intensity of the routes used by students is an important factor to consider when measuring walkability because it shows which roads are being used more than other roads which will inform urban planners and policy

makers. The least intensely used roads are mainly located in Sunnyside and Westhill. There are also some roads in the eastern parts of Central and one road (Gilbert Street) on the Rhodes University campus. There is a high intensity of roads used within the Rhodes University campus and Central. However, the walkability infrastructure within these areas are not conducive, safe and comfortable for pedestrians. Having considered the student walking patterns and walksheds in Makhanda, the next chapter will focus on discussing the findings found within each of the objectives as well as the limitations and recommendations of the study.

Chapter 8: Discussion and Conclusion

8.1. Introduction

The previous three chapters highlighted the results of this study, which were to spatially analyse, measure and observe walkability, walking patterns and walksheds in Makhanda, as well as consider the student perceptions of walkability. This chapter will discuss the importance of the findings and conclude with a summary of the importance of this research. This chapter will, commence with a discussion of the findings of the first two objectives. Following this, the findings of the last objective will be explored. Lastly, the recommendations and limitations will be discussed. This chapter will conclude with the key points presented in this research.

8.2. Walkability in Makhanda

The first objective of this research was to survey and spatially analyse the levels of walkability within the Rhodes University campus, Central, Sunnyside, and Westhill areas. This was done by investigating the walkability using a WI through observations as well as conducting a diversity of amenities and sidewalk connectivity analysis. The second objective of this research was to investigate the student perceptions of walkability within the four study areas, through semi-structured interview schedules. This was done by conducting interviews with the student community and key informants. The third objective combined the above two objectives to further identify walkability issues, as well as to identify the specific streets that needed focus in planning. This was done by analysing student walking patterns and walksheds, and will be further discussed in the next section.

As presented in Table 4 (Chapter 5.7), this study found that the Rhodes University campus is the most walkable area (70.71%). The second most walkable area is Westhill (60%). The third most walkable area is Sunnyside (52.5%). Central is the least walkable area (52.14%). However, after assigning weights (in percentages) to each walkability factor based on their importance as defined by students, the walkability index was adjusted.

Student rated the sidewalk conditions (71.67%) and pedestrian safety and security (90%) as being the most important walkability variables. However, pedestrian safety and security was rated higher than sidewalk conditions. Key informants agreed that safety is a major concern, specifically because of lighting and crime. Comfort levels (41.67%) were not rated as high, however, there was still an importance placed on this walkability variable. This is because, in the grander scheme of walkability issues, comfort levels were not a major concern as compared to the other two factors. Diversity of amenities and sidewalk connectivity were weighted evenly as an emphasis on the importance of these walkability variables were not noted by students. This is because walking is their main mode of transport and due to public transport being expensive, students are forced to walk if they need something.

In reference to Figure 6.4.1, the more walkable roads are mainly found within the Rhodes University campus and Sunnyside. The common walkability factors that students noted within these roads that made it more walkable are the evenness of the sidewalk and the presence of people. The routes around campus are where they felt the most comfortable because of lighting, visible security and the presence of people. The less walkable roads are mainly

found within Central. The common walkability factors that students noted within these roads that made it less walkable are the unevenness of the sidewalk, the lack of lighting, the unclean sidewalks, the lack of visible security, and the presence of people. Students felt that certain roads were more walkable during the day, but less walkable during the night. Additionally, the main roads used by students within each area were considered to be more walkable as compared to the smaller side roads.

With this being said, and based on student perceptions of walkability, Table 6 (Chapter 6.7) shows that the Rhodes University campus remained the most walkable area (77.78%). The second most walkable area became Central (58.5%). The third most walkable area became Westhill (56.44%). Sunnyside became the least walkable area (52%). The total score for the Rhodes University campus and Central has increased by 7.07% and 6.42% respectively. The total score for Sunnyside and Westhill has decreased by 0.5% and 5.56% respectively.

This shows that urban planning in walkability infrastructure needs to be rooted in increasing pedestrian safety and security before any other walkability factors. Features that students noted that needed improvement include, pedestrian crossings, crime, security features, lighting, the presence of people, and pedestrian visibility. If the security is improved and measures to reduce crime are put in place in the areas where students walk the most, an overall feeling of safety can be established amongst pedestrians.

Walkability factors are important for measuring and spatially analysing walkability and walking patterns. Sidewalk conditions include aspects relating to width, surface quality and connectivity, all of which plays an important role in making walking routes conducive, safe and comfortable. Traffic safety and security is highlighted as especially significant in a Global South context, where security is often a critical concern (Arellana *et al*., 2020; Anciaes *et al*., 2017). This factor is important in considering how visible security and functional street lighting can influence willingness to walk. Comfort level includes aspects relating to cleanliness, shade, benches, and the presence or absence of hazards. These all play an important role in providing a comfortable walking experience. Attractiveness relates to how well urban spaces support social interaction and accessibility to green spaces, mixed land use practices, and public transport. These aspects are important in making walking more appealing to the community. Furthermore, as emphasised by previous authors, these results highlight the importance of comprehensive, context-specific walkability assessments that consider both objective and subjective factors to improve urban design and foster active communities (Kelly *et al*., 2019; Fancello *et al*., 2020). In line with this, the student interviews revealed the importance of qualitative insights that capture how walkability variables influence how people interact and experience their walking environment and what they perceive as conducive, safe and comfortable. By assessing the existing walkability infrastructure with insights from the students, a more walkable environment can be developed.

The results from this study highlight both similarities and differences with previous walkability studies that analysed, observed and measured walkability through surveys, spatial analyses, and perceptions. Spatial analyses in prior research have consistently showed that street connectivity, mixed land-use practices and traffic safety and security are strong predictors of walkability (Adams *et al*., 2009; Oyeyemi *et al*., 2013; Oyeyemi *et al*., 2017). This study supports these findings while extending them by examining micro-scale urban features which include sidewalk conditions such as continuity and coverage. This approach has proved to reveal unique insights into the relationship between the built environment and walkability (Arellana *et al*., 2020; Almeida *et al*., 2021). If the sidewalk is in poor

condition and has too many breakages and is discontinuous, students have to either walk on the road which poses a safety issue, or risk being in discomfort which makes the walking experience unpleasant. These shortcomings in sidewalk conditions speak directly to the issue of the lack of infrastructural maintenance by the local municipality.

