END-OF-TRIP FACILITIES FOR CYCLISTS AND REALIGNMENT OF CURRENT SOUTH AFRICAN BICYCLE LEGISLATION

by
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Thesis presented in fulfilment of the requirements for the degree of Master of Science in the Faculty of Engineering at Stellenbosch University

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DECLARATION

By submitting this thesis electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof (save to the extent explicitly otherwise stated), that reproduction and publication thereof by Stellenbosch University will not infringe any third party rights and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

The processes undertaken in this study has been conducted in accordance with the "Policy for Responsible Research Conduct at Stellenbosch University" dated 24 June 2013 and particular attention has been paid towards complying with Section 13: Data Acquisition and Management (Stellenbosch University, 2013).

The surveys conducted within this thesis were for multiple organisations spanning two buildings within a business park. In attempting to successfully monitor staff usage of the shower and changing room facilities, the author has included his own activities within the survey results. I declare that my behaviour and usage of these facilities were purely motivated and in no way undertaken to try to influence the survey results whatsoever.

March 2016

ABSTRACT

In this thesis, the need to provide more End-of-Trip Facilities (EOTF) for cyclists (and/or other Non-Motorised Transport (NMT) users) is highlighted. Almost all Government sectors (national, provincial and local) have developed some form of NMT Plan, Policy, Strategy or Masterplan to address Travel Demand Management (TDM) and to promote the use of Public Transport and NMT. The level to which these policy documents address the needs of cyclists is however substandard.

The current planning legislation requires all new developments to provide vehicular parking to cater for the anticipated use. However, at present, little legislation exists to encourage/compel new developments to provide bicycle parking and bicycle facilities, which could greatly promote the use of NMT.

All major cities within South Africa are currently investing in NMT infrastructure or associated awareness programmes, but very little is being done regarding EOTF, which (apart from travel distance) is believed to be one of the most important criteria influencing whether commuters chose to cycle to work versus continue to use their private vehicles.

This thesis therefore explores the current South African legislation and highlights potential inhibiters to creating a commuter modal shift towards NMT. The thesis draws from guidelines and literature from international cities to support arguments and recommendations made within this thesis. The international examples were chosen to highlight the fact that South Africa cities are not unique in their pursuit to create a modal shift towards more sustainable transport modes, especially cycling.

A South African case study of an existing business complex without end-of-trip facilities is given, and measures the behavioural change following the introduction of some end-of-trip facilities.

SAMEVATTING

Die noodsaaklikheid vir eindpuntbewaringsfasiliteite (EBF) vir fietsryers of enige ander Nie-Gemotoriseerde Vervoer (NGV) word in die tesis uitgewys. Die drie regerings vlakke (nasionaal, provinsiaal en munisipaal) het omtrent almal een of ander NGV beplanning of strategie ontwikkel om die Vervoer Aanvraagbestuur te ondersteun asook die bevordering van openbare vervoer and NGV. Ongelukkig is die bevordering vir die gebruik van fietse nie goed ondersteun nie. Die huidige wetgewing vir beplanning vereis dat alle nuwe ontwikkelings voorsiening maak vir genoegsame parkering van voertuie. Daarenteen bestaan daar bitter min wetgewing om nuwe ontwikkelings aan te moedig of vereistes te stel om voorsiening te maak vir EBF vir fietse, wat die gebruik van NGV sou bevorder.

Huidiglik investeer al die groot stede in Suid Afrika in NGV infrastrukture of bewusmaking programme maar min word gedoen in verband met EBF. Afgesien van vervoer afstande is EBF een van die mees belangrike faktore om te bepaal of 'n pendelaar eerder 'n fiets sou gebruik instede van sy voertuig.

Die doel van hierdie tesis is om die huidige wetgewing te ondersoek en hindernisse uit te wys wat sal help om die NGV te laat slaag. Hierdie tesis gebruik riglyne and literatuur van internasionale stede om die argumente en voorstelle wat in die tesis verskyn, te ondersteun. Som internasionale voorbeelde was gebruik om te bewys dat Suid Afrikaanse stede nie uniek is in hul soektog na 'n modale verskuiwing na meer houbare vervoerstelsels, veral die gebruik van fietse.

'n Gevallestudie van 'n huidige besigheids kompleks in Suid Afrika sonder EBF word gebruik en die gedragsverandering word gemeet nadat verskeie EBF's ingestel is en word dan ontleed.

ACKNOWLEDGEMENTS

I would first like to thank my loving wife, Tanja (and unknowingly my son Noah) for allowing me the time to work on this project and for the constant support and encouragement.

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Mr Martin de Klerk for translating the abstract into Afrikaans.

Lastly, I would like to thank all the property developers, government employees and fellow cyclists whom I have spoken to over the past 2 years. Your conversations, opinions and advice have influenced my thoughts, which have subsequently influenced this thesis.

Thank you.

ABOUT THE AUTHOR

On my fourth birthday my parents gave me a bicycle and I can remember it like it was yesterday. Yes, it was a 'hand-me-down' from my older brother Justin. Pre-loved, just with a re-spray by the neighbour who used the left over yellow paint he used to spray my Dad's 1973 Ford Firenza. The bike was a Raleigh Chopper and it was my first bike, the bike my dad taught me to ride on. Balancing without stabilisers was the first hurdle to overcome, which my Dad reminds me was not a problem. Stopping however, was a problem. My Dad would give me a push to get going, I'd cycle to the end of the driveway, manage a slow U-turn and then cycle back to my Dad, who did all the stopping on my behalf.

I recall one occasion, having gained some confidence, where I decided to by-pass my waiting Dad as a bit of fun and proceeded to pedal straight into the garage door at full speed, almost knocking myself unconscious. The reason I tell this story is that even though 35 years have now passed, the impact this bicycle had on my life was so powerful that it remains some of my fondest childhood memories. The freedom the bicycle gave me, not to mention the mobility, played a part in cementing these wonderful memories. I'm sure you are familiar with the saying "it's like riding a bicycle" inferring that once you have learned to ride a bicycle, you will never forget, but I doubt few of us would ever forget how it felt to ride a bike as a child. There was something magical about the freedom of a bicycle and the seemingly endless destinations a child could conceive.

The downside of owning and mastering the riding of a bicycle is that you were then expected to cycle to school. One Sunday afternoon, aged 6, I was driven to school and shown the correct route to follow. The following morning I was pushed out of the door and instructed to follow my neighbour, who was a year older than me and already familiar with cycling to school. Getting to school was the easy part, there were segregated cycle paths for large sections of the ride and the busy dual carriageway was manned by a points man, who ensured all scholars crossed safely. The difficult part, however, was ensuring that you got to school early enough to find an open bicycle rack. The primary school had rows and rows of cycle racks filled with bicycles. After school the most time consuming exercise was remembering where you parked your bike that morning.

My son is now two years old and we have just bought him a balance bike. Within weeks he has gone from being afraid to even touch the bike, to riding it like Matt Hoffman (famous BMX professional). As a parent, watching his skills improve and finally letting go of my hand and letting him ride away on his own was emotional, as it reminded me of my own memories with my Dad, but also as it is a special part of my son's inauguration to cycling. The event could almost be described as a rite of passage, going from a baby to a toddler.

It is these emotional cycle related life events that has been my inspiration to make a difference by lobbying to change the current way in which we live and function. Cycling continues to play a vital role in educating both children and adults about responsibility, correct use of the road, staying safe, not to mention reducing the number of private vehicle trips.

What about a bicycle, you insist?
A certain late Cuban revolutionary once said:
'...Revolution is like a bicycle,
once its stops, it falls.'
It seems, therefore, that we are compelled to pedal
this particular one at our disposal,
even though it is the one we have inherited
from our abnormal past,
and that its chain keeps on slipping
over
the cog.

- Lebogang Lancelot Nawa, South African Poet

ABBREVIATIONS

AM	Morning
Austroads	Australasian road transport and traffic agencies
BEN	Bicycling Empowerment Network
B/C	Benefit Cost
BRT	Bus Rapid Transit
CBD	Central Business District
CoCT	City of Cape Town
CoJ	City of Johannesburg
COTO	Committee of Transport Officials
CSIR	Council for Scientific and Industrial Research
CTZS	Cape Town Zoning Scheme
DOT	Department of Transport (South Africa)
EIA	Environmental Impact Assessment
EOTF	End of Trip Facility
EThekwiniTA	eThekwini Transport Authority
GBCSA	Green Building Council South Africa
GFA	Gross Floor Area
GIS	Geographical Information System
HGV	Heavy Goods Vehicle
IRPTN	Integrated Rapid Public Transport Network
ITE	Institute of Transportation Engineers
ITP	Integrated Transport Plan
km	Kilometers
LOS	Level of Service
LUPO	Land Use Planning Ordinance (Western Cape)

m	Metres
NEMA	National Environmental Management Act No 107 of 1998
NHTS	National Household Travel Survey
NLTSF	National Land Transport Strategic Framework
NLTA	National Land Transport Act No 5 of 2009
NMT	Non-Motorised Transport
OD	Origin-Destination
PM	Afternoon
SA	South Africa
SABS	South African Bureau of Standards
SARTSM	South African Road Traffic Signs Manual
SP	Stated Preference
TA	Transport Authority
TDM	Travel Demand Management
TfL	Transport for London
TRB	Transportation Research Board (United States of America)
TRL	Transport Research Laboratory (United Kingdom)
UK	United Kingdom
USA	United States of America

GLOSSARY

No.	Term	Definition	First Mentioned
1	Access	Any public or private road, ramp, driveway, intersection or path which crosses or is connected to a public road.	1.1
2	Bicycle	A vehicle having at least two wheels designed to be primarily propelled by the muscular energy of the rider. The term includes power-assisted bicycles, also known as e-bikes.	1.1
3	Cycle Lane	A longitudinal strip within a roadway reserved for cyclists through designated road marking and/or signage.	1.1
4	Cycle Path	Part of a road that physically separated from the roadway and indented for the use of cyclists, but which may also be used by pedestrians.	3.2.1
5	Cycle to Work Scheme (also known as Bike 2 Work)	The Cycle to Work Scheme is a tax incentive scheme, which aims to encourage employees to cycle to and from work. It has been implemented in numerous European countries, being an European Union co-funded project. Employers who register under the scheme purchase bicycles and associated equipment for their employees and the employee pays back the amount over an agreed time frame, usually 12 months. The amount is deducted from the employee's gross salary before tax and any other deductions. A saving of between 31% – 51% of the cost can be expected. The employee merely visits a registered cycle shop, selects his/her bike and equipment and the shop invoices the employer directly.	3.7
6	Driver	A person driving a vehicle, primarily a private motor vehicle.	3.4.4
7	End of Trip Facility	Within the context of this paper, an EOTF includes bicycle parking in the form of a secure lockup (ideally non-intrusive and within the main building structure), lockers and showers/changing rooms. An EOTF as a designated place that support cyclists, joggers and walkers towards encouraging alternative ways to travel to work rather than driving or taking public transport.	1.1

8	Heavy Goods Vehicle	A motor vehicle, other than a motorcycle, motor car, minibus or bus, designed or adapted for the conveyance of goods on a public road.	3.4.4
9	Humidity	Humidity is the amount of water vapour in the air and is an important indicator in understanding climatic conditions. Humidity is usually expressed as a percentage and represents the amount of water vapour in the air relative to what the air can hold (Williams, 2005).	5.3.4
10	Isodistance	Is a line on a map showing equal travel distance.	6.5
11	Lane	A longitudinal strip of roadway that is intended for the passage of vehicles or a specific class of vehicle that is separated from other parts of the roadway by a longitudinal line or lines of paint or raised studs.	3.4.5
12	Mobility	The ability to reach a destination with a minimum of delay. A fundamental requirement for accessibility.	2.8
13	Parking Bay/Space	A recess set back from the general flow of traffic that can accommodate one parked vehicle.	2.2.1
14	Quantitative attribute	A quantitative attribute is one that exists in a range of magnitudes, and can therefore be measured. Measurements of any particular quantitative property are expressed as a specific quantity, referred to as a unit and may have dimensions. Examples of physical quantities and their dimension in brackets are distance (meter), mass (kilogram), and time (hour, minute, second).	3.1
15	Qualitative attribute	Qualitative data are described in terms of quality. It is the converse of quantitative, which more precisely describes data in terms of quantity and often using numerical figures without dimensions. Qualitative data describes properties or characteristics that are used to identify things.	3.4
16	Shoulder	Any part of the road not designed to be used by motor vehicles when travelling along the	3.2.2

		road.	
17	Stated Preference Survey	Refers to a set of techniques, which use individual respondents' answers regarding their preferences on a subject matter.	3.1
18	Transport Impact Assessment	The purpose of a Transport Impact Assessment is to assess the impacts of development on the transport network operations and identify reasonable solutions, as deemed appropriate, to mitigate these impacts.	1.1

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1. INTRODUCTION

"When man invented the bicycle he reached the peak of his attainments."

- Elizabeth H. West, American Librarian (1977)

1.1. Background Information

According to Statistics South Africa (STATSSA) the percentage of commuters cycling to work daily in South Africa has increased from 90 000 (0.9%) to 145 000 (1.3%) over the past decade (2003-2013) (Department of Transport, 2014, p.2) (Statistics South Africa, 2014, p.39). The three primary cities in South Africa (namely Cape Town, Durban and Johannesburg) are all promoting cycling through the introduction of new bicycle lanes and infrastructure. The results are both encouraging and disappointing - encouraging because cycling is beginning to receive the necessary planning consideration and capital investment required to promote this mode of transport; disappointing, because the investment is primarily focussed on bicycle lanes, which does not necessarily equate to increased ridership. Bicycle infrastructure is only one aspect of the greater vision to promote cycling. However, without careful attention to the detailed planning (e.g. integration with existing infrastructure, continuity of routes, bicycle signage and safety for cyclists at intersections) any cycling related project is unlikely to be successful.

In the opinion of Moss (2015), cities around the world are slowly outgrowing the automobile and those living in these cities are beginning to favour public transport, walking and cycling. In the last decade, the city of Lyon (France) has seen a decrease of 20% in the number of cars driving into the city everyday (Moss, 2015). Bike-sharing schemes, a service where bicycles are made available for shared use on a short term basis, have been implemented in over 700 cities globally (Fishman et al., 2014, p.3). Cities are reclaiming road space for walking and cycling and redirecting cars to the outskirts of the town in an attempt to make cities more liveable. Non-motorised planning (and regulation) plays a crucial role for shaping the cities of the future.

In 2009, the author relocated from London, United Kingdom (UK) to Cape Town, South Africa to continue his Civil Engineering career in Transportation Planning. During his time in the UK, he witnessed and contributed to the cycle renaissance that London has been experiencing over the last decade. Once he became familiar with South African design manuals and guidelines, it became apparent that certain planning policies were off-kilter with international best practice.

Of particular concern was the lack of legislation mandating the contents of a Traffic Impact Assessment (TIA), more specifically the Non-Motorised Transport (NMT) impact. Currently, the South African Traffic Impact and Site Traffic Assessment Manual (TMH16) is only a guideline, but is not mandatory (Committee of Transport Officials, 2012, pp.6-14). Having written and read numerous transport reports in South Africa, there is a clear lacklustre consideration towards NMT. TIA's almost

never include NMT details such as existing usage, existing NMT infrastructure and condition, as well as the predicted future demand from any proposed development. Instead these reports focus almost exclusively on traffic volumes, access and parking arrangements.

These antiquated policies are not unique to South Africa. In 1994, the United Kingdom (UK) published guidelines for conducting a TIA, which prior to this date placed little attention on NMT. Since then, significant inroads in Government policy regarding improved sustainability in transport has taken place. In recognition of these changes, the 1994 guidelines have been revised and subsequently superseded by the Department for Transport's "Guidance on Transport Assessments". The revised guideline document better explains the intention of the report and encompasses all modes of transport. The acronym TIA hereafter refers to 'Transport Impact Assessment' and not 'Traffic Impact Assessment', unless specified otherwise.

A similar change in policy and guidelines have been observed in other cities around the world (e.g. Sydney, San Francisco and Calgary).

This thesis makes recommendations suggesting the need to change South African policies and guidelines to support End of Trip Facilities (EOTF) for cyclists and other NMT users. A local case study of an existing business complex without EOTF's is presented, and the behavioural changes has been measured and analysed.

1.1.1. Definition of an End of Trip Facility

An EOTF is any facility that can be used at the end of a trip. They generally exist of a secure lockup facility for bicycles, changing rooms and showers for males and females, and might include lockers for personal belongings. An EOTF is most common within the workplace where it is intended to be used by employees who cycle, run or walk to work. The term EOTF can also apply to a facility that provides for other land uses such as shopping centres, educational institutions and residential buildings.

International studies using Stated Preference survey techniques have, in the past, analysed to ascertain the desirability of different bicycle facilities, including EOTF's. The majority of these surveys have focussed on bicycle facilities such as bicycle lanes and paths, which according to those studies appeared to be the most important facility provision for cyclists (Rewa, 2012, p.2), (Buehler & Pucher, 2011, p.411), (Krizek et al., 2012, pp.260-61) & (Shahan, 2007, p.12). The presence of safe bicycle parking and the provision of EOTF's was also found to be an important factor that encouraged bicycle usage and which would influence a person's decision whether to cycle or not (Noland & Kunreuther, 1995, pp.67-69).

Examples of existing EOTF's are presented below.

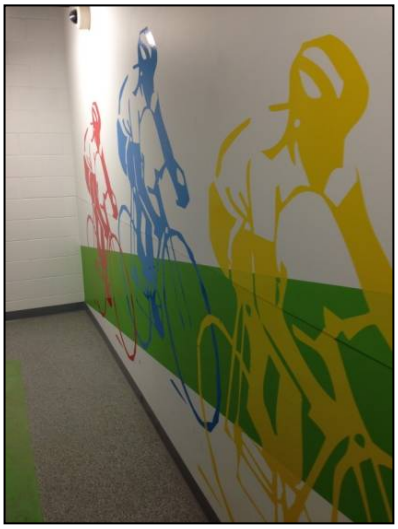
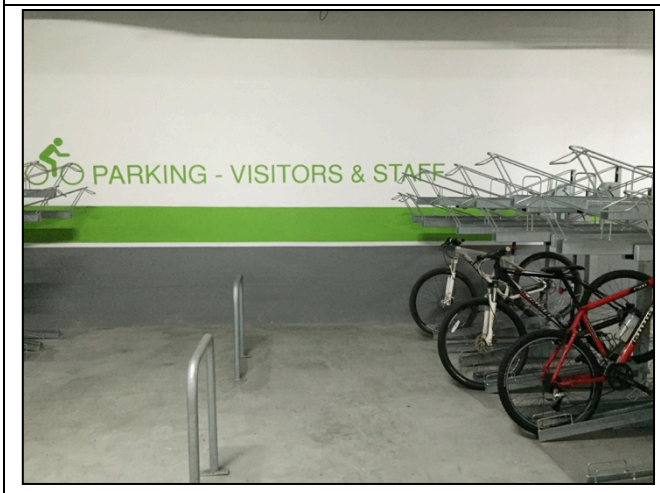
	Photo by Dr Laurent Hermant Comment: Secure Bicycle Lockup at Queensland Government Building, Brisbane
	Photo by Dr Laurent Hermant Comment: Secure Lockers at Queensland Government Building, Brisbane
 	Photo by Dr Laurent Hermant Comment: Good Signage at Queensland Government Building, Brisbane

	Photo by Dr Laurent Hermant Comment: Shower Facilities at Queensland Government Building, Brisbane
	Photo by Glen Randall Comment: Shower and Changing Facility at SMEC Offices, Cape Town CBD
	Photo by Glen Randall Comment: Clear signage to staff cycle parking at First National Bank, Cape Town CBD

	Photo by Glen Randall Comment: Clearly painted markings and dedicated cyclist access barrier to basement parking at First National Bank, Cape Town CBD
	Photo by Glen Randall Comment: Stackable bike racks and secure cycle parking at First National Bank, Cape Town CBD
 	Photo by Glen Randall Comment: Dedicated changing rooms with lockers including power sockets for charging bicycle lights/batteries at First National Bank, Cape Town CBD

1.2. Problem Statement Background

The current South African planning regulations require a 'Traffic Impact Assessment' to determine the traffic impact of a land development proposal and if such a development could be accommodated by the transportation system. In terms of the Municipal Systems Act (Act No 32 of 2000) Municipalities are empowered to govern, on its own initiative, all local affairs of its community, subject to national and provincial legislation. The Municipality is therefore responsible for the master planning required to accommodate developments (Committee of Transport Officials, 2012, p.2), (The National Treasury, 2000).

Within any TIA, parking provision and the layout thereof forms an essential requirement for most developments. In South Africa, parking spaces are required at a minimum rate, based on the characteristic of the particular land use, typically size or number of employees as is the case for office developments. These minimum rates vary greatly between different municipalities and most do not mention bicycle parking. It is apparent that the current parking guideline documents used by municipal officials are not in line with guidelines from international cities that have a long history of cycling as a mode of transport (e.g. Holland or Denmark) since they exclude parking provision for commuters using alternative modes (motorcycle/bicycle/electric car). No incentives currently exist for developers to provide parking and associated facilities for these alternative modes and, as a consequence, they are mostly ignored. This thesis therefore explores the current parking guidelines and recommends an amendment to include minimum bicycle parking provision together with the appropriate EOTF's.

In South Africa, the standard procedure for determining the number of car parking spaces required for a new office development is to consult the Department of Transport's Parking Standards Manual (1985) (Department of Transport, 1985). Unfortunately, this manual was last updated in 1985, a time when petrol cost less than R1/litre (Department of Energy, 2015). The cheap cost of fuel, together with relatively cheap operating costs, is one of the contributing factors why vehicle ownership levels has continued to rise since the 1940's (Letshwiti et al., 2003, p.6). Between 2003 and 2013 car ownership increased from 23% to 28.5% (Statistics South Africa, 2014, p.85). According to Electronic National Administration Traffic Information System (eNaTiS) the number of vehicles registered in South Africa has increased from 9.3 million in October 2008 to 11.7 million vehicles in October 2015, an average growth of 3% per year (eNaTiS, n.d.).

The private car accounted for the highest modal share in the 1980's, which would explain the focus on parking supply for motor vehicles. As such, the manual makes no reference to any other transport modes, bicycles included. This national parking standard has influenced parking related municipal documents where minimum parking standards were prescribed to ensure that vehicles could park off-street when reaching their destination, which reduced on-street parking usage. The provision of more parking encourages private car use, which increases congestion. The popularity of the private car meant that people could live further from Central

Business Districts (CBD's), which in turn contributed to the decline in public transport use (Hitge & Roodt, 2006, pp.368-69).

