Barriers to Walkability: Non-Motorised Transportation as a Sustainable Mobility Solution in Worcester, Western Cape

Non-Motorised Transportation (NMT) modes are a solution to many transportation problems caused by motorised transportation and are a key indicator of efforts towards sustainable transportation. Global and national development strategies towards sustainability call for promotion of NMT to improve sustainability. In cities where land uses, transportation infrastructure caters to fast-paced socio-economic activity, walking is not prioritised as a mode of travel hence the need to firstly explore barriers and factors that hinder the uptake of walking and use of other NMT modes as regular means of travel. This study assesses constraints and identifies some barriers to NMT use, focusing mostly on walking and cycling behaviours and infrastructure in the Western Cape town of Worcester. The paper employs both quantitative and qualitative methods; Quantitative data obtained through infrastructure assessments and questionnaire surveys and qualitative data obtained from residents of Worcester through open ended questionnaires. Travel behaviours of respondents, their regular attractions and activities that create non-motorised trips as well as their walking experiences are presented. The study also employs physical assessments of NMT supporting infrastructure to identify physical properties of infrastructure, develop relationships between walking and infrastructure. Relative Importance and Walkability Indices in the context of a South African farming town are drawn. Cross tabulation is used to establish relationships between factors likely to influence the use or lack thereof of non-motorised transportation modes to analyse the relationship between infrastructure, land-use and patterns of NMT use. The study is significant as it contextualises infrastructural, engineering, land-use planning and social factors relating to Non-Motorised Transportation in Worcester.

Keywords: *Non-Motorised Transport, Walkability, Sustainable Transport, Mobility*

Introduction and Background

Sustainability of transportation systems and urban areas that host has greatly been associated with the use of non-motorised transportation to access activities

and places within those areas. This association stems from the need to reduce carbon emissions and reliance on motorised vehicles aimed towards achieving the greater sustainable development goals. From a sustainability perspective, NMT modes such as walking and cycling are considered unharmful as they spare fossil fuel consumption and do not pollute the urban environments (Maciorowski and Souza, 2018). The surge of car use arose from improved economic and social outstanding of individuals and communities as well as the need for convenience amongst other factors, resulting in walking becoming less attractive. Moreover, there has been improved forms of demand responsive travel in the form of e-hailing instead of demand responsive taxi and bus services, which limits walking for its users as they directly fetch travellers from desired pick-up and drop-off locations (Klementschitz, Gkavra and Susilo, 2025). However, reasons for walking or use of MMT especially in developing countries and not necessarily due to accessibility reasons. NMT reliance can be attributed to inability to afford other modes of travel (Mokitimi and Vanderschuren, 2017). Although promoted as solutions to sustainability, the uptake or use of NMT is often times used as a captive mode or used together with other modes as way of accessing public transportation. Walking journeys, whether a necessity or a choice, primarily form part of people's daily trips. In cases where walking is a necessity or people walk because they do not have any other choice, there is less consideration for the decision-making process, neither is there many modal options.

Literature Review

Walkability as defined by Southworth, (2005) as the "extent to which the built environment supports and encourages walking by providing for pedestrian comfort and safety, connecting people with varied destinations within a reasonable amount of time and effort, and offering visual interest in journeys throughout the network". Otsuka et al (2025) lamented on the complexities of assessing walkability, stating the contributing factors such as perceptions affect walkability and walking behaviour differently. Perceptions on safety for example, are different for different genders, with younger men likely to walk at times considered unsafe by female or older people (Tavakoli et al, 2025; Rotem-Mindali 2025).

Walkable urban areas provide some environmental benefits like the reduction of greenhouse gas emissions, improved air quality and the conservation of natural resources (Middelton, 2021, Ramirez, 2025). The environmental and health benefits of walking have been acknowledged as one of the factors that could influence the decision to walk in older and recent literature (Southworth, 2005; Li, Zhang and Yang 2025). NMT produces zero emissions,

leading to reduced pollutants in the air and they also require less infrastructure, hence conserving natural resources that would have been used for construction and maintenance of roads, parking space used by cars (Ramirez, 2025). The growth of urban planning and mobility studies over the years has seen infrastructure development that not only promotes but accommodates non-motorised transportation; from managing conflict between cars and pedestrians using traffic lights to creating walkways that are free vehicular traffic and caters solely to pedestrians. Pedestrianisation has worked in European cities such as Copenhagen, however, this success was supported by expansion and improvement of pedestrian infrastructure and continued maintenance (Ramirez, 2025).

