Barriers to Cycling Mobility in Masiphumelele, Cape Town: A Best-Worst Scaling Approach

James Hamilton Irlam

(IRLJAM001)

A dissertation submitted in fulfilment of the requirements for the degree of

MASTER OF PHILOSOPHY
(Climate Change and Sustainable Development)

Centre for Transport Studies
Department of Civil Engineering
Faculty of Engineering and the Built Environment
University of Cape Town

Supervisor: A. Prof Mark Zuidgeest

February 2016

ABSTRACT

Background

Non-motorised transport (NMT) such as cycling and walking has multiple social, economic, environmental, climate and public health benefits and is integral to the agenda of sustainable development. There is considerable potential for more cycling mobility in South Africa, especially in low-income communities (LICs). Barriers to cycling mobility were investigated in Masiphumelele, a LIC in Cape Town, in order to inform recommendations for promoting cycling as a mode of transport in this community and beyond.

Methods

A mixed methods design of qualitative and quantitative methods was used. A focus group discussion (FGD) with local bicycle shop customers informed the design of a cross-sectional cluster sampling questionnaire and a Best-Worst Scaling (BWS) stated choice survey of 100 household residents. The BWS survey used 10 choice sets of 4 statements each to rank the relative importance to study participants of 20 potential barriers to cycling mobility on their average Best-Worse (B-W) scores.

Results

Taxis were the most frequently used mode of household transport (93%) followed by walking (44%), train (23%), bicycle (16%) and bus (11%). A third of households (32%) owned at least one bicycle that is used for transport. Twenty two participants (22%) reported that they cycle fairly often (n=15 respondents) or regularly (n=7 respondents), primarily to save money (44%), keep fit and healthy (32%), and to save time (15%). The main reasons against cycling were unsafe roads (23%), unaffordable bicycles (15%), inability to cycle (15%), inadequate health and fitness (12%), long distances (10%) and no bicycle (7%).

The BWS survey identified and ranked significant perceived barriers to cycling as poor road safety (B-W score = 0.16); inability to transport loads on a bicycle (0.15); not being permitted to transport a bicycle on the train during peak commuting hours (0.13); and

the risk of being late for work (0.12). Unaffordability and lack of safe storage of bicycles were significantly more important barriers for men than women, whereas poor health was more important for women than men.

Two thirds (68%) supported promotion of cycling mobility in Masiphumelele, mostly for reasons of financial savings (43%) and health benefits (28%). The main suggestions for promoting cycling were to teach cycling skills (30%), sponsor bicycles (21%), actively promote the benefits of cycling (20%), and create a safe environment for cyclists (12%).

Conclusion

There is a relatively high prevalence of bicycle ownership and use, as well as good support for promoting cycling mobility in Masiphumelele, mostly due to the perceived benefits of financial savings and health.

The BWS stated choice methodology proved to be a valid and feasible means of identifying and ranking perceptions of top barriers to cycling. Fears about road safety, arriving late for work, and being robbed while cycling; inability to transport loads by bicycle; and inability to transport a bicycle on the train during peak commuting hours emerged as significant barriers. Some significant differences in perceptions of barriers emerged between male and female participants.

Actively promoting the benefits of cycling, educating about road safety, teaching cycling skills, making bicycles and spares more affordable, enhancing the safety of the cycling environment, and building local capacity are recommended as key interventions for increasing cycling mobility in Masiphumelele.

AUTHOR'S DECLARATION

I, James Hamilton Irlam, declare that this dissertation is my own original work. I know the meaning of plagiarism and declare that all the work in this document, save for that which is properly acknowledged, is my own.

This dissertation is being submitted in partial fulfilment of the requirements for the degree of Master of Philosophy in Climate Change and Sustainable Development at the University of Cape Town.

It has not been submitted before for any degree or examination at any other university.

Signed by candidate

JAMES HAMILTON IRLAM

12 February 2016

ACKNOWLEDGEMENTS

I am grateful to the following for their assistance:

- My study supervisor Assoc. Prof Mark Zuidgeest
- My fieldworkers in Masiphumelele: Siyolisi Bani; Sisa Zihlwele
- Nicolas Commeignes for logistical assistance in Masiphumelele
- Gail Jennings; Andrew Wheeldon; Trevor Knowlden; Ulrich Doering; Morgan Chikumba; Marcela Guerrero Casas for their valuable advice and insights
- My wife Ros and my children Huw and Amy for their constant love and support

CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

BACKGROUND

Sustainable transport systems provide affordable, efficient modes of transport to support a vibrant economy, while limiting adverse impacts on the environment such as emissions, pollution, and land use (City of Cape Town, 2013). They allow '*the basic access needs of individuals and societies to be met safely and in a manner consistent with human and ecosystem health, and with equity within and between generations*' (City of Cape Town, 2013, p. 192). Sustainable transport systems are integral to sustainable development and interact with social, economic and environmental systems in multiple ways (City of Cape Town, 2013).

The social, economic and environmental benefits of sustainable development (Goodland & Daly, 1996) are particularly evident in non-motorised transport (NMT). Walking and cycling are the most common modes of NMT and are key targets for sustainable development approaches to encourage active transportation, as well as energy efficiency, improved air quality, and water and waste management (Heaton, Balbus, Keck, & Dannenberg, 2010). NMT has therefore been increasingly researched and promoted in recent decades as part of the global agenda of sustainable development (Behrens, Muchaka, Salazar Ferro, Schalekamp, & Zuidgeest, 2015; IPCC, 2014; Kirkels, 2011; Nkurunziza, Zuidgeest, & Van Maarseveen, 2012)

Cycling is healthy, affordable, and efficient over short distances, does not harm the environment with noise or air pollution, and improves the quality of urban life (Heinen, van Wee, & Maat, 2010; Pucher, Dill, & Handy, 2010). The public health benefits of increased levels of exercise with active mobility include reduced risks of cardiovascular diseases, diabetes, and certain cancers (Woodcock, 2009. In: (Watts *et al.*, 2015); (World Health Organisation, 2008)). People cycle for health and exercise, for pleasure, for utility purposes, for environmental reasons and because bicycles offer a flexible and convenient mode of transport (Gatersleben and Appleton, 2007; Gatersleben and Uzzell, 2007; Ryley, 2006; Bergström and Magnussen, 2003; Stinson and Bhat, 2004. In: (Heinen *et al.*, 2010)).

The climate mitigation potential of cycling is significant due to its zero direct greenhouse gas (GHG) emissions (Massink, Zuidgeest, Rijnsburger, Sarmiento, & Van Maarseveen, 2011; Wadud, 2014; Watts *et al.*, 2015). According to the international Partnership on Sustainable Low Carbon Transport, half of all trips in cities are within cycling distance (SLoCaT, 2016). The promotion of cycling must therefore be a key component of comprehensive mobility plans to mitigate GHG emissions in developing countries (SLoCaT, 2016; World Health Organisation, 2008). More compact urban environments that support cycling and walking are among the measures recommended by the Intergovernmental Panel on Climate Change (IPCC) to reduce transport-related carbon dioxide emissions, which are a significant and fast-growing contributor to global emissions (IPCC, 2014).

In South Africa the transport sector accounts for about 10% of total GHG emissions from liquid fossil fuels, of which road transport makes up more than four fifths (Department of Environmental Affairs, 2011a). The per-capita usage of inefficient transport modes in South Africa is high as the country's size and relatively low population density, the migrant labour system, the spatial divides of apartheid, and urban sprawl all necessitate long and frequent commuting trips. In addition, under-investment in public transport and NMT in favour of the road network has resulted in those who can afford it opting for private rather than public transport and for motorised transport rather than NMT for short urban trips (National Department of Transport, 2002). The National Strategy for Sustainable Development therefore has sustainable transport and infrastructure as one of its key focus areas towards the objective of a '*just transition towards a resource-efficient, low-carbon and pro-employment growth path*', which includes a shift towards public transport and NMT (Department of Environmental Affairs, 2011b).

There is good policy support for NMT in South Africa, with numerous policy and strategy documents that recognise the multiple benefits of cycling and its potential to provide low-cost mobility and to improve transport equity and access to socio-economic opportunities, especially among developing and low-income communities (LICs) (Bechstein, 2010; Jennings, 2014, 2015a; Mashiri, 2013). Policy implementation has often been poor however. A lack of political commitment to provide adequate

funding and training for capacity development indicates that authorities may not be fully convinced that NMT is a genuine solution for providing low-cost mobility (Behrens et al., 2015; Mashiri, 2013). In addition to the absence of dedicated funding, the lack of a critical mass of NMT projects, experts and technical specialists, as well as weak institutional development inhibit the mainstreaming of NMT initiatives (Mashiri, 2013).

Transport consumes about two thirds of energy in the City of Cape Town, accounts for about a third of carbon dioxide emissions, and contributes significantly to local air pollution (City of Cape Town, 2013). Cape Town is one of the most congested cities in South Africa, due in part to significant recent increases in car ownership, the high usage of single occupancy vehicles, and widespread concerns about the flexibility, safety, and congestion of public transport (City of Cape Town, 2013). Cape Town has been described as a tale of two cities: of motorists frustrated by long commuting times and rising fuel costs and users of public transport frustrated by long queues for frequently overcrowded and delayed trains or buses; of environmental activists eager to follow global urban cycling trends and cyclists in LICs riding to save on public transport fares while struggling to afford basic bicycle repairs (Jennings, 2011).

The question of how to incentivise a mass modal shift in favour of cycling is one that greatly concerns Transport for Cape Town (TCT), the City's transport authority (Kok, 2014). The City has developed a number of cycle-promoting guidelines, policies, frameworks, plans and infrastructure in response to the need for low-cost mobility (City of Cape Town, 2005, 2011, 2013; Jennings, 2015a). A 2015 review of utility or commuter cycling patterns in Cape Town since 2003 concluded that despite these promising policy developments however, there is little evidence of increasing or safer cycling mobility (Jennings, 2015a).

Masiphumelele (meaning "We will succeed" in isiXhosa) is a low-income community of more than 30 000 people living in formal and informal housing in ward 69 of the South Peninsula sub-district of the City of Cape Town[1]. It is within relatively easy cycling distance (less than 10 km of flat topography) of employment and business centres in the

[1] Projection from 2011 census figures supplied by the Development Information Analysis and Research, Development Information and GIS Department, City of Cape Town

suburbs of Kommetjie, Noordhoek, Sun Valley and Fish Hoek. Cycle commuters are frequently observed along the main access roads and within Masiphumelele [2], yet the factors that influence or deter cycling mobility there have not been fully explored (Boulle, 2013).

Masiphumelele therefore provided a suitable setting for this study of barriers to cycling mobility in a fairly typical low-income community, in order to make specific recommendations for promoting cycling as a mode of transport in this community and beyond.

[2] Personal communication, GJ (independent transportation researcher and cycling advocate), April 2015.

CHAPTER 2

LITERATURE REVIEW

This chapter provides an overview of the key national, provincial and municipal policies and plans related to NMT and cycling in South Africa. The literature on the determinants of choice of travel mode and of bicycle commuting in particular is reviewed. The chapter concludes with an overview of Best-Worst Scaling (BWS), a stated choice methodology which is used in this study to identify the most important perceived barriers to cycling mobility.

Overview of NMT Policy

Key National NMT Policy

The past two decades have seen a significant shift in transport policy and planning in South African cities from the prioritisation of private transport towards an improved user-centred public transport system and NMT (City of Cape Town, 2013; Walters, 2013). The notion of transport justice, or the more equitable distribution of the benefits of transportation, has been increasingly recognised worldwide and in South Africa, where it is mainly articulated in transport policies or interventions to improve accessibility and to reduce poverty and social exclusion (Jennings, 2015b). Transport justice is particularly needed in South Africa to help redress inequities of access arising from the legacy of apartheid spatial planning, where those most displaced from centres of employment are least able to afford the long commutes. The poor are affected most by motor vehicle crashes, by air pollution and by climate change arising from transport-related emissions, providing a further equity imperative for the shift to public and low-carbon transport (Department of Environmental Affairs, 2011b; Jennings, 2015b; Watts et al., 2015).

Key national transport policy with respect to NMT includes the *White Paper on National Transport Policy* (1996); the *Moving South Africa Transport Strategy for 2020* (1999); the *National Land Transport Strategic Framework* (2002; 2006); the *National Public Transport Strategy* (2007) and *Action Plan* (2007); the draft *National NMT Policy* (2008,

currently being updated); and the *National Land Transport Act* (2009) (Jennings, 2015a; Mashiri, 2013; Walters, 2013).

Although the *National Transport Policy* makes no specific mention of NMT, it does envision environmentally and economically sustainable transportation systems to support government strategies for economic and social development (National Department of Transport, 1996). *Moving South Africa* is a high profile strategy for implementing the *National Transport Policy* that recognises the significant role of NMT modes of walking and cycling in meeting South Africa's diverse mobility needs (National Department of Transport, 1999). NMT also features prominently in the *National Land Transport Strategic Framework* (National Department of Transport, 2002). The *National Public Transport Action Plan* recognises the job-creation opportunities of bicycles, such as rentals to commuters and tourists, and proposes ways to distribute bicycles among the urban and rural poor as a means of facilitating access to public transport (National Department of Transport, 2007). The draft *National NMT Policy* regards affordability of transport as a major barrier to access in low-income households. Cycling is seen as an affordable, accessible and reliable means of addressing transport inequities with significant potential health, economic and environmental benefit (National Department of Transport, 2008). The *National Land Transport Act* requires that NMT plans be developed and integrated into the *Provincial Land Transport Frameworks* (PLTFs) and municipal *Integrated Transport Plans* (National Department of Transport, 2009). The Western Cape PLTF of 2011 called for NMT plans to be implemented in each municipality, for dedicated cycle lanes to be doubled by 2014, and for a 13% modal shift from private to public transport into Cape Town's central business district (Department of Transport and Public Works, 2011 In: (City of Cape Town, 2013)).

City of Cape Town: NMT Policy and Strategy (2005)

The 2005 *NMT Policy and Strategy for the City of Cape Town* recognized that the NMT environment was generally of low quality, especially in poorer communities, and that public spaces were often poorly maintained, unsafe and therefore seldom used. Poor infrastructural planning, lack of an integrated design approach, and difficulties in managing public spaces were identified as key reasons (City of Cape Town, 2005).

Key objectives of the *NMT Policy and Strategy* were therefore to promote a culture of cycling and walking as modes of travel; to create safe pedestrian and cycling environments; to integrate land use development appropriate for NMT; and to enable social and economic empowerment by means of low-cost NMT mobility. Interventions that emphasise access for all, the importance of people and communities, the role of economic and social transformation, environmental sustainability, integration and awareness were therefore identified as essential (City of Cape Town, 2005).

City of Cape Town: Bicycle Master Plan (2011)

The City of Cape Town's *Bicycle Masterplan* (BMP) was first developed in the 1980s and 1990s to connect suburbs, workplaces and strategic facilities in the City by means of a network of bicycle paths. The BMP was updated in 2002 and again in 2011 by City consultants and bicycle stakeholders and a further update is currently in progress[3]. Sport cyclists rather than commuter cyclists were the primary target group of the 2011 BMP however, hence the focus was on higher-order routes for training, recreational cycling and long-distance commuting, as well as local roads frequently used by cyclists (City of Cape Town, 2011). Higher-order routes were previously identified in the *City-Wide NMT plan for the City of Cape Town* to accommodate long distance commuter and recreational cyclists, as opposed to local order NMT facilities for short distance trips (City of Cape Town, 2010).

Among the key recommendations of the BMP were annual counts of cyclists along major cycling routes and at key intersections; warning and information signage along frequently used cycling routes; increased law enforcement; and road closures to vehicles during peak training periods for major cycle events. It was further recommended that cyclists be included in transportation impact assessments and in planning for NMT, road management and road safety (City of Cape Town, 2011).

City of Cape Town: Comprehensive Integrated Transport Plan 2013-2018

The purpose of the *Comprehensive Integrated Transport Plan 2013-2018* (CITP) is to provide the Transport for Cape Town (TCT) authority with a mandate to deliver an

[3] Personal communication, TK (City of Cape Town Cycle Forum), July 2015.

'*integrated, intermodal and interoperable*' transport network (City of Cape Town, 2013, p. xv). The CITP is mandated by the *National Land Transport Act* as the transportation component of the City's *Integrated Development Plan* (IDP). The IDP seeks to promote sustainable environmental, human and social development to achieve '*a Caring City, an Opportunity City, an Inclusive City, a Safe City, and a Well-Run City*' (City of Cape Town, 2014a, p. 3).

The sustainability of the transport system in Cape Town is undermined by numerous social, economic and environmental problems however, that render it unsafe, inaccessible, inefficient, and unaffordable for many residents. The CITP's *Sustainable Transport Strategy* therefore aims to provide a transport system that is affordable and efficient, offers a choice of travel mode, helps create economic opportunities, enhances access to education, employment, community facilities and basic services, and that minimizes the environmental impact of emissions, noise, waste, land use and resource consumption (City of Cape Town, 2013). Although the social sustainability principles of quality of life, equity, and social cohesion are incorporated into the City's transport planning in theory, it is not clear how these are measured and included in decision-making in practice (Jennings, 2015a).