Since 1985, larger South African cities have developed their own parking standards, some published in planning documents, while others are merely personal handwritten notes kept by municipal officers. Bar a few exceptions, these parking standards all stem from either the DoT's manual or the USA guideline entitled 'Institute of Transportation Engineers Parking Generation Manual' (currently in it's 4th edition) and in the absence of dedicated surveys undertaken by the municipality, the default standard manual remains the DoT manual (Institute of Transportation Engineers, 2010). A detailed analysis of the various parking guidelines is presented within this thesis. It concludes that all current guidelines exclude cycle consideration when planning new developments. No legislation currently exists to mandate the provision of cycle parking and associated facilities and this is the primary reason for this thesis study.

To address this problem and to promote cycling as a mode of transport, this thesis, by way of a case study, demonstrates the importance of EOTF's and details the various legislation changes required to support cycling to work.

1.3. Problem Statement

The number of active cyclists in South African cities is growing, although nowhere near the rates experienced in other global cities. In South Africa, the development of bicycle-focussed guidance is reactive rather than proactive. The appetite for cycling in South African cities is apparent, with the number of bicycle shops and associated commercial activities (e.g. bike hire, cycling tours, bicycle cafés, etc.) increasing in the cities across South Africa.

Increased congestion levels in the primary cities as well as the operating costs of car ownership has lead to commuters considering alternative modes such as public transport or cycling. Therefore, the provision of EOTFs plays an important support function to enable commuters to cycle to work.

Reference is made to APPENDIX A – Masters Thesis Proposal, which provides the premise for the thesis topic.

1.4. Relevance and Need for the Study

In South Africa, little research relating specifically to cycling and even less research relating to cycling to work exists. The need and provision of EOTFs have not been researched at all. Currently, there are no detailed South African cycle to work survey data available that can provide governmental officials, cycle journalists and transport professionals with any evidence that will support the argument that the provision of EOTFs can greatly promote cycling to work. International research relating to cycling

to work is available and mentioned within this thesis; however, no study could be found which specifically explores EOTFs . Much of the literature currently available is based on European, North American and Australian cycle operations and direct transference to South African cities would be unwise without substantiation.

Currently, there is a considerable lack of empirical cycling data in South Africa. It is important to note that whilst many cycle to work studies have been conducted worldwide, it is impossible to make valid comparisons with these studies, as many variances in data collection methodologies, type of environment and behavioural characteristics of the population exist.

The need for empirical local cycling data is recognised by City of Cape Town with the development of South Africa's first Cycling Strategy (City of Cape Town, 2015a, p.3). The significance of this research will therefore determine the impact that EOTF's could have on cycling to work (in isolation of any other cycling initiatives).

The case study looks at the propensity for commuters to shift from using a private vehicle as a mode of transport to cycling. It highlights the willingness for commuters to cycle, despite cycling being a very small percentage of the modal split. As mentioned earlier EOTF's serve a variety of trip purposes, but within this study it was limited to home to work based trips on account that 38.4% of all trips to work are being made by private vehicles (either passenger or driver) (Statistics South Africa, 2014, p.4).

It is intended that the case study methodology should be utilised to support future studies throughout South African cities and that the findings be shared within transport planning documents, such as 'Integrated Transport Plans' and 'NMT Strategies/Frameworks'.

Even though there appears to be existing legislation that promotes cycling in South Africa, it is demonstrated within this thesis that the current guidance is far from comprehensive and that there are no requirements or incentives to encourage new developments to provide EOTF's for cyclists.

Cycling statistics and research data in South Africa are significantly lacking. This lack of data/research emulates in cycle related media articles that are based on perception rather than providing conclusive evidence. It is important to address commuters 'perceived barriers' preventing them from cycling to work. Conclusive evidence has to be collected and widely published, ideally via media channels before these commuters would consider changing their perception.

This lack of factual data and comprehensive legislation provides the justification for the goals and objectives identified in the next paragraph.

1.5. Research Goals and Objectives

The thesis has the following goals:

Goal 1 – To highlight the shortfalls in current South African legislation relating to the promotion of cycling as a mode of transport, inclusion of guidance on the provision of office-related bicycle parking and EOTF's in South Africa.

Goal 2 – To demonstrate by way of empirical data collection how the existence of EOTF's can make an impact on cycle to work volumes and to provide quantifiable results in isolation of other cycling initiatives.

Goal 3 – To encourage and promote cycling in South Africa as a sustainable means of travel through the contribution of South African specific research related to cycling and to provide a practical methodology to conduct EOTF surveys in the future.

In achieving these goals, the following objectives are to be met:

Goal 1	Objective 1	To gain an understanding of the current planning legislation and processes;
	Objective 2	To present a comprehensive summary of local transportation policies and guidelines relating to NMT and in particular commuter cycling;
	Objective 3	To review current international literature from well established and emerging cycle cities relating to bicycle parking guidelines, provision of EOTF's and to promote cycling to work initiatives successfully;
	Objective 4	To identify the changes required in South African legislation to promote cycling to work and to be aligned with international best practice;
Goal 2	Objective 5	To undertake a case study to demonstrate the role private developers and employers can play to encourage cycling to work by introducing EOTF's in the workplace;
	Objective 6	To ascertain the physical and physiological inhibitors that prevent South African commuters from cycling to work;
Goal 3	Objective 7	To encourage transport engineers, planners and researchers from the private and public sector to promote cycling in South Africa by commissioning of undergraduate and postgraduate research.

1.6. Original Contribution of Thesis

The research conducted in this study highlights shortfalls in current South African legislation, most notably the Parking Standards, Traffic Impact Assessment

guidelines as well as other planning documents that undermine National Government's objectives to reduce car dependency and to support NMT, specifically cycling as a mode of transport.

The South African literature review highlights the general dearth in cycle related studies and statistics.

The empirical study conducted in this research is considered unique to South Africa, as no other data of it's kind is currently known.

1.7. Research Limitations and Assumptions

The following limitations were experienced during the execution of the research for this thesis:

- Length of survey – Due to timeframes, the EOTF survey was conducted over a period of 9 months. It was hoped that a full year of data could be acquired to ascertain seasonal fluctuations. The study nevertheless is as accurate as possible and remains the first of it's kind in South Africa;
- The sample size and duration of collection of EOTF usage is too small to accurately reflect what influence climatic conditions has on cycling to work. The climatic influence is described in greater detail in Section 6.3;
- The study does not account for external factors, such as sidewalks, cycle lanes and other infrastructure factors, which has been shown to influence NMT usage;
- In the absence of sufficient local economic data, a Benefit-Cost Analysis was not possible;
- The number of cycling cities around the world is numerous and this research focussed on only a few cities. Preference was given to cities who have morphed into cycle cities within the last decade to showcase examples and to provide inspiration for South African cities;

1.8. Thesis Approach and Structure of Report

The structure of the report is best illustrated in Figure 1.1.

Chapter 1 (this chapter) provides the background, motivation, problem statement and objectives of this thesis.

Chapter 2 provides a literature review of South African design guidelines, standards, transport policies and other relevant documents pertaining to bicycle legislation. The literature review includes references to vehicle parking standards for several South African cities.

International literature is presented in Chapter 3 and includes relevant EOTF information from a variety of countries including Australia, Canada, United States of America (USA), United Kingdom (UK) and The Netherlands, although some additional research documentation includes Denmark and Germany.

Chapter 4 compares South African parking and bicycle legislation with international best practice to identify gaps and to establish which focus areas needs realignment.

Chapter 5 presents the case study and the selective process followed the collection of relevant data and the compiling of the employee questionnaire.

Chapter 6 analyses the collation of empirical data and presents the findings.

Chapter 7 concludes with a summary of the research results and a conclusion, along with a proposed list of recommendations, which includes proposed changes to current legislation.

References are provided in Chapter 8.

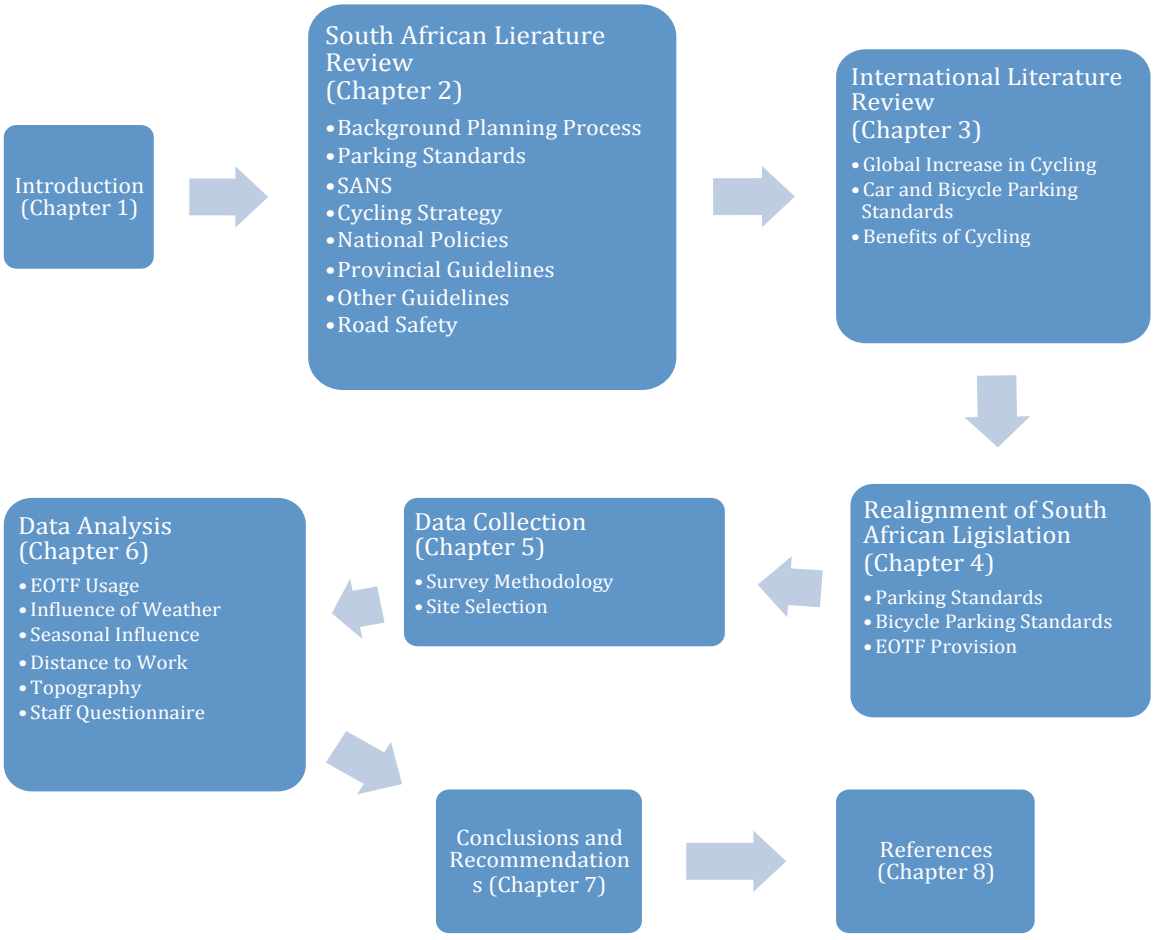


Figure 1.1 - Thesis Structure

2. SOUTH AFRICAN LITERATURE REVIEW

"Learn to ride a bicycle. You will not regret it if you live."
- Mark Twain, American author and humourist

Cycling in South Africa is in a forlorn state and could well be referred to as the 'forgotten mode of transportation'. Forgotten, because sometime during the 1990's cycling declined to insignificant levels, most notably amongst learners who previously accounted for the largest demographic percentage of cyclists. South Africa is not unique in this regard, USA for example in 2002 reported that 72% of people over the age of 16 had never ridden a bicycle (Bocain, 2012, p.2). In contrast, European countries such as The Netherlands actively sought to increase ridership, having realised the benefits cycling offers to both users and those around them.

This chapter reviews the current literature available within South Africa. The literature review begins with an outline of the current planning procedures and outlines known local guidelines/policies/standards.

2.1. Land Use Planning Ordinance (LUPO)

The current planning process in the Western Cape (which is similar in other provinces under their ordinances) is discussed below to outline the South African planning process when considering new planning applications. A local municipality will generally deal with urban area planning applications, depending on the jurisdiction under which the area falls. Once submitted, the planning follows the 'Land Use Management Process Flow' (City of Cape Town, 2014a, pp.3-7) which is summarised in Figure 2.1 below.

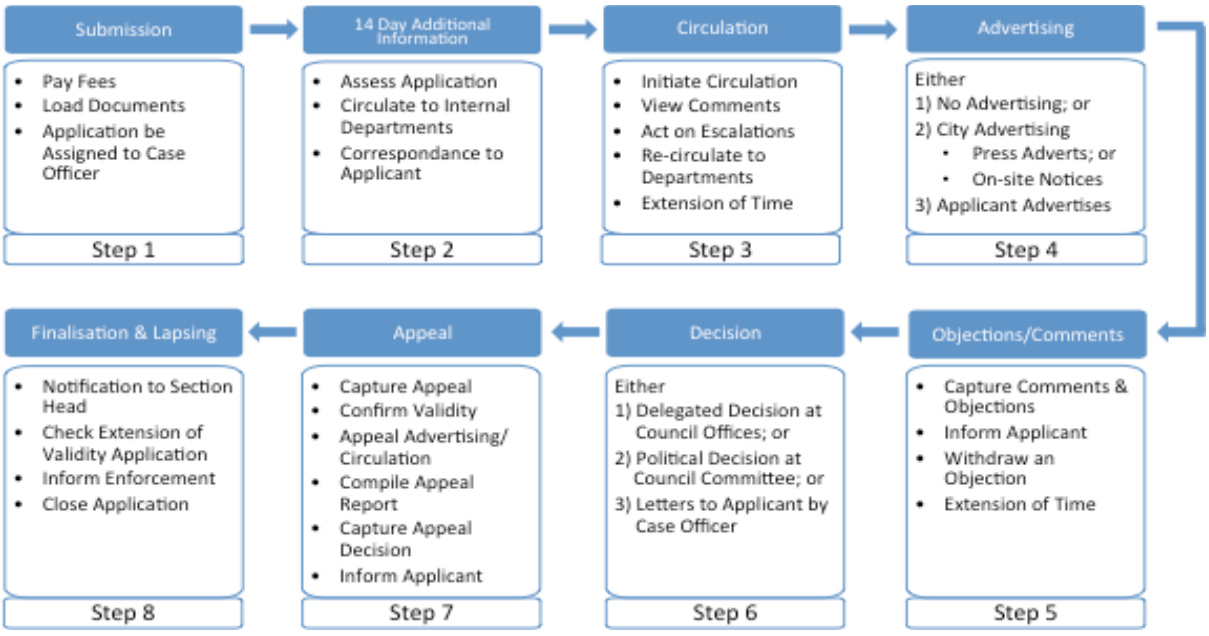


Figure 2.1 - LUPO Process

Step 3 'Circulation' requires the application to be distributed to all relevant Municipal Departments in order to provide comment and feedback relating to the proposed development's impact on the departmental functions and environment. With respect to transport, relevant transport officials would either be part of the 'Roads and Stormwater Department', or a 'Transport Authority', as in the case of Cape Town and eThekwini. The municipal officer will provide comments on the TIA which formed part of the original application, and which would include all matters relating to traffic, access, parking, public transport and NMT impact. Therefore, these municipal officials who, through enforcing planning conditions, are best placed to ensure sustainable transport development is achieved. The planning conditions must however be supported by government policies, frameworks and guidelines to ensure equitable treatment for all.

Once approved, the TIA together with the Planning Conditions prescribe the obligations and limitations of the development and will be legally binding. Within the TIA, parking standards will determine the parking provision.

2.2. Car Parking Standards

Every car trip begins and ends in a parking space (Kodransky & Hermann, 2014, p.1). Parking regulation is therefore a powerful way to manage trip generation and consequently congestion. Reducing car parking and can free up valuable public space in urban areas that can be used for bicycle lanes, bus lanes, other street furniture (benches, walkways, artscape, etc). Opportunities for sponsorship and advertisement can even help raise funds for these initiatives.

Notwithstanding this, vehicle parking is an important and integral part of the transportation system in any metropolitan area. The provision of parking, especially within the CBD is an expensive investment for any developer and the importance of providing the correct allocation has been well documented. Over-provision encourages the use of the private car, which ultimately places additional pressure on the road network and can also be a wasted resource if under-utilised. Under-provision, on the other hand, can result in externalisation of the problem, an overflow, which could lead to increased illegal parking on the sidewalks and in the road reserve. Internationally (e.g. UK, Northern Ireland, Germany, France, Japan, Australia, Sao Paulo in Brazil, Hong Kong and Singapore) there has been a change in parking standards from a maximum to a minimum provision together with the inclusion of minimum bicycle parking standards and EOTFs (Barter, 2013) (Department for Communities and Local Government, 2006, p.40). These revised parking standards are therefore aligned with overarching NMT and public transport strategies/policies and actively discourage private car use while at the same time incentivising other sustainable modes, including bicycles. A summary of the current parking (vehicle and bicycle) standards for the four largest metropolitan areas (viz. Cape Town, Durban, Pretoria and Johannesburg) within South Africa is stated below:

2.2.1. City of Cape Town (CoCT) Parking Standards

Off-street parking within the CoCT is provided according to the minimum parking requirements for respective land use types as determined in the Cape Town Zoning Scheme (CTZS) regulations (City of Cape Town, 2013b, pp.94-101). The draft parking policy for Cape Town recognises that the CTZS does not include any disincentives to limit parking provision beyond the minimum requirements nor does it provide any mechanism to change the parking standards to set a maximum provision.

Departures are permissible but are required to be motivated in discussions with development control officers and documented within the application, usually within the TIA. In the absence of any motivation, developers are required to meet the minimum parking requirements.

The parking requirements within the CTZS refer to off-street parking and do not include on-street parking. Off-street parking is generally private and therefore reserved for sole use by the owner/leasee. A sole use parking space in an office environment is unlikely to be 100% utilised (generally only used during office hours). For the remainder of the day this parking space would be vacant and it could be argued that this is an inefficient use of space. Shared parking, on the other hand would allow this parking space to be utilised by other land-uses such as gyms, cinemas and restaurants which generally operate outside the typical office working hours.

The latest Draft Parking Policy (City of Cape Town, 2013a, pp.10-11) does, as part of its action policies, discourage excess parking provision beyond the minimum and recommends that a maximum parking standard be included as well as levies for exceeding the maximum. The policy further identifies an action to support the provision of remote parking on the fringe of urban nodes with high parking demands, in order to increase unreserved parking and to share parking with other uses. Furthermore, the parking policy proposes that developments be allowed to convert parking bays for other uses, which is currently not allowable.

Another action policy relating to parking is the promotion of public transport through improved customer experience of park and ride facilities (e.g. parking at rail stations). Improvements include security guards, extended operational hours and reservation of parking for public transport users.

Finally, the policy wishes to implement bicycle parking facilities in areas where NMT networks linking employment zones have been upgraded. The following extracts refer to bicycles within the CTZS

- Council may require that parking be provided for motorcycles and bicycles;
- For every four motorcycle and six bicycle parking spaces provided, a credit of one parking bay may be given towards the parking requirements, provided that:

  (a) the total credit shall not exceed 2,5% of the parking bays required;

(b) the minimum dimension for a motorcycle space shall be 2.2 m in length and 1 m in width; and
(c) the minimum dimension for a bicycle space shall be 2 m in length and 0,6 m in width (City of Cape Town, 2013b, p.97). Bicycles can be spaced closer together than motorbikes due to that fact that the rider needs to dismount before parking.

2.2.2. eThekwini Transport Authority (eThekwiniTA) Parking Standards

The Head of Development Planning and Management and the Head of eThekwiniTA may relax the parking bay requirement by special consent by a maximum of 10% (to 90%) upon consideration of circumstances (excluding public transport considerations) pertinent to the development. (eThekwini Transport Authority, 2010). No provision for bicycle provision is stated other than an interpretation of the above reference as a claim to motivate a reduction in vehicular parking.

2.2.3. City of Tshwane Parking Standards

The requirements with regard to the number of parking spaces prescribed within this guideline document states that a reduction is permissible (Tshwane Municipality, 2008, pp.59-61). No mention is however given to bicycle provision.

2.2.4. City of Johannesburg Parking Standards

No mention of bicycle parking is given. The scheme does make provision for a relaxation of the parking requirements, which can only be motivated in writing to the Council (City of Johannesburg Metropolitan Municipality, 2011, pp.52-53).

2.2.5. Department of Transport Parking Standards, Second Edition

Commissioned in November 1985, this standard is an update of the original 1980 standards and contains minimum vehicular parking provision standards for most land uses. No mention however, is given to bicycles. The authors even then recognised the need for parking standards and therefore called for an update of this document to include recommended bicycle parking provision for all appropriate land-uses (Department of Transport, 1985, p.ii).

Secondly, the document prescribes minimum car parking provision for all land-uses with no maximum ceiling being proposed. As previously stated research has shown that this approach to parking leads to the promotion of car use (Hitge & Roodt, 2006). It is recommended that the parking standards be amended to a maximum provision, together with reduction options for the inclusion of sustainable modes such as electric cars and bicycles.

Thirdly, the parking dimensions specified within the document are based on typical vehicles from that period (mid 1980's) and the suitability of applying these guidelines to modern vehicles has not been published by way of revisions. A study of newer vehicle sizes indicated the need to revise the 1980 standards to increase design parking bay lengths as current dimensions can be construed as 50^{th} percentile or

median value. Instead, design should be based on at least the 85th percentile (Bester, 2012, p.43).

2.2.6. Green Building Council South Africa (GBCSA)

The GBCSA is an independent non-profit company and promotes the benefits of green buildings through facilitating the introduction of green building practices. The GBCSA has over several years developed the Green Star SA rating system, which establishes a best practice standard of measurement for green buildings.

Table 2.1 shows a summary of the GBCSA toolkit for new office developments and the points attainable under the 'Transport' category. The information has been extracted from the Green Star SA Office v1.1 Technical Manual (Green Building Council, 2015).