Transportation policy in most countries prioritise motorized form of transportation, neglecting NMT in their transport and urban planning (Namakula et al., 2025). This highlights the importance of prioritizing NMT friendly infrastructure, however, transportation policy in most countries prioritise motorized form of transportation, neglecting NMT in their transport and urban planning (Namakula et al., 2025). An earlier study by Southworth (2005) stated that walkable environments should be inviting. This urges responsible entities to design pedestrian friendly infrastructure. Walkability in urban areas, peri-urban areas is greatly supported by pedestrian friendly infrastructure, societal interactions and practices (Middleton, 2021). Factors such as safety and security should be considered in promoting NMT as they are also prioritised by travellers in mode choice decision making (Chakraborty et al, 2025).

The urban form of a town also influences the decisions to walk, for example, Li, Zhang and Yang (2025) stated that there is high consistency of walking in dense areas such as CBDs characterised by dense transport networks and pedestrian systems. Urban areas in South African cities still face mobility challenges due to insufficient infrastructure (Das and Mostafa, 2024). South African towns and cities carry different urban forms due to their historical planning, with most low-income urban settlements located in the outskirts of the city centres and having travel patterns influenced by the high occupancy mini-bus taxis and affluent areas and suburbs characterised by low occupancy vehicle dependency. Achieving sustainability by increased non-motorised transport use is therefore challenging due to the walking distances and geographic locations. Worcester's urban structure is not vastly different however, the agricultural land uses surrounding the town requires different approached to the mobility issues.

Study Area

The town of Worcester in the Western Cape province of South Africa is within the Cape Winelands District Municipality, enveloped by mountainous terrain of farm and winelands. In these mountains lies proportions of agricultural land which is one of the main activities contributing to the economy of this town. The population of Worcester, according to Statistics South Africa, was approximately 97 078, which formed a larger part of the project 222 891 Breede Valley local municipality population for 2026 (Western Cape Government, 2023). Areas in and around Worcester saw recent urban growth and population increase, with Zweletemba's urban growth spiking 4.8% and DeDoorns with 2.4%. The 2023 Socio-Economic Profile of Breede Walley Municipality reported 5 225 crimes per 100 000 people in Breede Valley of which most of them were drug related, common assault, residential burglaries and malicious damage to property. Only 70 crimes reported in 2023 were related to mobility and travel, i.e, driving under the influence. Mobility characteristics of Worcester are dominated by people who work in the industrial sector, daily workers who travel at varying hours of day for their day or night shifts. There is a significant number of seasonal employees who come to the town temporarily during ploughing and harvest seasons, their travel is primarily catered for by employers as they are collected and dropped off at central pick-up points in trucks and buses. Some travel weekly from the town to surrounding farms and only come to the town centre on specific days for shopping hence to not travel regularly as full-time day employees and students.

Methodology

The study utilizes questionnaire surveys and visual assessments of pedestrian and NMT support infrastructure to identify walking behaviours and constraints to walking and use of NMT modes. Visual assessment conducted between January and March 2026 and questionnaire survey administered to 403 participants in February to March 2026 are used as primary data. The questionnaire was administered to randomly selected residents of Worcester who consented to participating the study. The questionnaire was designed for quantitative and qualitative data that would reflect the state of NMT use and barriers where there is lack thereof. Each questionnaire was conducted in 15 – 20 minutes and a total of respondents participated.

The focus of the first section of the study was determining the demographic information of the participants, such as age, level of education, employment status and vehicle ownership. Secondly, the study had to determine how

walkable the town is perceived and the factors influencing those perceptions. The third section of the study focused on satisfaction with NMT infrastructure. This section was supported by a visual assessment of infrastructure in some selected areas of the town. All ethical considerations and permissions for the research project were observed.

Discussion of Results

The demographic characteristics of participants of the survey show that majority of the respondents were of the age groups 26 – 35 and 36 -45 years which were 24.9% and 28.6 % respectively. 49.3% of the participants had achieved matric or lower as their highest level of education followed by 25.8% who have a higher certificate. Only 14% of respondents had attained a diploma while a low 4.3% had completed a bachelor's degree. The occupation statistics show that 29. 5% of the respondents had full-time employment while 11.1 % were part-time employed, 9.8% were self-employed, 10.1% were students and 11.6 % were seasonal employees. These groups of people influence the frequency of travel and mode of transportation as they are likely to travel daily for work and educational purposes. 18.4 % of the respondents were unemployed while 9.1% were retired or pensioners. The frequency of travel and mode choice for these groups are likely to be different as they do not have structured regular trips. The study area can be described as a low-income small town because a significant portion of the respondent and below 4500 rands, this is supported by the higher percentage of unemployed and seasonal or part-time workers. Not surprisingly the vehicle ownerships statistics also indicate somewhat of low income because 76.3% of the respondent indicated that they did not have a vehicle or did not have access to a vehicle they could use freely or whenever they wanted. The lack of drivers licenses amongst the respondent also indicate that majority of them do not drive therefore they are users of the public transportation or non-motorised transportation.