Arellana *et al*. (2020) and Kelly *et al*. (2011) emphasise the subjective nature of walkability, noting that certain perceptions often diverge from objective measures. Consistent with findings from Van Cauwenberg *et al*. (2012); Lee and Dean (2018) and Battista and Manaugh (2019), this research identified differences between the spatial analysis of the built environment and perceptions of walkability. For instance, areas with objectively high diversity of amenities, sidewalk conditions, traffic calming measures, and sidewalk connectivity were rated poorly by participants due to perceived barriers, such as hazards or lack of visibility which negatively impacts their walking experience. This reemphasises the conclusions the above authors made that subjective and objective factors must be integrated together to holistically analyse, observe and measure walkability. The integration of surveys, spatial analysis, and perceptions that this study uses, aligns with the multi-method approaches advocated by researchers such as Lawton and Truelove (2020). By combining qualitative and quantitative techniques, this study addresses limitations found in single-method approaches.

Studies that integrate pedestrian perceptions often emphasise the individual preferences as key determinants of walkability (Leslie *et al*., 2005; Hung *et al*., 2010). For example, Telega *et al*. (2021); Owen *et al*. (2007); D'Orso and Migliore (2020) and Gebel *et al*. (2011) identified proximity to amenities, safety, and accessibility as important factors that shape walkability perceptions. However, these studies are based in the Global North where public transport is more accessible as compared to the Global South. While the findings of this research align with such studies by confirming the importance of these variables, it needs to be noted that this study shows the lack of accessibility to public transportation, which further highlights that students do not have an option but to walk to get to their destinations, and place an importance on different walkability variables. This study uniquely highlights specific walkability variables, which were less pronounced in some previous studies (Moura *et al*., 2017; Scorza *et al*., 2021; Villaveces *et al*., 2012). The specific walkability variables that this study highlighted include, visibility of markings, pedestrian visibility, bushes/vacant land, odor, noise, and sidewalk connectivity.

While previous studies that used walkability indexes and GIS-based approaches (Glazier *et al*., 2012; Frank *et al*., 2005; Owen *et al*., 2007; Mu & Lao, 2022) emphasise the importance of street connectivity, no walkability studies placed an emphasise on sidewalk connectivity. This suggests that walkability preferences and approaches may evolve or vary based on cultural or regional contexts. Authors that have placed a focus on street connectivity did so because it determines the density and arrangement of intersections and streets, which influences how people travel. Furthermore, sidewalks are considered part of the micro-scale environment (much like the context of this study) which adds to but does not replace the macro-scale connectivity that street networks provide.

Similar to the findings found by Leslie *et al*. (2005); Oyeyemi *et al*. (2013); Hung *et al*. (2010); Moura *et al*. (2017); Scorza *et al*. (2021) and Villaveces *et al*. (2012), this study found that pedestrians placed an importance on sidewalk conditions and pedestrian safety and security over other walkability factors. These findings also align with those in South Africa, where authors such as Isiagi (2019); Malambo *et al*. (2016); Kruger (2022); Van der Pas *et al*. (2015) and Memela *et al*. (2022) showed similar results. There were, however, previous studies in South Africa that did not

align with the results this study found. While Malambo *et al*. (2017) did look at similar perceived built environment walkability factors, the authors found that these walkability factors were strongly linked to leisure walking. These results differ from this study, as 100% of the participants in this study walk for utility purposes, while 51.67% did so for leisure purposes. While this is not a key finding in this study, it is still important to note that 100% of students in this study walk because they have to and not because it is a choice.

8.3. Walking patterns

The third objective of this research was to investigate student walking patterns and walksheds in Makhanda through participatory mapping. This was done by conducting a participatory mapping exercise with each student that was interviewed in the second objective. By analysing walking patterns and walksheds, insight into behaviours, needs, and challenges will be highlighted. This is important for urban planning and improving walking infrastructure that is conducive, safe and comfortable.

As presented in Chapter 7.2 (Figure 7.2.3, Figure 7.2.4, Figure 7.2.5, and Figure 7.2.6), this study found that the epicentre of student activity is focused on the Rhodes University campus during the week with lectures and university life being the dominant pull on student's time and activities. As the week progresses, the epicentre shifts with a shift in activity. Additionally, the student walkshed size and shape changes at the week progresses. The walkshed of each student on a typical weekday (Monday-Thursday) is within the Rhodes University campus and Central, however, the students that are stationed outside these boundaries (Sunnyside and Westhill residents) add to their own walkshed within their respective boundaries. The walkshed of each student on a typical Friday widens from their typical weekday trajectories to the northern, eastern, and southern parts of Central. The walkshed of each student on a typical Saturday and Sunday has moved from being within the Rhodes University campus and Central, to mainly being within Central. However, there is much less movement of student activity on a Sunday as compared to the rest of the week. The common walking patterns and walksheds for all students can be seen in that the student walkshed does not tend to go beyond the extent of the intersection between High Street and Hill Street, African Street and Hill Street, and Beaufort Street and Hill Street.

In reference to Figure 7.4.1, the least intensely used roads are mainly located in Sunnyside and Westhill. While not as many students reside within these two areas as compared to the Rhodes University campus and Central, these results are also because this study only surveyed 10 students each from Sunnyside and Westhill. If more students residing within those areas where interviewed, the results might differ. There are also some roads in the eastern parts of Central and one road (Gilbert Street) on the Rhodes University campus. The two most intensely used roads are located on the Rhodes University campus and Central. They are Prince Alfred Street and New Street. Based off these results, it can be seen that the walking trajectories of students are mainly focused within the Rhodes University campus and Central. Student-based activity is focused on lower campus and on the western parts of Central within African Street, Hill Street and High Street. This same pattern can be seen in the above paragraph with the student walking patterns and walksheds.

As mentioned above, there is a high intensity of roads used within the Rhodes University campus and Central because this is where student activity is the highest throughout the week. This should mean that the walking infrastructure within those areas should be conducive, safe and comfortable for pedestrians. However, as seen in Chapter 8.2, this is not the case. Sidewalk conditions and pedestrian safety and security within the Rhodes University campus and Central have walkability scores of 66.47% and 47.06% respectively. These roads are frequented by the walking population and the walking infrastructure needs improvement within each of the areas that these main roads are located in.