The aims of the CITP's *NMT Strategy* are to build a continuous NMT network within an integrated transport system, to improve safety and security, to improve the provision and maintenance of NMT facilities, and to create a culture of respect for NMT. Strategic leadership, successful projects, good visibility of NMT, and supportive law enforcement are all recognised as essential, as well as officials and stakeholders who are well–trained in NMT planning, design and maintenance. TCT is responsible for developing uniform design standards and for maintaining, monitoring and evaluating NMT infrastructure (City of Cape Town, 2013).

Determinants of Choice of Transport Mode

The study of choice considers the interaction of individual preferences with constraints when choosing from a set of alternatives. Behavioural rules are used to develop formal models of choice that encompass the sources of individual preferences, the constraints

imposed by individual, social, and contextual factors, as well as the available set of alternatives (Hensher, Rose, & Greene, 2005).

Modal choice is a key aspect of mobility in transport studies that is determined by the interaction of multiple inter-related objective and subjective factors (De Witte, Hollevoet, Dobruszkes, Hubert, & Macharis, 2013). It has been linked to Kaufmann's 'motility' concept, which identifies three basic elements: access to a range of mobility options; competences to be aware of and make use of the options; and appropriation or self-perception of access and competences (Kaufmann, 2004. In: (De Witte *et al.*, 2013)). These three elements of motility, as well as the available mobility options, are dependent on the prevailing economic, social, cultural and political context (De Witte *et al.*, 2013).

Kaufmann's 'motility' concept encompasses three major approaches to understanding modal choice: the rationalist, socio-geographical, and the socio-psychological approach. The rationalist approach assumes that travellers weigh up the pros and cons of the alternative modes and then choose the one with the maximum utility or level of satisfaction, usually in terms of minimum travel time and costs (Hensher *et al.* (2005); Shen *et al.*, 2009. In: (De Witte *et al.*, 2013)). The socio-geographical approach assumes that people travel in order to undertake activities distributed in space and time and it therefore considers people's activity schedules to explain modal choices (Meister *et al.*, 2005; Axhausen, 2002. In: (De Witte *et al.*, 2013)). The socio-psychological approach considers the attitudes, intentions and habits of individuals with regard to available transport modes (Van Acker *et al.*, 2010; Verplanken *et al.*, 1997. In: (De Witte *et al.*, 2013)).

Objective determinants of modal choice include socio-demographic factors (age, gender, education, occupation, income, household composition and household car ownership), spatial factors (density, diversity, public transport availability and parking), and characteristics of the specific journey (motive, distance, travel time, travel cost, departure time, trip chaining, weather circumstances, travel information and inter-modal connectivity). Socio-psychological factors like experiences, familiarity, lifestyle,

habits and perceptions are subjective determinants that influence the interactions of the objective factors (De Witte *et al.*, 2013).

Determinants of Bicycle Commuting

In their comprehensive review of the international literature on commuter cycling, Heinen *et al.* (2010) identify five categories of determinants of bicycle commuting to work, as distinct from cycling for sport or recreation purposes. These determinants include the built environment (distance; urban layout; cycling infrastructure); the natural environment (landscape; weather and climate); socio-economic factors such as gender, age, income, ownership of cars and bicycles, and employment status; psychological factors, including attitudes, social norms and habits; and aspects related to cost, travel time, effort and safety (Heinen *et al.*, 2010).

The built environment influences commuter cycling in a number of ways, of which distance is probably the most important (Parkin *et al.*, 2007, Timperio *et al.*, 2006; Stinson and Bhat, 2004. In: (Heinen *et al.*, 2010)). Higher urban density generally results in shorter commutes, so people living closer to city or town centres therefore tend to cycle more (Parkin *et al.*, 2008; Guo *et al.*, 2007; Dill and Voros, 2007. In: (Heinen *et al.*, 2010)). A continuous network of bicycle lanes and infrastructure, complemented by safe parking and workplace facilities like showers and lockers are important to cyclists, but their influence on choice or frequency of cycling remains an open question (Garrard *et al.*, 2008; Hunt and Abraham, 2007; Stinson and Bhat, 2005. In: (Heinen *et al.*, 2010)).

The natural environment has been shown to influence the share of bicycle commuting. Rain is considered by cyclists to be the most negative aspect of weather (Nankervis, 1999; Brandenburg *et al.*, 2004. In: (Heinen *et al.*, 2010)). Extreme or unpleasant temperatures, cold more so than heat, have been shown to decrease cycling, especially among women (Bergström and Magnussen, 2003; Brandenburg *et al.*, 2004. In: (Heinen *et al.*, 2010)). Darkness discourages cycling, particularly among women (Gatersleben and Appleton, 2007; Bergström and Magnussen, 2003. In: (Heinen *et al.*, 2010)). Although wind clearly increases the effort of cycling, little is known about its effect on choice or frequency of bicycle use (Parkin *et al.*, 2007. In: (Heinen *et al.*, 2010)).

The influence of socio-economic factors on cycling is unclear in the literature. Men cycle more than women in most countries, except where cycling is very common, such as Belgium and the Netherlands, where women cycle more (Dill and Voros, 2007; Ryley, 2006; Moudon *et al.*, 2005; Plaut, 2005; Witlox and Tindemans , 2004. In: (Heinen *et al.*, 2010)). Car ownership has a negative effect on cycling, while bicycle ownership has a positive effect (Parkin *et al.*, 2008; Dill and Voros, 2007; Guo *et al.*, 2007; Pucher and Buehler, 2006; Plaut, 2005. In: (Heinen *et al.*, 2010)). Few studies allow one to infer causality on the relationship between socio-economic factors and cycling however.

Attitudes, social norms and habits all affect the decision to cycle. Positive attitudes and perceptions of cycling, or negative perceptions of car use, tend to increase the chance that people will cycle, particularly where cycling is the norm (Dill and Voros, 2007; Gatersleben and Appleton, 2007; Bruijn *et al.*, 2005. In: (Heinen *et al.*, 2010)). Habitual use of another mode of transport may disincline people to consider cycling however, even if it may be the most rational choice (Stinson and Bhat, 2004 Verplanken *et al.*, 1997. In: (Heinen *et al.*, 2010)).

Cost, travel time, and effort are aspects related to the rationalist utility theory described above (Shen *et al.*, 2009. In: (De Witte *et al.*, 2013)). Reducing these factors can therefore be expected to increase cycling rates (Hunt and Abraham, 2007; Pucher and Buehler, 2006; Stinson and Bhat, 2005; Rietveld and Daniel, 2004. In: (Heinen *et al.*, 2010)). Road safety is often cited as a barrier to cycling, yet perceptions of road safety differ (Heinen *et al.*, 2010). Studies of the stated safety experience of transport users have shown that men and people with high incomes are generally less concerned about safety, whereas cyclists generally rate it of highest importance (Johansson *et al.*, 2005; Lohmann and Rölle, 2005. In: (Heinen *et al.*, 2010)). Subjective perceptions of safety do not always correspond with measures of objective safety however, such as the rate of bicycle-related incidents per million inhabitants. Travel time and safety appear to influence choice of cycling more than other modes of transport.

Other barriers to cycling include traffic congestion, inconvenience, discomfort, lack of fitness, and an inability to cycle (Gatersleben and Appleton, 2007; Gatersleben and Uzzell, 2007; Wardman *et al.*, 2007; Stinson and Bhat, 2004; Dickinson *et al.*, 2003;

Noland and Kunreuther, 1995. In: (Heinen *et al.*, 2010)). Further research from more countries, especially in the developing world, is required for better understanding of bicycle mode choice and frequency and hence for more effective promotion of bicycle commuting (Heinen *et al.*, 2010). Affordability, theft, negative social attitudes, and excessive and inappropriate regulation are key barriers to the use of non-motorised vehicles in developing countries (Replogle, 1994. In: (Vasconcellos, 2001)). Cultural barriers, such as bicycles being seen as a sign of poverty or 'backwardness', or of women being discouraged or banned from cycling for religious or ethnic reasons, are also important (Cusset, 1997; Peters, 1998. In: (Vasconcellos, 2001)).

A review by Pucher *et al.* (2010) of the international literature on programs and policies to promote cycling concluded that an integrated package of multiple complementary interventions is required. These interventions include bicycle infrastructure, pro-bicycle and car-restrictive policies and programs, supportive land use planning, and bicycle promotion and marketing. Interventions should be carefully planned with ongoing citizen input, especially from cyclists. Emphasising the proven health benefits of cycling is key to gaining public and political support for comprehensive measures (Pucher *et al.*, 2010).

A 2015 review of mobility and access in Sub-Saharan African cities found that the lack of cycling infrastructure and poor traffic safety limit the considerable potential of cycling, especially in low-income areas (Behrens et al., 2015). In South Africa there are multiple constraints on the potential of NMT to provide accessible, independent and affordable mass mobility. Poor road safety, lack of well-maintained and continuous NMT infrastructure and safe bicycle storage facilities, low availability of affordable bicycles, and low levels of cycling ability are significant barriers, particularly in LICs (Bechstein, 2010; Jennings, 2011, 2014, 2015a; Kok, 2014; Mashiri, 2013). Apartheid land-use planning resulted in long commuting distances for the poor majority and prioritisation of motorised transport for the affluent minority (Jennings, 2015a). Perceptions therefore persist about the association of NMT with low status, poverty and even backwardness compared to personal motorised transport (Mashiri, 1997. In: (Mashiri, 2013)).

Many of these factors were identified in a 2013 qualitative study of the role of cycling and bicycle entrepreneurs in improving the mobility and livelihoods of the poor in LICs in the City of Cape Town. Focus group discussion (FGD) participants from across the city, including Masiphumelele, identified the risks of crashes, theft and robbery; poor integration of cycling with public transport; inability to transport large loads or other passengers; low status of cycling; and social norms that discourage women from cycling, as barriers to using bicycles for transport in their communities. Under-promotion of the benefits of cycling, such as its affordability, convenience and economic opportunity, was perceived to contribute to a poor culture of respect for cyclists. Participants expressed frustration that there seemed to be little consultation with users in LICs about new cycling infrastructure (Boulle, 2013). Worldwide experience has shown that the public status of cycling grows if cyclists are meaningfully consulted in urban transport planning (Kirkels, 2011).

Choice Analysis and Best–Worst Scaling

An understanding of choice analysis in the field of transport studies is required to understand the determinants of bicycle commuting. Model estimation using primary or secondary choice data allows the analyst to forecast choices, analyse different scenarios, evaluate users' willingness to pay for various alternatives, as well as to understand better the influence of individual characteristics and the particular attributes of the alternatives (Hensher *et al.*, 2005).

Discrete choice models, such as multinomial logit, nested logit and mixed logit models are derived from discrete choice experiments (DCEs) to elicit people's preferences for a number of alternatives. These preferences are either revealed through observation or are stated in response to questioning. A DCE usually requires repeated choice of the one most preferred alternative from a choice set in order to observe the trade-offs (Louviere and Timmermans, 1990. In: (Flynn, Louviere, Peters, & Coast, 2007). Such 'pick one' tasks in DCE require few statistical assumptions, but it has been observed that many researchers utilise rating/ranking models to elicit additional preference information. This may induce respondent behaviour that violates the models' inherent statistical assumptions (Hausman and Ruud, 1987. In: (Flynn et al., 2007)).

Best–worst scaling (BWS) is a stated choice methodology that is rooted in the Random Utility Theory of human decision-making (Thurstone, 1927; McFadden, 1974. In: (Flynn et al., 2007)). BWS is increasingly used to obtain more choice data from individuals and to better understand choice processes, while reducing the chances of introducing invalid assumptions about human choice behaviour (Flynn et al., 2007; Flynn & Marley, 2014). BWS requires respondents to pick only the extreme alternatives of 'best' or 'worst' from a choice set i.e. an item that they consider the 'best' match to a given criterion of interest to the researcher and one that they consider the 'worst' match to that criterion. Participants are required to repeat the choice task for a pre-determined number of different choice sets of equal size. The number of repetitions per individual depends on the total number of choice items and the size of the choice sets. Once the BWS survey is complete, the choice items are scored and ranked by comparing the frequencies with which they were chosen.

The underlying statistical model of BWS assumes a simultaneous choice of that pair of items that maximises the difference between them on a latent (usually utility) scale. They are therefore usually called maximum difference or *maxdiff* scaling models (Burke et al., 2013; Flynn et al., 2007). Three different types, or cases, of BWS have been developed, which differ in the nature and complexity of the choice items viz. the Object case, the Profile case, and the Multi-profile case. The Object case is the simplest and is appropriate to the comparison, as in this study, of the relative value of a number of items. The other two cases are appropriate for the study of choice involving a structure of attributes and levels of attributes (Flynn & Marley, 2014).

BWS has been applied in various contexts, particularly in studies of consumer choices, personality research and health economics (Burke et al., 2013; Flynn et al., 2007). Although its use in transport studies is relatively new, it is widely considered to be an improvement over traditional methods of eliciting attitudes and beliefs (Beck, Rose, & Greaves, 2014) in order to build statistical models of the determinants of transport choices.

CHAPTER 3

METHODS

This chapter describes the purpose, aim and objectives of the study, which are consistent with national and municipal policies to promote cycling as a sustainable and affordable mode of mass transport in LICs. Qualitative and quantitative methods are described with reference to the selection of study participants and to the collection and analysis of data.

Study Purpose and Aim

The purpose of the study is to make specific evidence-based recommendations to promote cycling mobility in Masiphumelele, and low-income communities (LICs) elsewhere. This study therefore aims to identify the key barriers to cycling mobility in Masiphumelele.

Study Objectives

The objectives of the study are:

- To estimate the prevalence of cycling mobility in Masiphumelele
- To identify the perceived benefits of cycling mobility
- To rank the perceived barriers to cycling mobility by relative importance
- To elicit residents' suggestions for promoting cycling mobility in Masiphumelele
- To make recommendations for promoting cycling mobility in Masiphumelele

Study Design

The study used a mixed methods design of qualitative and quantitative methods. A focus group discussion (FGD) with a group of cyclists from Masiphumelele helped to inform the design of a cross-sectional cluster sampling questionnaire and Best-Worst Scaling (BWS) survey of 100 households.

Ethical approval for the study was obtained from the Research Ethics Committees of the Faculty of Science and of the Faculty of Engineering and the Built Environment at the University of Cape Town (*Appendix 6*). Study participants were required to sign a

standard informed consent form in the language of their choice (*Appendix 1*). Each received a small shopping voucher at the end of the survey as a token of appreciation for their participation.

Study Participants

Participants in the FGD were the owner and operator of the Masiphumelele Bicycle Empowerment Centre (BEC), five of his male customers and one non-cyclist. BEC owner-operators are trained and supported by the non-governmental organisation *Bicycling Empowerment Network* (BEN) to sell second-hand bicycles and undertake cycle repairs in a number of LICs in the Western Cape[4].

Eligible participants for the household survey were the household head or the most senior resident present at the time of the survey visit. Residents under the age of 18 years were not eligible.

Sampling

A sample of 100 households was considered adequate and feasible for the study. The sampling frame was a 1:2000 aerial photograph of Masiphumelele (published in August 2015 by the City of Cape Town Spatial Planning and Urban Design Department) that was divided into a grid of 12 clusters of approximately equal size of 3.75 sq. km. Two clusters of 10 households each were chosen for the pre-testing of the questionnaire and BWS survey. The remaining 10 clusters were used for the final sample. The starting point within each cluster was the house identified on the aerial photograph as nearest to the centre of the cluster. Subsequent houses visited in the cluster were those nearest each preceding house sampled when proceeding in a clockwise direction. If no eligible person was present at the house the field workers moved on to the next nearest household.

[4] Bicycling Empowerment Network http://www.benbikes.org.za/bicycle-centres.php

Data Collection and Analysis

Focus group discussion (FGD)

The FGD was held in a meeting room of the municipal library in the centre of Masiphumelele. Participants' perceptions about the benefits, facilitating factors, and barriers to cycling mobility in Masiphumelele were elicited using a set of questions (*Appendix 2*) adapted by the principal investigator (PI) from a study of the role of bicycles and BECs in improving the mobility and livelihoods of the poor in Cape Town (Boulle, 2013). The FGD was facilitated by the PI with isiXhosa translation by a local field worker when necessary.

Each participant received a copy of the FGD questions and their collective verbal responses were recorded by the PI on a flipchart. An exception to this protocol was the question: *Why do more people in your community NOT use bicycles as a means of transport?* Participants first recorded their responses on notelets, which were then summarised and listed by the PI on the flipchart. Each participant then individually ranked the listed reasons from most to least important on a response sheet and returned these to the PI for overall ranking based on the frequency and ranking of each barrier by the participants. The PI merged the list of eleven top barriers identified by his review of the literature with the nine top-ranked barriers from the FGD to derive a list of 20 potential barriers to cycling mobility in Masiphumelele (*Appendix 4*).

Household questionnaire

A structured questionnaire was designed by the PI and independently administered by two trained field workers resident in Masiphumelele for at least 5 years prior to the survey and fluent in English and isiXhosa. The fieldworkers were each allocated to survey five clusters of ten households each over two weeks in October 2015. The PI accompanied them as an observer on several household visits and met or communicated with them regularly to check the collected data and to address any queries. The questions were asked by the field worker in the preferred language of the respondent (English or isiXhosa). The isiXhosa version of the questionnaire was translated by a professional translation service and checked for local suitability by the

field workers before administration, which resulted in a few minor grammatical changes.