Table 1. *Demographic characteristics*

Variable	Group	N	Percentage	Variable	Group	N	Percentage
Age	18 - 25	53	13.2	**Level of education**	Matric or lower	197	49.3
	26 - 35	100	24.9			103	25.8
	36 - 45	115	28.6		Higher	56	14.0
	46 - 55	63	15.7		Certificate	17	4.3
	56 - 65	47	11.7		Diploma	3	.8
	66+	21	5.2		Bachelor	24	6.0
	Prefer not to	3	.7		Masters	400	100.0

	say	402	100.0		Prefer not to say		
	Total				Total		
Gender	Male	196	49.7				
	Female	193	49.0				
	Prefer not to say	5	1.3				
	Total	403	100				
Occupation	Student / intern	42	10.6	**Monthly Income (R)**	Less than R1500	82	20.9
	Part-time employment	44	11.1		R1500 - R3000	105	26.7
	Seasonal employment	46	11.6		R3000 - R4500	64	16.3
	Unemployed	73	18.4		R4500 - R 6000	77	19.6
	Self employed	39	9.8		R6000 - R10 000	43	10.9
	Pensioner / Retired	36	9.1		R10 000 - R20 000	11	2.8
	Full-time employment	117	29.5		More than R20 000	11	2.8
	Total	397	100.0		Total	393	100.0
Driver's License	No	253	62.8	**Vehicle Ownership**	No	297	76.3
	Yes	150	37.2		Yes	92	23.7
	Total	403	100.0		Total	389	100.0

R = ZAR (South African Rands)

Modal split between the respondents show mini-bus taxis as walking are the most used followed by private vehicles. Out of (N = 816) multiple responses 36.9% and 21.7% trips undertaken were by mini-bus taxis and private vehicles respectively. There is no public bus service in Worcester, however, private employers, companies and farms utilize contracted staff buses for transporting their employees which explains the 1.1% of respondents who indicated that thy use a bus as their regular transportation mode. Non-motorised trips are characterized by 31.9% walking trips and only 1.5% bicycle trips. The use of e-hailing is not common in Worcester, this can be attributed to financial capabilities and income, demand or necessity unlike mini-bus taxis which are cheaper. E-hailing platforms are also used for instances such as shopping when carrying an unusual load and not having to walk far to catch a mini-bus taxis, entertainment activities at night or trips to destinations that do not have direct mini-bus taxi routes.

Shopping and work activities generate most of the trips taken by the participants. 28.7% of the respondents travelled regularly for shopping, 27.9% for work followed by 9.4% of activities associated with family and children's school and related activities. Recreational and leisure activities generate the least trips. Also significant is the 5.4% of trips generated by school / educational trips, which together with the work trips are among some of the trips occurring daily throughout the week at the same times. These are bound to create patterns of travel based on origins and destinations as well as travel times.