The results from this study highlight both similarities and differences with previous walkability studies that analysed, observed and measured walking patterns and walksheds through participatory mapping. Participatory mapping has emerged as a valuable tool for capturing walking experiences and behaviours. Previous studies, such as Lizárraga *et al*. (2022); Rashidi (2019); Abeysinghe *et al*. (2023) and Makki *et al*. (2012), emphasise the value of participatory mapping in identifying gaps between planned and actual walking routes, particularly within student walkability. Additionally, studies such as Roger *et al*. (2024); Roper *et al*. (2024) and Saadi *et al*. (2021) have showed how participants mapping out their trajectories provides an in-depth insight into walking behaviours. Consistent with these studies, the findings of this study show that students often deviate from planned infrastructure, prioritising routes that maximise safety, convenience, and accessibility. Students mainly deviate from routes during the night because of the lack of lighting and, consequently, overall safety. Students tend to stay on main roads in this instance because visible security is more prominent and because there are more people on these roads as compared to darker, less busy side roads. However, this study does note and identifies additional factors, such as aesthetics and comfort, that influence walking patterns, particularly in diverse urban settings.

Walksheds, defined as the spatial area accessible within a specific walking distance or time, have been widely studied using participatory mapping. Unlike authors such as Frank *et al*. (2005) and Telega *et al*. (2021), who relied primarily on GIS data, the participatory mapping approach that this study uses, integrates perceived barriers such as poor sidewalk conditions, lack of visible security, and poorly-lit areas. This provides a unique understanding of walkshed patterns. Research by Rogers *et al*. (2012) showed how participatory mapping is a tool that complements GIS data. Similarly, this study shows that mapping trajectories captures unique behaviours that spatial analysis alone cannot capture. For example, while GIS-based methods assume the most optimal paths, participant-drawn trajectories reveal detours taken to avoid undesired areas, showing the gap between theoretical and actual walkability, much like how the results of this study reveals. The interactive approach of participatory mapping not only captures spatial data but also provides insights into why specific routes are chosen. As mentioned in the discussion of the first and second objective and in the section above, students preferred walking on the main roads as opposed to the side roads because of better sidewalks and lighting, more visibility and more people.

Similar to findings found by Roper *et al*. (2024) and Aditya (2010), this study concluded that walking infrastructure can be improved based on the roads perceived as more versus less walkable. By considering the roads most used by students and the walkability factors that students place the most importance on, urban planners can begin to improve walkability, especially in an under resourced area like Makhanda.

8.4. Recommendations for planning

This section looks at the possible recommendations proposed for planning for a more walkable environment in Makhanda. Planning for a walkable city in a South African context requires addressing historical inequalities and socio-economic and infrastructural challenges. These ideas are supported by Wood (2024); Wood (2022a) and Wood (2022b). It also needs to align with current policies such as SPLUMA, NSDF and NMTP. SPLUMA revolves around integrating spatial justice, sustainability, and resilience into urban planning while NSDF focuses on densification, diversification, and quality public spaces that enhance urban walkability while also ensuring accessibility for all socio-economic groups. The following recommendations are based on previous studies, as well as on the results of the spatial analysis of infrastructure and student perceptions of walkability that this study highlights.

In reference to the below recommendations, planning and maintenance is easier within the Rhodes University campus because they have their own planning and maintenance units. This means that the university is responsible for maintaining existing infrastructure and do not have to rely on the government for maintenance unlike in Central where planning and maintenance is the responsibility of the government. In the context of Southern Urbanism, where governments are not often reliable, the Makana Municipality similarly shows dysfunctionality in its planning and governance. This lack of responsiveness means that effective changes and implementation with the development of walkable infrastructure depends on when, and if, the government feels the need to address it (Memela *et al*., 2022; Dlongolo *et al*., 2024).

While it is evident that plans have been put forward to support and enhance walkability, the maintenance and/or completion of walkability infrastructure lacks. This study identified that students rated sidewalk conditions highly, with an emphasis on factors such as presence, evenness, and maintenance of sidewalks. Therefore, recommendations lie within the development, repair and maintenance of sidewalks (Wayas *et al*., 2023; Van Der Pas *et al*., 2015; Pretorius, 2018; Rashidi, 2019; Liao *et al*., 2022). Uneven, cracked, and poorly maintained sidewalks can make walking uncomfortable and unsafe. Even more so if pedestrians are forced to walk on the road because the sidewalk does not exist. It is important to regularly repair and maintain sidewalks, particularly in the more frequently used areas such as within the Rhodes University campus and Central. Sidewalks should also follow the recommended width of 1.8 m (Vanderschuren *et al*., 2014) to allow for better pedestrian flow and to ensure that they are accessible to people with disabilities. Accessibility features such as curb cuts and ramps should be better integrated into the design. Additionally, in Central, Sunnyside and Westhill, the sidewalks are inconsistent, with gaps and/or interruptions. Plans need to include consistent and continuous sidewalks, particularly on heavily trafficked roads. However, because of current management failures, creative ways to address the issues above should be explored. For instance, reporting platforms could be created to better raise awareness on the condition of sidewalks. By creating a bigger community audience on the issues they are facing, the government and urban planners might take action sooner rather than later. This will also raise awareness on other walkability issues the community might feel needs addressing. Additionally, communities can collaborate with private stakeholders to provide funding for the development and maintenance of better sidewalks.

One of the most significant factors contributing to walkability, that this study noted, is pedestrian safety and security. Pedestrian safety and security, especially in terms of pedestrian crossings, crime, security features, lighting, the

presence of people, and pedestrian visibility, emerged as a critical concern among students. Authors such as Malambo *et al*. (2018); van der Walt (2020); van Heerden (2018); Lizárraga *et al.* (2022) and Memon *et al*. (2020) recommended improvements in some of the same safety and security factors as they proved to play an important role in the perceptions of walking. This is particularly important in the context of Makhanda, where crime rates and inadequate street lighting were highlighted as the most noteworthy factors that make students feel unsafe, especially at night. Given that students rely heavily on walking as their primary mode of transport, especially with limited public transportation options, addressing night time walkability is essential. It is therefore recommended that planners improve street lighting. An increase in lighting is needed, particularly in areas like Central, Sunnyside and Westhill, which were identified as less walkable because of the lack of lighting. Moreover, more lighting and visible security features such as camera or patrols is needed along the most intensely used roads. Additionally, crime needs to be reduced. However, policing can be limited, especially in the context of the Global South, and so visible security by private security companies need to be improved in the more intensely used roads. This will enhance the sense of safety. Furthermore, enhancing the pedestrian crossings, particularly at major intersections where there is a high traffic volume, will improve safety and encourage walking. This means adding and maintaining pedestrian crossings and signals, raised crossings to reduce speeding, and ensuring that pedestrian crossings are clearly visible. This will help ensure that students feel safe crossing roads and walking along streets at night. However, due to current governmental failures, creative ways to address the issues above should be explored. For instance, reliable street lighting is needed. Due to national power cuts and the theft of solar panels, solar powered high mast lights can be used. Since these light poles are much higher than regular ones, it is more difficult to steal the solar panels. For example, mast lights have been installed on the Rhodes University campus. Additionally, solar lighting could be installed in the most intensely used roads. In these same areas, where visible security is lacking, community groups and private security companies could increase patrols. This will also, in turn, prevent theft of the solar lighting while simultaneously increasing overall safety.