The questionnaire consisted of three parts: socio-demographic questions; attitudes towards the use of bicycles as a mode of transport, including perceived barriers to cycling mobility; and suggestions for promoting bicycle use in Masiphumelele (*Appendix 3*). The attitudes towards the use of bicycles for transport were represented by six statements adapted from a Tanzanian study that used the Stages of Change or Transtheoretical model to identify 'market segments' among potential cyclists. The model assumes that the studied behaviour is within a person's ability and that behaviour change occurs gradually as people enter and exit a cycle of six stages of change: Pre-contemplation; Contemplation; Preparation; Action; Maintenance; and Relapse (Prochaska and Diclemente, 1984. In:(Nkurunziza *et al.*, 2012). The participants in this study were asked to select one of six attitudinal statements that best represented their attitudes towards the use of bicycles for transport (Table 1).

Best-Worst Scaling (BWS) stated choice survey

The 20 potential barriers to cycling mobility in Masiphumelele were presented as subjective statements in the BWS stated choice survey. They were randomly allocated using *Sawtooth SSI Web: MaxDiff* software[5] into 10 versions of 10 choice sets of 4 statements each. A balanced incomplete block design (BIBD), the most widely used design for BWS (Flynn & Marley, 2014), was used to ensure that each barrier appeared an equal number of times (n=20) across all 10 choice set versions, as well as a constant number of times with each of the other barriers. Each version was utilised in the BWS survey with equal frequency, so that each participant in the clusters of 10 households received a different version of the choice sets. Participants were asked to repeatedly select one statement in each of the 10 choice sets that they agreed with most (the 'best' match) and one statement that they agreed with least (the 'worst' match) as a barrier to cycling in Masiphumelele.

Pre-testing of the survey questionnaire and BWS choice sets was undertaken by both fieldworkers in ten households each after a training session with the PI. Some

[5] Sawtooth Software http://www.sawtoothsoftware.com/

modifications were consequently made to the phrasing and sequencing of the questions and a few errors and omissions in the recording of data were discussed and corrected. Participants' responses were recorded by the fieldworkers on paper questionnaires (*Appendix 3*) and on corresponding BWS survey data sheets (*Appendix 5*). All data were entered by the PI into *Microsoft Excel* (2007) for analysis and presentation.

The statements about barriers used in the BWS survey were ranked by relative importance based on their average Best-Worse (B-W) scores. Average B-W scores were computed as the difference between the overall number of times a statement was chosen as the 'best' match (B-score) versus the 'worst' match (W-score), divided by the number of times the statement occurred across all choice sets in the sample, expressed by the following formula (Marley & Louviere, 2005. In: (Hristov & Kuhar, 2014)):

Average B-W score = (B-score – W-score) / (frequency of statement in all choice sets)

The non-parametric One-Sample Wilcoxon Signed Rank Test in the SPSS statistical package (*IBM SPSS Statistics 23.0*) was used to test whether the medians of the average B-W scores of each statement differed significantly from zero i.e. whether a statement was chosen significantly more often as the 'best' match (B-score) than as the 'worst' match (W-score), or vice-versa. The non-parametric Independent Samples Median Test in SPSS was used to test for statistically significant differences in the average B-W scores of the responses between the subgroups of male and female participants, and between those who stated that they cycle 'fairly often' or 'regularly' ("cyclists') and those who stated that they never, seldom, or no longer cycle ("non-cyclists").

CHAPTER 4

RESULTS

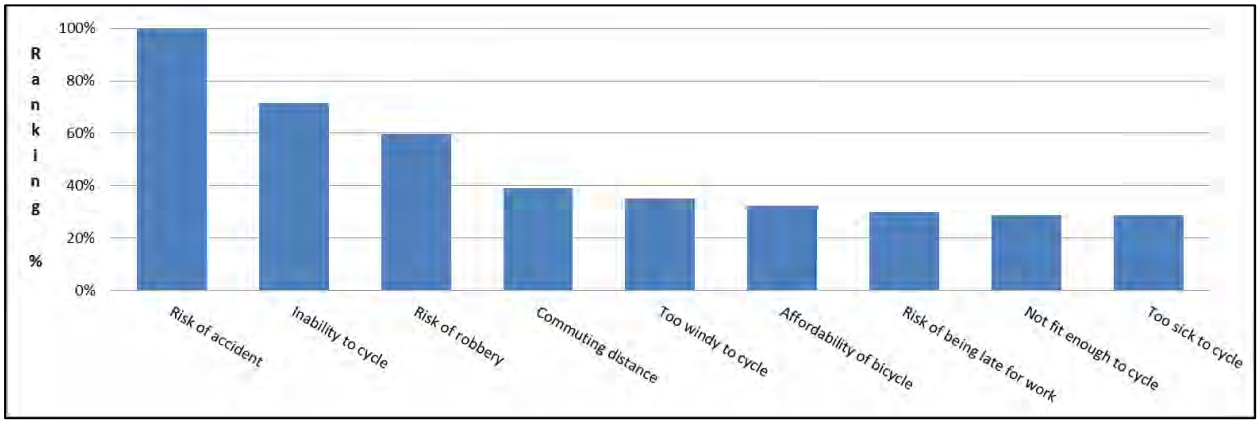
This chapter presents the results of the focus group discussion (FGD) and the household questionnaire survey, including the BWS ranking. The FGD elicited perceptions about the uses and benefits of cycling and the main barriers to cycling in Masiphumelele. The household survey results are presented in terms of the socio-demographic characteristics of the 100 participants, their attitudes towards and current use of bicycles for transport, their reasons for or against cycling and its promotion as a means of transport in Masiphumelele, and their suggestions for how to promote it better. The ranking of the barriers to cycling mobility based on their average scores from the Best-Worse Scaling (BWS) survey are presented for the whole sample and for sub-groups defined by the participants' sex and stated use of bicycles for transport.

Focus Group Discussion

Taxis and walking were identified by the FGD participants as the most common modes of transport used by residents of Masiphumelele. The main users of bicycles were said to be men, particularly foreign African nationals, and those working as labourers, security guards or gardeners who use them for commuting purposes. Bicycles were seen as an affordable and quick travel mode for local journeys that benefited people's health and fitness, reduced traffic and parking congestion, and improved road safety in Masiphumelele.

The risk of a crash was perceived as the top barrier to cycling by all seven participants and it therefore received the maximum weighted ranking of 100% in the analysis. The relative ranking of the barriers is shown in Figure 1. They include the inability to cycle; the risk of bicycle robbery while cycling; commuting distances too far to cycle; too windy to cycle; affordability of bicycles; the risk of being late for work; and not being fit or well enough to cycle.

Figure 1: Barriers to Cycling Mobility identified by the FGD (n=7 respondents)



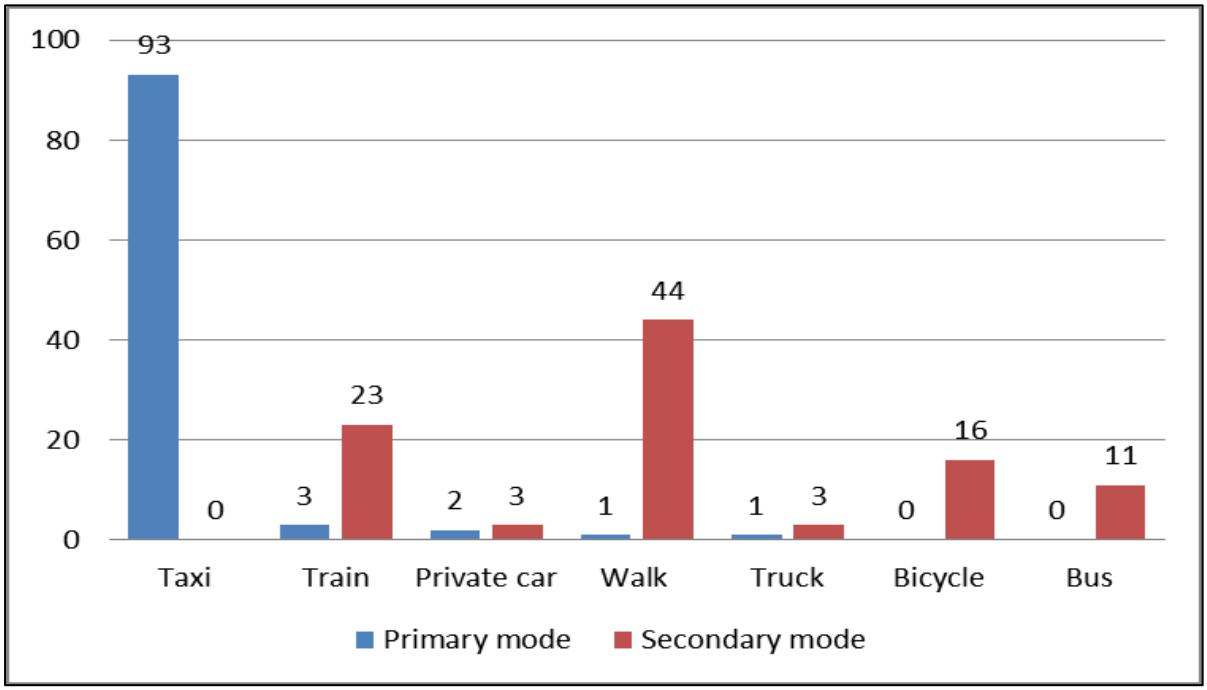
The focus group suggested that cycling be promoted in Masiphumelele by means of teaching cycling skills to the youth, undertaking cycling and road safety campaigns in the schools, having regular cycling events, starting a local cycling club, getting sponsored bicycles, and obtaining loans for bicycles from local community-based organisations.

Household Survey: Socio – Demographic Characteristics

The 100 household survey participants were either the head of the household (52%); the oldest child (26%); the spouse of the household head (10%); or another senior member of the household (12%). Equal numbers of male and female participants were interviewed, with an average age of 29.4 years, ranging from 18 to 56 years of age. The average duration of residence in Masiphumelele was 8.7 years, ranging from 1 to 25 years. Place of origin was predominantly the Eastern Cape province (81%) with a further 10% from either Malawi or Zimbabwe. More than half of the participants had either Grade 12 (39%) or a tertiary education (12%). The most common occupations were student (21%) or security worker (14%), and 21 % were unemployed.

According to the respondents, taxis were the primary mode of transport, or the mode used most often by households (93%). Other modes were walking (44%), train (23%), bicycle (16%) and bus (11%), as depicted in Figure 2.

Figure 2: Reported modes of household transport (n=100 respondents)



Thirty two households (32%) reported having at least one bicycle in working order (ranging from 1 to 5) that they use for transport. This equates to 1.4 bicycles per household for this group and 0.4 bicycles per household over the total sample.

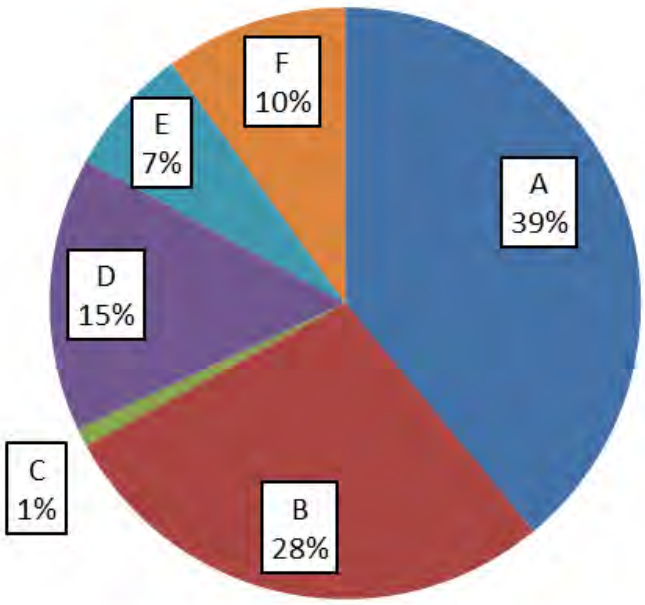
Household Survey: Attitudes towards Cycling Mobility

Table 1 and Figure 3 present participants' attitudes towards the use of bicycles for transport, based on the Stages of Change model (Prochaska and Diclemente, 1984. In:(Nkurunziza *et al.*, 2012)). Two thirds indicated that they had never (39%) or only sometimes (28%) thought about cycling as a means of transport, but had never used a bicycle. Only one respondent had seriously thought about cycling. Twenty two participants reported that they either cycle *fairly often* (n=15 respondents) or *regularly* (at least once a week; n=7 respondents). Of this group of 22 cyclists, three were women (one a bicycle tour guide) and six were employed as security guards, with an average age of 30 years.

Table 1: Attitudes towards Cycling Mobility (n=100 respondents)

	Attitudinal statement	**%**
A	I have never thought about cycling as a means of transport	39
B	I have never used a bicycle but I sometimes think about cycling as a means of transport	28
C	I seldom cycle but have seriously thought about cycling as a means of transport	1
D	I cycle fairly often as a means of transport	15
E	I cycle regularly (at least once a week) as a means of transport	7
F	I no longer cycle as a means of transport	10

Figure 3: Attitudes towards Cycling Mobility (n=100 respondents)

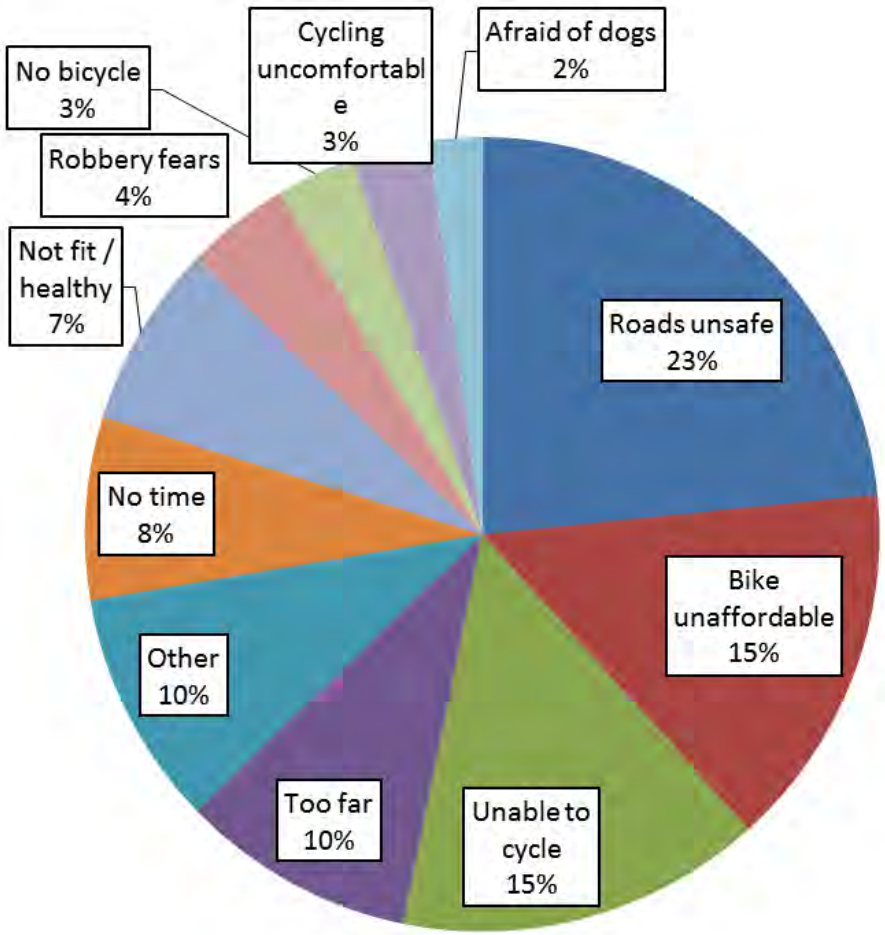


Among the 22 respondents who indicated that they cycle fairly often or regularly, the multiple reasons (n=34 responses) for cycling in response to an open-ended question are summarized in Figure 4. Saving money (44%), keeping fit and healthy (32%) and saving time (15%) were the most frequent reasons given for cycling.