Figure 1. *Modal split*

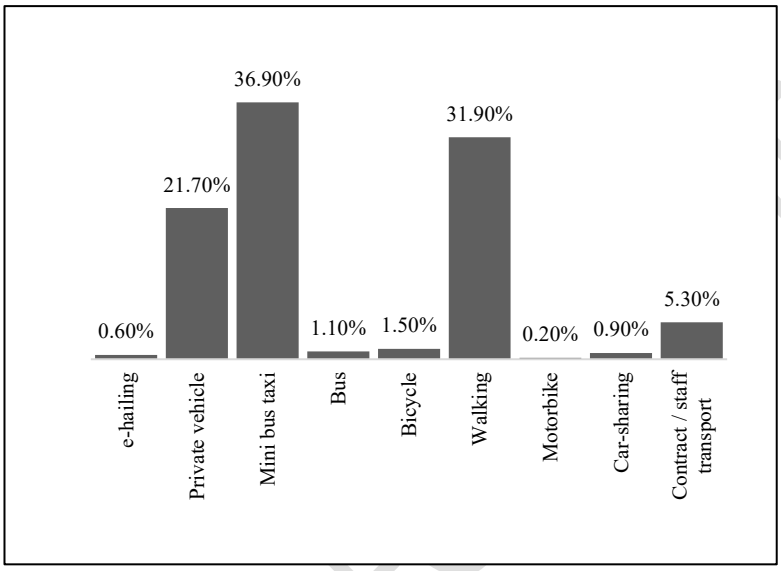
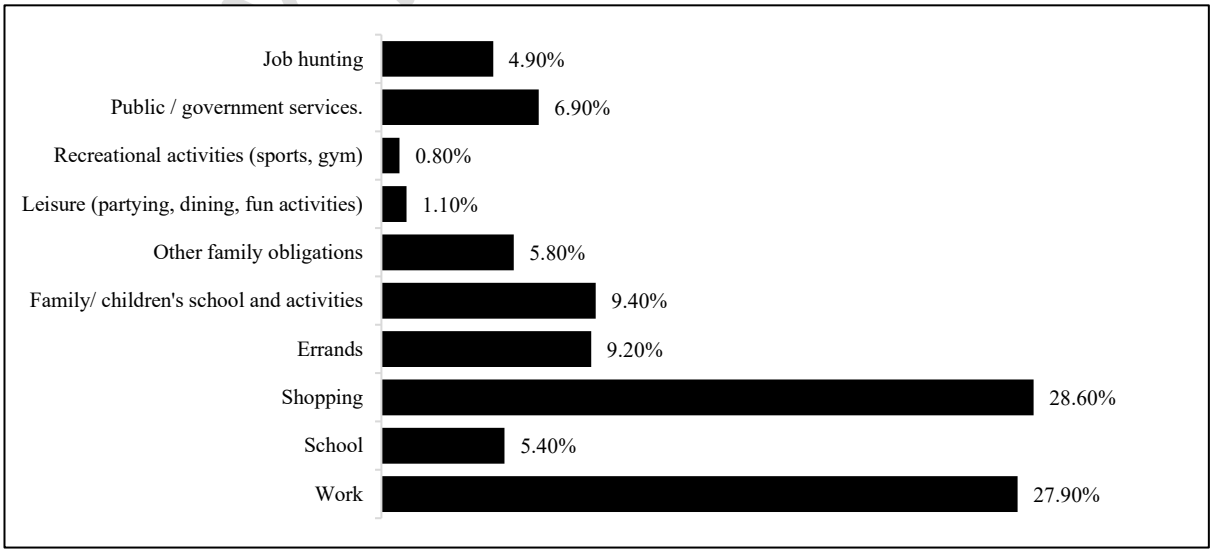


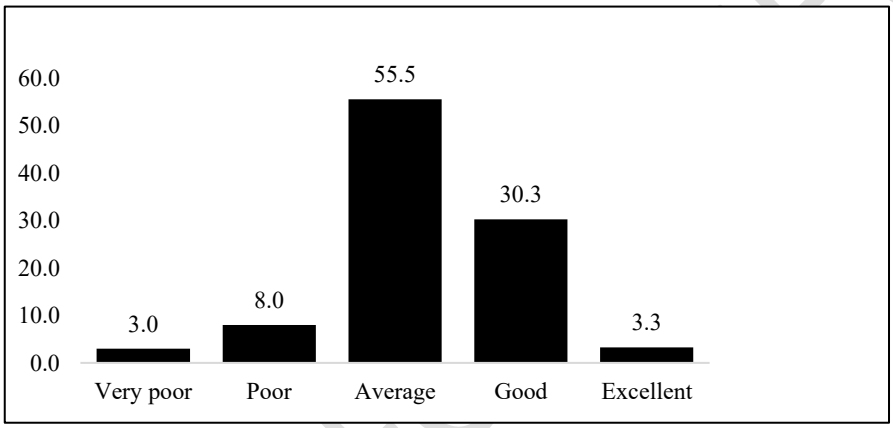
Figure 2. *Trip generating activities*



Perceptions on Walkability

How the respondents perceive or view walkable the town of Worcester is using a 1-5 Likert scale shows an overall positive outlook. Figure 3 shows that walkability in the town is generally considered above average as the result show that a majority of the respondents indicated that it was either excellent (3.3%), good (30.3%) and average (55.5%). Interactions and friendliness of drivers and pedestrians seem to contribute negatively to the perceived walkability, whereas traffic signal for pedestrians as well as provision of signage and message boards with information for pedestrian seem to contribute more positively to perceived walkability.