Table 2.1 - GBCSA Transport Scorecard

Provision	Aim of Credit	Maximum
Provision of Car Parking	To encourage and recognise developments that facilitate the use of alternative modes of transportation for commuting to work.	2 points
Fuel Efficient Transport	To encourage and recognise developments that facilitate the use of more fuel-efficient vehicles for work commuting.	2 points
Cyclists Facilities	To encourage and recognise developments that facilitates the use of bicycle by occupants and customers.	3 points
Commuting Mass Transport	To encourage and recognise developments that facilitates the use of mass transport for work commuting.	5 points
Trip Reduction – Mixed Use	To encourage and recognise retail centres that are built in mixed use areas in order to reduce the overall number of car trips taken by patrons.	2 points
	Total Transport Credits	14 points

The table indicates that a maximum of 14 points is possible within the transport category, of which 3 points is possible for the provision of bicycle facilities. Table 2.2 shows the tasks required in order to achieve the bicycle facilities points.

Table 2.2 – GBCSA Office Bicycle Provision

Provision	Criteria	Accreditation
Bicycle Parking	Secure storage for 3% of building staff (based on one person per 15 m^2)	1 point
Changing Rooms	Changing facilities adjacent to showers	
Lockers	1 secure locker per bicycle space in the changing facilities	
Showers	Accessible showers based on 1 per 10 bicycle spaces	
Bicycle Parking	Secure storage for 6% of building staff (based on one person per 15 m^2)	2 points
Changing Rooms	Changing facilities adjacent to showers	
Lockers	1 secure locker per bicycle	
Showers	Accessible showers based on 1 per 10 bicycle spaces	
Bicycle Parking	Secure storage for 6% of building staff + visitor parking at 1 per 700m^2	3 points
Changing Rooms	Changing facilities adjacent to showers	
Lockers	1 secure locker per bicycle	
Showers	Accessible showers based on 1 per 10 bicycle spaces	
Signage	Good signage provided in an accessible location, signposted and close to, or adjacent to a major public entrance to the building	

These guidelines are comprehensive and outlines precisely what future parking and NMT guideline documents should include. However, at present the Green Star rating system is a voluntary tool and only applies to those buildings seeking accreditation. It is therefore recommended that bicycle parking provision be made mandatory for all new developments in South Africa. The onus should be placed on the developers to ensure that bicycle consideration takes place during the early planning stages of a building instead of it being an afterthought.

2.2.7. Parking Standards Summary

None of the large cities provide for bicycle facilities in their planning controls. The inclusion of bicycle parking within the City of Cape Town standards (policies and guidelines are not standards) is encouraging and should be echoed throughout the other municipalities. The promotion of cycling as a mode of travel is part of the overall desire to reduce private car usage and to encourage more sustainable means of travel.

2.3. South African National Standard (SANS)

The national building regulations is simply a requirement to ensure that buildings are designed and built in such a way that people can live and work in a healthy and safe environment. Qualities such as comfort levels and convenience are not controlled under these regulations. Market and economic considerations limit the extent to which user comfort and convenience is addressed and the regulations make it clear that developers should be aware that the mere fact that a building complies with the regulations does not necessarily indicate that the building is desirable (South African National Standard, 2010a, p.2).

Therefore, it is not surprising that no thought has been given to accommodate bicycles, bicycle parking or any EOTF provision.

SANS 10400-P which deals with drainage for buildings does provide the minimum number of sanitary fixtures (known as 'Table 4') which includes toilets, urinals and handwash basins for both male and females. It is assumed that items such as showers are considered convenience facilities and are not required under the regulations unless personnel are specifically exposed to excessive amounts of dirt (dust, soot, oil, grease or similar). Should employees be exposed to dirt showers are required at a ratio of 1 shower per 15 persons with separate male and female facilities with a changing room or at least be directly connected to one (South African National Standard, 2010b, p.29).

A review of all South African Bureau of Standards (SABS) publications reveals the following bicycle related publications.

Table 2.3 - SABS Cycling Related Publications

	SABS publication	Title
1	11243:2014	Cycles — Luggage carriers for bicycles — Concepts, classification and testing
2	4210:2014	Cycles – Safety requirements for bicycles
3	6742-1:2014	Cycles – Lighting and retro-reflective devices – Photometric and physical requirements Part 1: Lightning equipment
4	8098:2014	Cycles – Safety requirements for bicycles for young children

Based on the table above the SABS is lacking any regulation with regards to bicycle storage, bicycle stands and lockup facilities.

2.4. National Policies and Guidelines

South Africa has over the previous decade set about updating its policies and legislation to incorporate NMT and to raise awareness thereof. This section provides a summary of the current policies guiding NMT.

2.4.1. National Transport Policy White Paper

In 1996 DoT prepared a national policy on transport which included NMT as one of its strategic objectives to encourage, promote and plan for the use of NMT where appropriate. The policies expressed in this paper formed the basis of the framework document for implementation of these objectives, also known as the National Land Transport Strategic Framework (NLTSF) (Department of Transport, 1996).

2.4.2. NLTSF

The National Land Transport Act (Act 5, 2009) (NLTA) prescribes the requirements, guidelines, frameworks and standards that must be applied nationally. It prescribes the duties and responsibilities which can be delegated to provincial and municipal

levels. In terms of the Act, a NLTSF must be prepared by the Minister (Department of Transport, 2006).

The most current NLTSF is the overarching national five-year (2006-2011) strategy and provides guidance on transport planning; more specifically public transport, rural transport and safety. The guidance is presented in the form of an action plan and assigns each action to one or more implementation spheres (national, provincial or municipal) responsible for rolling out the particular action. The intention is for this organic document to be updated as and when the action items are completed, although it is uncertain whether this was ever completed. In 2011 a complete review of the framework document was required, although no draft of the new NLTSF has been published or available at the time of writing this thesis.

2.4.3. Draft National NMT Transport Policy

In 2008, the Department of Transport (DoT) produced a transport policy echoing both the White Paper and NLTSF with regards to raising awareness of NMT and promoting safety. It aimed to provide clear roles and responsibilities for the various authorities and for the first time a clear distinction is made between walking and cycling, with cycling receiving its own set of policy statements, albeit only one – to update all legislative documents to reflect a bicycle friendly environment (Department of Transport, 2008, pp.29-30).

2.4.4. Department of Transport (DoT) NMT Facilities Guidelines

In March 2015, the DoT released their NMT Facilities Guidelines document, which supersedes the original 2003 version. These guidelines aim to change the way in which South African street and roads are designed and to address safety and sustainability issues experienced by NMT users (Department of Transport, 2014, pp.118-38).

The guideline represents a vast improvement over the original version and includes a dedicated chapter on EOTF's. The document provides guidance on the principles of bicycle parking and the best locations thereof. Unfortunately, no guidance is offered relating to the amount of bicycle parking, although useful information is given with regards to bicycle facilities located at public transport interchanges and schools. No information is given with regards to bicycle provision and EOTF's for office environments.

2.5. Provincial Guidelines

South Africa is divided into nine provinces and only one province, namely the Western Cape Government (WCG), has a dedicated NMT strategy (Provincial Government Western Cape - Department of Transport and Public works, 2010). The strategy aims to set long-term objectives and to assist Local and District Municipalities to identify projects to consider in planning and funding and this strategy ensures that NMT projects are aligned with government policy.

2.6. Other Guidelines

The Department of Environmental Affairs published a NMT 'Best Practice Manual' in 2014, which includes some valuable lessons learnt by municipalities through past projects. The Manual includes design criteria for providing NMT facilities, although little mention is given to EOTF's (Department of Environmental Affairs, South Africa, 2014).

2.7. Bicycle Planning in South Africa

The CoCT is presently undertaking South Africa's first Cycling Strategy to create a unified vision together with a set of objectives and strategies for future cycling. The strategy envisions the growth of commuter cycling through addressing safety and legislation. It is anticipated that other South African cities will follow suit, which is encouraging for the future of cycling in South Africa (City of Cape Town, 2015a, p.3).

Caution must be exercised when preparing these strategies as often mandatory planning documents are expensive and require detailed knowledge of the city's vision. A cycling strategy is only beneficial if the city in question understands its community, their needs and has a clear vision of what it wishes to achieve. A cycling strategy would be useless in a city where no-one wishes to cycle or where average Origin-Destination (OD) trips exceed 15-20 km.

A second concern is the effort involved in the preparation of a cycling strategy. Legal strategies such as the writing of Integrated Transport Plans (ITP's) are more often than not outsourced to consultants and the funding thereof is received from either provincial or national government. There is the possibility that in the absence of a strong willingness to cycle among commuters in a city, the preparation of a cycling strategy would be very tedious and there could be a tendency to merely tick the boxes.

Lastly, another concern is whether or not cities would invest their own money to prepare a cycling strategy if funding was not made available from national government or if the preparation thereof is not made mandatory.

2.8. NMT Neglect

Despite the numerous legislative and guideline documentation being produced, cycling in South Africa has not increased to the extent of some other cities around the world. A possible reason for this could be the lack of adequate investment in NMT. Compared to the investment in roads being built in South Africa, the NMT investment remains only a small percentage. Furthermore, when NMT facilities are provided, it is seen as an add-on to the road rather than its own facility and as a consequence sidewalks are often obstructed by telephone and street lighting poles, trees, dustbins, manholes, etc. which collectively creates an undesirable environment of NMT users.

The traffic systems in South Africa have traditionally been designed to maintain vehicle mobility and place their needs above those of the pedestrian and cyclist. The lack of dedicated NMT facilities on South Africa's road network may be a large contributor to the high number of accidents involving pedestrians. Finally, these traffic systems, which favour motor vehicles, impose inconveniences to NMT users who often are required to travel further to use dedicated crossing facilities.

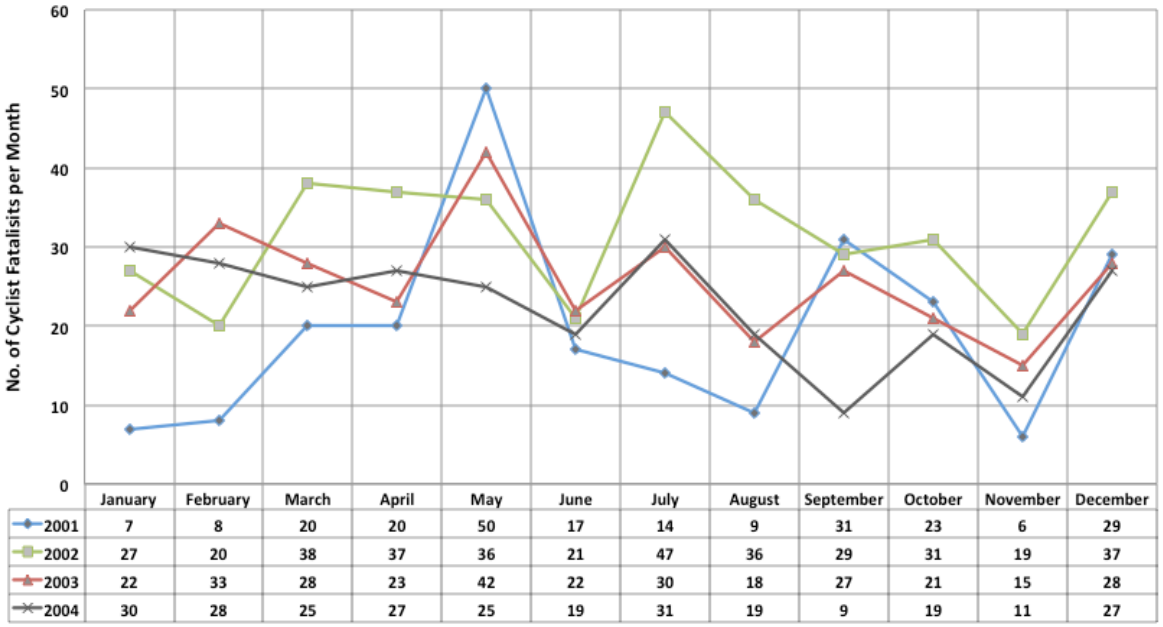
2.9. Dependence on Imported Oil

South Africa has, since the commissioning of the SASOL Coal-to-Fuel facilities in the 1960s produced liquid fuels. Although provision is only estimated at around 36% of demand, the remaining 64% is provided from imported crude oil. The petrol price in South Africa is linked to the price of crude oil in international markets, which is driven by supply and demand. Crude oil prices combined with the Rand/Dollar exchange rate have a major impact on petrol prices. When crude oil prices increase (as is generally the case over the long-term), the petrol price has to increase in order for crude oil refineries to recover their own costs. This volatility of oil prices, and the diminishing global reserves makes NMT alternatives more attractive by reducing the dependency on oil (Department of Energy, 2005).

2.10. South African Road Safety

Although the number of fatalities and serious injuries from road traffic incidents is a concern around the world, South Africa's road safety record compared to the rest of the world can only be described as tragic. South African statistics indicate that there are around 14 000 fatalities each year, 34% of which are NMT users. South Africa therefore has some of the highest accident rates in the world (Jobanputra, 2013, pp.41-42) (Road Traffic Management Corporation, 2011, p.5).

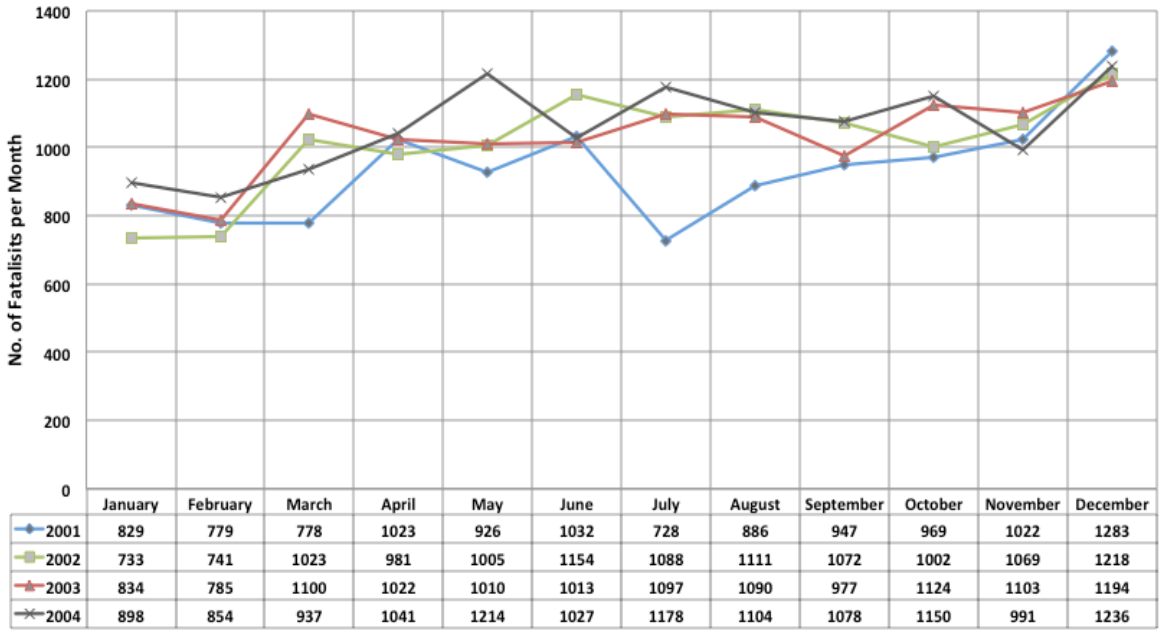
The South African Arrive Alive website published the number of cyclist fatalities between the period 2001 to 2004 and the results are presented in Figure 2.2 (Arrive Alive, 2004).



	January	February	March	April	May	June	July	August	September	October	November	December
2001	7	8	20	20	50	17	14	9	31	23	6	29
2002	27	20	38	37	36	21	47	36	29	31	19	37
2003	22	33	28	23	42	22	30	18	27	21	15	28
2004	30	28	25	27	25	19	31	19	9	19	11	27

Figure 2.2 - Number of Cyclist Fatalities per Month

Arrive Alive presents the results without any quantification and the data source is unknown. It is unclear whether the data includes mountain bike fatalities. It has been assumed that the statistics refer to road-based fatalities only. The worst month occurred in May 2001 with 50 cycle fatalities. The total number of fatalities for all road users over the same period is also provided and included in Figure 2.3.



	January	February	March	April	May	June	July	August	September	October	November	December
2001	829	779	778	1023	926	1032	728	886	947	969	1022	1283
2002	733	741	1023	981	1005	1154	1088	1111	1072	1002	1069	1218
2003	834	785	1100	1022	1010	1013	1097	1090	977	1124	1103	1194
2004	898	854	937	1041	1214	1027	1178	1104	1078	1150	991	1236

Figure 2.3 - Number of Fatalities per Month (All Road Users)

A comparison of the total number of fatalities with the cyclist fatalities indicates that cyclists accounted for 2.09% of all fatalities in 2001, 3.10% in 2002, 2.50% in 2003 and 2.12% in 2004. The Road Traffic Management Corporation (2011) presents a slightly improved scenario and states that only 1.5% of the people killed on South African roads are cyclists.

3. INTERNATIONAL LITERATURE AND BEST PRACTICE IN EOTF

"Whenever I see an adult on a bicycle, I do not despair for the human race."

- HG Wells, English author

3.1. Introduction

The objectives of this thesis as set out in Section 1.5 are centred on the relationship between EOTF's and cycling to work in South Africa. This chapter involves the review of various international papers and guidelines relating to EOTF's and studies that have observed what impact various types of bicycle facilities might have on a commuter's willingness to cycle to work.

Recognised 'cycling countries' are often not natively English speaking and therefore research conducted in these countries is not always available in English. The countries with the highest bicycle ownership per capita (not actual number of bicycles) are shown in Figure 3.1 below:

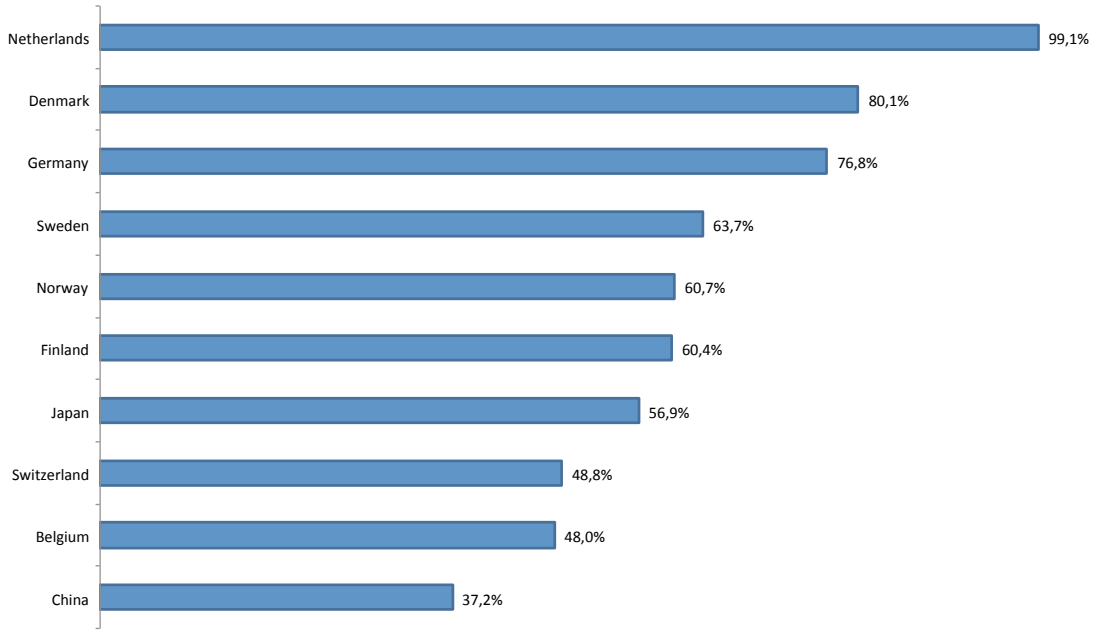


Figure 3.1 - Top 10 Cycling Countries by percentage ownership

This thesis reviewed bicycle related literature and more specifically bicycle studies that include stated preference surveys, statistical studies of different bicycle facilities and studies measuring changes in bicycle behaviour. Almost all of the studies relating to bicycle facilities supports a general perception that any facility will encourage bicycle travel, although the measurable extent to which the different facilities contribute to the increase in bicycle travel is far more difficult to establish. Studies also show that some facilities have a stronger influence on bicycle travel behaviour than others (Shahan, 2007). Despite the extensive literature available on cycling in general, quantitative evidence of the extent to which EOTF's can encourage cycling to work is limited to a handful of studies.

Section 3.2 provides a global perspective on cycling as a whole, while highlighting some key focus areas. Section 3.3 includes a review of emerging cycle cities and the legislation currently in place to promote cycling. Section 3.4 focuses on the numerous benefits of cycling, with specific attention given to the benefits that EOTF's provide as well as guidance on the promotion of EOTF's in the workplace.

3.2. Global Increase in Cycling

Cycling in cities (such as Paris, Barcelona, London, Dublin, Tokyo, Rio de Janeiro and Montreal) according to is flourishing; given the numerous health benefits and environmental benefits, time and cost savings, increased number and better bike lanes, successful cycling schemes together with supportive policies and legislation (Copenhagenize Design Co., 2015). Cycling is no longer limited to those who are either poor or who are sport cyclists. Many cities have excelled at promoting cycling as a mode of transport and underpinning this achievement is a comprehensive program of infrastructure investments and bicycle promotion programs, all motivated by a culture of cycling (Krizek et al., 2012, pp.258-59).

Pucher (1997) wrote that cycling in some German cities increased by as much as three fold in the period 1972 to 1995 despite rising car ownership, longer average trip lengths and increasing income per capita. He attributes this bicycle uptake to the expansion of Germany's bicycle networks together with policies that encourage cycling (Pucher, 1997, p.31). Buehler & Pucher (2011) report a similar experience where the Canadian cities of Quebec and Ontario both invested heavily in bicycle infrastructure and also observed a significant increase in bicycle use in these cities (Buehler & Pucher, 2011, p.411). Shahan (2007) points out limitations of such studies as they fail to isolate the relationship between facilities and bicycle usage by fixing other factors, which also could have had a significant influence on the results (Shahan, 2007, p.14).

In Europe, Urbanczyk (2010) shows the cycling modal share for nine European countries from 1920 to 1995 and highlights a period before and after World War II when the bicycle was popular as a form of transport as it was affordable and easy to acquire. During the 1960s and 1970s the increase in car ownership and longer travel distances and the dependence on cars became apparent, which lead to a decrease in cycling. In the last two decade however, regeneration of urban areas has encouraged people to live in cities. With people living closer to their destinations (employment, shops, leisure, etc.) an opportunity exists to re-invent the bicycle as an essential transport mode within both urban and rural areas (Urbanczyk, 2010, p.3).