Figure 4: Reasons for Cycling (n=34 responses)

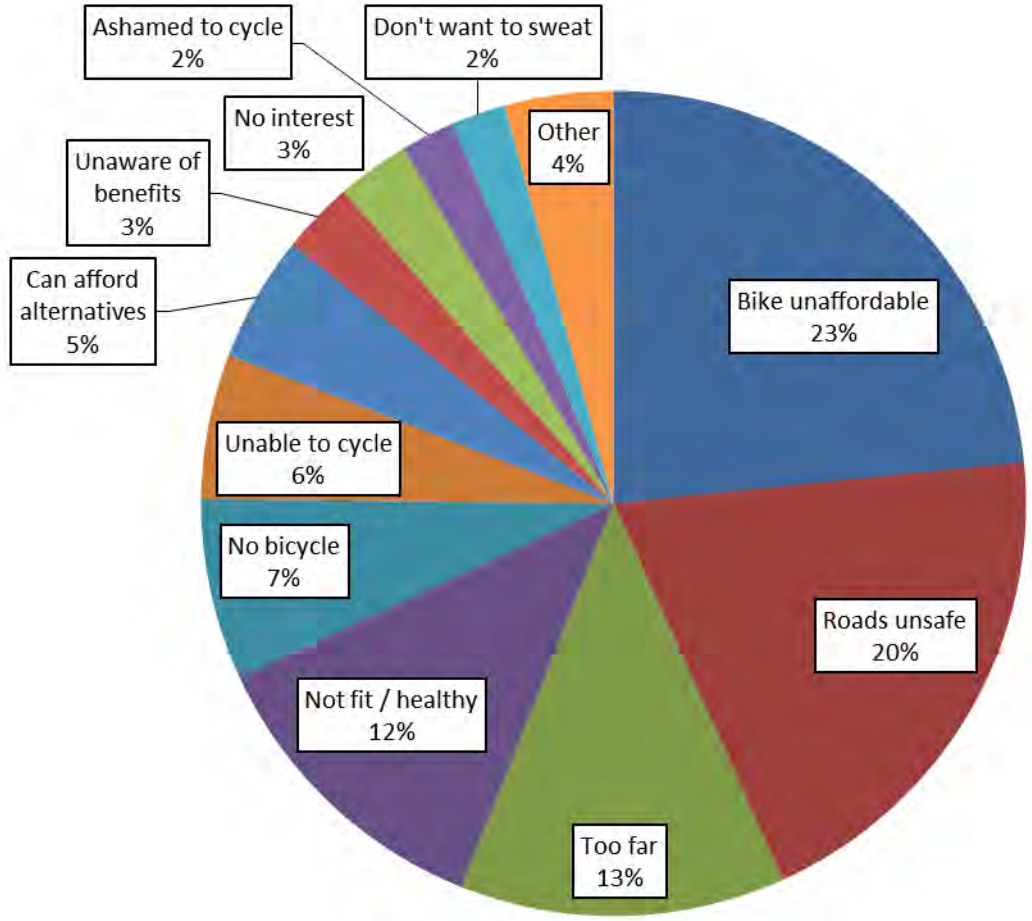
Among those who do not cycle fairly often or regularly (n=78 respondents), reasons against cycling (n=94 responses) are summarized in Figure 5. Unsafe roads (23%), inability to afford a bicycle (15%), inability to cycle (15%) or distances too far to cycle (10%) were the leading reasons given for not cycling personally.

Figure 5: Personal Reasons against Cycling (n=94 responses)



All participants were also asked why they think others in Masiphumelele do not cycle. Their multiple responses (n=141) are summarised in Figure 6. The most frequent reasons perceived for others not cycling were inability to afford a bicycle (23%), unsafe roads (20 %), distances too far (13%), inadequate health and fitness to cycle (12%), not having a bicycle (7%), or not being able to cycle (6%).

Figure 6: Perceived Reasons against Cycling among Other Residents (n=141 responses)



BWS Survey: Perceived Barriers to Cycling Mobility

The 20 perceived barriers to cycling derived for the BWS survey from the literature and the FGD responses were ranked by their average B-W scores. The responses are presented for all participants (Table 2 and Figure 7) and for subgroups defined by self-identified cycling status (Table 3 and Figures 8a and 8b) and by sex (Table 4 and Figures 9a and 9b).

Among all participants, the following barriers had significantly positive B-W scores, which means that they were the 'best' choice significantly more often than the 'worst' choice: fear of being hit by a car while cycling (average B-W score = 0.16; Wilcoxon SR Test p = 0.002); inability to transport loads by bicycle (0.15; p = 0.003); not being permitted to transport a bicycle on the train during peak commuting hours (0.13 p = 0.010); and the risk of being late for work (0.12; p = 0.026). Significant negative B-W scores were associated with barriers that were the 'worst' choice significantly more often than the 'best' choice: not feeling confident riding a bicycle (-0.14; p = 0.009); too windy to cycle (-0.12; p = 0.018); not socially acceptable to cycle (-0.12 p = 0.014); and fear of being bitten by dogs (-0.11; p = 0.028). There were no significant differences overall in the frequency of 'best' versus 'worst' choices for any of the other 12 barriers (Table 2 and Figure 7).

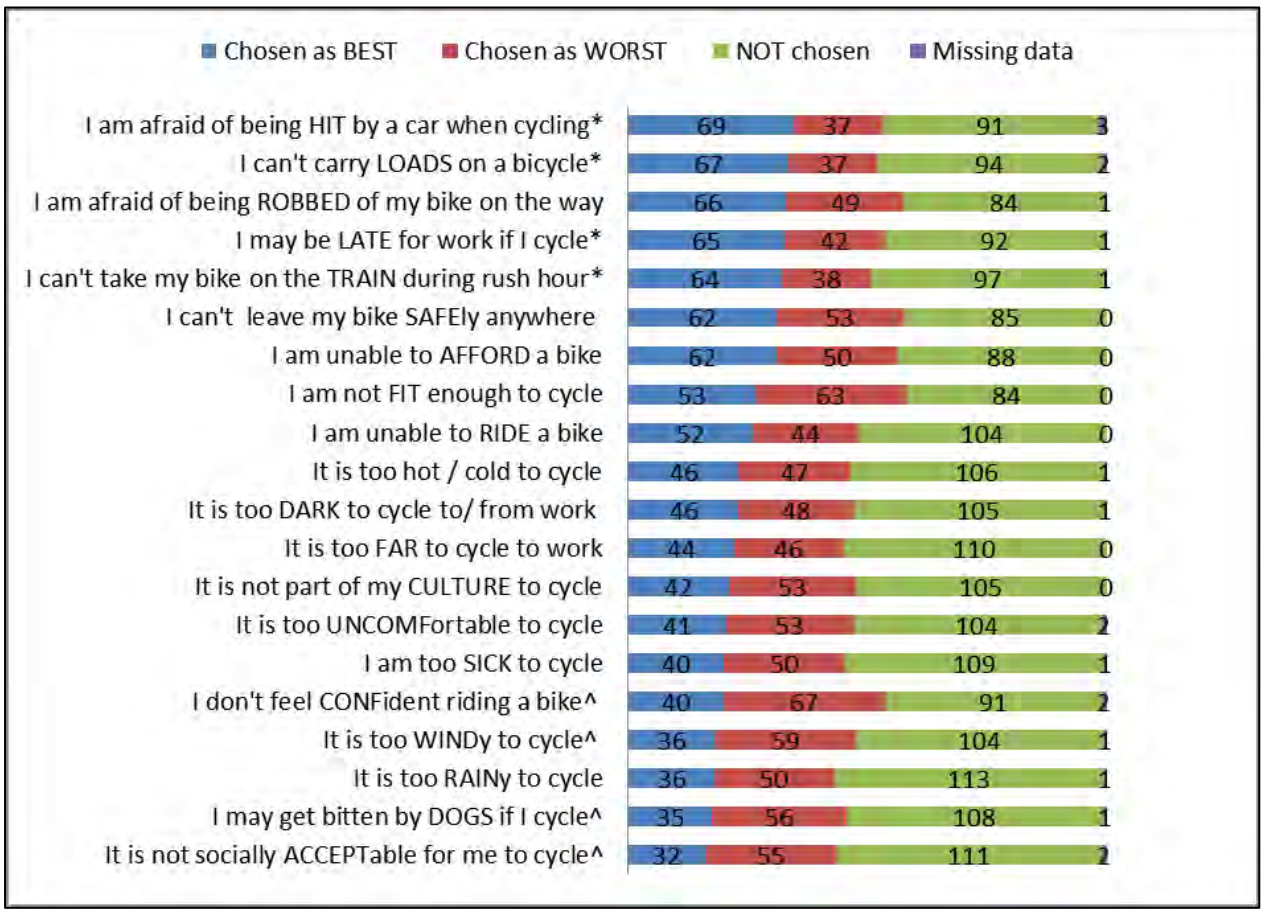
Table 2: Perceived Barriers to Cycling Mobility ranked by Average B-W score

Barrier Code #	**Average B-W score**	**Std. Deviation**	**Wilcoxon S-R p-value**
HIT	0.16	0.712	0.002*
LOADS	0.15	0.707	0.003*
TRAIN	0.13	0.704	0.010*
LATE	0.12	0.724	0.026*
ROBBED	0.09	0.755	0.113
AFFORD	0.06	0.748	0.257
SAFE	0.05	0.759	0.401
RIDE	0.04	0.693	0.414
TEMP	0.00	0.684	0.917
DARK	-0.01	0.687	0.837
FAR	-0.01	0.672	0.833
FIT	-0.05	0.762	0.353
SICK	-0.05	0.671	0.292
CULTURE	-0.06	0.689	0.259
UNCOMF	-0.06	0.685	0.216
RAIN	-0.07	0.654	0.131
DOGS	-0.11	0.668	0.028*
ACCEPT	-0.12	0.651	0.014*
WIND	-0.12	0.681	0.018*
CONF	-0.14	0.722	0.009*

See Appendix 4 for explanation of Barrier Codes

* Median of average B-W score differed significantly from zero

Figure 7: Perceived Barriers to Cycling Mobility, ranked by frequency of BEST counts



** Chosen as BEST significantly more often than WORST*
^ Chosen as WORST significantly more often than BEST

Perceived Barriers by Cycling Status

Cyclists were defined as those who stated that they cycle '*fairly often'* or '*regularly*' (at least once a week) as a means of transport (Table 1). Among cyclists, no barriers had significantly positive B-W scores (Table 3 and Figure 8a). Lack of confidence to cycle (average B-W score = -0.23; Wilcoxon SR Test p = 0.028) and rain (-0.19; p = 0.033) were chosen as 'worst' barriers significantly more often than 'best'.

Among non-cyclists, fear of being hit by a car when cycling (0.18; p = 0.002); fear of being late for work (0.15; p = 0.01); and inability to transport loads on a bicycle (0.15; p = 0.01) were perceived barriers with significantly positive B-W scores. The following barriers were chosen as 'worst' significantly more often than 'best': fear of being bitten by dogs (-0.15; p = 0.006); too windy to cycle (-0.15 p = 0.008); and not socially acceptable (-0.12 p = 0.031) to cycle (Table 3 and Figure 8b). There were no significant differences between cyclists and non-cyclists in the B-W scores of any barriers according to the Independent Samples Median Test.

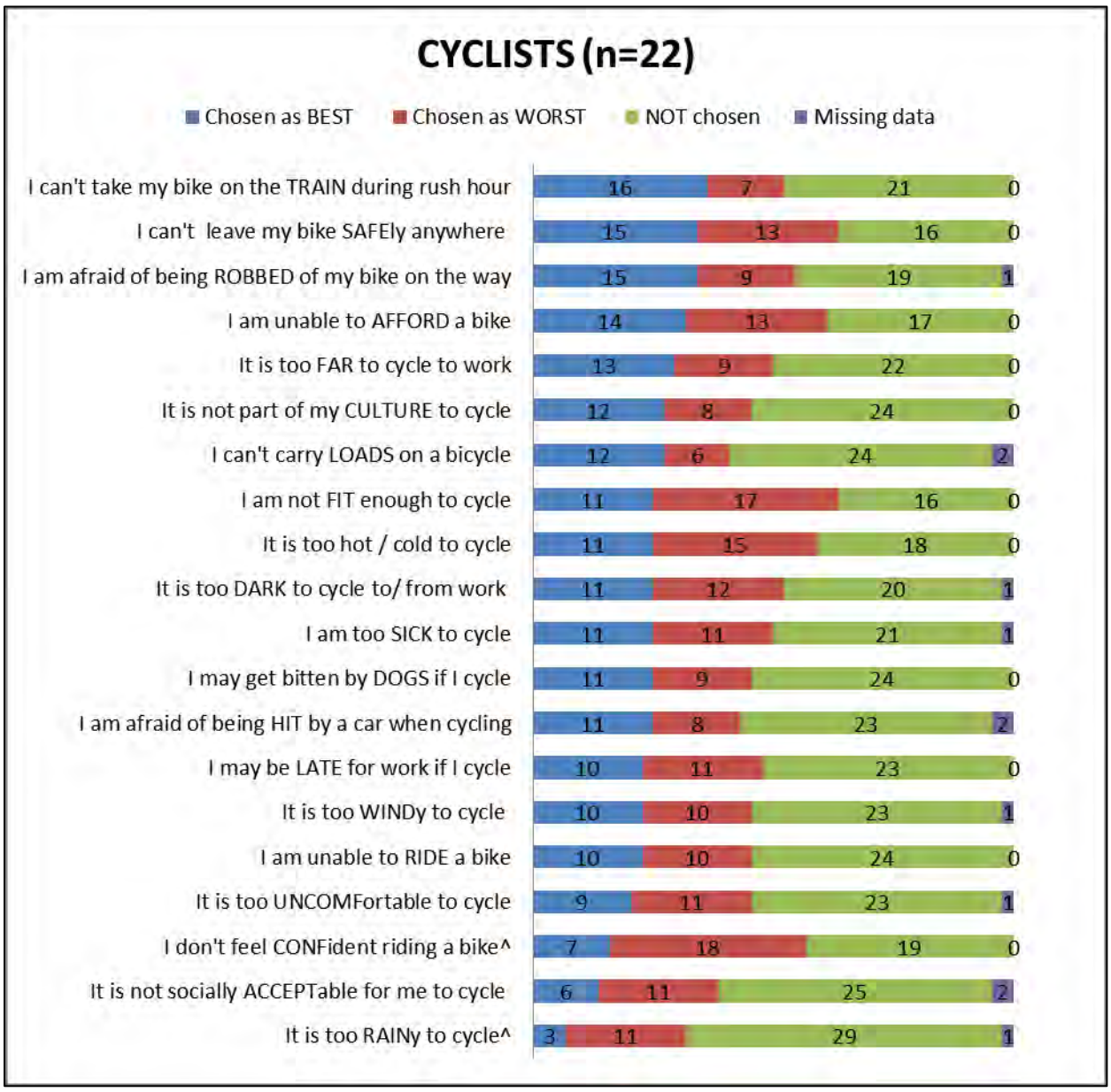
Table 3: Perceived Barriers to Cycling Mobility by Cycling Status ranked by Average B-W score

CYCLISTS				NON-CYCLISTS			
Barrier code #	**Average B-W score**	**Std. Deviation**	**Wilcoxon S-R p-value**	**Barrier code #**	**Average B-W score**	**Std. Deviation**	**Wilcoxon S-R p-value**
TRAIN	0.21	0.717	0.061	HIT	0.18	0.721	0.002*
ROBBED	0.14	0.743	0.221	LATE	0.15	0.729	0.010*
LOADS	0.14	0.632	0.157	LOADS	0.15	0.729	0.010*
CULTURE	0.10	0.700	0.371	TRAIN	0.11	0.701	0.056
FAR	0.09	0.701	0.394	AFFORD	0.07	0.737	0.233
HIT	0.07	0.677	0.491	ROBBED	0.07	0.761	0.249
DOGS	0.05	0.680	0.655	RIDE	0.05	0.698	0.359
SAFE	0.04	0.796	0.705	SAFE	0.05	0.750	0.453
AFFORD	0.02	0.792	0.847	TEMP	0.02	0.661	0.714
WIND	0.00	0.674	1.000	DARK	-0.01	0.677	0.906
SICK	0.00	0.715	1.000	FIT	-0.03	0.753	0.670
RIDE	0.00	0.682	1.000	RAIN	-0.04	0.678	0.480
LATE	-0.02	0.698	0.827	FAR	-0.04	0.663	0.467
DARK	-0.02	0.731	0.835	SICK	-0.06	0.659	0.225
UNCOMF	-0.05	0.680	0.655	UNCOMF	-0.06	0.688	0.245
TEMP	-0.09	0.755	0.433	CULTURE	-0.09	0.682	0.083
ACCEPT	-0.11	0.611	0.225	CONF	-0.11	0.729	0.077
FIT	-0.14	0.795	0.257	ACCEPT	-0.12	0.664	0.031*
RAIN	-0.19	0.546	0.033*	DOGS	-0.15	0.660	0.006*
CONF	-0.23	0.698	0.028*	WIND	-0.15	0.682	0.008*