Figure 3. Perceived walkability



It is challenging to measure walkability based on people's perceptions. Different factors, firstly, the areas in which the person lives and visits regularly or walks around contribute to the opinion. The distance that they usually walk and circumstances under which the walking trips are undertaken; whether they are walking for leisure, whether they are carrying any luggage while walking, the distance and weather conditions affect the ease of walking.

Spatial Analysis

Figure 4. *Visual analysis sites Source: Author on QGIS using OSM base map*

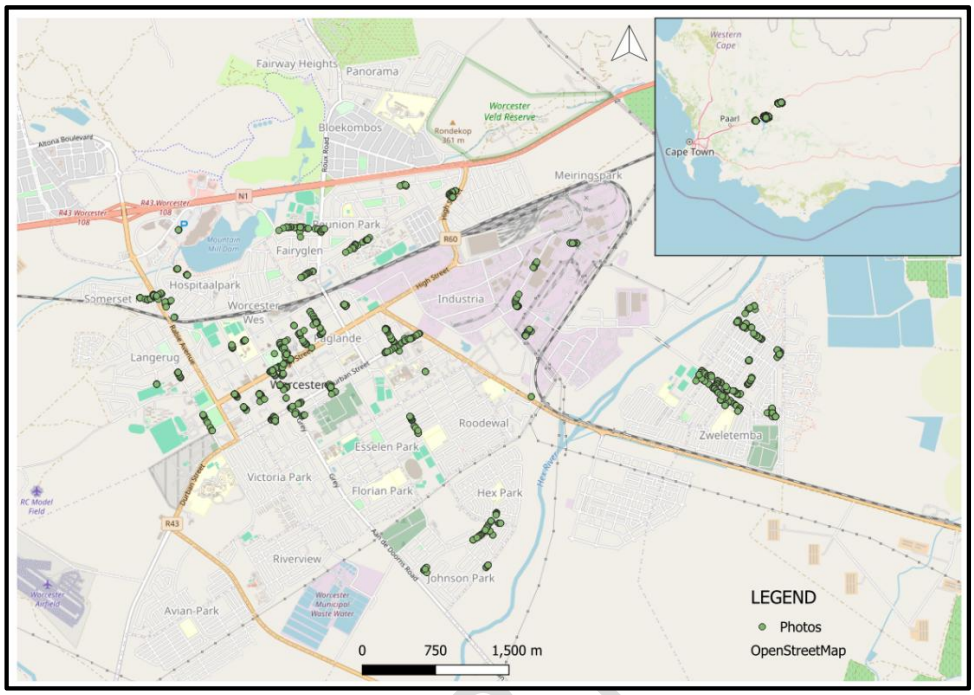


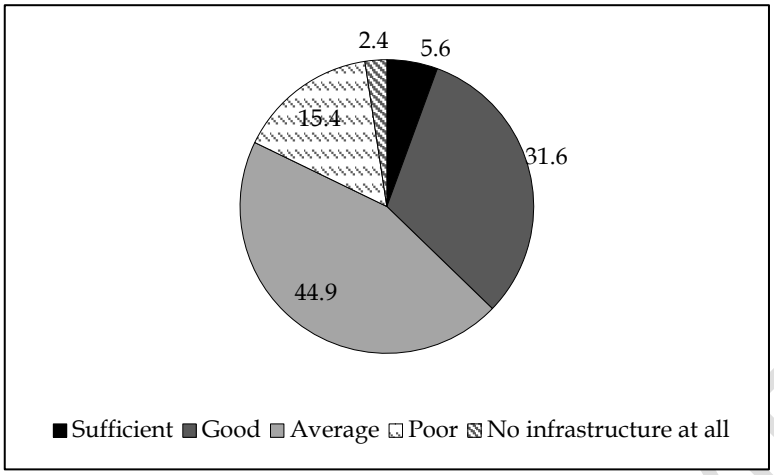
Figure 4 shows the geolocation of all visual assessments. Representative images showing varying conditions of walking and cycling infrastructure are presented in Figures 7, 8, 9 and 11. There are visible differences in availability and conditions of facilities in areas within the town. Areas such as Worcester Central, Hospital Hill and Langerug have well maintained and newer infrastructure compared to areas such as Johnson Park, Hexpark and Zweletemba. Even within these areas with better infrastructure, instances of degrading or lack of infrastructure are visible. Worcester Indusria, which is the industrial area have extremely limited NMT infrastructure.

Pedestrian Infrastructure

To understand the how pedestrians and cyclists understand and relate to the infrastructure, they were asked to describe the state of infrastructure in their areas

of residence. The results are presented in Figure 5 below.