While comfort levels were not rated as highly as sidewalk conditions and pedestrian safety and security, it still played an important role in student perceptions of walkability. Issues such as distance/proximity, odor/smell and litter/dumping negatively impacted the walking experience. It is therefore recommended that regular cleaning and maintenance is needed. Ensuring that sidewalks are free from trash and other hazards will improve the odor/smell along those areas, but also improve the physical comfort and aesthetic appeal of walking routes (Stefanidis and Bartzokas-Tsiompras, 2022; Keat *et al*., 2016; Shields and Osorio, 2017). This study noted that students walk primarily for utility purposes rather than for leisure, and have consequently rated distance/proximity to destination highly. Urban planners should integrate residential, commercial and recreational facilities within walking distance of each other, particularly in Sunnyside and Westhill. This is because students residing within those areas have to walk further to Central, where all the main amenities are located, as compared to the shorter distances those residing within the Rhodes University campus and Central have to walk. This can be done by ensuring important amenities such as grocery stores are connected to the more used pedestrian routes within those areas. However, in light of current failures in implementation, creative ways to address the issues above should be explored. For instance, reliable public transport is needed. Where public transport lacks, affordable and abundant private taxis should fill the gap. Creating student-friendly prices will cater to their needs, while simultaneously bringing in more customers. Furthermore,

voluntary community clean-up groups can be created to address the litter/dumping issues where every week volunteers are provided with gloves and trash bags to clean up their area.

This study used participatory mapping to capture the walking patterns and perceptions of students, revealing differences between planned routes and actual walking behaviours. Tools like participatory mapping and surveys can help identify areas that require improvements based on lived experiences. It is important to engage the community, particularly student residents, in the planning and design of walkable infrastructure (Moura *et al*., 2017; Kelly *et al*., 2011; Clark *et al*., 2010; Roper *et al*., 2024). Ongoing surveys and participatory workshops can help planners keep track of changing walking patterns, emerging safety concerns, and shifting priorities among pedestrians.

Walkability is not just about transportation but is also linked to broader public health outcomes. Walking can promote physical activity and improve mental health, reduce traffic congestion and air pollution, promote social cohesion, and increase sustainable and inclusive environments. Urban design should encourage walking as a healthy, sustainable mode of transport and local government policies should encourage active travel by promoting and developing walkable infrastructure (Malambo *et al*., 2017; Malambo *et al*., 2016; Keat *et al*., 2016; Frank *et al*., 2010). Public spaces such as parks can be designed to prioritise pedestrians, with green spaces that encourage social interactions and physical activity. Additionally, creating these spaces also increase the attractiveness of walking.

Improving walkability in Makhanda, requires a comprehensive, multi-dimensional approach. Addressing sidewalk conditions, enhancing pedestrian safety and security, promoting comfort levels, and encouraging a mix of land-uses are all important factors in creating a more walkable environment. Furthermore, by engaging the community in participatory mapping and planning processes, urban planners can ensure that infrastructure improvements meet the needs of the people who use it. With a focus on these aspects, Makhanda can create an environment that is conducive, safe, accessible, and comfortable, while simultaneously promoting health, sustainability, and community well-being.

8.5. Limitations

This section explores the limitations of this study. First, this study used objective walkability measures to survey and spatially analyse the walkability levels. However, certain walkability variables, such as attractiveness, captured the subjective perception of the observer. By including subjective variables in the survey and spatial analysis, this study risked relying on assumptions of what people find attractive, which may not be universally applicable. What one person finds attractive, may not necessarily be attractive to another person based on their backgrounds, preferences, or past experiences. This can lead to biased conclusions. Additionally, ratings of good, fair, and poor were used to assess certain walkability variables. These ratings are, again, based on the subjective perception of the observer. The use of this rating system relies on the subjective perception of the observer which introduces individual bias. For example, what might seem as fair to one person, might be considered as poor to another person. This subjective nature of opinions would have influenced the overall scores given in the walkability index in Chapter 5.7. Furthermore, this creates variability in how walkability variables were rated which makes it difficult to ensure consistent and comparable results across different studies or observers. These differences can be to skewed data and undermine the validity of the walkability variables.

Second, the traffic volume in the four study areas were taken at different times of the day. This is because data was collected on different days at different times. This would affect the results shown in terms of traffic volume that was seen on a road on a specific time and day, especially on the non-main roads. By collecting traffic volume data this way, this research introduces variability that could lead to inaccurate or biased results. This makes it difficult to compare traffic conditions across study areas and reduces the reliability of the conclusions. Traffic data should be collected at consistent times or averaged over several time periods.

Third, this study had a sample size of 60 students within the four study areas as these are where students reside the most. By focusing on areas where students reside and go to the most, this study neglects to account for students who live outside these areas. Students living further away may face different walking challenges such as longer distances, different urban environments, or less pedestrian-friendly infrastructure. By not including these students, this study may over represent the experiences of students who live closer to campus and under represent those who live further away. Additionally, only 10 students each were interviewed in Sunnyside and Westhill, which can produce biases. With the small sample size, the validity of this study is reduced. A larger and more diverse sample should be included. Additionally, this study did not account for demographic variations such as the unique needs of the elderly or people with disabilities, which is important for inclusivity. By not considering the unique needs of these groups of people, this study lacks inclusivity and misses important demographic insights, which may lead to biased conclusions about the overall walkability of an area.

Fourth, the use of direct quotations from participants in this study is absent. This could have enriched the analysis by more deeply capturing their individual perspectives and would have provided a more nuanced understanding of their experiences and viewpoints. Including their voices within the narrative could have added authenticity to the discussion, offering depth in the interpretation of the data. The absence of direct quotations may limit the ability to fully engage with the lived experiences of the participants and could have enhanced the impact of the overall study.

Fifth, one of the subjective walkability variables that were assessed where noise levels. Noise is experienced differently by individuals due to personal sensitivity to sound, cultural factors, and even psychological and physical conditions. As a result, what may be perceived as an acceptable or moderate noise level by one person could be regarded as disruptive or intolerable by another. This subjectivity can introduce variability in the data, making is challenging to draw universally applicable conclusions and to ensure consistency.