 # See Appendix 4 for explanation of Barrier Codes

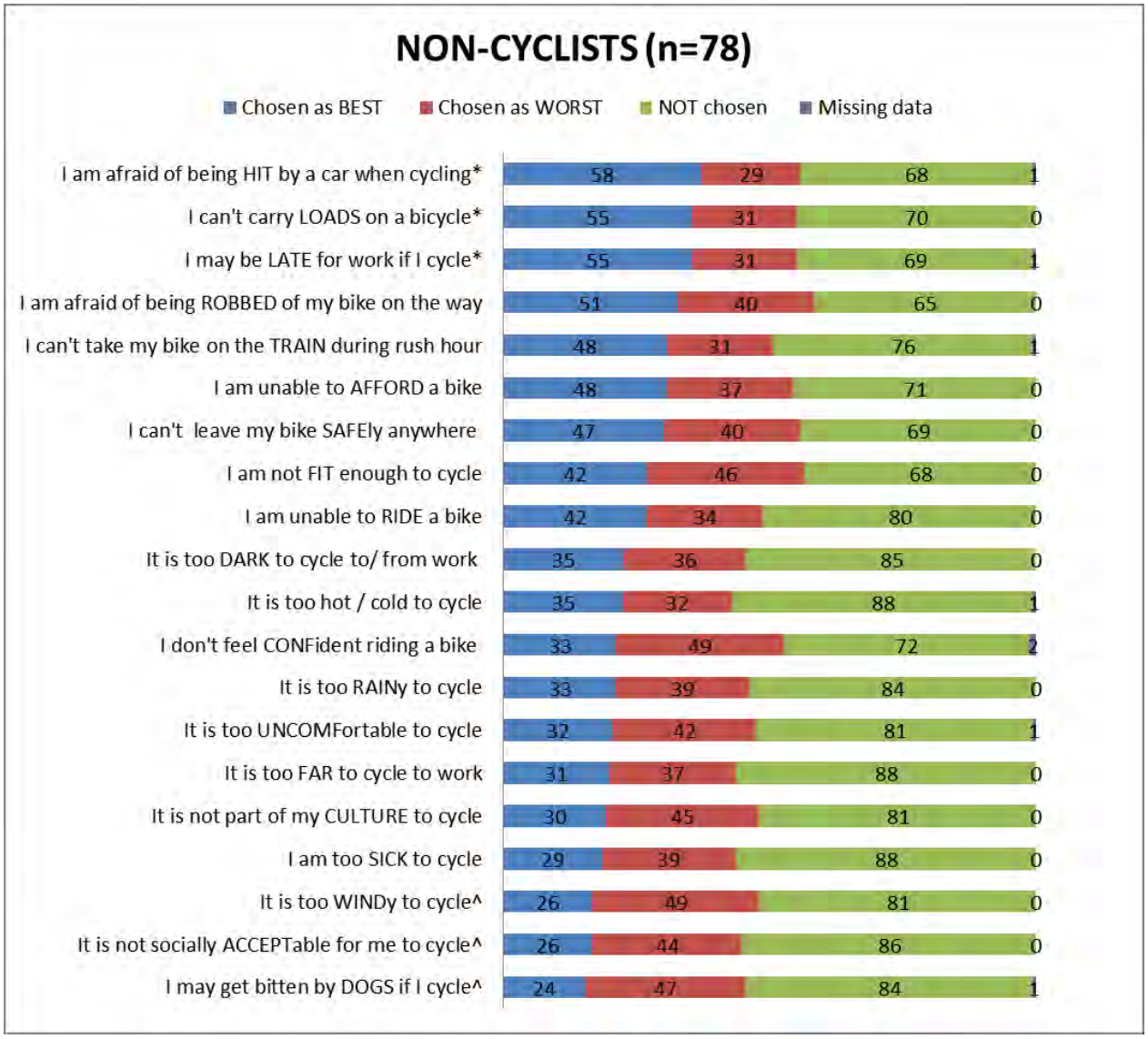
** Median of average B-W score differed significantly from zero*

Figure 8a: Perceived Barriers to Cycling Mobility among Cyclists



** Chosen as BEST significantly more often than WORST*
^ Chosen as WORST significantly more often than BEST

Figure 8b: Perceived Barriers to Cycling Mobility among Non-Cyclists



** Chosen as BEST significantly more often than WORST*
^ Chosen as WORST significantly more often than BEST

Perceived Barriers by Sex

Among men, the following barriers were chosen as 'best' significantly more often than 'worst': unable to afford a bicycle (average B-W score = 0.20; Wilcoxon SR Test p = 0.01); risk of being robbed of one's bicycle while cycling (0.19; p = 0.013); afraid of being late for work if cycling (0.15; p = 0.036); and unable to carry loads on a bicycle (0.14; p = 0.043). The following barriers were men's 'worst' choices significantly more often than 'best' choices: not confident riding a bicycle (-0.18; p = 0.018); too sick to cycle (-0.15; p = 0.016); too rainy to cycle (-0.14; p = 0.027); and not socially acceptable to cycle (-0.13; p = 0.042) (Table 4 and Figure 9a).

Among women, barriers with significant positive B-W scores were fear of being hit by a car when cycling (0.21; p = 0.006); unable to carry loads on a bicycle (0.16; p = 0.033); and inability to transport a bicycle on the train (0.15; p = 0.036). Wind was the only barrier with a significant negative B-W score among women (-0.19; p = 0.005) (Table 4 and Figure 9b). Significantly more men than women perceived unaffordability of bicycles and inability to store them safely as barriers, whereas significantly more women perceived poor health as a barrier ($p<0.05$ on Independent Samples Median Test).

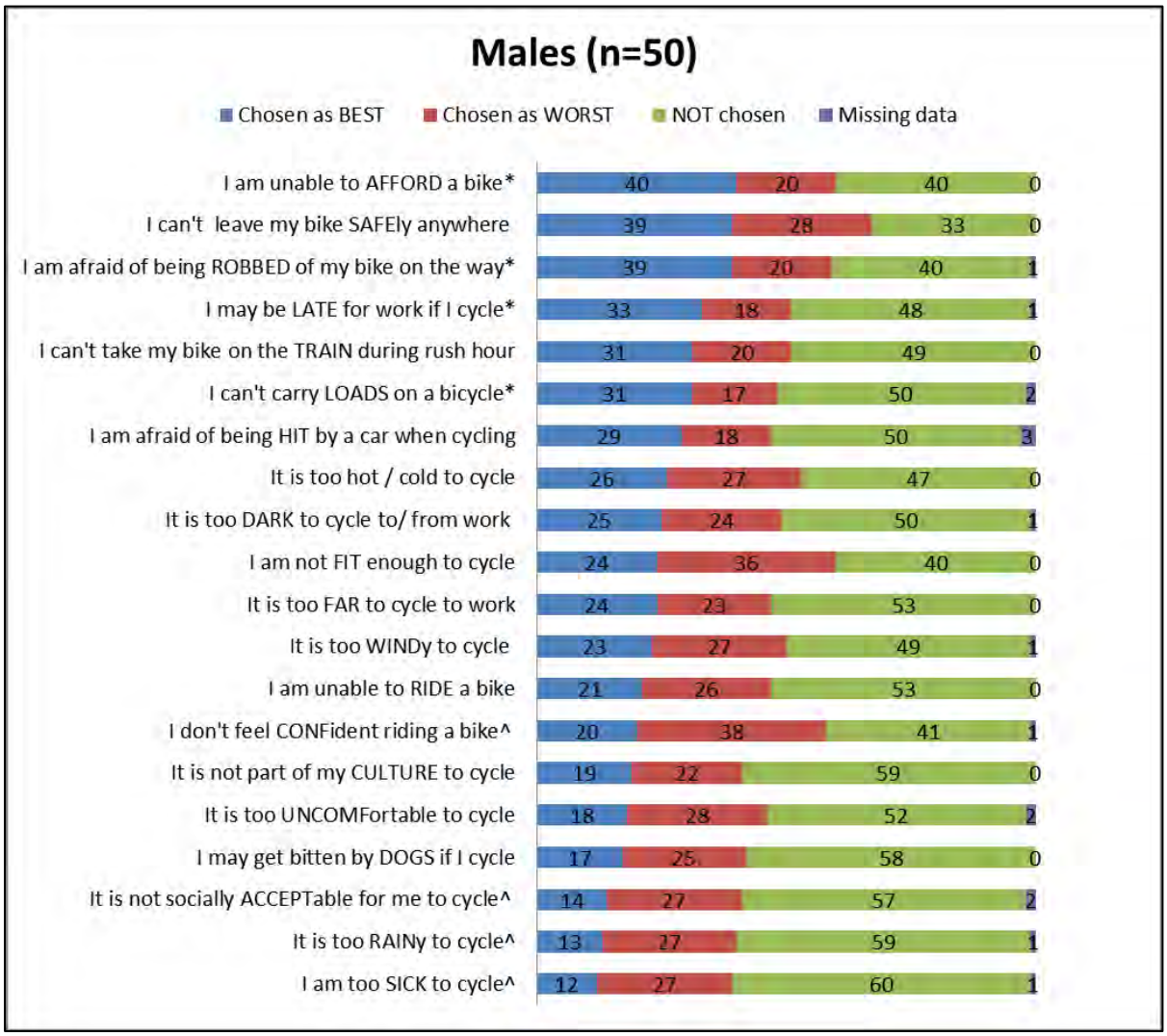
Table 4: Perceived Barriers to Cycling Mobility by Sex ranked by Average B-W score

FEMALES (n=50)				MALES (n=50)			
Barrier code #	**Average B-W score**	**Std. Deviation**	**Wilcoxon S-R p-value**	**Barrier code #**	**Average B-W score**	**Std. Deviation**	**Wilcoxon S-R p-value**
HIT	0.21	0.736	0.006*	AFFORD	0.20	0.646	0.010*
LOADS	0.16	0.735	0.033*	ROBBED	0.19	0.703	0.013*
TRAIN	0.15	0.695	0.036*	LATE	0.15	0.643	0.036*
RIDE	0.13	0.691	0.063	LOADS	0.14	0.756	0.043*
LATE	0.08	0.748	0.285	TRAIN	0.11	0.740	0.123
SICK	0.05	0.716	0.484	HIT	0.11	0.630	0.109
FIT	0.02	0.752	0.789	SAFE	0.11	0.689	0.179
TEMP	0.00	0.642	1.000	FAR	0.01	0.682	0.884
RAIN	0.00	0.685	1.000	DARK	0.01	0.702	0.886
UNCOMF	-0.02	0.696	0.773	TEMP	-0.01	0.687	0.891
ROBBED	-0.02	0.752	0.789	CULTURE	-0.03	0.748	0.639
SAFE	-0.02	0.703	0.773	WIND	-0.04	0.674	0.572
FAR	-0.03	0.658	0.647	RIDE	-0.05	0.769	0.466
DARK	-0.03	0.674	0.655	DOGS	-0.08	0.724	0.217
AFFORD	-0.08	0.717	0.267	UNCOMF	-0.10	0.807	0.140
CULTURE	-0.08	0.734	0.276	FIT	-0.12	0.617	0.121
CONF	-0.09	0.705	0.199	ACCEPT	-0.13	0.716	0.042*
ACCEPT	-0.10	0.674	0.140	RAIN	-0.14	0.609	0.027*
DOGS	-0.13	0.691	0.063	SICK	-0.15	0.687	0.016*
WIND	-0.19	0.644	0.005*	CONF	-0.18	0.713	0.018*

 # See Appendix 4 for explanation of Barrier Codes

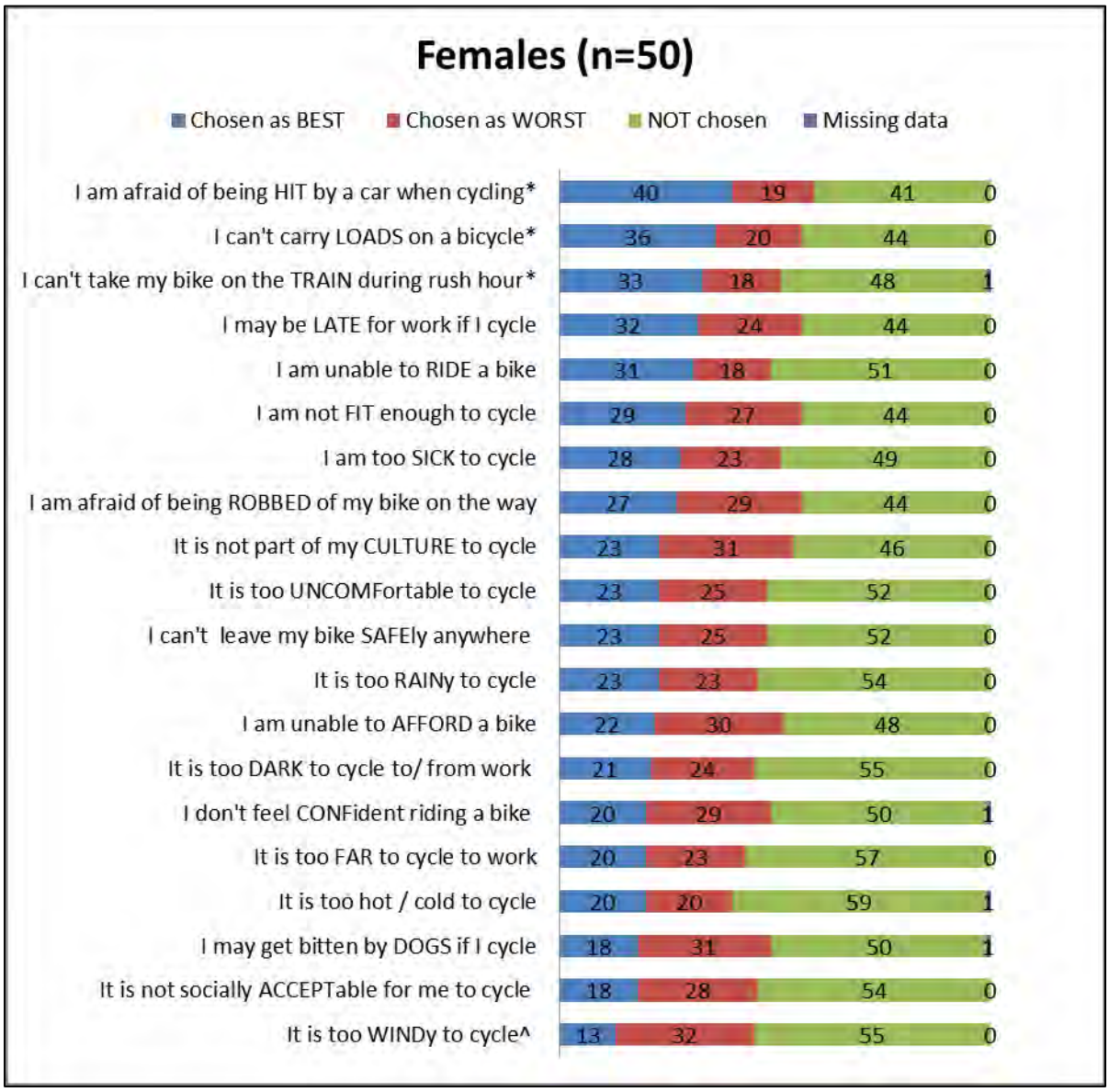
** Median of average B-W score differed significantly from zero*

Figure 9a: Perceived Barriers to Cycling Mobility among Males



** Chosen as BEST significantly more often than WORST*
^ Chosen as WORST significantly more often than BEST

Figure 9b: Perceived Barriers to Cycling Mobility among Females

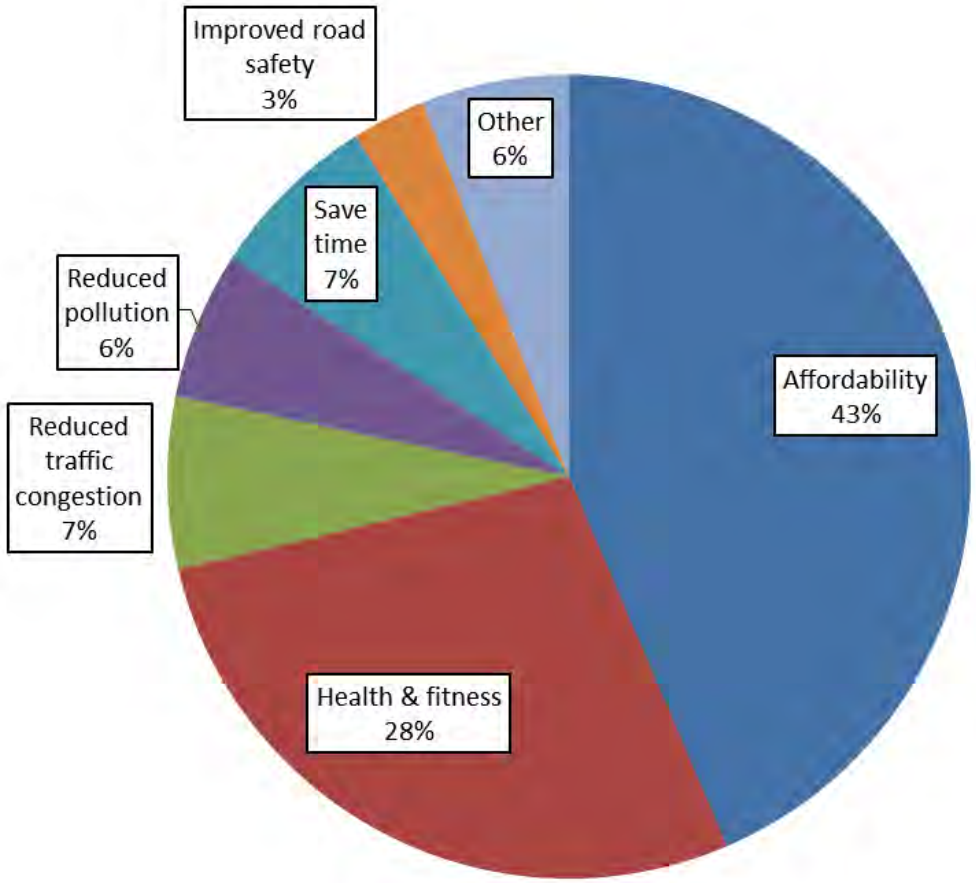


** Chosen as BEST significantly more often than WORST*
^ Chosen as WORST significantly more often than BEST

Household Survey: Attitudes towards Promoting Cycling Mobility

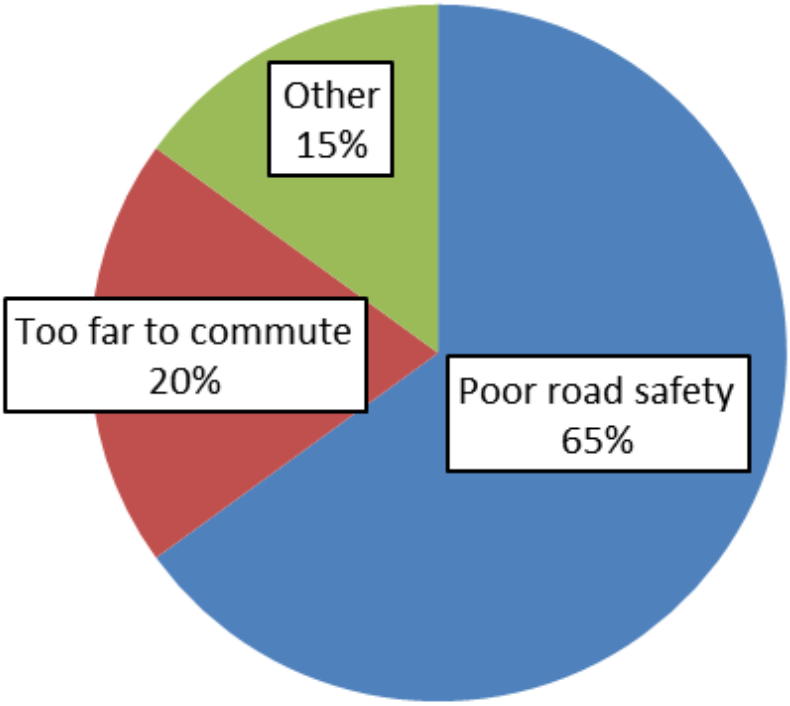
Participants were asked whether and why they think bicycles should be used more for transport in their community. Two thirds (68%) were in favour of promoting cycling mobility for the reasons (n=101 responses) presented in Figure 10. Financial savings (43%) and health benefits (28%) were the most frequent reasons given. Other reasons (29%) included less traffic congestion (7%), reduced air and noise pollution (6%), and saving time (7%).