The number of cyclists in London increased by 72% between 2000 and 2005, exceeding their cycling targets five years ahead of schedule (Transport for London, 2006, p.1). This boom in cycling is most likely as a result of the extensive expansion of their bicycle network in the mid and late 1990s.

The increase in cycling is not only limited to 'first world' or 'developed' cities. Sao Paulo, Brazil for example, which would be considered poor in comparison to London, has identified the impact increased bicycle usage can have on the urban environment by reducing traffic congestion and noise pollution. The Association of

Bicycle Users (ASCOBIKE), a Non-Governmental Organisation (NGO) based in Sao Paulo, constructed several formal bicycle parking facilities to store bicycles safely around the city and the results indicated a growth from 200 users/day in 2001 to more than 1700 users/day in 2008 (ASCOBIKE, 2011, p.23).

None of the studies reviewed specifically tested the quantitative significance of the provision of a bicycle facility and the associated increase in bicycle use as a direct result. The author is therefore not aware of any statistical studies measuring the actual impact of whether or not bicycle usage increased as a result of the introduction of a bicycle facility.

3.2.1. Proximity of Bicycle Facilities

The three most common types of bicycle facilities are bicycle paths, bicycle lanes and shoulders. The most desirable facility is a bicycle path as it has limited interaction with motorised vehicles. Bicycle lanes and the use of shoulders for cycling are more common than bicycle paths because they are easier (and therefore often cheaper) to implement and maintain.

The general opinion is that cyclists prefer off-road paths and that bicycle travel is generally higher in countries that have more bicycle facilities. Krizek & Johnson (2006) found that the proximity of an off-street bicycle path is not significantly related to bicycle use although cycle lanes did show a significant correlation for increased bicycle use, but only when the cycle lane is located within 400 m of the facility (Krizek & Johnson, 2006, p.39).

3.2.2. Safety

The existence of bicycle facilities can greatly improve the real and conceived safety of riders, which could in turn boost ridership, especially if safety is one of the deterring factors preventing potential cyclists from cycling.

(Bocain, 2012, p.2) created a GIS application that allows users to determine the safest route possible between origin and destination. Although the model always yielded the safest routing option possible, the route was not necessarily perceived as safe for all cyclists, but rather the least dangerous, especially for young and novice riders. The term “safest route” in the context of Bocain’s research was a Level of Service ranking system proposed by Landis et al. in a research paper in 1997 (Landis et al., 1997). Various factors such as traffic volumes, number of lanes, speed limits, the percentage Heavy Goods Vehicles, trip generation values for adjacent road segments and surface condition, etc. are weighted to provide a Bicycle Level of Service Table.

The software application developed by (Bocain, 2012) is only as accurate as the information available and in the absence of safe cycle routes, the route mapped would require the user to travel along an undesirable route. (Bocain, 2012, pp.4, 19) explains that this issue can be used to highlight areas for future bicycle facility consideration and would help municipalities in future planning as well as identify gaps in the bicycle network. The benefit of such a model is that it can be expanded and updated continuously as new and better data becomes available. The

application can also be merged with other GIS systems such as City of Cape Town's Interactive Map (City of Cape Town, 2015b) or eThekwini's Green Map (eThekwini Municipality, 2015). Both these mapping sources are free online GIS systems available for use by everyone.

Hunter (1999) studied the differences in cyclists perception of safety and the distance between cyclists and passing vehicles when travelling along roads with different cycle lane treatments (surface colour and lane marking colour). The study found that 79% of respondents felt safer if the shoulder along a road was painted a colour which differentiated it from the trafficked lanes (Hunter, 1999, p.41).

3.3. Bicycle Parking Standards

Many cities have moved away from a minimum to a maximum car parking provision to assist in reducing car dependency. International studies and research on cities in Australia, Canada, USA and the UK confirm that their parking guidelines limit the amount of private vehicle parking developments can provide. Furthermore, these parking guideline documents also stipulate the minimum amount of bicycle parking required. Emphasis is placed on the information being provided in the same document, negating any need to consult other guidelines (New South Wales Government, 2013, p.46), (The City of Calgary, 2007, pp.211-12), (City of Vancouver, 2012, pp.1-10), and (City of Portland Oregon, 2015, p.11).

A brief summary of some exemplary cities that are fast becoming 'cycle cities' is given below:

3.3.1. London, United Kingdom

The overwhelming increase in cyclists in the last decade has required both additional infrastructure and bicycle parking facilities. In 2006, the Roads Authority (Transport for London (TfL)) prepared a guide entitled "Workplace Cycle Parking Guide" to provide organisations with measures that will maximise the return on investment by helping to make cycling to work a viable and sustainable option. The guide recommends a minimum bicycle parking provision of 1 space per 250m^2 of Gross Floor Area (GFA) of office space, with a minimum of 2 spaces. There has been on-going reviews of their bicycle parking and in 2014, TfL recommended increasing the minimum requirement for offices to 1 space per 90m^2 as studies revealed that significant further growth in cycling is anticipated (Greater London Authority, 2014).

Car parking standards for the Greater London area are included in the same parking standard and based broadly on the density and car ownership levels within the city. Table 3.1shows a summary of the maximum car parking standards.

Table 3.1 – Maximum Office Car Parking Provision for London

Location	Ratio (m^2 of GFA)
Central London	1000 - 1500
Inner London	600 - 1000
Outer London	100 - 600
Note 20% of all spaces must be for electric vehicles with an additional 10% for future electric vehicles connections.	

3.3.2. Sydney, Australia

Sydney (state capital of New South Wales (NSW)) has seen similar increases in the number of cyclists within the city. Surveys indicate that the number of regular (i.e. cycle at least once a week) cyclists increased from 11.9% in 2010 to 18% in 2011 (Bureau of Transport Statistics, 2012). The NSW guidelines recommend that bicycle parking be provided for 3-5% of all employees within the office building (New South Wales Government, 2004, p.46).

The number of showers deemed appropriate is usually defined by the number of employees likely to cycle or use the facility. Table 3.2 shows an extract of typical bicycle requirements for office developments in Sydney, which highlights the simplicity of the table.

Table 3.2 – EOTF Provision in Sydney

No. of Staff	Lockers	Showers	Change Rooms
0-12	1 per 3 racks	One shower	none
13-49	1 per 3 racks	Two showers (1 male, 1 female)	Two (1 male, 1 female)
50-149	1 per 3 racks	Four showers	Two (1 male, 1 female)
150-299	1 per 3 racks	Six showers	Two (1 male, 1 female)
300-500	1 per 3 racks	Eight showers	Two (1 male, 1 female)
>500	Showers (and associated facilities) to be provided at a rate of two showers (1 male, 1 female) for every 250 staff		

3.3.3. Vancouver, Canada

The City of Vancouver have published their parking regulations under a by-law and Section 6 requires all office developments to provide a minimum number of bicycle spaces at a ratio of 1 space per 500m^2 of GFA. The by-law also requires a reduction of vehicle parking spaces, which is dependant on the number of bicycle spaces provided (City of Vancouver, 2012, p.4).

The same by-law document also stipulates the security specifications for the secure lockup facility, the type of door, size of room, etc. together with appropriate EOTF's including locker sizes, electrical outlets as well as safe access to and from the secure lockup. Interestingly, the number of showers required is not specified within this section, but rather a reference to the building by-law is given indicating that shower provision forms part of the overall building requirements.

The car parking provision for various land-uses is also provided within the same by-law document. Office developments are required to provide between 1 space per 100m^2 to 300m^2 of GFA (City of Vancouver, 2012, p.9).

3.3.4. San Francisco, USA

In 2013, San Francisco amended their Planning Code to revise their bicycle parking standards and they have not only experienced one of the highest economic growths within the USA, but has also seen a 66% increase in bicycle commuters from 2002 to 2010 (San Francisco Planning Department, 2013, pp.4-8). The new guidelines require bicycle parking of at least one space per 5000 ft^2 (464 m^2).

Car parking is set out under Section 151 of Article 1.5 of the San Francisco Planning Code and requires all new office developments to provide a minimum of 1 space per 1000ft^2 (92m^2) of occupied floor area where the occupied area exceeds 5000ft^2 (464.5m^2). (City and County of San Francisco, 2008)

3.3.5. Summary of International Parking Standards

Although only four examples of 'Cycle Cities' are given above, the research conducted as part of this thesis confirmed that a multitude of cities around the world are investing in bicycle facilities. Despite differences in size, wealth, historical heritage, climate or topography, amongst other differentiators, cycling continues to grow and is being supported through changes in legislation. Reducing vehicle parking requirements and increasing bicycle parking requirements is vital to creating the modal shift.

It is accepted that the provision of vehicle parking spaces is related to market force and should a development provide too few spaces, a developer might find it difficult to sell/let. The same argument should therefore apply to NMT facilities, but it is all about getting the right balance. A one size fits all solution is therefore not possible, nor encouraged, and the 'right' balance would likely vary from city to city (and country).

In summary, it has been demonstrated that cities around the world have implemented several policy changes to both restrict car parking provision, while at the same time promoting both public transport and NMT. Various bicycle incentives exist to encourage this mode, parking provision being one example. The differences between South African standards (previously presented in Chapter 2) and international standards are apparent.

3.4. Benefits of Cycling

For eligible or potential bicycle users, it is believed that the type and quality of an EOTF would influence their modal choice. For example, having a secure, covered bike rack and shower at work could encourage an employee to cycle instead of using his/her private car. Alternatively, an employee who currently enjoys cycling, could choose a place of employment based on both the ability to cycle to work, and the quality of the bicycle facilities. The quality of the EOTF could, for some employees,

be the deciding factor between choosing a particular employer, should the EOTF be significantly better than the other (Morse, 2014, pp.1-2).

McMahon (2012) argues that the benefits of cycling (and walking) far outweigh the cost of upfront investments in infrastructure in the USA. McMahon refers to the Rails to Trails Conservancy which claims benefit to cost ratios in excess of 5 to 1 for bicycle projects when compared to other transport infrastructure projects (McMahon, 2012).

3.4.1. Health

McMahon (2012) and the World Health Organisation state that physical inactivity is the greatest cause to coronary heart disease, which is the most common cause of death. Inactivity can also lead to increased absenteeism from work. Exercise (including cycling) therefore plays an important role in improving people's health. Healthy people are proved to incur reduced health care costs and it is for this reason medical aid companies invest in marketing healthy lifestyles (Discovery Life, 2013).

The American Centre for Disease Control and Prevention promotes regular physical activity as it helps a person's overall health and fitness, and reduces the risk for numerous chronic diseases. They also suggest that the most effective activities are moderate exercise levels of intensity, customised to the individual and incorporated into the individual's daily lifestyle. Cycling or walking to work, school, shopping, or elsewhere as part of one's day-to-day routine can be a sustainable as well as time-efficient exercise regime. It accomplishes two activities at once: travel and exercise (Wendel, 2013).

Cycling, in general offers significant health benefits. Studies have shown that cycling regularly can reduce or prevent heart disease, obesity, high blood pressure, Type 2 diabetes, osteoporosis and depression. As a form of exercise, every kilometre of moderate cycling completed, a person weighing 70 kg can expect to burn about 35 calories or 150 kilojoules. An 8 km bike ride taking about 20 minutes will therefore use the equivalent energy contained in a chicken and salad sandwich (British Columbia Recreation and Parks Association, 2011, pp.2-5).

In short, cycling does not require a high level of fitness to begin with and can be undertaken at whatever pace the cyclist wishes, all while burning calories rather than car fuel.

3.4.2. Safety

Road engineering has, over the decades, focused primarily on mobility for motorised vehicles, providing an expanding road network thereby allowing vehicles to travel faster. Although mobility benefits those using the road network, it is often the local residents whose quality of life is negatively impacted through severed neighbourhoods and increased pedestrian accidents.

In Section 2.10 the South African context was presented and indicated that only 1.5% of the people killed on our roads are cyclists. In New South Wales, Australia

2.7% of the road users are cyclists (Bicycle New South Wales, 2010). It could be argued that the fatality rate is low in South Africa because ridership is low compared to other countries. This low percentage does not necessarily indicate that cycling is safe in South Africa, but it does help to quantify the problem to some extent and perhaps reduce the hysteria surrounding cycle safety. The notion of perceived danger is echoed by Urbanczyk (Presto, 2010, p.6) who conforms that fears relating to cycling are often not based on fact.

A non-cycle related analogy relates to shark attacks in South Africa – in the last decade the highest number of attacks in one year was eight, which occurred in 2010. The highest fatalities occurred in 2009 when four people died. In 2008 no attacks occurred whatsoever (International Shark Attack File, 2014). If one considers the number of people who have entered the ocean during the same period, the actual percentage of being attacked by a shark are one in 3.1million. Compare that to the odds of dying in a car crash, is 1 in 5000! (Barrabi, 2014). Despite this, many South Africans refuse to enter the ocean for fear of sharks.

Cycling is not an inherently dangerous activity, but certain situations can become dangerous if road users do not respect one another, or if rules are violated. Studies have shown that despite an increase in cyclists in European cities, the number of cycle related accidents have also decreased. As more people, cycle the risk of being killed per kilometre cycled also reduces (Urbanczyk, 2010, p.6).

The concept of ‘safety in numbers’ has not yet been proven untrue and suggests that as more people cycle, the safer cyclists will be, as motorists become more aware of cyclists due to the increased number of visual encounters. As the percentage of cyclists increase, the overall safety levels also increase due to fewer cars. Buelhler & Pucher (2011, p.417) argue that additional safety levels are achieved if a motorist cycles infrequently. The logic is that a motorist who is also a cyclist, is more likely to respect other cyclists whist driving.

Buelhler & Pucher (2011, p.417) state that as cycling numbers increase, motorists will become accustomed to interacting with other transport modes and this will gradually become the norm (similar to children cycling to school 20 years ago) rather than feel foreign. Only once cycling numbers increase will it gain public and political support for more and better cycling facilities.

The safety of a cyclist is only one facet when considering all road users. As more people transfer from private car onto bicycles the overall safety level should improve as a collision with a bicycle is more often less severe than a collision with a car. Pedestrian safety also improves as cycling numbers increase as they are far less likely to be killed through a cycling related accident than by a car or HGV. Furthermore, vehicle drivers and occupants are also likely to benefit by an increased level of safety as they are unlikely to be injured in an accident with a bicycle. The opposite cannot be said for the cyclist involved in the same accident, meaning that cyclists are vulnerable but harmless. Lastly, it could therefore be argued that as bicycle ridership increases, there is a social benefit to society as a whole.

3.4.3. Cost

3.4.3.1. User Costs

In the USA, (McMahon, 2012) claims that if the number of trips made by bicycle increased from 1% to 2%, the collective fuel savings would be in the order of 2.6 billion litres each year.

In Europe households spend on average 13% of their income on transport according to Urbanczyk (2010, p.7). The cost of owning (and operating) a car in Europe is estimated at €300 (R4500) per month (www.exchangerates.org.uk, 2015). Compare this to the cost of a bicycle which is a once off investment of approximately €500 Euros (R7500), free parking and annual maintenance of €50 Euros (estimated) a year. It must however be quantified that a bicycle might not replace the car for all trips and that a car might still be required. Despite this, using a bicycle to replace short car journeys will still lead to significant savings in fuel, parking, tolls and maintenance (Urbanczyk, 2010, p.7).

The South African Department of Environmental Affairs completed a cost comparison for all transport modes as part of a pilot NMT project and determined that cycling was five times cheaper than using a private car (Department of Environmental Affairs, South Africa, 2014, p.9).

3.4.3.2. Infrastructure Costs

According to McMahon (2012) the provision of bicycle infrastructure is significantly cheaper than all other modes of transport with the exception of walking. The counterargument is that the provision of bicycle infrastructure does not guarantee an increase in bicycle numbers. However, he argues that only once cities begin investing in bicycle infrastructure, will residents begin to use bicycles at rates that are higher than the national average. The provision of any bicycle infrastructure should always strive to meet the five needs of cyclists (i.e. safety, coherence linking origin-destination zones, directness, attractive and comfort) (Ireland. National Transport Authority, 2011).

In Portland, Oregon (USA) over 6% of residents commute to work by bicycle despite the national average being less than 1%. Bicycle use in Portland has grown 400% since 1990, while private car usage has decreased 4% over the same period. Portland's city traffic engineer attributes the success to the fact that bicycle infrastructure is relatively easy to implement and low cost compared to other modes. McMahon (2012) estimates Portland's 480 km's of bikeway network to have cost approximately R824million which translates to only 1.6 km of new urban freeway in the USA (McMahon, 2012).

3.4.4. Quality of Life

According to (Schreckenberg, n.d.) 61% of people living in urban areas admit to being influenced negatively by noise pollution. The most annoying noise source reported was road traffic. Constant noise not only disrupts sleep, but according to the World Health Organisation can also lead to stress and high blood pressure (Urbanczyk, 2010, p.5). Cyclists passing through urban areas are also more likely to interact with the community, rather than merely passing through (in a car for example). Social benefits can be achieved through cycling, which is likely to instil a

sense of belonging within that community. Urbanczyk (2010, p.9) states that cities where cycling represents a moderate percentage are also places where people are more likely to know each other.

Although not strictly criteria to measure Quality of Life, cycling more recently has become ‘cool’ or ‘trendy’ in certain cities. The term ‘Bicycle Subculture’ is used to describe community activism efforts aimed at promoting cycling and has achieved major success around the world. Critical Mass for example began in San Francisco in 1992, but now takes place in over 300 cities around the world. Events usually attract over 1 000 riders, although the Critical Mass event in Budapest attracted over 80 000 in 2008 (Critical Mass, n.d.).

3.4.5. Environment

Cycling and walking provide a variety of environmental benefits. Making fewer trips by motor vehicle means less air pollution and lower carbon emissions. The emission savings are compounded when considering that a cold engine generates more emissions, which accounts for all short trips. Urbanczyk (2010, p.10) argues that there is disproportionate contribution of exhaust emissions for short trips (i.e. less than 5 km), which accounts for nearly 50% of all car trips in Europe.

McMahon (2012) estimates that in Minnesota (USA) the public savings derived from reduced pollution, oil import, and congestion costs amount to between 5 to 22 US cents for every automobile mile displaced by biking or walking.

In the UK if cycling numbers increased to the same levels to those found in the Netherlands (i.e. where 27% of all trips are made by bicycle), there would be a reduction of 20% in CO_2 emissions (Urbanczyk, 2010).

3.4.6. Space

Bicycles are more efficient users of scarce road space than private vehicles. Up to 10 bicycles can be stored in the equivalent space of 1 car (Cyclehoop, 2015) (Urbanczyk, 2010, p.11).

Assuming the relevant parking policies highlighted in Section 2.2 are amended to reflect limited car parking provision and support bicycle provision, the overall car parking provision for new developments can be reduced, thereby allowing more space for other uses. Bicycle parking can easily be retrofitted utilising available space or occupying 1-2 parking bays.

3.4.7. Bicycle versus Car

Whitelegg (1997, p.124) neatly presented an argument challenging the logic why commuters would choose to use a car for commuting to work in Europe. He discusses space requirements and explains that most car owners only use their car 5% of the time, the remaining time vehicles are parked either at home or at work, requiring parking spaces at both ends. He continues to explain that although modern cars are designed to travel at speeds beyond 120 km/h, in reality they spend a majority of time at speeds of less than 30 km/h. Whitelegg (1997) argues that even

though cars are capable of carrying up to 4-5 people, they predominately only carry 1 person. He concludes that 75% of car journeys made in Europe are shorter than 8 km (Whitelegg, 1997).

3.5. Benefits and Cost of Bicycle Facilities

To undertake a comprehensive analysis of the benefits and costs of providing bicycle facilities or not is by no means straight forward. The number of variables to consider is manageable, and usually infrastructure costs are readily available. Benefits on the other hand are more difficult to quantify, and considerably more difficult to cost. A simplistic example of the likely benefits a commuter in South Africa might experience is provided in APPENDIX B – Example of Benefits and Cost for Cycling. The example also highlights the difficulties in estimating the full economic benefits of cycling. Given that in South Africa only approximately 1% of all trips are made using bicycles, understanding the benefits, and the costs, play an important role in determining whether investments in cycling are the most suitable use of government funds.

In the USA, (Krizek et al., 2007, p.198) reported a similar level of bicycle patronage for all trips (0.8%) but highlighted that although the modal share might be low, there are benefits to those who actually cycle, as well as indirect benefits to non-cyclists. For example the provision of a bicycle lane might only result in a small modal shift, but if those new cyclists shifted from private cars, there would be an equal reduction of cars, which would improve traffic conditions for other motorists.

Krizek et al. (2007, pp.198-200) attempted to develop a toolkit to assist planners, policy officials and decision-makers with the ability to assess the benefits of providing bicycle facilities, given that these officials are required to justify spending on such facilities. Justifying the value of providing bicycle facilities is accepted in order to ensure public money is spent effectively.

A similar calculation was necessary to motivate the support for South Africa's Integrated Rapid Public Transport Networks (IRPTN's), which are currently being implemented in larger cities across the country. The difference however, is that the value of these public transport systems have been well documented, both internationally and more recently locally. This is not the case with cycling.

Krizek et al. (2007, pp.203-04) developed the following procedure to estimate the demand of a future bicycle facility:

1) Obtain existing cycle volumes for estimating overall cycle levels within the city;
2) Assume all existing cyclists within vicinity of new facility would make use of the new facility;
3) Determine number of residents living within close proximity to facility. This confirmed the perception that those living closest to a facility are more likely to make use of the facility than those living further away. The same study suggested that an induced demand can be created for distances up to 1600 m away from the facility;

4) Estimate the number of new cyclists anticipated using the new facility. The difficulty is in estimating these new users and highlights the lack of research in this area dealing with causal effect between facilities and new users. The toolkit for this reason estimates new users as a function of the number of existing cyclists within the area.

3.6. Influence of Weather

Previous research by Buehler & Pucher (2011, p.417) concluded that climate and topography can effect cycling levels and found that rain as well as by very cold / very hot weather deterred cyclists.

In 2012, the University of Vermont undertook a study to determine the impact that specific weather conditions could have on daily bicycle use specifically for travel to work purposes. The data includes interviews obtained 100 adult bicycle commuters for pre-selected days over a ten month period (Flynn et al., 2012, pp.2-3). Weather data such as precipitation, temperature and wind were captured in the morning periods to coincide with typical morning commuting hours. Data such as age and gender and educational profiles were captured as well as their commuting distance.