Figure 5. *Perceptions of the state of NMT infrastructure*



Source, author

31.6% and 5.6% or respondent described the infrastructure in their residential areas as either good or sufficient respectively. The remaining 44.9% described it as average while 17.8%described it as below average. These results present an image that shows even though there is availability of facilities in the town, it may be perceived as insufficient and provides opportunity for infrastructure development. The high number of respondents perceiving the infrastructure as average could also reflect sufficiency in some areas and lack in other areas. Further, a chi-square analysis of the level of satisfaction against residential areas produced a chi-square value of 0.04 and a likelihood ration of 0.209.

Comparing the general perceived walkability and perceptions towards the state of infrastructure, very low numbers perceive the walkability and infrastructure as excellent and sufficient respectively. In both cases, less than 50% of the respondents perceive these two conditions as good and could be associated with the location or areas of residents, potentially people who reside in areas were NMT facilities are provided and well maintained. The 15.4% of respondents who indicated that there is no NMT infrastructure in their residential areas may also be residents of areas that are lowly catered for, reside in areas with provisions but their immediate environment or street do not have any infrastructure. Such conditions are common in the low-income area and informal settlements in the Zweletemba areas of town. Lack of infrastructure in some case may be associated with theft and vandalism where parts of the infrastructure such as sign poles and manhole covers are dismantled.

Figure 6. *Perceptions of NMT infrastructure in residential areas*

A correlation between residential areas and NMT infrastructure is shown on Table 2 below. Respondents were asked how common infrastructural problems where in their residential areas. The correlation relationships were stronger, with significant chi-square values for variables such as untidy pavements with vegetation and uncut grass or shrubs, lack of cycling lanes and conflicts between pedestrians, cyclists, and motorised transportation. The rest of the variables produced insignificant chi-square values. The indication by the results that most of the problems are rare emphasises the use of walking as a necessity regardless of the conditions.

Table 2. *Relationship between residential areas and perceptions of NMT infrastructure*

Residencial area * Common infrastructure problems	**N**	**Percent**	**Chi-Square**	**Likelihood Ratio**
Limited or lack of sidewalks	390	96.8%	0.164	0.055
Conflict between pedestrians, cyclists with motorized vehicles	389	96.5%	0.016	0.039
No cycling lanes	377	93.5%	0.069	0.015
Potholes on the sidewalk	387	96.0%	0.135	0.03
Dysfunctional traffic lights and lack of traffic signals	378	93.8%	0.152	0.065
Lack of or poor road markings and signs	38	95.0%	0.578	0.386

	3			
Untidy pavements with vegetation, uncut shrubs and grass	386	95.8%	0.04	0.023
Manholes, open channels or blocked drainage and flooded walkways or sewage on walkways/ cycle ways	381	94.5%	0.26	0.133

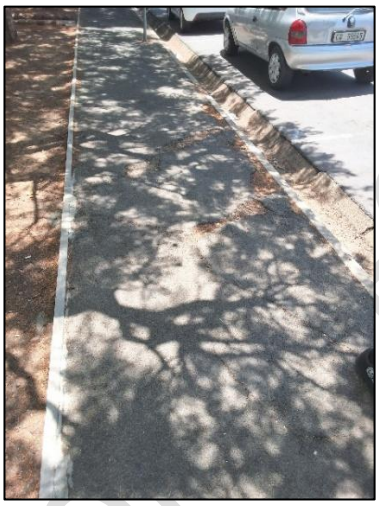
Figure 7. *Benches provided along walkways*

Source: Author

In some parts of the town specifically the town centre and some suburbs with recreational parks, there are rest benches that have been provided to allow people to sit down and rest. These provisions together with waste disposal bins are necessary part of NMT support infrastructure. The benches provide a place for sitting and resting while in the town area. The disposal bins are also significant to NMT support as people walking and cycling in the town can dispose of any waste and continue their journeys without caring anything that

might contribute to their discomfort.

Figure 8. *Damages on sidewalks showing (a) peeling off asphalt layer (b, c) Cracks and broken kerb*