Figure 10: Reasons for Promoting Cycling Mobility (n=101 responses)



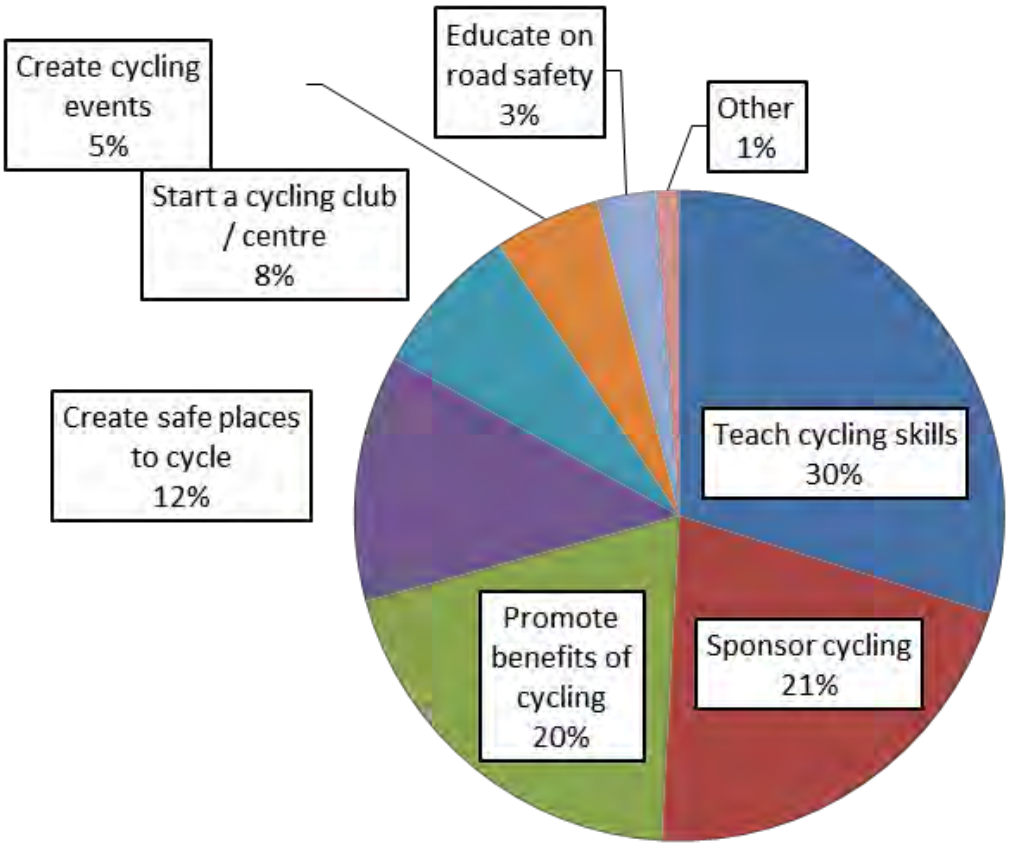
Poor road safety (65%) and long commuting distances (20%) were the most common reasons (n=60 responses) against cycling given by those not in favour of promoting cycling for transport (n=32 respondents). Other reasons (15%) included poor health, the risk of robbery, strong wind and because cycling is perceived to be too slow.

Figure 11: Reasons against Promoting Cycling Mobility (n=60 responses)



Finally, all participants were asked to suggest ways of promoting bicycles for transport in Masiphumelele. Their responses (n=171) are summarised in Figure 12. Teaching cycling skills (30%), sponsoring bicycles (21%); actively promoting the benefits of cycling by means of campaigns, community meetings and media (20%); and creating safe places for cyclists (12%) were most frequently suggested. Starting a cycling club or centre (8%) and hosting cycling events or competitions (5%) were suggested as ways to attract the youth especially to cycling.

Figure 12: Suggestions for Promoting Cycling Mobility (n=171 responses)



CHAPTER 5

DISCUSSION

This chapter explains the key findings of this study with reference to the reviewed literature. The strengths and limitations of the study are appraised and the implications for further research are considered.

Focus Group Discussion

The top barriers to cycling identified by the focus group discussion are consistent with reviews of local (Bechstein, 2010; Jennings, 2011, 2014, 2015a; Mashiri, 2013) and international studies (Heinen *et al.*, 2010), which found road safety, distance, and affordability to be significant barriers. The fear of road crashes, theft, and robbery as well as distance, affordability, and cycling inability were perceived as important barriers to cycling in a qualitative study of bicycles in LICs in Cape Town (Boulle, 2013). These factors were therefore all included as choice statements in the BWS survey. Although other barriers identified by the FGD (wind, poor health and fitness, risk of being bitten by dogs) have been cited less often, they were also included in the BWS survey for local relevance.

Household Survey: Travel-related findings

Taxis were the most frequent mode of transport used by almost all households and walking was the second most frequent mode. The train, bus, and bicycle were each named as modes of transport by more than 10% of households. The 2013 *National Household Travel Survey* (NHTS) found that among work commuters nationally, 39.1% used public transport as their main mode of travel to work, 38.4% used private transport and 21.1% walked all the way. In the Western Cape these figures were 35.6%, 46.2%, and 16.8% respectively. Taxis made up 67.6% of the share of all public transport trips nationally and 42.3% of provincial trips. Other modes, which include cycling, were reportedly used by 1.3% of national workers and 1.4% of provincial workers for work commuting (Statistics South Africa, 2013). Although this study did not distinguish the purpose of household trips for each mode of transport, it is evident that the use of taxis, walking and cycling is much higher in Masiphumelele and the use of private vehicles is

much lower than reported in the NHTS. The high usage of taxis is not unexpected, given that it is the most accessible mode of public transport in Masiphumelele. The bus service is far less frequent and the nearest train station in Fish Hoek is more than 5 km away.

The relatively frequent use of bicycles for transport is consistent with the high levels of household ownership of bicycles. A third of households reported at least one bicycle in working order that is used for transport, which is about five times higher than the national NHTS 2013 figure of 6.1% and about four times higher than the Western Cape figure of 8.5% (Statistics South Africa, 2013). This study did not enquire about the purpose or frequency of recent bicycle trips, but FGD participants indicated that bicycles are mainly used for commuting to work or to nearby shops. They also observed that most learners walk to school as the distances are short. Countrywide more than two thirds of learners (69%) walk and about 13% use taxis to get to school, while fewer than 1% cycle (Statistics South Africa, 2013).

Household Survey: Attitudes towards Cycling Mobility

With reference to the Stages of Change model used to classify attitudes towards cycling for transport (Prochaska and Diclemente, 1984. In:(Nkurunziza *et al.*, 2012), the majority in this study are either in the Pre-contemplation stage (no intention to change to cycling: 39%) or in the Contemplation stage (sometimes think about cycling: 28%). About a quarter (22%) stated that they cycle fairly often or regularly (at least once a week), which is similar to the levels of 24% in the Action or Maintenance stages found in Dar-es-Salaam (Nkurunziza *et al.*, 2012). Although the contexts of the two studies are different in many ways, these findings suggest that transport planners should first identify the stage of contemplation of commuters with respect to cycling prior to designing and implementing interventions to promote cycling mobility.

Over a quarter (n=6 respondents) of the 22 self-reported cyclists in this study were employed as security guards, which is consistent with observations by the FGD participants about who are the regular bicycle commuters. The affordability and flexibility offered by bicycles make them an attractive option for an occupational group that is generally poorly paid and required to commute at times when public transport is

less available. Working hours that require commuting early in the morning or late at night put cyclists at increased risk however of being hit by a car or robbed of their bicycles in the dark, which may deter others in low-income occupations from cycling.

Only three of the cyclists in the survey were women. This is not unexpected given the international trend for men to cycle more in countries with low cycling rates (Garrard *et al.*, 2008 In:(Heinen *et al.*, 2010)), as well as prevalent fears about crime and personal security. Social norms may also discourage women from cycling (Boulle, 2013). These norms may be rooted in traditional patriarchal ideas of what is acceptable behaviour for women, as well as limited understanding of the benefits of cycling due to inadequate promotion and exposure to bicycles (Mashiri, 2013).

The primary reasons for cycling among those who do cycle fairly often or regularly were consistent with several other studies: financial savings, health benefits, and saving time (Bechstein, 2010; Boulle, 2013; Mashiri, 2013; Nkurunziza *et al.*, 2012). Income opportunities from bicycle rentals were identified by only one participant in the FGD and one in the household survey. The former referred to renting bicycles to commuter cyclists and the latter to tourists and foreign visitors, which her tour company employer does on a small scale. Given sufficient demand, short-term rentals may create opportunities for bicycle entrepreneurs, as recognised by the *National Public Transport Action Plan* (National Department of Transport, 2007). The main reasons against cycling identified by the survey were consistent with the findings of the FGD and other studies: poor road safety, affordability of bicycles, inability to cycle, and long commuting distances (Bechstein, 2010; Boulle, 2013; Heinen *et al.*, 2010; Mashiri, 2013; Nkurunziza *et al.*, 2012).

BWS Survey: Perceived Barriers to Cycling Mobility

The BWS survey elicited participants' perceptions about the relative importance of 20 barriers to cycling mobility in Masiphumelele. The finding that the top perceived barrier overall is the risk of being hit by a car is consistent with findings from the FGD and open-ended survey questions that the risk of crashes is among the greatest deterrents to cycling. Road safety is a very valid concern in an overcrowded township like Masiphumelele, where sidewalks are usually occupied by street vendors, roads are

narrow, and speeding vehicles are a constant threat to the safety of pedestrians and cyclists. This is particularly true of the only access road into Masiphumelele that exits at the taxi rank and onto Kommetjie Road. Kommetjie Road, which links Masiphumelele to the commercial and employment centres of Kommetjie, Fish Hoek, Sun Valley and Noordhoek is narrow and busy, with little space for NMT traffic. Safety concerns related to road crashes, as well as bicycle theft and robbery, have also been identified as important deterrents to cycling in other South African studies (Bechstein, 2010; Boulle, 2013; Heinen et al., 2010).

The risk of being robbed while cycling was perceived as a significant barrier among the men surveyed and by the participants in the FGD. Crime is a particular concern in Masiphumelele and in many other LICs in South Africa, but is exacerbated in this community by the longstanding lack of an effective policing presence that contributed to recent civil unrest. Cyclists, particularly those commuting to work early or returning late, are relatively easy targets for criminals. FGD participants referred to a particular location along Kommetjie Road where robbery is apparently common.

Bicycle theft is also a concern where there is no safe storage in small overcrowded homes or at public places like taxi ranks, train stations, shops, and schools. Fish Hoek is the nearest train station and the main departure point for those commuting to workplaces in Cape Town, Simonstown and the Cape Flats. Taxis provide a frequent service to the station and beyond during commuting hours. The route is mostly flat and can be cycled in under half an hour by a reasonably fit cyclist, but there is no safe bicycle storage at the station. Lack of facilities for bicycle parking and storage at workplaces and public transport nodes is a deterrent to cycling worldwide and especially in crime-ridden communities (Heinen *et al.*, 2010; Pucher *et al.*, 2010).

Current Metrorail policy prohibits transporting bicycles on trains during peak commuting hours due to severe overcrowding and lack of bicycle storage space in passenger carriages. This was perceived as a significant barrier overall and by women respondents in the BWS survey. Although Metrorail has permitted bicycles on off-peak trains in recent years, it is unlikely that bicycle carriage will be permitted during peak hours given their current constraints on operating capacity. National and municipal

policy recognises that NMT is often poorly integrated with public transport and that bicycle carriage and safe parking is desirable (City of Cape Town, 2011, 2014b; Jennings, 2015a).

The inability to transport loads by bicycle also emerged as a significant barrier among men, women and non-cyclists in the BWS survey, which is consistent with a previous study in LICs in Cape Town (Boulle, 2013). Panniers and customised bicycle designs are potential solutions to this obstacle, but are not readily available or affordable in South Africa at present. The risk of being late for work also emerged as a significant barrier for all and among the male and non-cyclist sub-groups. This barrier is related to commuting distance, which is an important determinant of commuter cycling worldwide (Heinen *et al.*, 2010) and a particular challenge in apartheid-era LICs in South Africa. Permitting bicycles on public transport therefore assumes greater importance in the post-apartheid context of redressing inequities in the benefits of transportation (Jennings, 2011, 2015b).

High unemployment and poverty mean that bicycles, even second-hand ones selling for under R500, are unaffordable for many. Men in the BWS survey and FGD identified this as a significant deterrent to cycling, which is consistent with local studies and policy motivations (City of Cape Town, 2011, 2013, 2014b; Jennings, 2011, 2015a). The distribution of free or sponsored bicycles by the government and private sector was suggested by many participants as a means to promote cycling. One FGD participant suggested obtaining loans for bicycles through organisations that are working in Masiphumelele, but since none of them have a mandate to improve mobility this is unlikely to be a feasible intervention.

Adverse weather conditions, such as wind, rain and extreme temperatures, may be expected to deter cycling (Wadud, 2014), especially strong winds that are common in Masiphumelele. Despite being given as reasons against cycling by some respondents, they did not emerge as significant barriers in the BWS survey however. The absence of significant differences in the perceptions of barriers between cyclists and non-cyclists is unexpected. This may be due to inadequate statistical power to detect differences,

misclassification bias arising from the inability of the attitudinal statements to accurately distinguish cyclists from non-cyclists, or unknown confounding variables.

Barriers with significantly negative B-W scores, which may therefore be considered unimportant deterrents to cycling in Masiphumelele, were the social acceptability of men cycling, the risk of being bitten by dogs, and wind. The low numbers of women cyclists and the responses given by some women in the survey suggest that social norms may discourage some from cycling, even though it did not emerge as a significant barrier in the BWS survey. A prevalent traditional belief in places of origin of many residents, such as rural areas of the Eastern Cape, is that married and mature women should not wear trousers, a practice which hinders cycling. Such beliefs are generally perceived as 'old-fashioned' however by a younger generation that has grown up in urban areas with different social norms[6].

Household Survey: Attitudes towards Promoting Cycling Mobility

In addition to the relatively high levels of bicycle ownership and reported use for transport, there was considerable support for promoting cycling in Masiphumelele, motivated primarily by its cost savings and health benefits. The environmental and quality-of-life benefits of reduced traffic congestion, air and noise pollution, and safer streets were mentioned less often as motivating factors. These benefits have often been cited in the literature (Bechstein, 2010; Heinen *et al.*, 2010; Jennings, 2015a; Mashiri, 2013; Nkurunziza *et al.*, 2012) and in NMT policy (City of Cape Town, 2011, 2013).

Mashiri *et al.* (2013) provide a comprehensive classification of the interventions required to achieve 'critical mass' conditions for bicycle ownership and usage in South Africa. They characterise these interventions as the four 'pillars' of a sustainable low-cost mobility platform, namely socio-psychological, socio-economic, infrastructural and auxiliary interventions. Socio-psychological interventions include skills training in bicycle riding; technical improvements to improve the robustness and load-carrying capability of bicycles under local conditions; employer support and incentives for bicycle commuting; public awareness campaigns and social marketing; community workshops to elicit and influence the opinions of local leaders and role models; road

[6] Personal communication with SB (research fieldworker and Masiphumelele resident); 24 Oct 2015.

safety education; and stricter enforcement of traffic laws. Community-based funding schemes, advance credit from employers, and discounted customs duties for spare bicycle parts are suggested socio-economic interventions to enhance the affordability of bicycles. Infrastructural interventions include continuous cycling networks; safety improvements to roadways and intersections; better integration with public transport; and safe bicycle parking, lockers and showers at workplaces and popular destinations. Building capacity at government and community level is essential to sustain the interventions above, which has been a weakness in many South African NMT projects to date. Identifying and nurturing small and medium enterprises to provide a range of auxiliary services in diverse communities is therefore required. These services include the construction and maintenance of infrastructure; the manufacturing and assembly of bicycles; and the distribution, sales and repairs of bicycles, spares and accessories. This classification provides a useful framework for evaluating and complementing the suggestions by study participants for promoting cycling mobility in Masiphumelele, such as bicycle skills training, safe places for cycling, sponsoring bicycles, starting a cycling club, and cycling events and competitions.