The survey established that most participants (81%) were seasonal cyclists and chose not to cycle in the coldest months. Participants admitted to using their bicycles for recreational purposes in addition to commuting to work. The average commuting distance was 10km, with the average time spent on a bicycle being 37 minutes. Interestingly, the same journey by car was estimated to be 19 minutes, indicating that the participants chose to cycle to work despite it taking a longer time to travel to work.

Analysis of the survey data showed that participants were almost twice as likely to commute by bicycle on days when no precipitation occurred. A similar correlation was found for temperature, where a one degree increase raised the likelihood of cycling to work by 3%. An increase in wind speed of 1.6km/h decreased the likelihood of cycling by 5%, while 2.5cm of snow decreased this likelihood by 10%. Distance was also modelled and concluded that a 1.6km increase in commute distance by bicycle resulted in a reduced likelihood of 8%. Other statistics concluded that men in this study were nearly three times more likely to commute by bicycle than woman.

3.7. Cycle to Work Schemes

In 1999 the UK Government, in an attempt to promote good health and reduce pollution introduced an annual tax exemption on bicycles and associated safety equipment. Known as the cycle to work scheme it offers a tax exempt benefit to the employee through a salary sacrifice mechanism, which provides a cost efficient way to encourage employees to cycle to work. Employees choose their bicycle and purchase it using company vouchers. The bicycle is therefore owned by the employer and loaned to the employee until the end of the loan period. Thereafter the

employee may choose to purchase the bicycle and equipment. Employees benefit by not having to pay tax on the cost of the bicycle, saving between 32% and 42% of the cost of the bicycle depending on the employees income tax bracket. (Department for Transport, 2011, p.4), (Transport for London, n.d., p.15).

Since its introduction more than 600 000 individuals have utilised the scheme with over 180 000 employees signing up for the scheme in 2014. A survey by the Cycle to Work Alliance highlighted that over 70% of individuals were previously non-cyclists or novices prior to joining the scheme (Darby, 2015, p.1).

The Republic of Ireland, in 2009 commenced its cycle to work scheme with similar success (Revenue - Irish Tax and Customs, n.d.).

4. REALIGNMENT OF SOUTH AFRICAN LEGISLATION

"If I can bicycle, I bicycle."
- Sir David Attenborough, Naturalist

4.1. Car Parking Standards

A comparison of both the local and international parking standards confirms that South African standards prescribe a minimum parking provision with no set maximum. International standards on the other hand either prescribe a maximum provision with no set minimum, or provide both a maximum and minimum envelope within which is market related.

Several international cities have amended their parking standards in order to prevent over supply and to promote other modes of transport. It is therefore recommended that the South African DoT revise the 1985 Second Edition standard. As a national standard, it is the imperitive that the DoT, through legislation, encourage lower parking provision, better parking management, as well as promoting other modes of transport. The provision of car parking is in most developments expensive, requires vast amounts of developable land and increases surface run-off thereby making attenuating stormwater more costly and more difficult to achieve. Futhermore, car parking utilisation, as alluded to in Section 2.2 is often low due to poor management.

It is thought that the following items could be addressed as part of revising the parking standard:

1) Provide maximum car parking ratios. Should this be considered too drastic, as a minimum, a range including minimum and maximum ratios chould be given;
2) Differentiate between different densities, i.e. urban, rural, CBD;
3) Include the possibility for developments to be car free developments (assuming they meet specific sustainable criteria). For example only buildings that attain a five star Green Building acreditation would qualify;
4) Inclusion of bicycle parking standards for all land-uses. It is recommended tha the ratios provided within the Green Building regulations be adopted as they have been tested and implemented sucessfully for green star buildings;
5) Consideration must be given with regards to distribution and adoption of the revised standard. As mentioned in Section 2.2 some municipal workers, in the absence of clear guidance, have developed their own hybrid of parking ratios, based on historical and local knowledge.

4.2. Inclusion of Bicycle Parking Standards

International cities reviewed in Section 3.3 confirm that it is best practice to include bicycle parking standards in the same document as the car parking standards or at least to provide the appropriate cross referencing between the standards to make users aware of the legal planning requirements.

It was highlighted in Section 2.2 that the City of Cape Town is the only major city in South Africa that provides an allowance for cycle parking. The GBCSA provides the

desirable standards for all new buildings and it recommended that these standards be incorporated into the revised DoT parking standards. It is further recommended that these standards be presented as minimum requirements with no set maximum to help promote cycle usage.

4.3. Development of a Cycling Strategy

Prior to the 17th Conference of the Parties (COP17), which took place in Durban in 2011, eThekwini Municipality had only one shared bicycle/pedestrian lane (along the beachfront). As the conference related to climate change and attracted international delegates, additional bicycle infrastructure was added to link the venue to the Botanical Gardens and North Beach. In addition to the bicycle routes, bicycles and related equipment were made available during the conference. The conference has lead to the municipality investing in developing a five-year Cycling Plan for Durban CBD as well as a NMT Strategy (eThekwini Municipality, 2014, p.1).

The Johannesburg Development Agency (JDA), who manage and facilitate development within the City of Johannesburg, are investing in the city's bicycle infrastructure in an attempt to encourage people to cycle more. The JDA, in 2014 allocated R120million for the construction of bicycle lanes connecting the University of Johannesburg with Park Station in Braamfontein and will continue to construction new routes connecting the surrounding areas with the CBD.

Notwithstanding the ongoing planning and investment in bicycle lanes, as stated in Section 2.7 Cape Town is the only South African city to commission a dedicated cycling strategy focussing wholeheartedly on the future of cycling in it's city. It is recommended that a similar approach be adopted for all major cities within South Africa.

4.4. EOTFs in New Developments

The South African National Standards review described in Section 2.3 confirms that no EOTF standard exists. It would be easy to amend the regulations to make shower and changing room provision mandatory for all developments, not just for developments were employee 'encounter excessive dirt'. It is therefore recommended that these regulations be amended to include provision of showers and changing rooms as a minimum requirement.

It has further been shown in Section 2.2 that only one city in South Africa promotes the provision of EOTF's offset against lower parking requirements. The Green Building Council of South Africa has provided all necessary guidelines and limitations within their Green Star accreditation program. It is therefore recommended that these standards be adopted by the South African Department of Transport for inclusion into the revised parking standards. Alternatively, provision must be given to allow local municipalities to develop their own EOTF standards.

5. DATA COLLECTION

> *"Life is like riding a bicycle. In order to keep your balance, you must keep moving."*
>
> - Albert Einstein, Physicist (1930)

In order to establish the willingness of commuters to cycle to work within the South African context, it was necessary to conduct commuter observations in a typical office environment. Chapter 2 confirms that no South African research on cycle to work statistics exists or is known to the author at the time of undertaking this thesis. Furthermore, international research also indicates that little quantitative research has been undertaken on the impact that EOTF's has on cycling to work. Therefore, it is clear that a detailed survey was required and this survey aims to capture the percentage of commuters willing to cycle to work purely based on the influence of EOTF's. The selected site would therefore be required to have sufficient EOTF's available for use or being constructed at the time of the survey. The survey requires a before and after analysis in order to quantify the uptake based purely on the EOTF.

Many international cycling studies conclude that there is a significant relationship between cycling facilities and cycling levels, although the analysis is generally unable to pinpoint the causation (i.e. which intervention). These studies generally use regression analysis of the observed cycling levels over a period of time. Generally, the volumes of cyclists are measured before and after the specific bicycle facility is installed/ constructed/ commissioned and provides clear time-based evidence of usage. However, these studies almost never control the influence of other factors, which can also affect cycling levels (Buehler & Pucher, 2011, pp.410-11).

Cycle to work data is usually collected in one of two ways; the percentage of commuters travelling to work by bicycle (i.e. bicycle mode split), or the number of commuter cycling to work per 10,000 population. The latter measurement method has the added advantage of referencing population size, but in terms of this study population reference was not deemed necessary and therefore the before and after bicycle mode split, expressed as a percentage, was selected. These measures are normally based on the community level.

A description of the study area chosen is presented in Section 5.1 below. Section provides a background description of the factors considered when selecting a suitable study area.

5.1. Study Area

5.1.1. Location

The study was conducted at an existing business complex, approximately 18km east of Cape Town Central Business District (CBD). The business complex is situated on the southern side of Tygerberg Hill, located on the fringe of a disused quarry and forms part of the Tygerberg Nature Reserve. The business complex is only accessible from Uys Krige Drive, a Class 3 Local Distributor road in terms of the

Municipal Road Network Classification with few intersections and driveways along its length. Uys Krige Drive runs parallel to the N1, accessible via either Plattekloof Road to the west, or Jip de Jager to the east. Both Plattekloof Road and Jip de Jager are Class 2 Primary Arterials in terms of their road classification. Access to areas towards the Cape Town CBD is quickest via Plattekloof Road, while access towards the Paarl area is quickest via Jip de Jager.

The portion of Uys Krige Drive where the business complex access exists is relatively flat, although the rest of Uys Krige Drive varies with some portions being steep. This is due to Uys Krige Drive following the natural contours of Tygerberg Hill.

5.1.2. Office Park

The business complex, due to it's orientation, offers good views of Cape Town CBD and Table Mountain. The complex is known as the Tygerberg Park and comprises of ten buildings and each building has three to five floors. Several companies are present within the business complex; some of the larger or relevant companies include:

- Pepkor IT – Subsidiary of Pep Stores;
- Royal Haskoning DHV – Engineering Consultancy;
- BT – Telecommunications company;
- Hatch Goba – Engineering Consultancy (58 staff members)
- Transet Ltd – Railway, Port and Pipeline company (60 staff members);
- Siemens – Technology company (12 staff members);
- DR Power – Electrical Engineering Consultancy (5 staff members)

Hatch Goba and Siemens share the same building, Plattekloof House. Transnet occupies the adjacent building, along with DR Power who occupies one small office area.

5.1.3. Company Description

The company selected for the purpose of this study is Hatch Goba (Pty) Ltd. This multi-disciplinary engineering consultancy is a merge of two previously separate companies, namely Hatch (Pty) Ltd and Goba (Pty) Ltd. Goba (Pty) Ltd was a successful South African engineering consultancy with offices throughout South Africa, focussing mainly on infrastructure. Hatch (Pty) Ltd is a global engineering consultancy, with origins in Canada where it services the oil and gas industry. The two companies merged in 2013 to form Hatch Goba (Pty) Ltd (hereafter referred to as Hatch Goba). Hatch Goba is a subsidiary of Hatch (Pty) Ltd. Globally, the company has over 10 000 employees in over 65 offices.

Before the merger, Goba (Pty) Ltd had offices near Tygervalley Shopping Centre in Belville and in January 2014 the Goba (Pty) Ltd employees relocated to the new Hatch Goba offices located in the Tygerberg Park complex. Before the merger, Hatch (Pty) Ltd occupied one floor of the three-story building (Plattekloof House) while Siemens and Oxford University Press occupied the remaining two floors. In 2013 when the office relocation occurred, Hatch Goba occupied two floors, with only Siemens occupying the ground floor.

The Cape Town Hatch Goba office comprises of 60 employees, although two employees were site staff who rarely came into the office. Some employees also travel extensively as their projects are located outside of Cape Town. Approximately five employees “hotdesked” on a weekly basis between the Cape Town and Johannesburg office.

Male employees account for 76% with the remaining 24% being female.

5.1.4. Type of Business

Within the Cape Town office the following engineering services are offered together with the number of employees in each department:

- Transmission and Distribution (12 employees);
- Procurement and Process Control (4 employees
- Project Delivery (1 employees);
- Rail and Transport (22 employees);
- Structures (5 employees);
- Water and Tailings (4 employees); and
- Ports and Marine (2 employees)

In addition to the engineering staff and managers listed above, the Cape Town office included 8 administrative staff whose duties cover reception, accounts and document control.

As an engineering consultancy Hatch Goba demand a highly educated workforce, with 4 employees having attained their Doctorate in Engineering (PhD) and 2 employees with a Masters in Engineering. Almost half of the employees had a Bachelor’s Degree, most of which was in Civil Engineering. A further 12 employees were either Civil Engineer Technicians or Professional Technologists. 10 Employees had non-engineering related qualifications and 4 employees had no tertiary education whatsoever.

5.1.5. Surrounding Area

The Tygerberg Park complex lies within a predominately residential area known as Plattekloof 1, the numeral “1” denoting that it was the first phase of the Plattekloof development. Although formerly within the Plattekloof suburb, the complex, due to its orientation visually appears to belong to the suburb of Tygerberg, which in terms of cadastral boundaries only begins south of the N1. Access to the Tygerberg suburb is therefore only possible via Hannes Louw Drive, which makes use of an underpass to cross the N1.

The nearest commercial and business operations are located some 2km to the west in a suburb called Panorama, where a petrol filling station, supermarket, pharmacy and some offices exist. To the east of the complex is the residential suburb of Loevenstein.

5.1.6. Surrounding Road Network

According to the Western Cape Government's "Road Access Guidelines" Uys Krige Drive, being a Class 3 distributor road should have a minimum access spacing 120m, although several sections of Uys Krige Drive contravene this access spacing guideline (Provincial Administration Western Cape, 2002). In an interview conducted with Mr W. Liebenberg, Transport Professional Officer for City of Cape Town, on 14 March 2013, he mentioned that Uys Krige Drive was originally designed as a Class 4 road, but upgraded to a Class 3 road due to its attractiveness as a mobility route parallel to the N1.

The N1 freeway lies just south of Uys Krige Drive and is one of the primary routes to and from Cape Town. The only roads providing linkages with the N1 is Plattekloof Road, a Class 2 Primary Arterial providing access to Parow to the south where it terminates with Voortrekker Road. To the north Plattekloof Road passes the suburbs of Welgelegen and Bothasig before intersecting with the N7 and ultimately terminates with Koeberg Road. The Plattekloof Road and its close proximity to the N1 provide good vehicular accessibility to the wider metropolitan area.

To the east Uys Krige Drive intersects with Jip de Jager, also a Class 2 road. Jip de Jager runs in a north-south direction, providing access to Welgemoed to the north. To the south Jip de Jager connects with the N1 by way of a grade separated signalised intersection, thereafter intersecting with Frans Conradie Drive and terminating in Belville.

With regards to cycling on the surrounding road network the nearest bicycle infrastructure is located along Plattekloof Road and a portion of Uys Krige Drive where bicycle lanes have been constructed (see Figure 5.1). Also shown in Figure 5.1 are the recommended bicycle routes as defined in the Cape Town Bicycle Map (Jennings, 2015). On account that cyclists are not allowed on the N1 freeway, Uys Krige Drive offers a suitable alternative for those wishing to travel in an east-west direction. Frans Conradie Drive also runs in an east-west direction serving cyclists south of the N1.

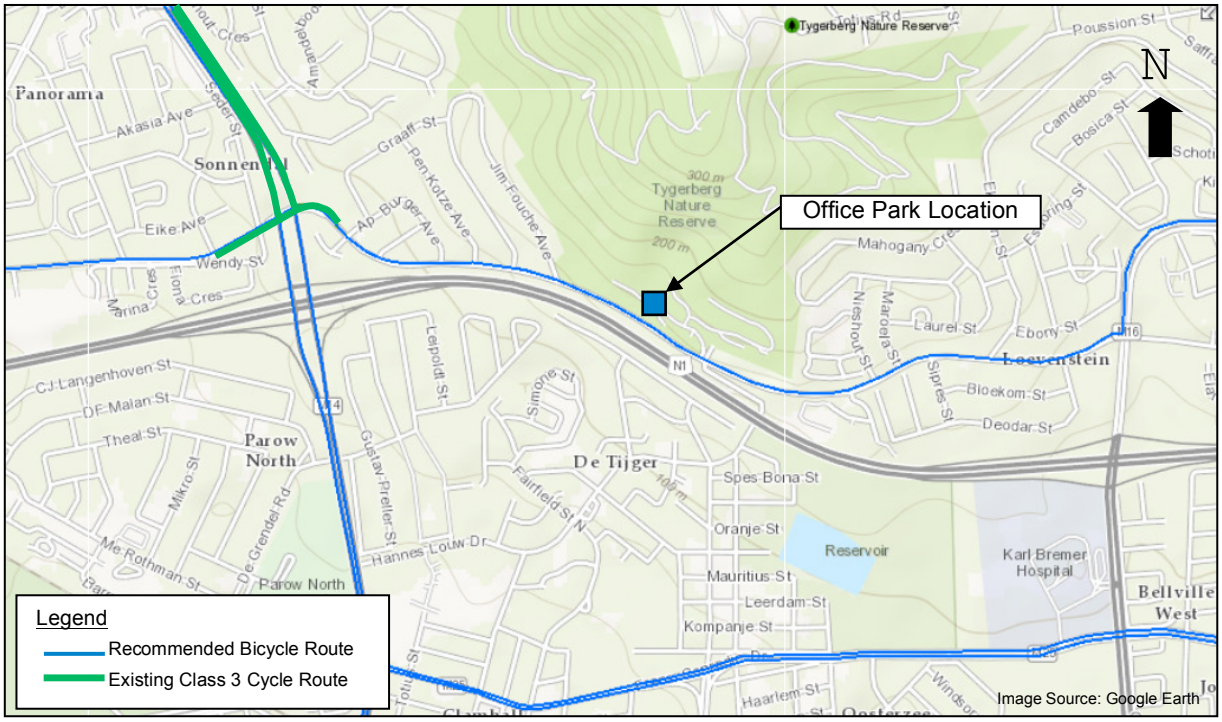


Figure 5.1 – Existing Bicycle Network

5.2. Identification of Study Area

As the End of Trip Facility data required is quantitative, the study area had to be accurate, safe and affordable. The following criteria was considered when identifying a suitable site for the survey:

1) Identify an office building with a single entry/exit point. This is purely to simplify the survey and to reduce costs;
2) Identify an existing office building within an established neighbourhood, and avoid new office developments as employees might not be completely familiar with the surrounding road network;
3) Avoid an environment were extensive construction activity exists, e.g. new business park. Cyclists prefer to avoid construction areas due to the following:
    a. The likelihood of a tyre puncture is higher than elsewhere on the road due to the proximity of sharp objects such as broken glass, road rubble, additional oil patches and potholes;
    b. The size of construction vehicles are enormous compared to a cyclists;
    c. Construction vehicles are often required to perform irregular turning manoeuvres either to enter a construction site or to park for loading/unloading;
    d. The close proximity of heavy materials such as steel being lifted by cranes or any other activity occurring near to the road;
    e. Where construction occurs on a road additional dangers include the narrowing of lanes, temporary removal of shoulders or temporary suspension of sidewalks/cycle lanes during construction. One or more of these barriers could make it difficult for motorists and cyclists to keep a safe distance between one another;

4) Avoid steep terrain or mountainous areas. Cyclists are influenced by road gradients and generally avoid any gradients steeper than 5% (6.67% for short distances) (Department of Transport, 2014, p.47);
5) Attempt to identify an office building were no EOTF's currently exist in order to measure cycle activity prior to an EOTF being implemented.

The facility met four of the five criteria listed above except for the steep terrain approaching the office park. A suitable case study location with an existing EOTF was identified located within the business park where the researcher worked. The EOTF was located in the basement of the adjacent Transnet building and was unknown to all Hatch Goba employees, but was also largely unknown to the various employees of the companies located in the Transnet building. A possible reason could be that some of Transnet employees were not permanent employees, but rather seconded from AECOM, an engineering consultancy to work on a specific Transnet project. The majority of these transient employees were not from Cape Town.

The EOTF has a dedicated male and female changing room with a shower, clothes hook, washbasin, mirror and a wooden bench for sitting. Photo 1 is a picture of the male shower and Photo 2 indicates the signage identifying the location of the showers. Unfortunately no signage is present outside the building directing cyclists to the EOTF, which is though the basement car park, the most natural route to access the facility.

Photo 1	Photo by Glen Randall Comment: Shower and Changing Facility at Tygervalley Office Park, Cape Town
	

Photo 2	Photo by Glen Randall Comment: Shower and Changing Facility Signage at Tygervalley Office Park, Cape Town

5.3. Survey Methodology

This section presents the methodology adopted throughout the study period. It is admitted that the results cannot be generalised, as many factors play a role in the isolated study, such as location, income level of workers and availability of public transport.

5.3.1. Establish Baseline

38 Hatch Goba employees (including the author) relocated to the new Hatch Goba offices (see Section 5.1.3). During that time the author observed that none of the Hatch Goba employees cycled to work, nor were there any EOTF's available. A formal motivational email was submitted to the Hatch Goba Office Manager to request installation of a shower and a bicycle cage in the basement for employees who wished to cycle to work. The Hatch Goba Office Manager mentioned the request at a management meeting and the Hatch Goba Facilities Manager, based in the Johannesburg office, authorised the installation of a shower and a secure lock-up facility in the Cape Town office. Upon discussions with the Facilities Manager of the Business Complex it emerged that there were existing changing rooms and showers in the Transnet building. The Business Complex Facilities Manager negotiated with Transnet to allow Hatch Goba employees to use the changing room and shower facilities, which required special access cards. (access cards are unique for each building for safety reasons).

The Hatch Goba and Business Park Facilities Managers invited the author to tour the EOTF to verify that the facility would be suitable. It was further agreed that a secure lock-up facility would be installed if Hatch Goba employees could demonstrate that there was a willingness to cycle to work.

The author is therefore confident that he and the Johannesburg based Facilities Manager were the only Hatch Goba staff who were aware of the EOTF. The availability of the EOTF was announced to Hatch Goba employees soon thereafter, which provided a sufficient length of time to establish a method of recording the EOTF usage.

It is possible that those employees who lived very close to the Business Complex (less than 5km) could have cycled and not showered, although in this instance the author would have noticed bicycles parked either in the office area or basement.

In order to establish a baseline, only Hatch Goba employees were informed of the EOTF and it was uncertain how frequent the EOTF was utilised by non Hatch Goba employees. In retrospect the survey should have commenced one or two months prior to the announcement of the existence of the EOTF to Hatch Goba employees in order to establish a comparative baseline survey.

5.3.2. Existing Mode Split

The majority of employees used private vehicles (92%), while 5% of employees were a car passenger either being dropped off at work or making use of a lift share with another employee. Motorcycles accounted for the remaining 3% of employees. No bus or minibus taxi routes operate along the road passing the office park and as a consequence no employees used these modes of transport for commuting to work. The nearest train station is Avondale Station 1.7 km away from the office park. Despite being an easy commute to Belville train station, no employees used the train to commute to work.

As mentioned earlier no Hatch Goba employees cycled to work prior to the survey commencing.