8.6. Recommendations for future research

Based on the above limitations, this section will explore the recommendations for future research. Other authors could use standardised measures to minimise any biases in the assessment of walkability variables. This will ensure the ratings are reliable and validation, and can be used in future studies. By using standardised measures, a consistent rating system can be established allowing for a more accurate assessment. The use of uniform tools and metrics such as Walk Score or the 5D model of walkability offer a repeatable means of assessing walkability features.

Other studies could develop ways of collecting data about traffic volume in walkability studies to ensure consistency. To ensure that traffic data is reliably integrated into walkability assessments, other studies should adopt standardised

methods for measuring and recording traffic flow. This can include, the use of automated traffic counters, GPS tracking, or video analyses. Additionally, the difference in traffic on weekdays versus weekends versus holiday periods should also be noted. These variations can significantly impact the pedestrian experience. For instance, areas with high traffic on the weekends may see a reduction on weekends. By noting these differences, a more accurate reflection of walkability can be made.

Third, by expanding the sample size and population beyond students to include a diverse range of demographic groups, the study becomes more inclusive. A comparative study can be done that includes multiple neighbourhoods with varying levels of walkability. This will help identify both local and systematic walkability infrastructure challenges, as well as differences in perceptions of walkability amongst different populations. Furthermore, it ensures that walkability variables as well as planning for walkability is inclusive.

Fourth, other authors should include direct quotations into their analyse. Walkability is a subjective concept and views on the safety, comfort and accessibility of walking can differ significantly. Additionally, direct quotations help to contextualise the findings of the study by linking personal experiences to theoretical concepts. Furthermore, they enhance the credibility of the study by grounding the findings in firsthand accounts. It provides transparency and shows how conclusions are drawn from actual experiences. Direct quotations also show the variability and diversity of participant experiences and how pedestrians perceive and interact with the environment differently.

Other authors could implement the use of a noise measuring app or other objective tools could mitigate this by providing standardised, quantifiable data on noise levels. These tools could measure sound intensity in a consistent way, which reduces the influence of bias and individual variation in noise perceptions. By incorporating an objective measurement, the study could offer a more precise assessment of the noise environment, improving the reliability and comparability of the data.

8.7. Conclusion

This section will conclude the study by summarising the key research findings in relation to the research aims and objectives. It will also discuss the value and contribution for future research. This study aimed to measure and spatially analyse walkability and walking patterns in the student community of Makhanda, South Africa.

The results show that walkability infrastructure needs improvement, particularly in Central, Sunnyside and Westhill which has significantly lower walkability scores as compared to the Rhodes University campus. Additionally, sidewalk conditions (sidewalk presence, evenness, and maintenance) and pedestrian safety and security (pedestrian crossings, crime, security features, lighting, the presence of people, and pedestrian visibility) were rated as the most important walkability factors to consider. Furthermore, the epicentre of student activity is focused on the Rhodes University campus during the week and as the week progresses, the epicentre shifts along with a shift in activity.

This study informs the research aim because it used objective walkability factors to spatially analyse walkability and subjective walkability factors to investigate walking patterns in the student community of Makhanda. This study highlights the importance of integrating both objective and subjective measures to assess walkability and inform

urban planning and infrastructure improvements. The inclusion of an objective walkability index with student perceptions provides a holistic assessment of walkability. This can be linked back the need for collaborative planning in walkability developments. Wood (2022a) and Sager (2017) emphasise how urban planners and stakeholders should engage in planning strategies that involve the community so as to not only meet the needs of the community directly involved, but to also improve accountability, reduce conflict, and develop social capital and a sense of unity.

A key framework for this study was to bring attention to the perspectives of Southern Urbanism. This study looked to bring light to the lack of representation of walkability studies in a Global South context, and to also form an understanding of the walkability perspectives of communities in a different socio-economic and geographic background as compared to those residing in the Global North. With this being said, this study highlights context-specific insights on the challenges that are unique to walking in Makhanda and, more broadly, in the context of the Global South. This study emphasises the unique socio-economic and cultural factors that shape walkability, and highlights the need for comprehensive, context-specific walkability assessments. With less than 20 walkability studies been done in South Africa in the last 10 years, with none placing a focus on student walkability, this study is increasingly relevant because it is adding to walkability research in an underrepresented area. This study places a focus on a smaller city with the aim of addressing student walkability and walking patterns. While this study is the second walkability study based in Makhanda (the first being done by Memela *et al*., 2022), it is not focused on a peripheral township area, but rather on the student walking community in the central areas of the city. With this being said, this study contributes to generating new evidence from a small-sized city to question if the characteristics of the built environment promote walking and are able to be applied to other cities, as found in literature (Arellana *et al*., 2020).

The concept of New Urbanism shows that walkability directly links to urban planning and design, as well as to creating sustainable urban environments. This research offers insights into walkability that can be directly applied to urban planning and policy-making. The challenges highlight the need for accessible and sustainable environments which emphasis the direct link walkability has in promoting sustainable development. This study identified Rhodes University and Central as the most intensely used areas. Therefore, planners should focus their resources on improving walkability in these areas, particularly in sidewalk conditions and pedestrian safety and security. Additionally, policy-makers can use the weighted walkability factors to guide regulations and prioritise infrastructural improvements in these areas. This shows that by incorporating participatory mapping into the urban planning process, planners can have more context-specific insights that cater to the needs of the community directly affected. Moreover, this research highlights walkability challenges unique to under resourced areas, which can guide interventions placed in similar urban communities. This study emphases that walkability improvements contribute to broader goals such as increasing sustainability and enhancing liveability. By applying the findings of this research, planners can create more conducive, safer, and comfortable walking environments.

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Appendices

Appendix A

Observation Schedule/Visual Survey

Identifying Information					
Area:	Rhodes Campus	Central (CBD)	Sunnyside	Westhill	
Street Name:					
Sidewalk (Overall)					
Sidewalk	Yes		No		
Both Sides	Yes		No		
Width	m				
Continuity and Coverage	Poor	Fair	Good		
Comments					
Sidewalk Condition					
Condition	Poor	Fair	Good		
Overgrown	Yes		No		
Uneven	Yes		No		
Hazards	Yes		No		
Encroachment	Yes		No		
Comments					
Traffic Safety					
Traffic Volume	Low	Medium	High		
Crosswalk/Zebra Crossing	0	1	2	3	>4
Visibility of Markings	Low	Medium	High		
Signal/signage	sign	signal	none		
Traffic Calming	Yes		No		
Comments					
Safety					
Lighting	Poor	Fair	Good		
CCTV	Yes		No		
Security Personnel	Yes		No		
Visibility	Poor	Fair	Good		
Bushes/Vacant Land	Yes		No		
General Activity Levels	Low	Medium	High		
Comments					
Comfort & Convenience					
Slope	Flat	Gentle	Steep		
Benches	Yes		No		
Odor	Yes		No		
Noise	Yes		No		
Dumping	Yes		No		
Litter	Yes		No		
Overgrown Verge	Yes		No		
General Maintenance	Poor	Fair	Good		
Trees	None	Few	Many		
Visually Attractive	Poor	Fair	Good		
Comments/Notes					

Appendix B

Students: Interview Schedule

---

1. Please indicate your:
   Gender: _____
   Race: _____
   Age: _____
   Number of Years at Rhodes University: _____

2. What transport do you use to get around town? Why?

3. Why do you walk? (Utility/physical exercise/leisure)

4. How do you define walkability or walkable spaces?
   4.1. What factors are important?
   4.2. What factors add to walkability?
   4.3. What factors reduce walkability?