Although these suggestions are useful and relevant, more strategic thinking may be required by municipal authorities and local role-players if cycling is to realise its considerable socio-economic, public health and environmental benefit potential. Identifying and profiling target groups of potential cyclists who may be motivated to cycle for different reasons is a worthwhile prerequisite to designing interventions to promote cycling. A study in Dar-es-Salaam from which the attitudinal statements in this study were adapted, ranked the perceived motivational factors for cycling by 'market segment', which correspond to each stage in the Stages of Change model (Prochaska and Diclemente, 1984. In: (Nkurunziza *et al.*, 2012)). These factors, their promotional implications and potential barriers to effecting behaviour change are summarised by stages of change in Table 5 (Nkurunziza *et al*., 2012).

Table 5 Perceived motivational factors, barriers and promotional implications by cycling target group in Dar-es-Salaam, Tanzania; adapted from Nkurunziza et al., 2012.

Stage of Change	Perceived motivational factors ranked by importance	Promotional implications	Potential barriers to promotion
PRE-CONTEMPLATION	Separate bicycle paths (52%)	Re-evaluate travel behaviour	Hard to reach
	Cycling training and education on traffic rules (15%)	Increase problem awareness	Success less likely
	Public awareness on cycling (10%)		
	Other factors (23%)		
CONTEMPLATION	Special bicycle infrastructure (45%)	Develop action plans	
	Cycling training and education centres (20%)		Traffic law enforcement
	Reduction of bicycle prices (13%)		
	Enforcement of road safety rules (10%)		
	Other factors (12%)		
PREPARATION	Access to bicycle loans (57%)	Develop action plans	Traffic law enforcement
	Enforcement of road safety rules (20%)	Remove barriers	Sustainability of free bikes
	Reduction of bicycle prices (15%)	Take small initial steps	
	Free bicycles (8%)		
ACTION	Reduction of bicycle prices (65%)	Promote long-term benefits	Traffic law enforcement
	Enforcement of road safety rules (20%)	Give positive feedback (health; savings)	
	Traffic laws and road safety rules should be designed in favour of cyclists (10%)	Social support and reinforcement	
	Other factors (5%)		
MAINTENANCE	Reduction of bicycle prices (57%)	Give positive feedback (health; savings)	Educating car drivers
	Educating car drivers to change theirattitude towards cyclists (35%)	Social support and reinforcement	
	Other factors (8%)		
RELAPSE	Special bicycle infrastructure (60%)	Reassess motivation and barriers	Risk of crashes
	Enforcement of road safety rules (25%)	Stronger coping strategies	Sweat and tiredness
	Shorter travel distances (11%)		Distance
	Other factors (4%)		

In summary, this segment profiling shows that for maximum effect a combination is required of socio-psychological (public awareness, law enforcement, education and skills training), financial (loans, price reductions) and infrastructural interventions (separate bicycle paths, safe parking facilities), complemented by good insight into the best ways and potential obstacles to promoting cycling among different groups of potential and current cyclists.

Strengths and Limitations of the Study

The mixed methods design was appropriate for this study. The FGD was useful for identifying locally relevant barriers to cycling for inclusion in the BWS stated choice sets, as well as for lending insight into cycling behaviour in Masiphumelele. Although no women were included in the FGD, it was reassuring that the FGD responses were mostly consistent with the key findings of the literature review and household survey. The household sample, although not large, did represent the study population well in terms of gender, occupation, age, and education.

This appears to be the first study to use the BWS stated choice methodology to assess perceptions of barriers to cycling mobility in a LIC. The methodology proved to be sufficiently simple and appropriate to this setting for clearly ranking the relative importance of barriers to cycling mobility. Utilising these findings to build a choice model would be a useful next step in order to explore the importance of the barriers at an individual level (Hristov & Kuhar, 2014), supplemented with data on the purpose and frequency of bicycle trips.

Accurate isiXhosa translation and thorough pre-testing of the survey tools were also strengths of the study. The validity of the BWS results may have been compromised by fatigue or impatience of some respondents however, leading to them not fully considering their BWS choices. Re-visiting a sample of surveyed households to check the validity of the results was considered, but an upsurge in civil unrest shortly after the fieldwork ruled out this option.

Employing Masiphumelele residents as field workers greatly facilitated data collection, as they were familiar with the local terrain, language and customs. They were able to

visit households when residents were more likely to be at home and were fully aware of the volatile security situation that made fieldwork dangerous at times.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

This chapter concludes with recommendations for promoting cycling mobility in Masiphumelele. These recommendations follow the classification of interventions proposed for a sustainable low-cost mobility platform in South Africa (Mashiri, 2013). Socio-psychological interventions are those that promote the benefits of cycling, educate about road safety, and teach cycling skills. Socio-economic recommendations relate to the affordability of bicycles and spares, and infrastructural interventions are those that enhance the safety of the cycling environment. The discussion concludes with recommendations for building capacity at community level to sustain these interventions.

Promote the Benefits of Cycling

The cost savings and health benefits of cycling were common reasons given by the two thirds of study participants who expressed support for promoting cycling mobility in Masiphumelele. These perceived benefits and the high level of support found in this study for more cycling mobility should be communicated via public awareness campaigns and social marketing in a diversity of settings: community facilities, libraries, schools, shops, health centres, sporting and cultural events for example. Local leaders and popular personalities should be highly visible in the campaign, which could capitalise on the media attention on cycling garnered by the annual Cape Town Cycle Tour. Besides the mass media, targeted messages that incorporate the most effective motivational factors for specific groups should be designed and disseminated by cycling advocacy organisations like the Pedal Power Association[7].

The Open Streets movement has shown the potential for promoting a more democratic use of streets by pedestrians and cyclists in cities worldwide, including Cape Town[8]. Such events can be powerful means of shifting perceptions about public open spaces and the current priority given to motorised traffic, with all the attendant dangers in a

[7] Pedal Power Association www.pedalpower.org.za
[8] Open Streets www.openstreets.co.za

crowded township setting. Although an Open Streets event is a relatively expensive undertaking requiring significant local partnership and external sponsorship[9], the use of Masiphumelele as a potential venue should be considered. Inviting local leaders to such an event may be an effective way of influencing their opinions and lending their support to bring Open Streets to their community.

The health benefits of active transport, such as cycling and walking, should be vigorously promoted as a means of regular exercise by health workers and public health facilities. This is especially important in a country like South Africa where physical inactivity is one of the leading risk factors for the high national burden of non-communicable disease (Mayosi & Benatar, 2014).

Educate about Road Safety

Poor road safety and the risk of being hit by a car while cycling were perceived as the primary barriers to cycling in Masiphumelele, in common with many other communities where there is a low level of awareness and respect for the rights of cyclists to share road space with motorists. Education about road safety should target all road users, including cyclists. Schools, libraries, health centres, shops, public transport vehicles and transport nodes are strategic settings for road safety messages, including respect for cyclists and pedestrians. Involving schoolchildren in designing promotional material, perhaps in the form of a competition, would raise the profile and local applicability of road safety messaging. Stricter and more visible enforcement of traffic laws by the authorities would greatly help to reinforce these messages.

Teach Cycling Skills

Teaching skills in cycling was recommended by participants in the FGD and in the household survey. Schoolchildren should be a primary target group for developing safe cycling proficiency as a lifelong skill and habit. Hands-on training at schools could be complemented by training in maintenance and simple repairs. The *Bicycling Empowerment Network* (BEN) offers training programmes on bicycle safety and maintenance for learners in partnership with local role players who are responsible for

[9] Personal communication, MC (Director: Open Streets), 11 Nov 2015

facilitating the logistics[10]. BEN's experience is that committed partners who take ownership of these training programmes are critical to the long-term success of these courses, especially when supported by motivated learners, parents, and teachers[11]. *Ikamva Youth*[12] is a national non-profit organisation that provides after-school tutoring and mentoring for high school learners in Masiphumelele. *Ikamva Youth* may be a suitable partner for piloting a short bicycle training course with its learners prior to seeking funding via BEN for a longer-term programme of cycle skills training and promotion.

There are plans to launch a sport and recreational cycling club in Masiphumelele to prepare young cyclists for the 2017 Cape Town Cycle Tour that routes directly past the township[13]. Such an initiative may help to develop young cycling talent, attract sponsorship for sport cycling, and provide recreational opportunities for the youth, which may in turn promote a culture of commuter cycling and create economic opportunities for bicycle entrepreneurs.

Make Bicycles and Spares More Affordable

Although many participants suggested that bicycles be donated to learners, BEN's experience has shown that it is more sustainable to donate bicycles to institutions responsible for safe storage and routine maintenance, rather than to individuals[14]. The failure of the Department of Transport's *Shova Kalula* programme to meet its targets to distribute thousands of low-cost bicycles has been partly attributed to a failure to properly involve beneficiary communities in safeguarding and maintaining donated bicycles (Mashiri, 2013). Community involvement should therefore include dedicated state funding to train and support local bicycle entrepreneurs to provide more affordable bicycles and spares via sales and rentals.

Encouraging employers to promote bicycle commuting by means of financial incentives, loans, and facilities like safe parking, storage lockers and showers for cyclist employees

[10] Bicycling Empowerment Network www.benbikes.org.za
[11] Personal communication with UD (BEN Operations Manager); 18 Nov 2015
[12] IkamvaYouth http://ikamvayouth.org/
[13] Personal communication with TK (BEN Outreach Manager); 18 Nov 2015
[14] Personal communication with TK (BEN Outreach Manager); 30 Oct 2015

may be another sustainable way to make bicycles more affordable and hence promote a culture of commuter cycling (Heinen *et al.*, 2010; Jennings, 2011; Pucher *et al.*, 2010).

Enhance the Safety of the Cycling Environment

Creating safer places for cycling, which was one of the main suggestions from participants, is a challenge in Masiphumelele due to overcrowding, narrow streets, and the lack of effective traffic law enforcement. The current upgrade of Kommetjie Road and other roads in Sun Valley to include cycle lanes provides an opportunity to push for a continuous network of good-quality cycling infrastructure in the Fish Hoek valley for commuter, recreational and sport cyclists[15], backed by stricter enforcement of road safety. Consultation with cyclists and other road users is critical to the success of such interventions. Metrorail should also be pressured to provide safe bicycle storage at its main train stations, such as Fish Hoek, and to permit bicycles on certain trains during peak commuting hours.

Build Local Capacity

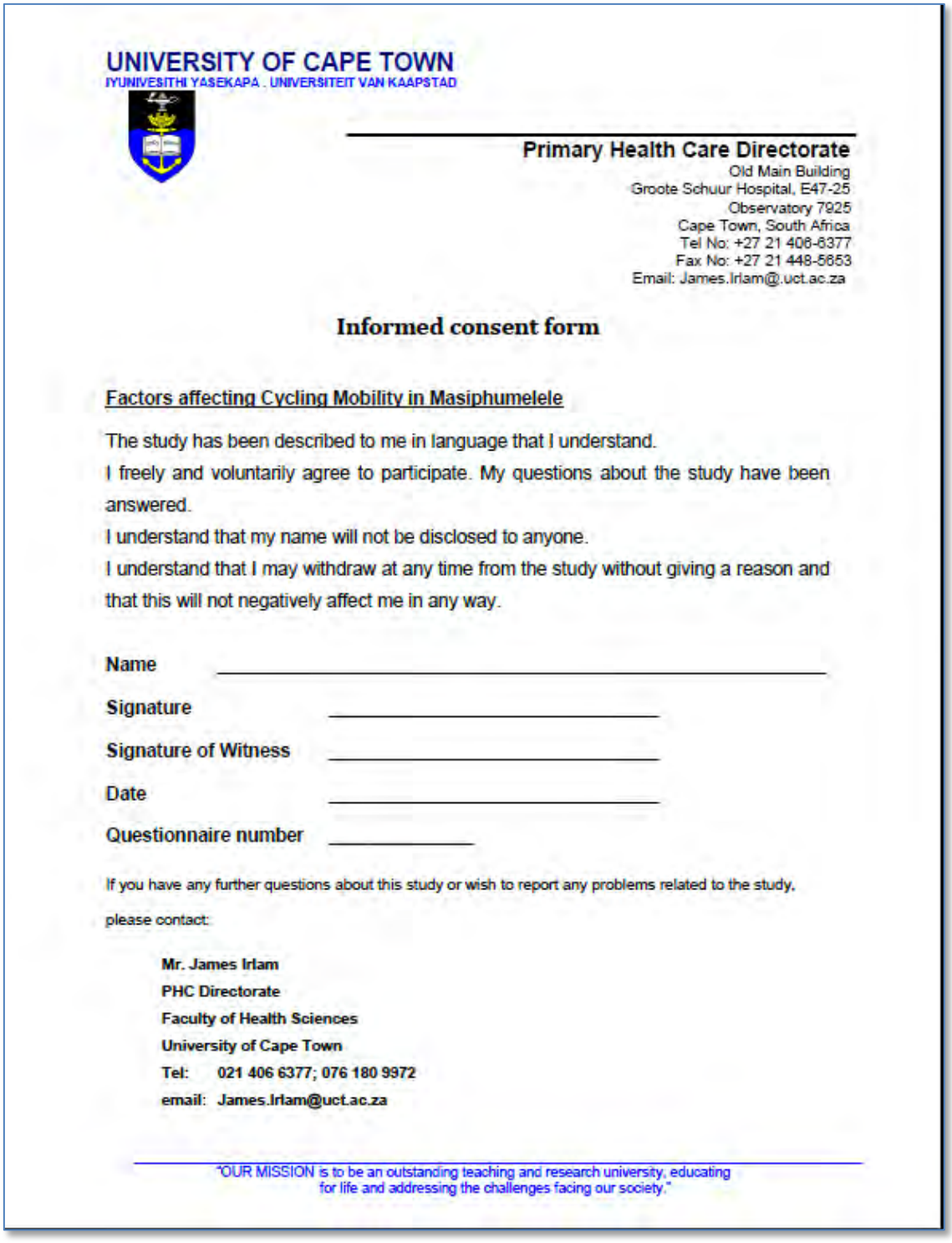
Masiphumelele is a low-income community with a relatively high prevalence of bicycle ownership and mobility, but with potential for much more given the high levels of support for cycling. This study has identified key barriers to cycling mobility in order to make recommendations for promoting bicycles as a means of transport. Implementing these recommendations successfully and sustainably will require good partnerships between all role players, such as local government authorities, community leaders and residents of Masiphumelele, local NGOs, and cycling advocacy organisations.

Building local capacity to sustain interventions to promote cycling can take many forms, depending on the role players: training and funding assistance for owners and operators of small and medium bicycle enterprises; training school learners to safely ride and maintain bicycles; teaching administration and financial skills to cycling club administrators; and imparting organisational and media skills to organisers of local cycling events.

[15] Focus group of cyclists, including the author, who participated in a public participation process around future planning for the City of Cape Town with the Noordhoek Ratepayers' Association, 3 Feb. 2016

Investing in the skills development of local residents to promote cycling with passion and competence will pay dividends not only in the sustainability of the cycling interventions but in better health and quality of life of the people of Masiphumelele.

Appendix 1: Informed consent form



UNIVERSITY OF CAPE TOWN
IYUNIVESITHI YASEKAPA . UNIVERSITEIT VAN KAAPSTAD

Primary Health Care Directorate
Old Main Building
Groote Schuur Hospital, E47-25
Observatory 7925
Cape Town, South Africa
Tel No: +27 21 406-6377
Fax No: +27 21 448-6853
Email: James.Irlam@.uct.ac.za

Informed consent form

Factors affecting Cycling Mobility in Masiphumelele

The study has been described to me in language that I understand.
I freely and voluntarily agree to participate. My questions about the study have been answered.
I understand that my name will not be disclosed to anyone.
I understand that I may withdraw at any time from the study without giving a reason and that this will not negatively affect me in any way.

Name _____

Signature _____

Signature of Witness _____

Date _____

Questionnaire number _____

If you have any further questions about this study or wish to report any problems related to the study, please contact:

Mr. James Irlam
PHC Directorate
Faculty of Health Sciences
University of Cape Town
Tel: 021 406 6377; 076 180 9972
email: James.Irlam@uct.ac.za

Appendix 2: Focus Group Discussion Guide

Factors affecting Cycling Mobility in Masiphumelele

FOCUS GROUP DISCUSSION

1. What is the most common means of transport for people in this community to get to work and school and shops?
2. Who are the main users of bicycles in this community ?
   (Men/women? Children/ young adults/ older adults? Labourers/ artisans/ students etc.)
3. What do these people use bicycles for?
4. Why do you think these people use bicycles rather than another means of transport?
5. What do you think are the benefits to individuals of using bicycles?
6. What do you think are the benefits to your community of more people using bicycles?
7. Why do you think people DO NOT use bicycles as a means of transport in this community?
   (Please write your responses to question 6 on the notepads provided.
   When you are finished I will collect the notes and compile a summary list on the flipchart of all your responses.
   We will then discuss if there are any other reasons to add to this list before we proceed)
8. Please use the table on p.2 to rank order the listed reasons from most important to least important.
9. How do you think cycling can be promoted in this community as a means of transport?
10. Write any other comments or questions below:

(Questions adapted from Boulle, M. J. (2013). The role of bicycles and bicycle empowerment centres in improving the mobility and livelihoods of the poor, and assisting with low-carbon development in Cape Town. University of Cape Town)

Factors affecting Cycling Mobility in Masiphumelele

FOCUS GROUP DISCUSSION

Write the reasons why YOU think people do not use bicycles in this community. Rank them in order from most to least important	
MOST IMPORTANT	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
LEAST IMPORTANT	

THANK YOU

James Irlam
Researcher, UCT Centre for Transport Studies
Faculty of Engineering and the Built Environment

(Questions adapted from Boulle, M. J. (2013). The role of bicycles and bicycle empowerment centres in improving the mobility and livelihoods of the poor, and assisting with low-carbon development in Cape Town. University of Cape Town)

Appendix 3: Household Survey questionnaire

Factors affecting Cycling Mobility in Masiphumelele
HOUSEHOLD SURVEY

Questionnaire #	_____
Date:	_____
Location	_____
Interviewer:	_____

Good day.