5.3.3. EOTF Survey

A logbook and an A3 sized poster was mounted on a wall of the male and female changing rooms. The poster requested all users to kindly complete the logbook every time they made use of the facility providing the following information:

1) Name;
2) Company Name;
3) Time of use (AM, lunchtime or PM); and
4) Intended use (cycle, run or other).

To ensure Hatch Goba employees complied with the survey methodology the author, upon noticing a bicycle parked within the office, would cross check the logbook to ensure that the entry had been captured.

The author intentionally did not make any announcements to employees of the other companies for fear that this would alter their EOTF usage and skew the survey. The

case study assumed that the employee behaviour of non-Hatch employees would remain unchanged.

It is possible that the announcement email to Hatch Goba employees relating to the availability of a shower and changing room, along with the knowledge of the author's intentions to monitor bicycle usage for research purposes could have influenced their willingness to try to cycle to work. During discussions with the author some employees conveyed their willingness to try to cycle, and mentioned their reservations preventing them from cycling. It became clear to the author that cycling to work is a personal choice, and that it would be highly unlikely that an employee would attempt to cycle to work purely to help a colleague with his research. In summary, if any employee started to cycle to work under the pretence that he/she was helping a colleague, there would most certainly be other motivating factors, which could collectively persuade a person to cycle to work.

The information from the logbook has been utilised to determine the number of weekday users and to calculate the usage for the months from August 2014 to April 2015 (9 months). The survey commenced on Friday the 1st of August 2014, following an email to all 58 Hatch employees, encouraging them to use the dedicated Male and Female shower and changing facility. The survey terminated on the 30th April 2015, in order to allow sufficient time for data analysis. APPENDIX C – Changing Room and Shower Logbook provides a complete inventory of the data captured daily.

5.3.4. Employee Questionnaire Survey

An online questionnaire was undertaken to ascertain an understanding of the concerns employees might have relating to cycling in general and the reasons why they choose not to cycle to work.

The following questions were asked:

1) Age Group;
2) Whether or not they use a bicycle;
3) The purpose and frequency they use a bicycle;
4) How safe they feel when cycling on the road;
5) Whether or not they had been in a cycle accident in the last 5 years;
6) The level to which other road users influence their decision to cycle;
7) The reasons which prevent them from cycling to work; and
8) Changes required increasing the possibility of cycling to work.

The results have been analysed in **Chapter 6** while APPENDIX D – employee Questionnaire provides the complete set of questions and answers.

6. DATA ANALYSIS

"The bicycle is the noblest invention of mankind."
- William Saroyan, Nobel prize winner

This chapter presents the data collected and analysis. The chapter first focuses on the EOTF usage and is followed with an analysis of the questionnaire survey results in order to identify trends.

6.1. Introduction

The logbook dataset comprises the names and dates of all users, both male and female, who made use of the facility. Based on the literature presented in Chapter 2, there does not appear to be any prescribed methodology relating to undertaking cycle to work surveys. All surveys appear to focus on questionnaire type information gathering and are not empirical based.

Section 6.2 discusses the monthly EOTF usage. Section 6.3 links the influence that weather had on employees that cycled to work and compares weather data with the observed cycle data to establish possible correlations. Section 6.4 provides details relating to possible seasonal fluctuations which were observed during the study.

Section 6.5 displays the EOTF usage geographically and reviews the distances employees has to travel to work. Section 6.6 assesses topography and the possible effect this has on cycling to work, within the context of this survey.

The results of the employee questionnaire are presented in Section 6.7 together with an overall summary.

6.2. Monthly EOTF Usage

6.2.1. Observed EOTF Usage (Other Organisations)

The existing EOTF usage at the start of the survey relates to the number of users who were aware of the facilities at the time the survey commenced. The users represent a variety of companies situated within the building where the EOTF is located. Figure 6.1 shows the monthly usage for these users.

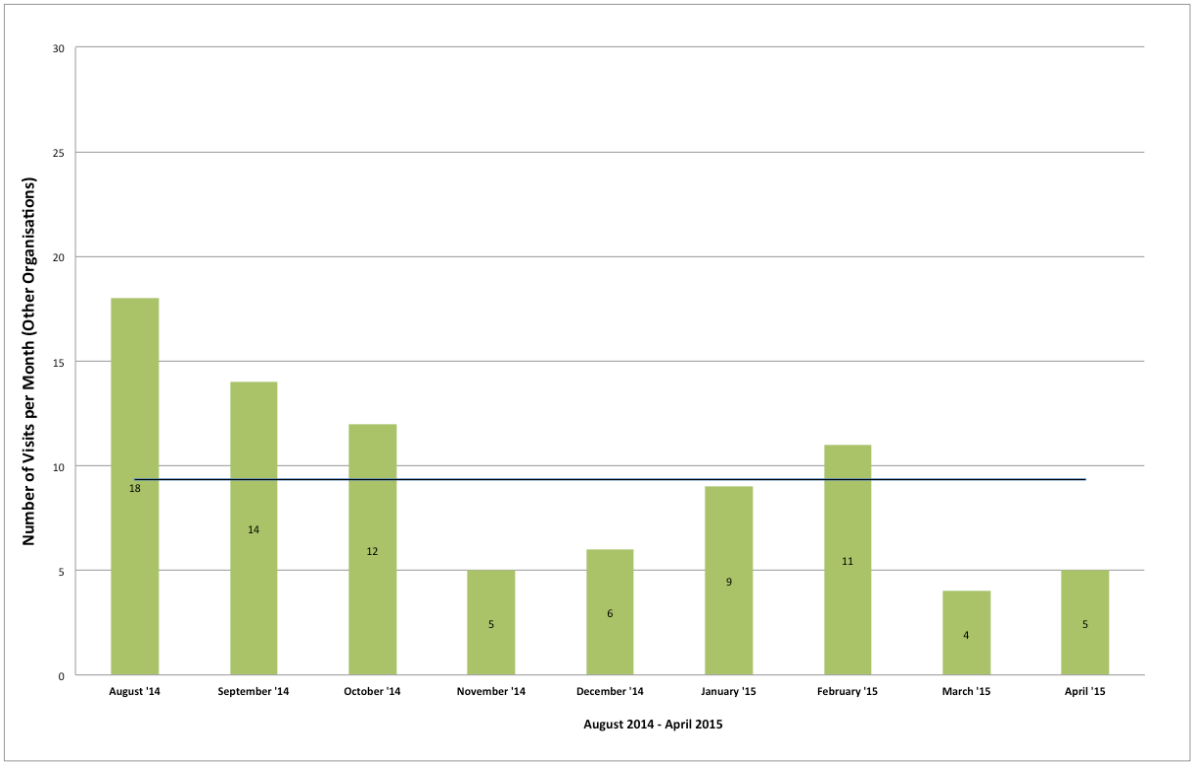


Figure 6.1 - EOTF Monthly Usage (Other Organisations)

It is noticeable that the usage fluctuates from month to month and the average is 9.3 visits per month. A steady decline was observed from months August 2014 to November 2014, thereafter a noticeable drop in the month of November 2014. The usage increased steadily from November 2014 to February 2015 followed with another noticeable drop in March 2015.

A breakdown of the users is provided in Table 6.1. The 'Observed Usage' column corresponds to the values provided in Figure 6.1, the 'Number of Different Users' indicates the employees who utilised the EOTF, while 'Number of First Time Users' refers to the employees counted only when they were first observed using the facility. 'Bicycle Use' refers to the number of times the EOTF was used specifically for a cycle to work trip.

Table 6.1 - EOTF Monthly Usage (Other Organisations)

Month	Observed Usage	Number of Different Users	Number of Unique Users	Bicycle Use
August	18	3	3	1
September	14	2	0	0
October	12	1	0	0
November	5	1	0	0
December	6	2	1	0
January	9	1	0	0
February	11	2	1	1
March	4	1	0	0
April	5	1	0	0
Total	84	-	5	2

The results indicate that although the EOTF is being used, the number of employees using the facility is small. A maximum of three different employees where observed in any one month during the survey period, with an average of only two different employees using the facility. Five unique users were observed during the 9 month survey period. Disappointingly, only two of the 84 times the facility was used, was for cycle related purposes, i.e. cycle to work trips. The remaining 82 visits were predominately made by a single employee who exercised in the morning and used the EOTF before work.

6.2.2. Observed EOTF Usage (Hatch Goba)

The announcement of the EOTF to all 58 Hatch Goba Employees was made on the 1st August 2014, which was the start of the survey. Figure 6.2 below shows the additional EOTF usage (i.e. visits by new users) after the announcement.

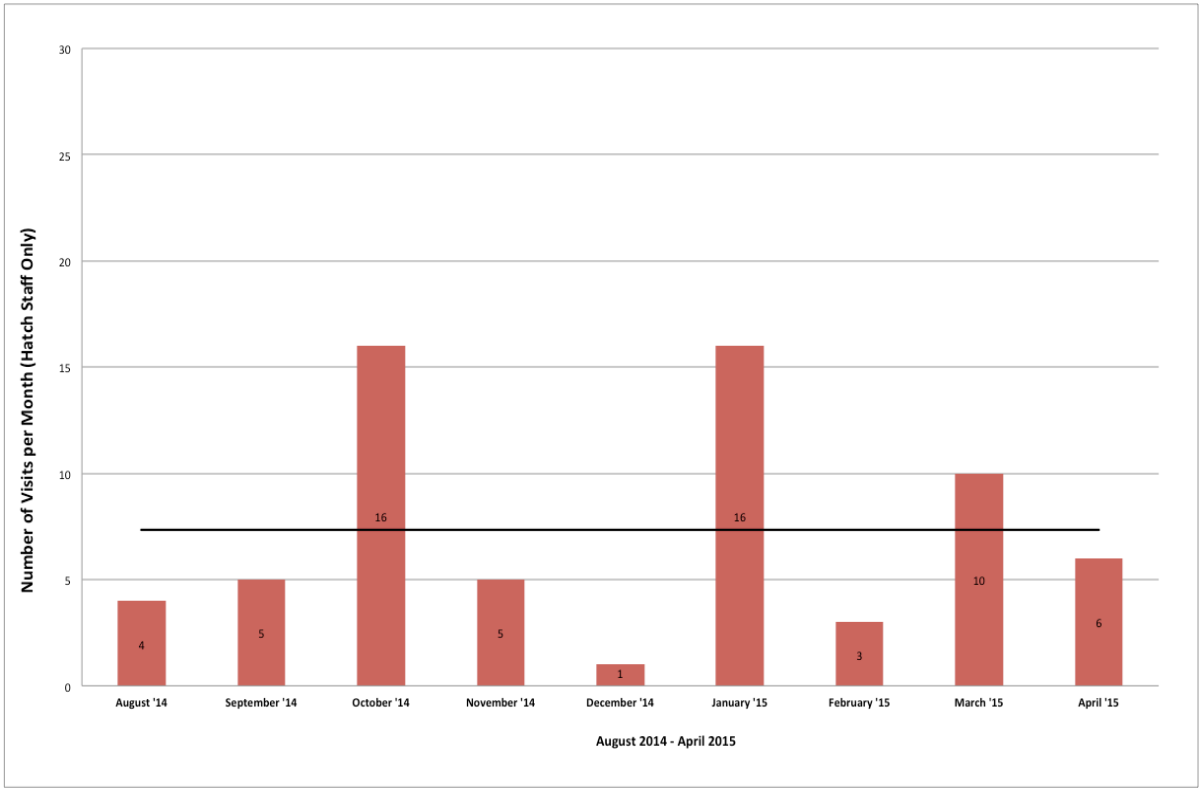


Figure 6.2 - EOTF Monthly Usage (Hatch Goba Employees Only)

The monthly trends highlighted in Figure 6.1 are significantly different when comparing the usage of Hatch Goba Employees following the EOTF announcement. The peak usage occurred in the months October 2014 and January 2015 where 16 visits were observed. The average number of employees using the facility per month was 7.3. Table 6.2 shows a breakdown of the users in more detail.

Table 6.2 - EOTF Monthly Usage (Hatch Goba Employees only)

Month	Observed Usage	Number of Different Users	Number of Unique Users	Bicycle Use
August	4	2	2	4
September	5	2	0	5
October	16	4	2	13
November	5	3	0	3
December	1	1	0	1
January	16	4	2	12
February	3	1	0	3
March	10	4	2	9
April	6	3	0	6
Total	66	-	8	56

The results indicate that 66 new visits were made during the 9 month survey period, which is less than the existing 84 (Table 6.1) visits made by non-Hatch Goba employees. Eight unique users (representing 13.7% of all non-Hatch Goba employees) made use of the EOTF, and all made at least one trip to work using a bicycle. 56 Bicycle trips were made, which accounted for 84% of all new EOTF visits.

6.2.3. EOTF Monthly Usage (Combined)

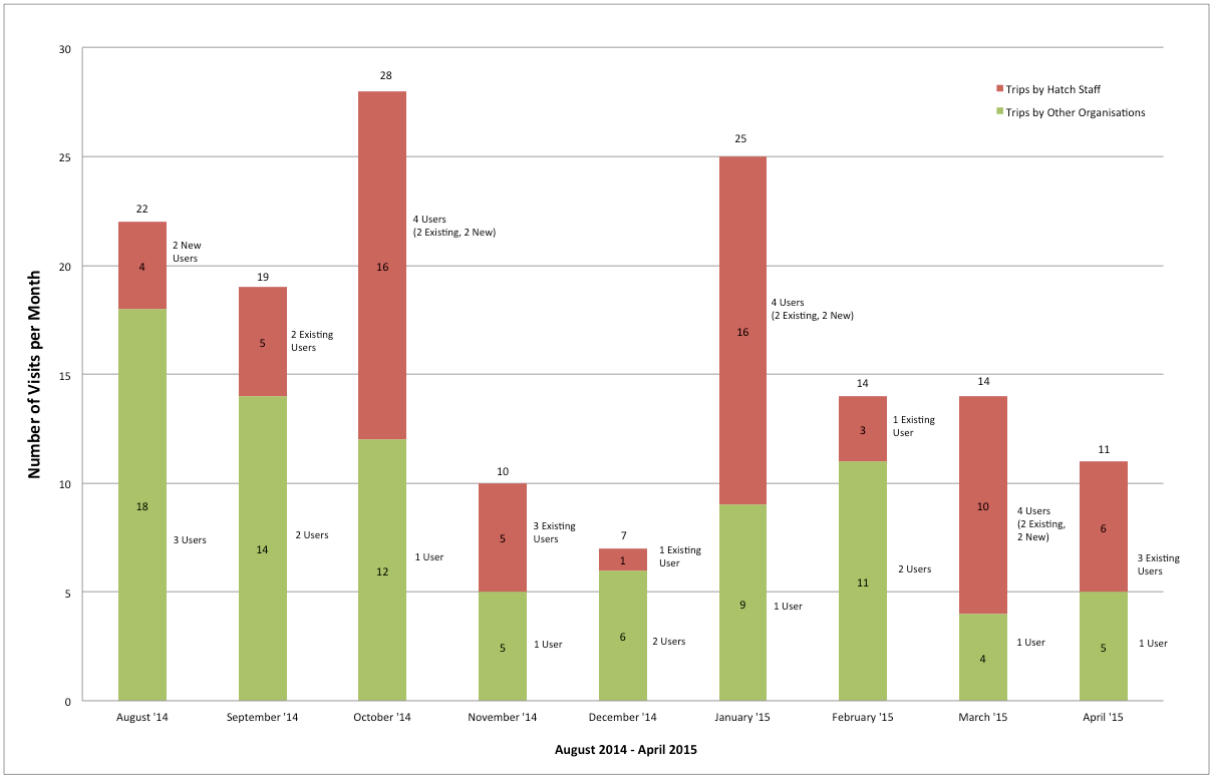


Figure 6.3 - EOTF Monthly Usage (All Organisations)

The results displayed in Figure 6.3 indicate that of the 58 Hatch Goba employees, only 2 employees (3.6%) started to cycle to work during August 2014, the first month of the survey. This resulted in an increase in the total EOTF usage from 18 to 22 visits (18% increase). In September 2014, the same 2 employees continued to cycle a total of 5 times. The maximum usage was observed during October 2014 when 4

employees (including 2 employees cycling to work for the first time) used the facilities a total of 16 times.

The survey showed a decline in usage for both months November 2014 and December 2014. The survey concluded on the 19th December 2014 due to year-end closure, which attributes to the poor usage in that month. The overall usage by non-Hatch employees also declined, most likely due to seasonal events (client/office parties, vacation, etc.). The survey re-commenced on the 5th of January 2015 and the EOTF usage increased significantly to 25 visits, 16 (64%) of whom were made by Hatch Goba employees. January 2015 also saw 2 new Hatch Goba Employees make use of the EOTF.

February 2015 saw a decline in overall usage from 25 to 14 visits, despite an increased use by non-Hatch employees as well as a new Non-Hatch Employee who cycled to work. The Cape Town Cycle Tour (previously known as the Cape Argus Cycle Tour) took place on the 8th March 2015, which traditionally sees a noticeable upsurge of cyclists training on the roads within Cape Town leading up to the race event. The survey observations, however, are contrary to expectations. Several employees did participate in the event, but chose not to use cycle to work as a form of training. Section 6.4 investigates seasonal change in more detail.

During March 2015 the usage showed that two new Hatch Goba employees chose to cycle to work, increasing the number of trips to 10. The overall EOTF usage by non-Hatch Goba employees was low at 4 and 5 visits for the months March and April 2015 respectively.

In conclusion, during the 9 month survey a total of 13 unique EOTF users were identified, 8 of which were Hatch Goba employees who as explained in Section 5.3.2 only started making use of the facility after the announcement that an EOTF was available for use. The remaining 5 users were non-Hatch Goba employees and it was assumed that they were aware of the facility before the announcement. As the survey did not monitor the facility usage prior to the announcement, it is possible that non-Hatch Goba employees were incentivised, through indirect marketing (e.g. word of mouth, visual observation, etc.) to utilise the EOTF. It was not possible to establish if all 5 non-Hatch Goba employees were existing users or not. Worst case scenario, assuming all 5 non-Hatch Goba employees were existing users, it indicates that through positive marketing the usage of the EOTF increased by 2.6 times.

6.2.4. Cycle to Work Only

The information presented thus far is based on the EOTF usage, which includes a multitude of uses. The data has been further disaggregated to identify the cycle to work trips only and Figure 6.4 indicates the monthly cycle to work usage throughout the survey period.

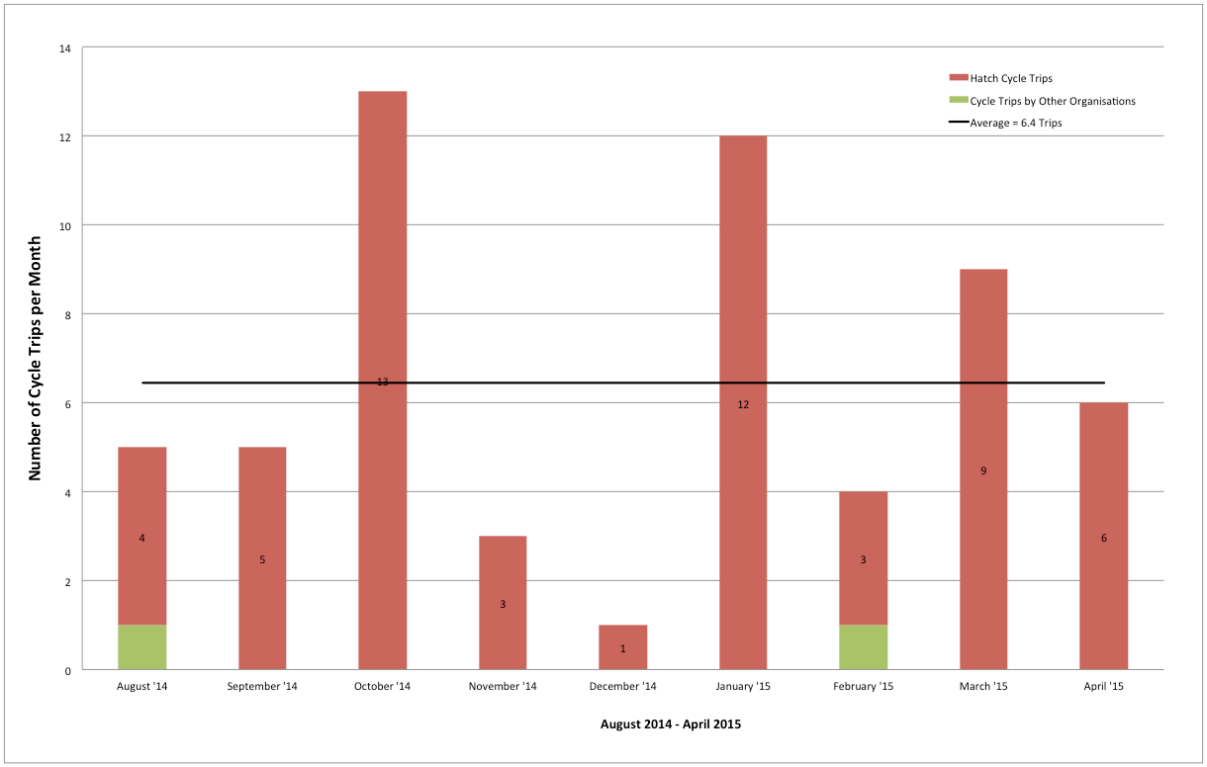


Figure 6.4 - Trips (All Organisations)

Comparing the month-to-month 'cycle only' usage with 'all EOTF usage' (see Figure 6.3) indicates a similar profile from month to month. The months October 2014 and January 2015 indicated the highest cycle to work trips with 13 and 12 trips respectively. Figure 6.4 also shows that only two cycle to work trips were made by non-Hatch employees. The vast majority (96%) were Hatch Goba employees who all made new trips.

Given that this survey only measured cycle to work trips via the EOTF usage, it could have been possible that some trips by bicycle were made without the cyclist using the shower. However, in this instance the author, being an Hatch Goba employee, was able to observe any unfamiliar bicycles parked within the office.

To conclude the case study provides clear evidence that without the existence of an EOTF, these trips would have been made by a private vehicle.

6.2.5. Cycle to Work Analogous to Other Uses

Having established in Figure 6.4 that the Hatch Goba Employees represent almost all of the cycle to work trips, a comparison was undertaken to ascertain what proportion of the total EOTF usage constitutes cycle to work trips. Table 6.3 shows the observed usage together with the cycle usage.