5. Refer to the map.
   5.1. What spaces do you perceive as more or less walkable?
   5.2. Do any walkability factors play a role in the routes you choose to take?

6. Did walkability play a role in your choice of residential location?

7. What recommendations would you make to ensure these spaces become more walkable?

Consider the following walkability variables and rate their importance in your walking activity or choice of route.

Factor	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Sidewalks/pavements					
Condition of the sidewalk e.g. paved, uneven					
Maintenance of sidewalk					
Width of the sidewalk					
Barriers on the sidewalk e.g. cars, traders					
Distance/proximity					
Slope/topography					
Zebra/Pedestrian crossing					
Safety/Crime					
Bushes/vacant land					
Security features e.g. CCTV, SOS buttons, security personnel					
Traffic safety e.g. speedbumps					
Lighting at night					
Benches					
Attractiveness of environment e.g. trees/buildings					
Weather/climate e.g. rain, hot					
Odor/smell					
Noise					
Litter and dumping					
Presence of other people/users					
Visibility					

Appendix C

Students: Participatory Mapping Exercise

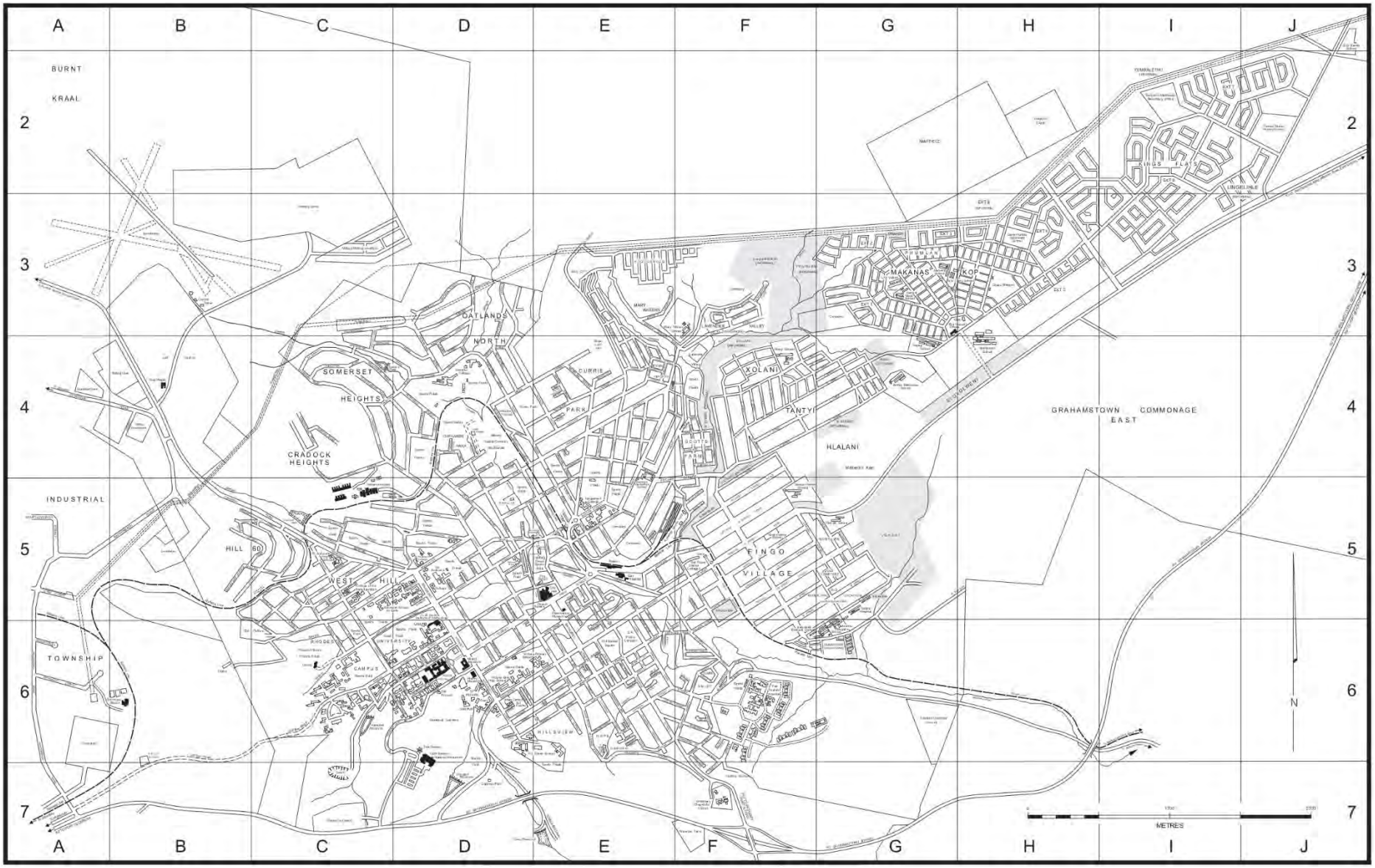
Refer to the satellite image.

1. Indicate on the map where you live

2. Consider your movements on the following days:
    - Typical weekday (Monday-Thursday)
    - Typical Friday
    - Typical Saturday
    - Typical Sunday

    and indicate on the map:
    - Where do you go? (stations e.g. shops, lecture venues, dining hall, church)
    - What routes do you take? (trajectory e.g. streets, shortcuts)
    - What mode of transport do you use?
    - How long does each trip take you?