Source: Author

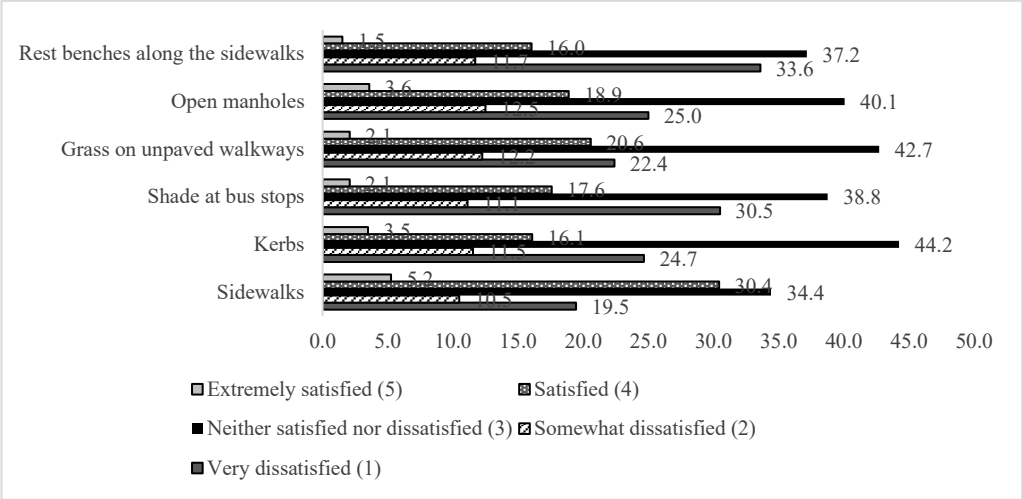
Figure 8 and 9 show surface conditions of sidewalks in Worcester Central. There are visible cracks on the sidewalks, exposing aggregate. The unevenness of walking surfaces can be hazardous and cause some accidents to pedestrians. Marked road crossings such as in Figure 9 (b) and paved sidewalks such as in Figure 9(a) are common in the town centre and areas closest to the centre. Due to the density high vehicle traffic large numbers of pedestrians in the centre compared to the residential areas, these measures assist in managing the pedestrian and vehicle conflict. The designated walkways keep pedestrians away from traffic and the markings guide pedestrian movement at intersections.

Although these are provided, cases of pedestrians crossing at their own desired sections of the road still occur.

Figure 9. *Paved walkway showing uneven surface (a), pedestrian crossing (b)*

Source: Author

Figure 10. *Level of satisfaction with NMT support infrastructure*

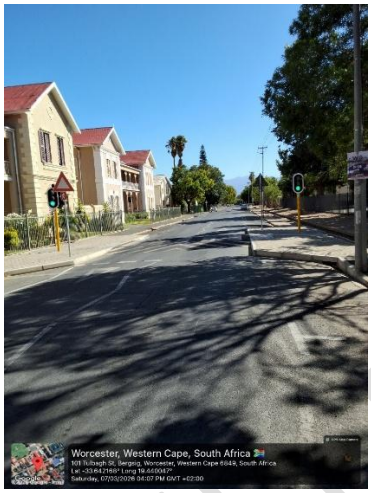


Source: Compiled by author

Most respondents were not convincingly satisfied with walking support elements as the results indicate majority average or below level of satisfaction. Sidewalks were the only infrastructure most respondents 30.5% and 5.2% were satisfied and extremely satisfied with respectively. 33.6% of respondents were very dissatisfied with the rest benches along sidewalks and a significant 30.5 % were very dissatisfied with the shades at bus or taxi stops. Walking is a mode of transport that supports and is supported by other modes of transportation, hence the need to provide infrastructure that is supportive of walking at places of access for other modes of travel such as bus and taxi stops and bus ranks.

Figure 11 shows (a) cycling lane in Zweletemba, Worcester, (b) Lack of sidewalk along a road in Zweletemba and (c) road with sidewalk, marked road signs and signalised pedestrian crossing in Worcester. These images show unequal infrastructure development in different areas, highlighting the disparities. In Zweletemba, for instance, there is sufficient infrastructure provided along the main road that leads from the industrial area. Cycling lanes and pedestrian sidewalks are provided, however, the internal streets do not accommodate walking and cycling infrastructure Some streets have sufficient space available for sidewalks that could serve as a walking and cycling lane. In some cases, however, property lines encroach the roadway and there is no space to accommodate waking and cycling lanes. In some parts of Church Street and Tulbagh streets, better infrastructure is provided. It is worth noting that these streets accommodate schools and centres for the deaf and blind and infrastructure caters to their basic mobility needs and universal access.