Table 6.3 - Percentage Cycle Usage

Month	Observed Usage	Total Cycle Usage	All Other Uses	% Cycle Usage
August	22	5	17	23%
September	19	5	14	26%
October	28	13	15	46%
November	10	3	7	30%
December	7	1	6	14%
January	25	12	13	48%
February	14	4	10	29%
March	14	9	5	64%
April	11	6	5	55%
Total	150	58	92	39%

The percentage of cycle to work trips has been included in the last column and indicates that December 2014 saw the lowest percentage of cycle to work usage with only 14% of all EOTF usage. The highest percentage usage was during the month of January 2015 where 48% of all EOTF usage was cycle to work related. Overall, 39% of all EOTF visits were cycle related.

6.3. Influence of Weather

South Africa has a huge potential to become a cycling country as it has good weather and a population who enjoy sport and exercise (De Waal, 2012, p.308).

The term “Mediterranean climate” best describes the Cape Town climatic condition (Wikipedia, 2015a). Cape Town’s weather is mild, with moderately wet winters and warm summers. Winter is usually from June through to the end of August, during which time numerous cold fronts pass over the city, resulting in precipitation and strong north-westerly winds (Wikipedia, 2015b).

The climatic conditions during the survey period were obtained from a meteorological website (www.weatherspark.com) that provides weather services from around the world to the public in a variety of formats, including historical data. Through using their services it was possible to capture historical data from the nearest weather station, in this case the Cape Town International Airport, approximately 10 km away from the office. The minimum and maximum temperatures where captured together with the maximum wind speed and overall climatic conditions for each day. The data is presented in APPENDIX E – Weather Data and includes all days throughout the nine-month survey period, and has been utilised to identify the number of rainy or unfavourable days to ascertain if any patterns could be identified.

The following climatic conditions were analysed along with the cycle to work trips per day.

1) Temperature
2) Wind Speed
3) Precipitation

6.3.1. Temperature

The maximum and minimum temperatures were obtained for all weekdays throughout the survey period and this is shown in Figure 6.5. The maximum temperature (indicated in red) varies daily, although it is possible to see a gradual increase in maximum temperature between August 2014 (a winter month) and peaking at the end of February 2015 then gradually decreasing towards the end of the survey period. Similarly, the minimum temperature shows the same trend of lower temperatures in the winter months, and higher temperatures in the summer months. Also shown on a secondary axis is the number of cycle to work trips shown as green bars, each bar representing a day when an employee cycled to work. The height of the bar represents the number of cyclists observed that that day. Mid January 2015 for example indicates two days when three employees cycled to work.

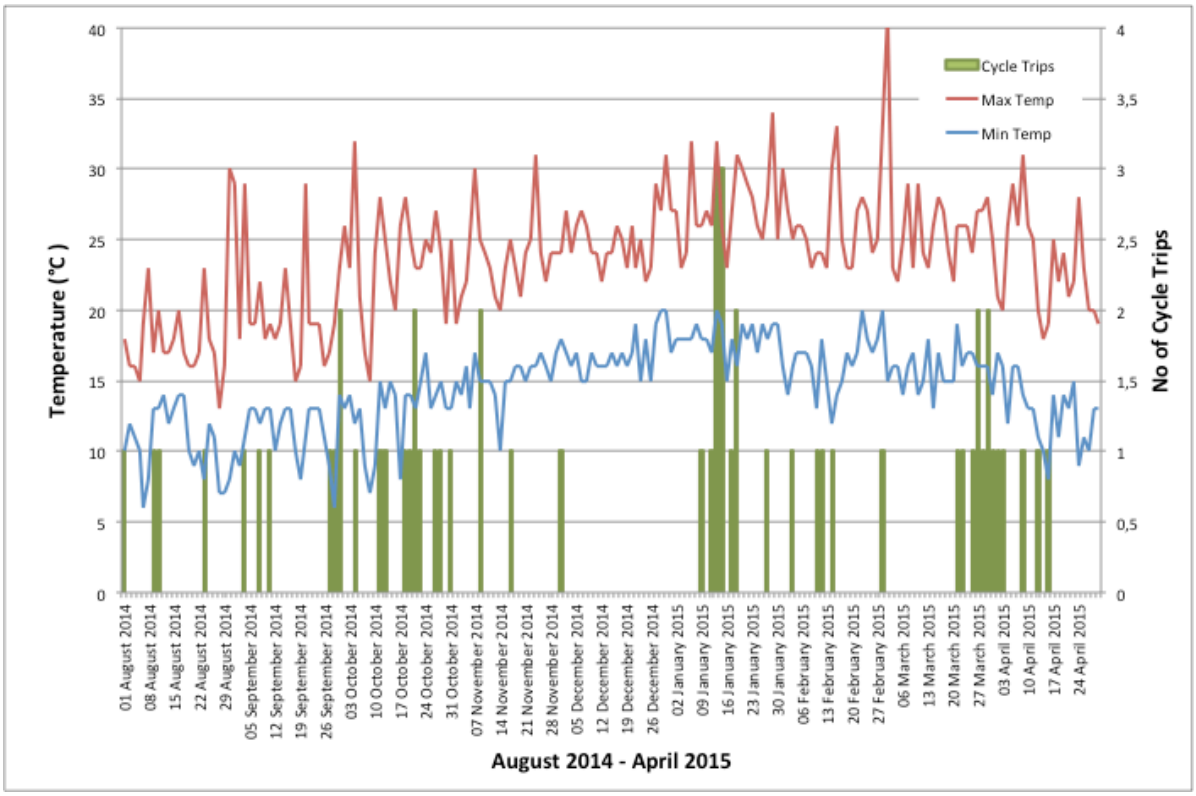


Figure 6.5 – Temperature Variance (August 2014 – April 2015)

Figure 6.6 and Figure 6.7 present the weekday temperature variance for the months of October 2014 and January 2015 respectively. The months of October 2014 and January 2015 were selected as they represented the highest cycle usage. The daily temperature variations are shown together with the cycle to work trips.

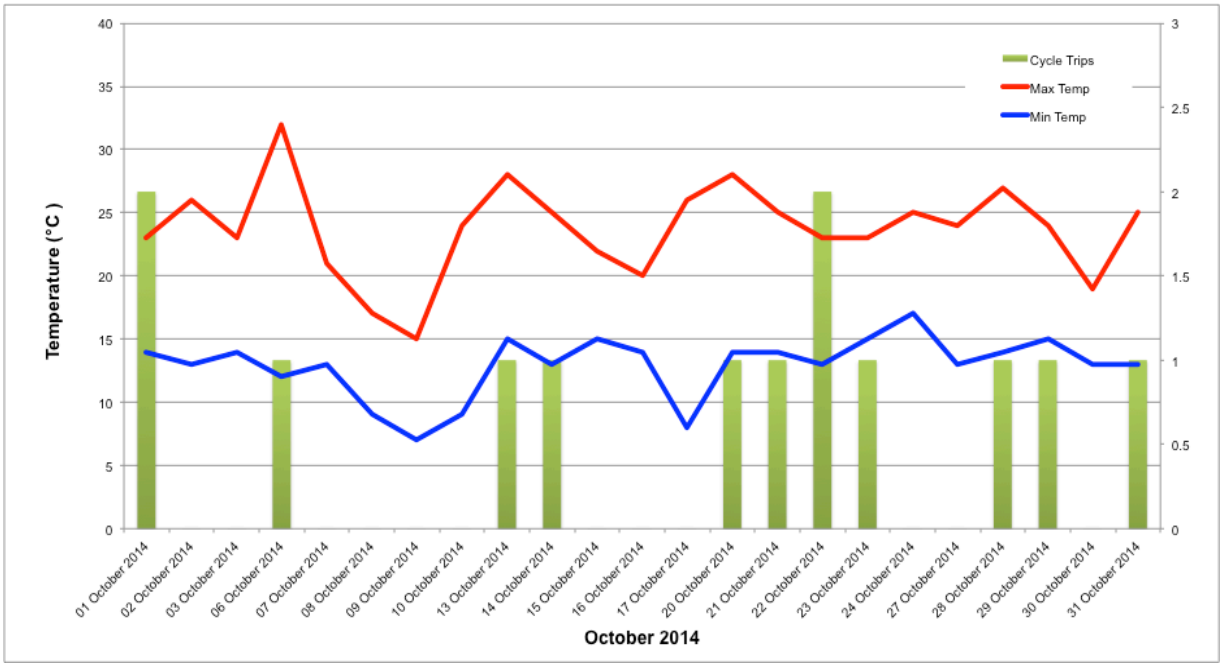


Figure 6.6 - Temperature Variance October 2014

Figure 6.6 indicates the that hottest weekday of the month was the 6th October 2014 (32°C), on which 1 person cycled to work (weekends have been removed as the Hatch Goba offices were closed). The coldest weekday of the month was the 9th October 2014 (15°C), and no employees cycled to work. A similar dip in temperature was observed on the 16th and 17th October 2014 and no employees were observed to cycle to work on those particular days. A third dip in temperature occurred on 30th October 2014 and is possibly the reason why no employees cycled to work on that particular day. In conclusion, it appears that cyclists prefer to cycle on warmer days.

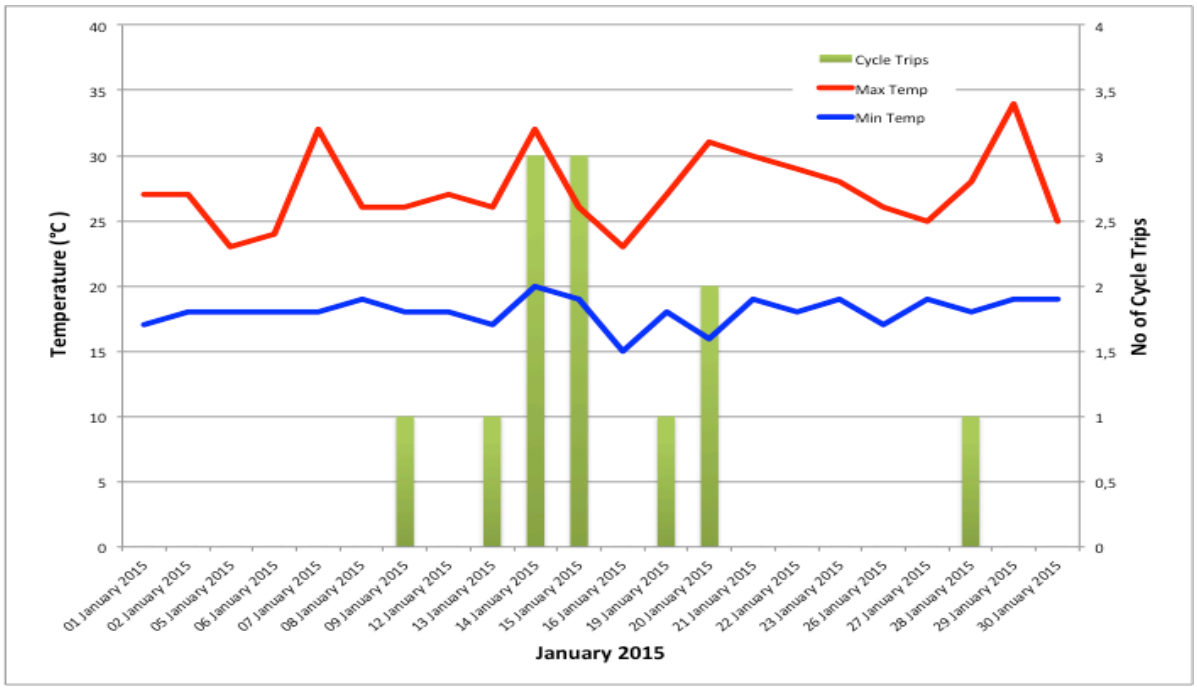


Figure 6.7 - Temperature Variance January 2015

The warmest days observed in January 2015 occurred on the 7th January 2015 (32°C), 14th January 2015 (32°C), 20th January 2015 (31°C) and 29th January 2014 (34°C). The employees returned to work on Monday the 5th January 2015 which accounts for no activity during the first week of January 2015. The 14th and 15th January 2015 indicates that three employees cycled to work which correlate well with favourable weather conditions. Similarly, two employees cycled on 20th January 2015, which again correlates with a warm day.

Overall, the fluctuation in temperature appears to correlate reasonably well with the days employees cycled to work suggesting that within this survey the employees were influenced by the weather. Section 6.4 explores temperature as well as other climatic informants when reviewing seasonal influences.

6.3.2. Wind Speed

A similar comparison to that of temperature was undertaken to measure wind speed to ascertain whether any behaviour patterns could be identified. Both the maximum wind speed and AM wind speed were obtained for all weekdays during the survey period. The AM wind speed was recorded at 8am for each day and represents the likely wind speed encountered by a commuter when they would leave their household to travel to work. The morning wind speeds are typically less than the afternoons as the atmosphere closest to the earth's surface is cooler and denser than the air higher up (Dave, 2008).

The AM and maximum wind speeds for the months of October 2014 and January 2015 are shown in Figure 6.8 and Figure 6.9 respectively (weekdays only).

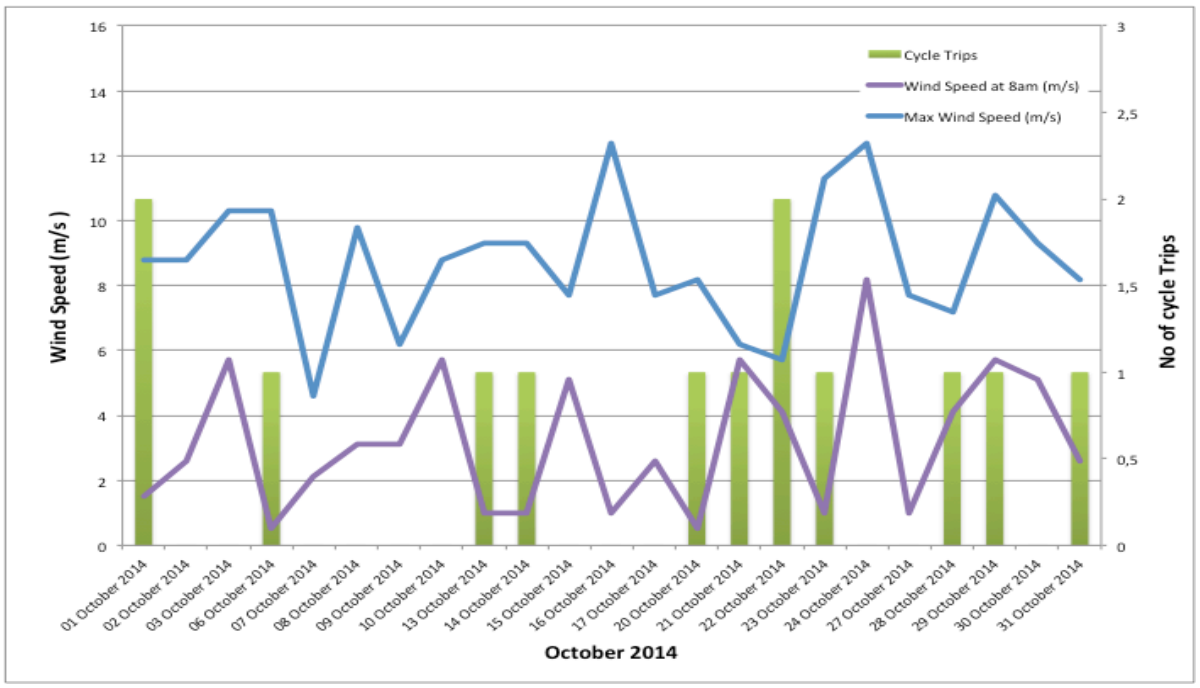


Figure 6.8 - Wind Speed October 2014

The graphs indicates that the maximum wind speed recorded has several peaks throughout the month. These peaks generally coincide with days when no cyclists

were observed. Comparison of the AM wind speed also supports this trend, despite the ratio between the AM and maximum wind speed being different on some days.

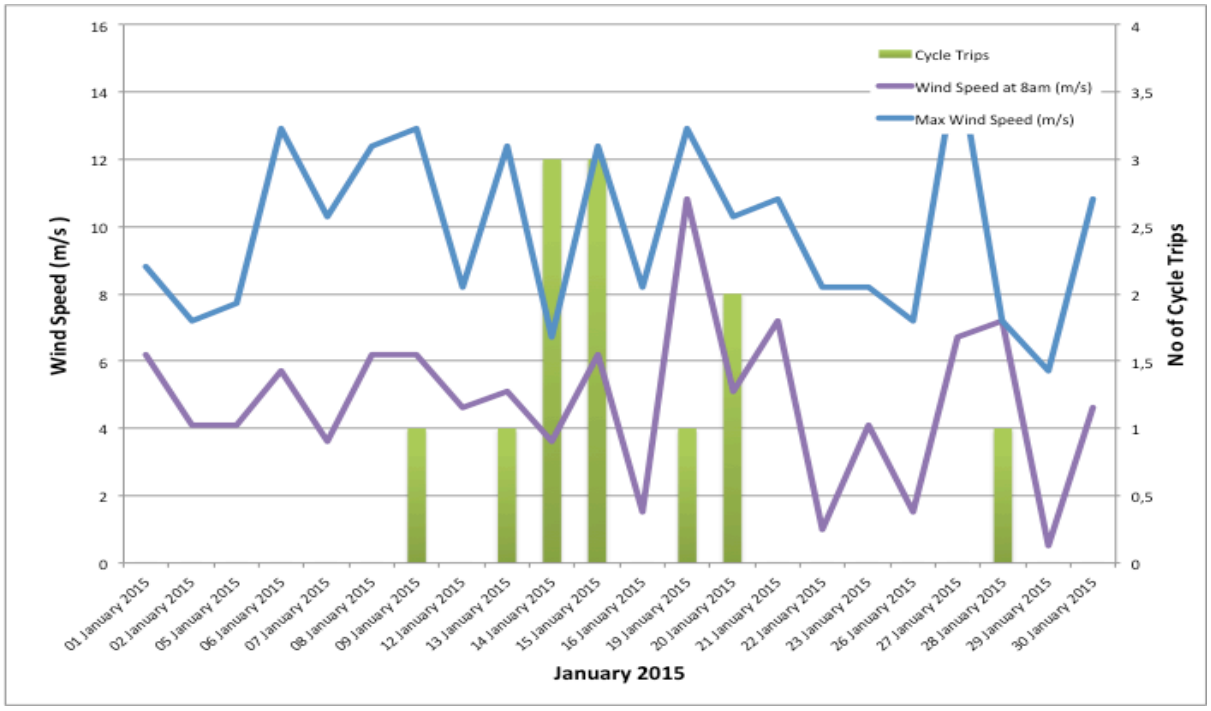


Figure 6.9 - Wind Speed January 2015

January is traditionally one of the windiest months in Cape Town and the data supports this statement. The windiest day occurred on 27th January 2015 (14.9 m/s) which is the second highest wind speed recorded during the survey. Several days experienced maximum wind speeds of nearly 13 m/s. The AM wind speed tracks the maximum wind speed profile.

The influence of wind speed on cycle to work trips does not reveal any specific trends. One possible reason could be that a commuter's decision to cycle to work is not based purely on wind speed, although wind speed is a contributing factor when deciding whether to cycle or not. It is perhaps shortsighted to use wind speed in isolation of other climatic characteristics such as temperature and precipitation.

6.3.3. Precipitation

Cyclists are directly exposed to the weather and heavy rain is considered the biggest deterrent for cyclists. (Ahmed et al., 2010) identified through a survey in Australia that 67% of cyclists indicate that heavy rain would deter them from cycling. The author is not aware of any cycle-related climatic studies conducted in South Africa, although the results from the Australian study could apply to South African cyclists. A possible reason why precipitation could be a strong deterring factor is that South Africa is overall a sunny country and the abundance of sunny days means that bicycle commuters can choose to be more selective and only ride on fair weather days.

Precipitation or rainfall levels were not available as the metering station does not measure the amount of rain, but merely indicates when precipitation occurs and the

intensity of that rainfall on an hourly basis. This data was however recorded and used to identify which days precipitation occurred. The information is shown for the months October 2014 and January 2015 in Figure 6.10 and Figure 6.11 respectively (weekdays only). The cycle trips are also shown using a secondary axis for comparative purposes. A precipitation day within the context of this survey is any day where precipitation occurred, irrelevant of the time of day it occurred, the intensity or duration of rainfall.

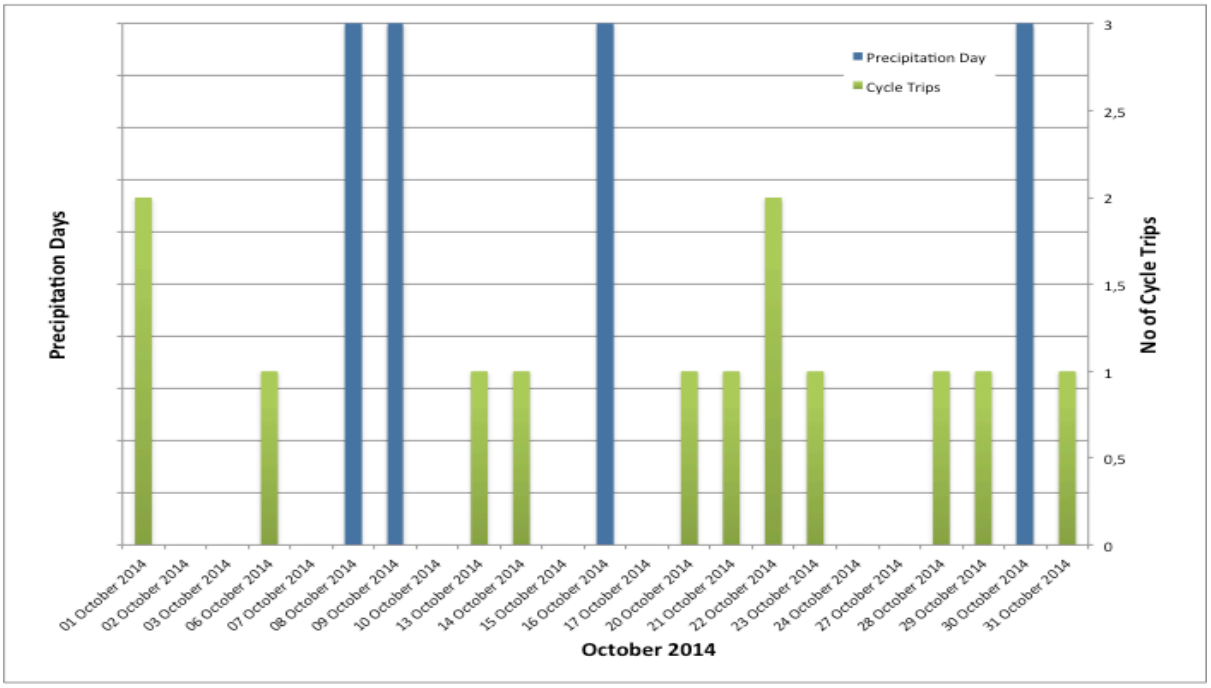


Figure 6.10 - Precipitation October 2014

The results indicate that during the month of October 2014, precipitation occurred on 4 working days. The inclusion of the cycle trips in the histogram indicates that on days when precipitation occurred, no cycle trips were made.