My name is James Irlam. I am a lecturer and researcher from UCT. I am undertaking a study in Masiphumelele about the use of bicycles for transport.

I would like to ask the head or most senior member of this household some questions for about 20 minutes. This person must be 18 years or older and have been resident in Masiphumelele since at least January 2015 to participate.

The aim of the study is to find out about bicycles as a means of transport. I am interested in what people in Masiphumelele think about using bicycles, whether they do use them, or why they do not use them. Your honest responses to my questions will help me to write a report for UCT and the City of Cape Town. Your name will not be disclosed to anyone.

You will receive a small gift in appreciation for your time.

Would you like to participate in the study?

If you agree then please sign the **Informed Consent Form.** This form is required by the UCT Research Ethics Committee that has approved the study (FSREC 37 – 2015).

Thank you!

1

Factors affecting Cycling Mobility in Masiphumelele
HOUSEHOLD SURVEY

PART 1: Background

I would first like to ask some questions about yourself and your household

1.1 What is your position in the household? _____
(Head / spouse / oldest child/ other…..)

1.2 Sex: M / F

1.3 What is your age? _____ years

1.4 How long have you lived in Masi? _____ years

1.5 What is your place of origin i.e. the place where you were born?

_____
(Town & Province/ Country if not South Africa)

1.6 What is your highest level of education? Gr 1-7 / Gr 8-12 / Tertiary _____

1.7 What is your occupation?

_____
(Student / Unemployed / Self-employed / Labourer / Business / Govt. / Other…)

1.8 What TWO modes of travel does the household usually use?

_____ _____
(Bus / taxi/ private car/ bicycle / walking / Other...)

1.9 How many bicycles in working order does this household own and use for transport? ___

2

Factors affecting Cycling Mobility in Masiphumelele
HOUSEHOLD SURVEY

PART 2: Attitudes towards cycling

I would like to ask you now about your use of bicycles to get to your workplace or other places that you travel to regularly (at least once a week).

2.1 Please indicate (**X**) which ONE of the following statements is most true about you:

A		*I have never thought about cycling as a means of transport*
B		*I have never used a bicycle but I sometimes think about cycling as a means of transport*
C		*I seldom cycle but have seriously thought about cycling as a means of transport*
D		*I cycle fairly often as a means of transport*
E		*I cycle regularly (at least once a week) as a means of transport*
F		*I no longer cycle as a means of transport*

2.2 If you DO cycle fairly often or regularly (**option D or E above**), please tell me why you cycle:

_____

_____

(To keep fit and healthy / Save money / Save time / Other…)

2.3 If you DO NOT cycle fairly often or regularly (**option A, B, C, or F above**), please tell me why you DO NOT cycle.

_____

_____

2.4 Please tell me why you think others in your community DO NOT cycle:

_____

_____

I would now like to find out which are the most important reasons why people in Masiphumelele DO NOT cycle.
I will give you TEN sets of four statements each which we will read together.
I will ask you to indicate which ONE of the statements in each set you AGREE MOST with and which ONE of the statements you AGREE LEAST with.

Factors affecting Cycling Mobility in Masiphumelele
HOUSEHOLD SURVEY

PART 3: Attitudes towards promoting cycling

3.1 Do you think that bicycles should be used more for transport in Masiphumelele? Y / N

3.1.1 If YES, why?

3.1.2 If NO, why not?

3.2 How do you think cycling could be promoted in Masiphumelele?

Thank you for your time.

A report on the completed study will be given to the library.

4

Appendix 4: BWS Statements for Choice Sets

Code	Statement about perceived barrier
ACCEPT	It is not socially ACCEPTable for me to cycle
AFFORD	I am unable to AFFORD a bicycle
CONF	I don't feel CONFident riding a bicycle
CULTURE	It is not part of my CULTURE to cycle
DARK	It is too DARK to cycle to/ from work in the mornings/ evenings
DOGS	I may get bitten by DOGS if I cycle
FAR	It is too FAR to cycle to work
FIT	I am not FIT enough to cycle
HIT	I am afraid of being HIT by a car when cycling
LATE	I may be LATE for work if I cycle
LOADS	I can't carry LOADS on a bicycle
RAIN	It is too RAINy to cycle
RIDE	I am unable to RIDE a bicycle
ROBBED	I am afraid of being ROBBED of my bicycle on the way
SAFE	I can't leave my bicycle SAFEly anywhere
SICK	I am too SICK to cycle
TEMP	It is too hot / cold to cycle
TRAIN	I can't take my bicycle on the TRAIN during rush hour
UNCOMF	It is too UNCOMFortable to cycle
WIND	It is too WINDy to cycle

Appendix 5: BWS Survey Data Sheet

Questionnaire nr ________

MOST	1 1	LEAST		MOST	1 2	LEAST		MOST	1 3	LEAST		MOST	1 4	LEAST		MOST	1 5	LEAST
	It is too far to cycle to work				I can't take my bike on the train during rush hour				It is too uncomfortable to cycle				I don't feel confident riding a bike				It is not part of my culture to cycle	
	I am unable to afford a bike				It is not part of my culture to cycle				It is too hot / cold to cycle				I am afraid of being hit by a car when cycling				I am unable to ride a bike	
	It is too rainy to cycle				I am afraid of being robbed of my bike on the way				It is too dark to cycle to/ from work in the mornings/ evenings				It is not socially acceptable for me to cycle				I am too sick to cycle	
	I can't take my bike on the train during rush hour				It is too uncomfortable to cycle				I am not fit enough to cycle				I can't leave my bike safely anywhere				I can't carry loads on a bicycle	

MOST	2 1	LEAST		MOST	2 2	LEAST		MOST	2 3	LEAST		MOST	2 4	LEAST		MOST	2 5	LEAST
	I may be late for work if I cycle				I am afraid of being hit by a car when cycling				I can't leave my bike safely anywhere				I am unable to ride a bike				I am unable to afford a bike	
	It is too rainy to cycle				It is too far to cycle to work				It is too windy to cycle				I can't take my bike on the train during rush hour				I can't leave my bike safely anywhere	
	I can't carry loads on a bicycle				It is not part of my culture to cycle				I am not fit enough to cycle				I may be late for work if I cycle				It is too dark to cycle to/ from work in the mornings/ evenings	
	I am afraid of being hit by a car when cycling				It is too hot/ cold to cycle				It is too rainy to cycle				It is too dark to cycle to/ from work in the mornings/ evenings				It is not part of my culture to cycle	

Questionnaire nr ________

Appendix 6: EBE Faculty: Assessment of Ethics in Research Projects

EBE Faculty: Assessment of Ethics in Research Projects

Any person planning to undertake research in the Faculty of Engineering and the Built Environment at the University of Cape Town is required to complete this form before collecting or analysing data. When completed it should be submitted to the supervisor (where applicable) and from there to the Head of Department. If any of the questions below have been answered YES, and the applicant is NOT a fourth year student, the Head should forward this form for approval by the Faculty EIR committee: submit to Ms Zakiya Chikte (Zakiya.chikte@uct.ac.za); New EBE Building, Ph 021 650 5739) Students must include a copy of the completed form with the dissertation/thesis when it is submitted for examination.

Name of Principal Researcher/Student: Mr James Irlam **Department:** Civil Engineering

If a Student: **Degree:** MPhil (Climate Change & Sustainable development
Supervisor: A. Prof Mark Zuidgeest

If a Research Contract indicate source of funding/sponsorship:

Research Project Title: Factors affecting Cycling Mobility in Masiphumelele and Ocean View, Cape Town

Overview of ethics issues in your research project:

Question 1: Is there a possibility that your research could cause harm to a third party (i.e. a person not involved in your project)?	~~YES~~	NO
Question 2: Is your research making use of human subjects as sources of data? If your answer is YES, please complete Addendum 2.	YES	~~NO~~
Question 3: Does your research involve the participation of or provision of services to communities? If your answer is YES, please complete Addendum 3.	~~YES~~	NO
Question 4: If your research is sponsored, is there any potential for conflicts of interest? If your answer is YES, please complete Addendum 4.	~~YES~~	NO

If you have answered YES to any of the above questions, please append a copy of your research proposal, as well as any interview schedules or questionnaires (Addendum 1) and please complete further addenda as appropriate.

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

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

Signed by:

	Full name and signature	Date
Principal Researcher/Student:	James Hamilton Irlam Signed by candidate	4 Aug 2015

This application is approved by:

Supervisor (if applicable):	Signed by candidate M. Zuidgeest	05 Aug 2015
HOD (or delegated nominee). Final authority for all assessments with NO to all questions and for all undergraduate research.		
Chair : Faculty EIR Committee For applicants other than undergraduate students who have answered YES to any of the above questions.	G. Sithole Signed by candidate	18 SEP 2015

REFERENCES

Bechstein, E. (2010). *Cycling as a Supplementary Mode to Public Transport: A Case Study of Low Income Commuters in South Africa*. Paper presented at the 29th Southern African Transport Conference (SATC 2010), Pretoria.

Beck, M. J., Rose, J. M., & Greaves, S. P. (2014). *I Can't Believe Your Attitude: Eliciting Attitudes and Beliefs Through Best-Worst Scaling and Jointly Estimating Their Impact on Electric Vehicle Choice.* Paper presented at the Transportation Research Board 93rd Annual Meeting.

Behrens, R., Muchaka, P., Salazar Ferro, P., Schalekamp, H., & Zuidgeest, M. (2015). *Mobility and access in Sub-Saharan African cities : The state of knowledge and research environments*. Centre for Transport Studies, University of Cape Town.

Boulle, M. J. (2013). *The role of bicycles and bicycle empowerment centres in improving the mobility and livelihoods of the poor, and assisting with low-carbon development in Cape Town.* University of Cape Town.

Burke, P. F., Schuck, S., Aubusson, P., Buchanan, J., Louviere, J. J., & Prescott, A. (2013). Why do early career teachers choose to remain in the profession? The use of best–worst scaling to quantify key factors. *International Journal of Educational Research, 62*, 259-268.

City of Cape Town. (2005). *NMT Policy and Strategy Volume 1: Status quo assessment*. Cape Town: City of Cape Town.

City of Cape Town. (2010). *City-Wide NMT plan for the City of Cape Town*. Cape Town: City of Cape Town.

City of Cape Town. (2011). *City of Cape Town Bicycle Masterplan Update*. Cape Town: City of Cape Town.

City of Cape Town. (2013). *2013 – 2018 Comprehensive Integrated Transport Plan*. Cape Town: City of Cape Town.

City of Cape Town. (2014a). *Integrated Development Plan 2012 – 2017: 2013/14 Review*.

City of Cape Town. (2014b). *Integrated Public Transport Network Plan 2032*. Cape Town: City of Cape Town.

De Witte, A., Hollevoet, J., Dobruszkes, F., Hubert, M., & Macharis, C. (2013). Linking modal choice to motility: A comprehensive review. *Transportation research part A: policy and practice, 49*, 329-341. doi: 10.1016/j.tra.2013.01.009

Department of Environmental Affairs. (2011a). *National Climate Change Response White Paper*. Pretoria: Republic of South Africa.

Department of Environmental Affairs. (2011b). *National Strategy for Sustainable Development and Action Plan 2011-14*. Pretoria: Republic of South Africa.

Flynn, T., Louviere, J. J., Peters, T. J., & Coast, J. (2007). Best–worst scaling: what it can do for health care research and how to do it. *Journal of health economics, 26*(1), 171-189.

Flynn, T., & Marley, A. A. J. (Writers). (2014). Best-worst scaling: theory and methods, *Handbook of Choice Modelling*.

Goodland, R., & Daly, H. (1996). Environmental sustainability: universal and non-negotiable. *Ecological applications*, 1002-1017.

Heaton, S. K., Balbus, J. M., Keck, J. W., & Dannenberg, A. L. (2010). Healthy Communities. In H. Frumkin (Ed.), *Environmental Health: from global to local (2nd ed.)*: Jossey-Bass.

Heinen, E., van Wee, B., & Maat, K. (2010). Commuting by bicycle: an overview of the literature. *Transport reviews, 30*(1), 59-96.

Hensher, D. A., Rose, J. M., & Greene, W. H. (2005). *Applied Choice Analysis: A Primer*: Cambridge University Press.

Hristov, H., & Kuhar, A. (2014). Young Urban Adults' Preference for Wine Attributes Applying Best-Worst Scaling: An Exploratory Study for Republic of Macedonia. *Bulgarian Journal of Agricultural Science, 20*(3), 541-551.

IPCC (2014). Summary for Policymakers. *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*.

Jennings, G. (2011). A Tale of Two Cycling Cities: Bicycle pride, promotion and politics in Cape Town *Bicycle Politics.* Lancaster: Centre for Mobilities Research.

Jennings, G. (2014). Finding our balance: Considering the opportunities for public bicycle systems in Cape Town, South Africa. *Research in Transportation Business & Management, 15*, 6-14. doi: 10.1016/j.rtbm.2014.09.001

Jennings, G. (2015a). *A Bicycling Renaissance in South Africa? Policies, Programmes and Trends in Cape Town.* Paper presented at the Proceedings of the 34th Southern African Transport Conference.

Jennings, G. (2015b). *Public transport interventions and transport justice in South Africa: a literature and policy review.* Paper presented at the 34th Southern African Transport Conference, Pretoria.

Kirkels, M. (2011). Cycling at the Crossroads of Poverty Alleviat ion and Sustainable Transport. Retrieved 21 July 2015 from www.slocat.net/about-slocat

Kok, T. (2014). *Cycling in the City of Cape Town: Status Quo and Developments*. Transport for Cape Town.

Mashiri, M., Maphakela, W., Chakwizira, J., & Mpondo, B. . (2013). *Building a Sustainable Platform for Low-Cost Mobility in South Africa. In SATC 2013 (pp. 198–212). Pretoria*. Paper presented at the 32nd Southern African Transport Conference (SATC 2013), Pretoria.

Massink, R., Zuidgeest, M., Rijnsburger, J., Sarmiento, O. L., & Van Maarseveen, M. (2011). The climate value of cycling. *Natural Resources Forum, 35*(2), 100-111.

Mayosi, B. M., & Benatar, S. R. (2014). Health and health care in South Africa—20 years after Mandela. *New England Journal of Medicine, 371*(14), 1344-1353.

National Department of Transport. (1996). *White Paper on National Transport Policy*. Republic of South Africa.

National Department of Transport. (1999). *Moving South Africa Transport Strategy for 2020*. Republic of South Africa.

National Department of Transport. (2002). *National Land Transport Strategic Framework.*: Republic of South Africa.

National Department of Transport. (2007). *National Public Transport Action Plan*. Republic of South Africa.

National Department of Transport. (2008). *Draft National NMT Policy.*: Republic of South Africa.

National Department of Transport. (2009). *National Land Transport Act No 5 of 2009*. Pretoria: Republic of South Africa.

Nkurunziza, A., Zuidgeest, M., & Van Maarseveen, M. (2012). Identifying potential cycling market segments in Dar-es-Salaam, Tanzania. *Habitat International, 36*(1), 78-84. doi: 10.1016/j.habitatint.2011.06.002

Pucher, J., Dill, J., & Handy, S. (2010). Infrastructure, programs, and policies to increase bicycling: an international review. *Preventive medicine, 50*, S106-S125.

SLoCaT. (2016). Non-Motorised Transport. Retrieved 18 Jan. 2016, from www.slocat.net/content-stream/183

Statistics South Africa. (2013). *National Household Travel Survey: Statistical Release P0320*. Pretoria.

Vasconcellos, E. A. (2001). *Urban Transport, Environment and Equity*. London: Earthscan.

Wadud, Z. (2014). Cycling in a changed climate. *Journal of Transport Geography, 35*, 12-20.
Walters, J. (2013). Overview of public transport policy developments in South Africa. *Research in Transportation Economics, 39*(1), 34-45.
Watts, N., Adger, W. N., Agnolucci, P., Blackstock, J., Byass, P., Cai, W., . . . Costello, A. (2015). Health and climate change: policy responses to protect public health. *The Lancet, 386*(10006), 1861-1914.
World Health Organisation. (2008). Protecting Health from Climate Change: Key messages for the Transport Sector. Retrieved from www.who.int/globalchange/publications/factsheets/WHD2008_transport_sector_2.pdf?ua=1