Figure 11. *(a) Cycling Lane in Zweletemba, Worcester. (b)Roadway and adjacent unpaved walkway (c) Road showing marked road signs, paved sidewalk, road signage and a pedestrian crossing*



Relative Importance Index

A relative importance index analysis was conducted on factors that contribute to people's decision to walk. A Likert Scale rating of 1 – 5 was used (i=1; Not important at all, i=2; Not really important, i=3: Somewhat important, i=4: Important and i=5: Extremely important). Safety was the most important factor with RII = 0.790 followed by travel time and Fitness or keeping active with 0.769 and 0.768 respectively. Lack of public transportation had the least RII of 0.735.

$$RII = \frac{5_{n5} + 4_{n4} + 3_{n3} + 2_{n2} + 1_{n1}}{A \times N}$$

Table 3. *Relative Importance in decision making and choice of walking*

	Not Important at all (n_1)	Not really important (n_2)	Somewhat Important (n_3)	Important (n_4)	Extremely Important (n_5)	Total cases $\sum(i \times ni)$	N	A*N	RII	Rank
Safety	8	20	168	940	405	1541	390	1950	0.790	1
Travel time	14	34	168	904	360	1480	385	1925	0.769	2
Fitness and keeping active	7	20	273	812	355	1467	382	1910	0.768	3
Convenience	7	18	309	800	220	1354	363	1815	0.746	4
Affordability	15	40	183	1008	200	1446	388	1940	0.745	5
Travel distance	20	40	207	860	300	1427	384	1920	0.743	6
Comfort	12	28	285	856	245	1426	384	1920	0.743	7
Unfavourable weather conditions	16	32	237	860	240	1385	374	1870	0.741	8
Waiting time	24	36	177	924	245	1406	381	1905	0.738	9
Lack of public transport	24	42	204	864	285	1419	386	1930	0.735	10

Unfavourable weather conditions being one of the least crucial factors means that people are likely to walk in bad weather conditions. This could be attributed to short walking trips to access other forms of transportation or dire cases where the traveller has no alternative means. Safety when walking could be associated with fear of crime, interactions with other road users specifically cars and motorcycles, possible accidents due to infrastructure conditions. This could mean that before a person decides on a mode of travel, they consider their safety. The time in which they are walking will also influence how safe they feel. There are less chances of respondents not walking when they feel unsafe. The decision to walk or use other NMT modes is based on the perception of importance of factors relating to actual travel. Factors such as weather conditions that are beyond the traveller's control often have minimal influence on travel compared to time of travel and affordability.

Respondent were asked of the times and the perception of safety while working and all areas around Worcester. From the result it is evident that it is very unsafe to walk between midnight and 4 am as well as between 8 pm and midnight. Are the times that people feel safer when working around Worcester are between 8 am and midday and from midday until 4 pm thereafter the safety or the perception of safety decreases. The respondents were asked for suggestions to improve walkability and suggestion related to safety and security were prevalent. One respondent "create a safer place with more law enforcement", "increase law-enforcement in the area", " encourage more law-enforcement patrolling". One respondent suggests that installation of cameras

for safety they indicated that their areas that aren't safe and need security cameras in every street corner or police patrolling in the dangerous areas". Suggestions related to infrastructure included fixing of potholes on the road, construction of more walkways, installation of streetlights or the municipality to do more road marks which will improve walking safety.

Conclusion

This paper highlights the state of non-motorised mobility in a small South African town. The disparities in availability and condition of NMT facilities in different areas of the same town is evident and this provides an opportunity for development in the areas least catered to. The town of Worcester, given its size and compactness offers opportunities for development NMT infrastructure that could cover the entire town. Moreover, there are strong relationships between safety and weather conditions, and sufficiency of infrastructure and weather conditions towards deciding to walk, whereas factors such as travel distance and travel time contribute less to the decision to walk. The results are evidence that walking in Worcester in used as a necessary mode due to the socio-economic realities of travellers. Other forms of Non-Motorised Transport, such as bicycles, electric bicycles and scooters are not as accessible as walking and therefore seldom used in Worcester. Travel distance for residents of townships and low-income areas may not always be a walkable distance. The location of industrial areas near low-income residential areas gives opportunity for design for walkability and NMT, however, the lack of NMT friendly infrastructure within the industrial area is a hinderance to NMT.

Walking as a necessity can be likened to the use of some modes of transportation by what is deemed the captive users because no matter the circumstance, the need for travel will exceed the need for comfort or perfect travel conditions. Promotion of walkability to counter the effects of increased car ownership as an approach in small Southern African cities should be considerate of the socio-economic characteristics and urban forms of these cities. The study concludes that even though there are challenges and potential barriers to walking, cycling and the use of non-motorised travel modes, Worcester provides a case study that is unique from most small towns that are expanding, the different urban forms within one town and the surrounding areas create mobility challenges that force the use of motorised vehicles. The travel distances to farms are not easily walkable distances, they do however provide opportunity for development of cycling lanes in the roads leading to farm areas.

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