3. Indicate on the map the extent of your territory in town/the extent of your experience of Makhanda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NORTH
SOMERSET
HEIGHTS
CURRIE
PARK
CRADOCK
HEIGHTS
INDUSTRIAL
HILL 60
WEST
HILL
TOWNSHIP
RHODES
UNIVERSITY
CAMPUS
HILLSVIEW
SOUTH
FARM
MARY
WATERS
VALLEY
MAKANAS
KOP
XOLANI
TANTYI
HLALANI
FINGO
VILLAGE
GRAHAMSTOWN
COMMONAGE
EAST
KINGS
EAST
LINGELIHLE
N
METRES

Appendix D

Key Informant Interview Schedule – Rhodes University Campus Protection Unit (CPU)

---

1. How do you define walkability or walkable spaces?
   What factors are important?
   What factors add to walkability?
   What factors reduce walkability?

2. Do you think that the Rhodes University campus is a walkable?
   Why or why not?
   - Specifically, the Rhodes University campus, Central, Sunnyside, and Westhill

3. Is walkability a high priority for the university?
   Why or why not?

4. Which areas of campus do you consider to be more or less walkable?
   - Specifically, the Rhodes University campus, Central, Sunnyside, and Westhill

5. In the areas considered to be walkable:
   5.1 What infrastructure is there?
   5.2 What condition is the infrastructure in?
   5.3 How often is the infrastructure maintained?

6. In the areas considered to be less walkable:
   6.1 What are the challenges faced in these areas?
   6.2 Does the university have plans to make these spaces more walkable?
   6.3 In your opinion, what can be done to tackle the challenges?

Appendix E

Key Informant Interview Schedule – Municipal Town Planner

---

1. How do you define walkability or walkable spaces?
   What factors are important?
   What factors add to walkability?
   What factors reduce walkability?

2. Do you think that Makhanda is a walkable city?
   Why or why not?
   - Specifically, the Rhodes University campus, Central, Sunnyside, and Westhill

3. Is walkability a high priority for the city?
   Why or why not?

4. Which areas do you consider to be more or less walkable?
   - Specifically, the Rhodes University campus, Central, Sunnyside, and Westhill

5. In the areas considered to be walkable:
   5.1 What infrastructure is there?
   5.2 What condition is the infrastructure in?
   5.3 How often is the infrastructure maintained?

6. In the areas considered to be less walkable:
   6.1 What are the challenges faced in these areas?
   6.2 Does the municipality have plans to make these spaces more walkable?
   6.3 In your opinion, what can be done to tackle the challenges?

Appendix F

Key Informant Interview Schedule – Security Companies

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1. In general, how does safety relate to walkability?

2. Do you think that Makhanda is a walkable city in terms of safety?
   Why or why not?

3. Which areas do you consider to be more or less safe for walking?
   - Specifically, the Rhodes University campus, Central, Sunnyside, and Westhill

4. What safety measures or features are in place in these specific areas to support walkability?

Appendix G

RHODES UNIVERSITY
Where leaders learn

RU 120 1904-2024 YEARS

Rhodes University Human Research Ethics Committee
Main Admin Building, Drostdy Road, Makhanda, 6139, South Africa
PO Box 94, Makhanda, 6140, South Africa
t: +27 (0) 46 603 7314
e: ethics-committee@ru.ac.za
https://www.ru.ac.za/researchgateway/ethics/
NHREC Registration number: RC-241114-045

14 November 2024

Ms Huresha Padayachee

Email: huresha.padayachee@gmail.com

Review Reference: 2023-7269-7927

Dear Ms Padayachee,

Re: Stamping Ground: student walksheds, walking patterns and walkability at Rhodes University.

Researcher: Ms. Huresha Padayachee

Supervisor(s): Dr. Sinenhlanhla Memela, Ms. Philippa Irvine

This letter confirms that the above research proposal has been reviewed and **APPROVED** by the Rhodes University Human Research Ethics Committee (RU-HREC). Your Approval number is: 2023-7269-7927

Approval has been granted for 1 year. An annual progress report will be required in order to renew approval for an additional period. You will receive an email notifying you when the annual report is due.

Please apply for a protocol amendment should any substantive change(s) be made, for whatever reason, during the research process. This includes changes in investigators. Email your request to ethics-committee@ru.ac.za.

Please submit a brief report to the ethics committee on the completion of the research. The purpose of this report is to indicate whether the research was conducted successfully, if any aspects could not be completed, or if any problems arose that the ethical standards committee should be aware of.

If a thesis or dissertation arising from this research is submitted to the library's electronic theses and dissertations (ETD) repository, please notify the committee of the date of submission and/or any reference or cataloguing number allocated.

Sincerely,

Janet Hayward

Dr Janet Hayward

Chair: Rhodes University Human Research Ethics Committee (RU-HREC)

Appendix H

PARTICIPANT INFORMED CONSENT DECLARATION

(To be signed by research participant/s)

Project Title: Stamping Ground: student walksheds, walking patterns and walkability at Rhodes University

Ms Huresha Padayachee from the Department of Geography, Rhodes University has requested my permission to participate in the above-mentioned research project.

The nature and the purpose of the research project and of this informed consent declaration have been explained to me verbally in a language that I understand.

I am aware that:

1. The purpose of this research is to investigate and assess the student walkability and walking patterns in the Rhodes University and Makhanda CBD (Central Business District) precinct, West Hill and Sunnyside areas.

   Walkability is an important research topic in the Global South where many people in urban settlements walk because of transport poverty. University students are a subset of the urban population in Makhanda who experience transport poverty and largely rely on walking to navigate the city. The purpose of this study is to investigate and understand the student walkability, walking patterns and walksheds with specific focus on students who a resident in the Rhodes University, CBD (Central Business District) (Central), West Hill and Sunnyside areas. These specific areas were chosen because, in terms of student residents, these are the most densely populated residential areas in the city, but are also the epicentre of student activity. This research intends to explore the existing walkability within these four study sites through a visual survey using common measures of walkability, digital mapping as well as student perceptions of walkability. Additionally, this research seeks to understand student walking patterns and walksheds within Makhanda through participatory mapping of their typical daily trajectories and interviews. The quantitative data collected through visual surveys, digital mapping and participatory mapping will be spatially analysed using GIS (Geographic Information Systems). It is hoped that the findings of this research will help to understand whether or not the walkability of these areas adhere to the needs of its student population and will, thereby, give direction to planning strategies to support walking practices. It is important to note whether these walking routes are safe, accessible and comfortable for the walking population. As there is currently little research done in South Africa on student walkability and walking patterns, this study aims to create a pathway to future comparative analyses.

The role of the participant (where necessary) is to participant in a participatory mapping exercise, a short questionnaire, and an interview.

The participatory mapping exercise requires the participant to map out the approximate area/road on which they reside, as well as their walking journeys during four different events.
This includes a typical weekday (Monday-Thursday), a typical Friday, a typical Saturday, and a typical Sunday.
Once this is done, the interview will be conducted. This includes a series of questions that speak to the participants walking experiences.
The interview will end of with short questionnaire that the participant is required to fill in. This includes questions that speak to both the walking experience of the participant and also the participants' opinion on the state of the existing walking infrastructure in Makhanda.

2. Rhodes University has given ethical clearance to this research project ***(2023-7269-7746)*** and may request to see the clearance certificate by contacting the Ethics Coordinator (ethics-committee@ru.ac.za).

3. By participating in this research project, I will be contributing towards the understanding of walkability and walking patterns within the student community in Makhanda and can inform municipal and institutional planners about challenges that need to be addressed in order to increase walkability.

4. I will participate in the project by answering a series of questions regarding walkability and walking patterns. My participation is entirely voluntary and should I at any stage wish to withdraw from participating further, I may do so without any negative consequences.

5. I will not be compensated for participating in the research.

6. The following risks are associated with my participation: there are no anticipated risks and/or negative consequences for interviewees involved in this study.

7. The Researcher intends to publish the research results in the form of a research paper. However, confidentiality and anonymity of records will be maintained and my name and identity will not be revealed to anyone who has not been involved in the conducting of the research, ***unless I indicate to the contrary/recognize that as a public figure my identity will inevitably be/become known, in which case I agree to accept the loss of anonymity.***

8. In terms of the Protection of Personal Information Act (No. 4 of 2013) it remains my right to request the Researcher to provide me with a detailed explanation of exactly how confidentiality and anonymity of the

data I provide will be achieved. I may also request to know exactly how my personal information will be stored securely, for how long it will be stored.

9. If any data collected from me for this research project is to be used by the Researcher for any further study, I am to be informed in writing and my written consent requested again. I need not give consent for the new research if it is incompatible with the initial purpose of the present study (POPIA, s15 (3)). Equally, I can simply reject the request. In such cases, a formal request needs to be made to me by the researcher via the Ethics Coordinator (ethics-committee@ru.ac.za).

10. In terms of the POPI Act, I possess the right to receive feedback about this research. This will take the form of a PDF document via email and/or messenger applications, unless ***I elect not to receive this feedback.***

11. Any further questions that I might have regarding the nature of the research and/or my participation in it will be answered by Ms Huresha Padayachee by email (huresha.padayachee@gmail.com). Alternatively, one may contact the research supervisor, Ms Philippa Irvine (p.irvine@ru.ac.za) or co-supervisor, Dr Sinenhlanhla Memela (s.memela@ru.ac.za).

12. By signing this informed consent declaration, I am not waiving any legal claims, rights, or remedies. A copy of this informed consent declaration will be given to me, and the original will be kept on record by the Researcher.

13. I ***agree/disagree*** (delete inapplicable) to the Researcher's use of voice recording of my comments and opinions during interviews, the purpose of which is to ensure the accurate recording of my views/responses. Furthermore, I have the right to request a copy of the interview transcriptions to confirm that my opinions are accurately recorded

I, ……., have read the above information / confirm that the above information has been explained to me in a language that I understand and I am aware of this document's contents. I have asked all questions that I wished to ask, and these have been answered to my satisfaction. I fully understand what is expected of me during the research.

I have not been pressurised in any way and I voluntarily agree to participate in the above-mentioned project.

……. …… …….

Participants signature **Witness** **Date**

Appendix I

PARTICIPANT INFORMED CONSENT DECLARATION

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The interview schedule will be conducted. This includes a series of questions that speak to the participants walking experiences.
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15. Rhodes University has given ethical clearance to this research project ***(2023-7269-7746)*** and may request to see the clearance certificate by contacting the Ethics Coordinator (ethics-committee@ru.ac.za).

16. By participating in this research project, I will be contributing towards the understanding of walkability and walking patterns within the student community in Makhanda and can inform municipal and institutional planners about challenges that need to be addressed in order to increase walkability.

17. I will participate in the project by answering a series of questions regarding walkability and walking patterns. My participation is entirely voluntary and should I at any stage wish to withdraw from participating further, I may do so without any negative consequences.

18. I will not be compensated for participating in the research.

19. The following risks are associated with my participation: there are no anticipated risks and/or negative consequences for interviewees involved in this study.

20. The Researcher intends to publish the research results in the form of a research paper. However, confidentiality and anonymity of records will be maintained and my name and identity will not be revealed to anyone who has not been involved in the conducting of the research, ***unless I indicate to the contrary/recognize that as a public figure my identity will inevitably be/become known, in which case I agree to accept the loss of anonymity.***

21. In terms of the Protection of Personal Information Act (No. 4 of 2013) it remains my right to request the Researcher to provide me with a detailed explanation of exactly how confidentiality and anonymity of the data I provide will be achieved. I may also request to know exactly how my personal information will be stored securely, for how long it will be stored.

22. If any data collected from me for this research project is to be used by the Researcher for any further study, I am to be informed in writing and my written consent requested again. I need not give consent for the new research if it is incompatible with the initial purpose of the present study (POPIA, s15 (3)). Equally, I can simply reject the request. In such cases, a formal request needs to be made to me by the researcher via the Ethics Coordinator (ethics-committee@ru.ac.za).

23. In terms of the POPI Act, I possess the right to receive feedback about this research. This will take the form of a PDF document via email and/or messenger applications, unless ***I elect not to receive this feedback.***

24. Any further questions that I might have regarding the nature of the research and/or my participation in it will be answered by Ms Huresha Padayachee by email (huresha.padayachee@gmail.com). Alternatively, one may contact the research supervisor, Ms Philippa Irvine (p.irvine@ru.ac.za) or co-supervisor, Dr Sinenhlanhla Memela (s.memela@ru.ac.za).

25. By signing this informed consent declaration, I am not waiving any legal claims, rights, or remedies. A copy of this informed consent declaration will be given to me, and the original will be kept on record by the Researcher.

26. I ***agree/disagree*** (delete inapplicable) to the Researcher's use of voice recording of my comments and opinions during interviews, the purpose of which is to ensure the accurate recording of my views/responses. Furthermore, I have the right to request a copy of the interview transcriptions to confirm that my opinions are accurately recorded

I, ……., have read the above information / confirm that the above information has been explained to me in a language that I understand and I am aware of this document's contents. I have asked all questions that I wished to ask, and these have been answered to my satisfaction. I fully understand what is expected of me during the research.

I have not been pressurised in any way and I voluntarily agree to participate in the above-mentioned project.

……. …… …….

Participants signature **Witness** **Date**