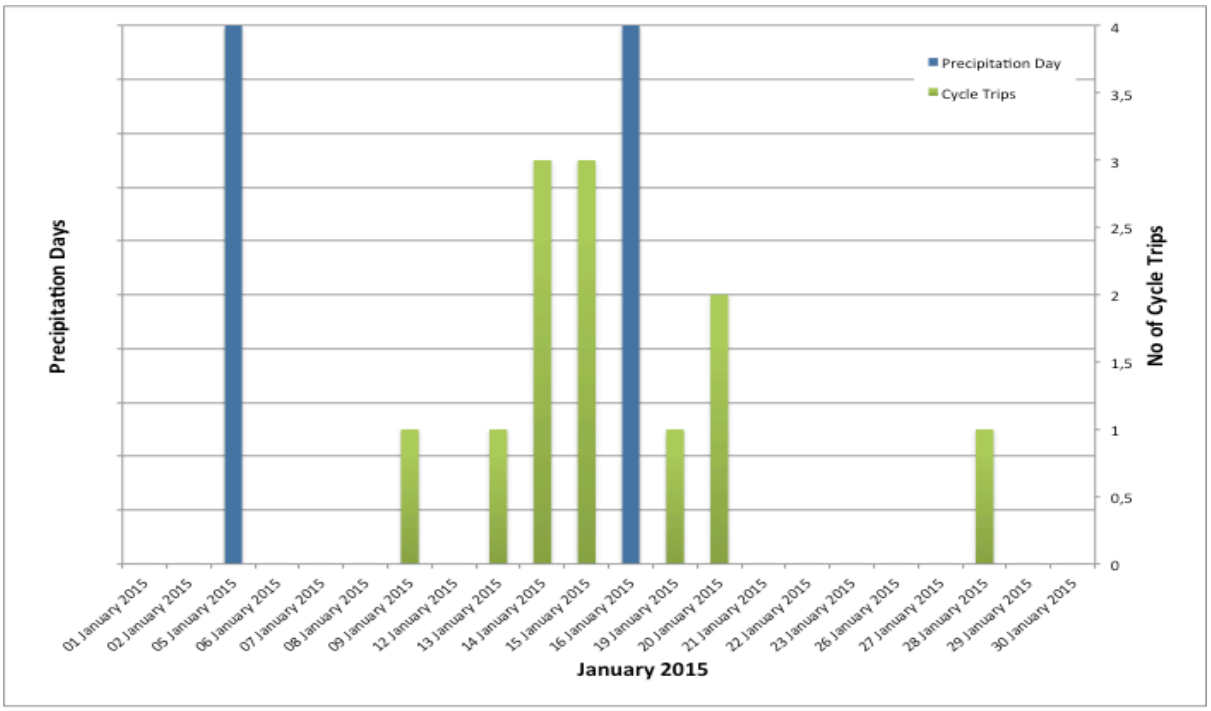


Figure 6.11 - Precipitation January 2015

Similarly to Figure 6.11, January 2015 experienced 2 precipitation days and on both these days no cycle trips were observed.

The results suggest that during these two months there was a strong correlation between rain days and cycling to work. Precipitation throughout the study period is discussed again in Section 6.4.

6.3.4. Humidity

Humidity is the amount of water vapour in the air and is an important indicator in understanding climatic conditions. Humidity is usually expressed as a percentage and represents the amount of water vapour in the air relative to what the air can hold (Williams, 2005).

The humidity for every weekday during the study was captured using the Weatherspark Website and the details are included in APPENDIX E – Weather Data. An initial review of the humidity data does not contribute to determining the climatic conditions which would influence a commuters decision to cycle to work or not. For this reason the humidity criteria is not included within this thesis, although the data has been included for completeness.

6.3.5. Summary of Climatic Influence

Although based on only a single study, the results indicate that South African commuter cyclists are influenced by climatic conditions. Temperature and wind speed both correlated well with the observed data for the months October 2014 and January 2015. No conclusions could be drawn from analysing humidity by itself.

One of the limitations of the observations is that the sample size is quite small, with only 48 cycle to work trips being made over a 9 month period. In order to substantiate the findings of this study, several similar studies needs to be undertaken across the country and their findings cross-referenced against the findings within this study. This research is an exploratory study that indicates that there are a number of aspects of cycling behaviour that need to be researched in greater detail.

A study in the USA by Flynn et al (2012) confirms that precipitation and temperature appeared to have a strong influence on commuting to work by bicycle.

6.4. Seasonal Influence

Section 6.3 described how climatic conditions can influence cycle trips on a day-to-day basis. Factors such as temperature, wind speed and rainfall all indicated to some extent (some more than others) that climatic conditions either encourage or deter employees from cycling to work.

A month-to-month comparison was undertaken to ascertain whether any seasonal influences could be observed. The results are presented in Figure 6.3 and do not confirm a reduction in EOTF usage during winter months when temperatures are lower and precipitation is more frequent. Unfortunately, the survey did not extend for a full year to better ascertain the seasonal influences. However, interpretation of the monthly survey results does not demonstrate seasonal fluctuations, but rather the opposite. Section 6.3 confirms the influence of climatic conditions, while the monthly analysis disputes the seasonal influence. The plausible explanation could be that the employees who chose to cycle, chose ‘favourable’ days throughout the year, rather than be guided by seasons. A favourable day in the context of this report is a day when

1) No precipitation occurred;
2) The wind speed is less than 20km/h (5.55m/s) at 8am in the morning;
3) The minimum temperature is above 8^{o}C; and
4) The maximum temperature is below 30^{o}C.

No international definition for a ‘favourable’ day exists as this varies from country to country. Cyclists in colder climates for example would be prepared to cycle even if it was raining and the minimum temperature was approaching zero.

January, which traditionally is the hottest month of the year, also indicated that cyclists chose ‘favourable’ days to cycle to work. The hypothesis then falls down when reviewing months February and March as these months usually have the highest ‘favourable’ days, but in reality showed a decline in cycle to work trips.

6.5. Distance to Work

It was previously established in Section 5.3.4 that the Employee Questionnaire required all employees from Hatch Goba to provide their home address or their temporary address while working at the office.

Of the 58 Hatch Goba employees, 5 employees (8.6%) lived more than 100 km away from the office and travelled to the office infrequently. The remaining 53 employees live between 50 km and 1.3 km from the office building.

Figure 6.12 shows the office location together with the home locations of Hatch Goba employees. All employee homes were plotted although the figure is centralised on the office and is zoomed to focus on those living within a reasonable cyclable distance to the office. The following information has been included

a) 2 km radius (small black circle)
b) 5 km radius (large black circle)
c) 5 km road based Isodistance (shaded in red)
d) Red dot - Home location of staff who never cycled to work
e) Yellow dot – Home location of staff who cycled to work occasionally (once a month)
f) Green dot – Home location of staff who cycled to work regularly (once a week)

The 2 km and 5 km radius is merely shown to provide a sense of scale. Research indicates that 5km is the accepted maximum distance people are prepared to cycle (Transport Canada, 2010). The road-based isodistance shows the area within a 5 km route distance to the office and extends to the suburbs of Edgemead to the Northwest, Welgemoed to the Northeast, Plattekloof Glen and N1 City to the West, Parow and Parow East to the South, and Tyger Valley to the East. The office park is located along the slopes of Tygerberg Hill, which essentially severs any East-West movement North of the office park. The road-based isodistance recognises this and as such the 5 km extent is almost the same as the 2km radius. Plattekloof Road is the dominant north south corridor and as such the road-based isodistance is close to the 5 km radius.

The figure indicates that 8 of the 58 (14%) employees would be ideal candidates to cycle to work. A further 5 employees started cycling to work on a regular basis (at least once a week), 3 live within the 5km radius (shown as green dots). A further 5 employees live within the 5km radius, but never cycled to work, for various reasons. The survey also revealed that 2 of the 58 Hatch Goba employees occasionally cycled to work (once a month) although they both live further than 5km away (see employee 10 and 42 shown as yellow dots).

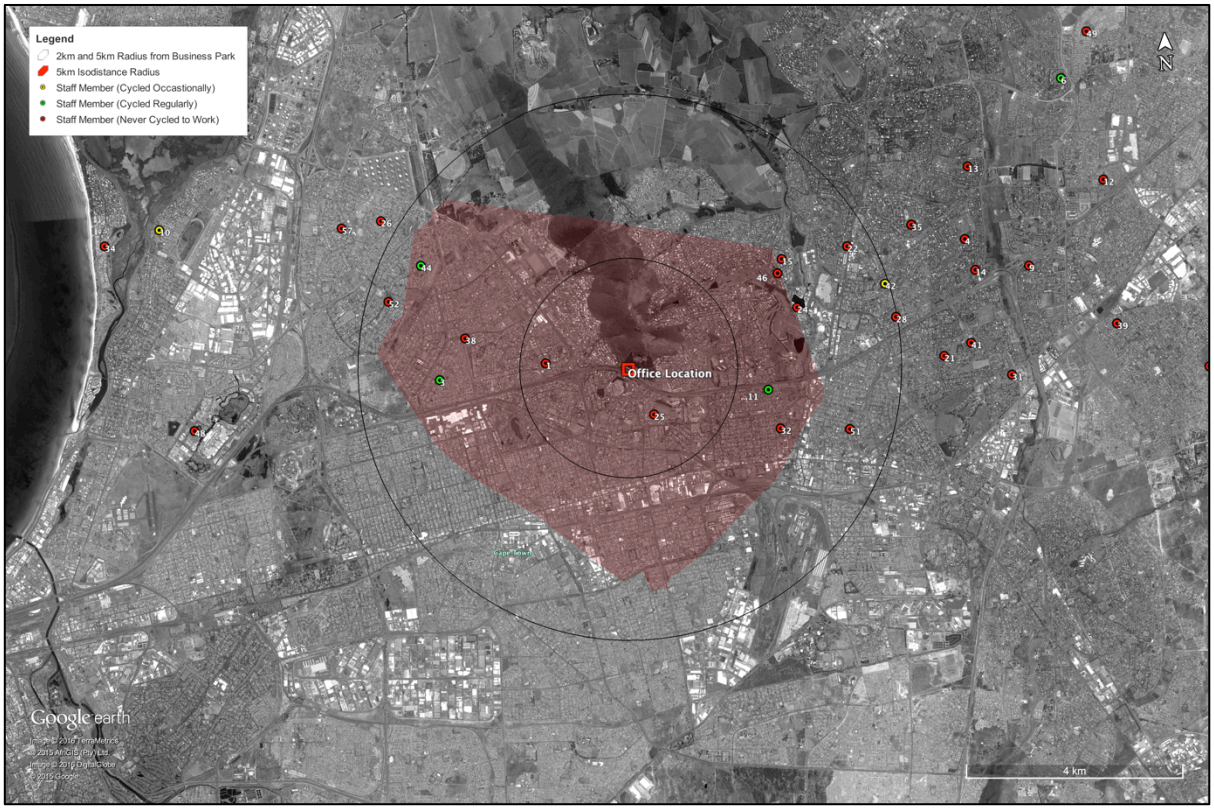


Figure 6.12 – Employees within 5km Radius of Office

In conclusion, distance to work is generally regarded as the major deciding criteria whether an employee would consider cycling to work. This study indicated that the majority of employees who chose to cycle lived further than 5 km from the office, but closer than 20 km.

6.6. Topography

Topography has a significant impact on commuter cycling. Cyclists prefer to avoid steep terrain or mountainous areas. Cyclists are influenced by road gradients and generally avoid any gradients steeper than 5% (6.67% for short distances) (Department of Transport, 2014, p.47). Almost all studies find that a flat topography benefits cycling together with the opportunity to use direct routes (Buehler & Pucher, 2011).

Within the Google Earth mapping software some Geographic Information System data is available to approximate the height above sea level. Google Earth uses Shuttle Radar Topographic Mission (SRTM) data to provide elevations which has a 30 m vertical accuracy at 90 m horizontal grid spacing (Hunter, 2010).

In the absence of detailed terrain mapping data Google Earth was utilised to determine the elevation change for those employees who live within the 5 km catchment but chose not to cycle to work within the study period.

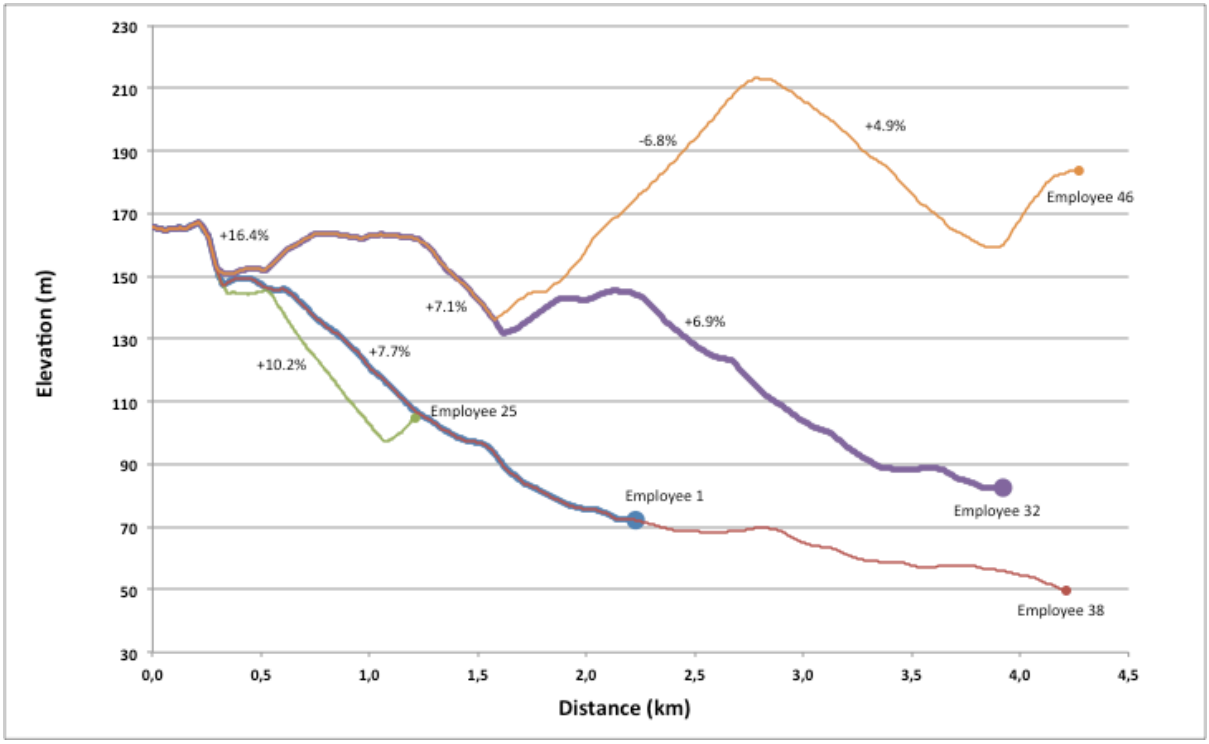


Figure 6.13 - Route to Work Profiles

Figure 6.13 shows the elevation profiles for the 5 employees who live within 5 km of the office previously mentioned in Section 6.5. The figure indicates that the office is approximately +165.89 m above sea level. All profiles except for employee 46 show predominantly uphill climb from their homes to the office. Employee 46 lives higher above sea level (+183.94 m) than the office, although the road network to the office requires a combination of up and down gradients.

Although the employees all live at different locations, some employees travel a portion of their journey along the same roads. As an employee approaches the office (final 300 m), all routes have merged which represents the access to the office park. The merging of journeys is represented in the figure as overlapping lines.

Table 6.4 shows the various topographical data for employees within 5 km cycle distance to the office and includes both the average and maximum gradients these employees would experience if they chose to cycle to work. Also included is the sum of uphills as well as the percentage uphill of the journey, which clearly demonstrates that all journeys are predominately uphill when travelling to work.

Table 6.4 - Employees Topographical Data

Employee	Distance from Office (m)	Home Elevation (m)	Elevation Change (m)	Sum of Uphill	% of Total	Maximum Gradient (measured over 100m)
Employee 1	2229	72	94	1976	89%	16.4%
Employee 25	1211	105	61	848	70%	16.4%
Employee 32	3921	83	83	2732	70%	16.4%
Employee 38	4215	50	116	3506	83%	16.4%
Employee 46	4271	184	-18	2140	50%	16.4%

The results indicate that although all employees live within 5 km to the office, their vertical climbs/drops will vary along the route. The maximum gradients have been calculated using a 100 m length of road to smooth out any anomalies in the terrain data and are included in the table. The position that the gradient was measured from differs between employees and a chainage column indicates the position chosen. The maximum gradients all exceeded 7% and confirms that although the distance to the office is short, the gradients required to negotiate all exceed the recommended desirable maximum.

Topography could therefore play a partial role in deterring employees from cycling.

6.7. Employee Questionnaire

Section 5.3.4 described the methodology for undertaking the questionnaire and the results are analysed below.

6.7.1. Age

Figure 6.14 shows the age distribution of employees and indicates that 82% of employees are between the ages 25 to 55. Cyclists can be of any age, although it is believed that employees under the age of 55 would be the target audience for cycling to work. International guidelines suggest that bicycle infrastructure should be designed in such manner that anyone between the ages of 8 to 80 so as to not preclude users wishing to cycle.

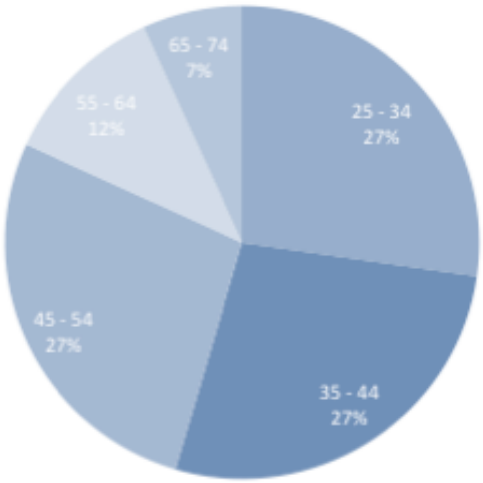


Figure 6.14 - Age Distribution

6.7.2. Bicycle Use

Employees were asked whether or not they use a bicycle and 52% answered yes to the question. Those employees who did use a bicycle were requested to define the usage, which is summarised in Figure 6.15.

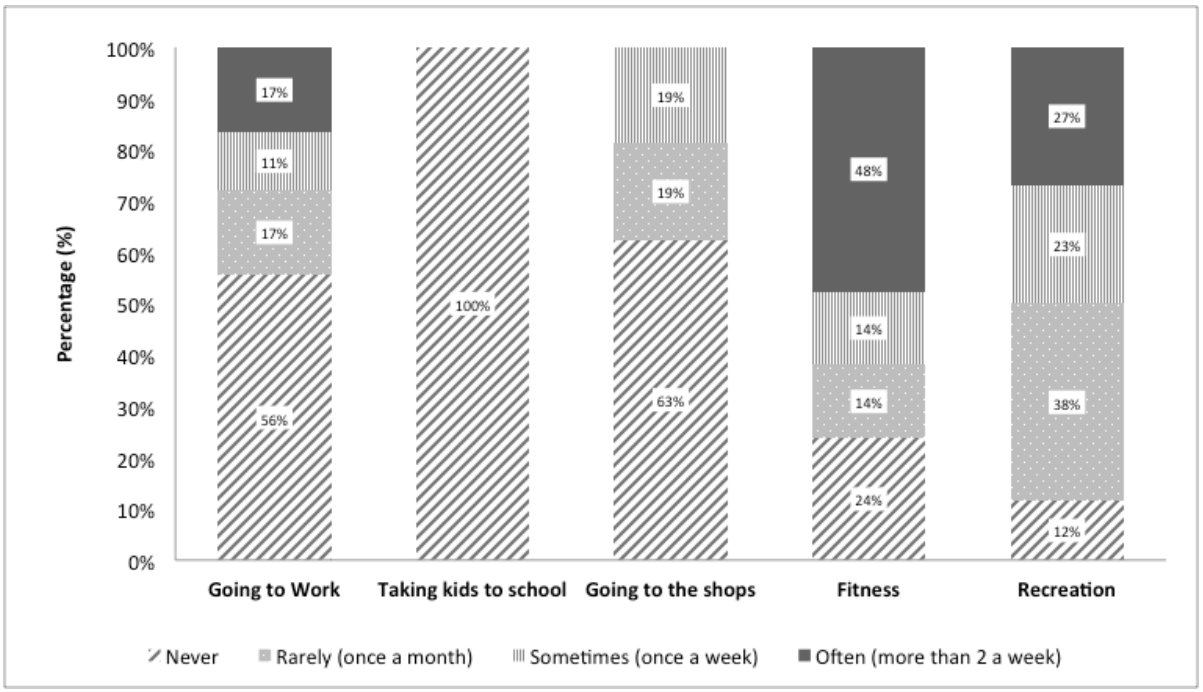


Figure 6.15 - Bicycle Use

Results indicate that 56% of employees who own or use a bicycle, have never used it to cycle to work. No employees used a bicycle to accompany their child to school. The majority of bicycle use was for fitness where 62% used their bike more than once a week. Recreation accounted for 50% of employees usage.

Interestingly, when the results are filtered by gender, only 18% of females owned a bicycle and the reasons are discussed in Section 6.7.7.

6.7.3. Cycle Infrastructure Safety

The common answer to the perceived safety of roads is it “It is too dangerous to cycle on our roads due to the volume of motorised traffic” (De Waal, 2012, p.308).

It is speculated that safety concerns are the primary reason why commuters refrain from cycling to work and although not the primary focus of this thesis, it remains a key factor.

Employees were asked to express their level of comfort when using various cycle infrastructure ranging from nothing at all (i.e. cycling with traffic) to cycling on segregated dedicated cycle paths. The results are presented in Figure 6.16.

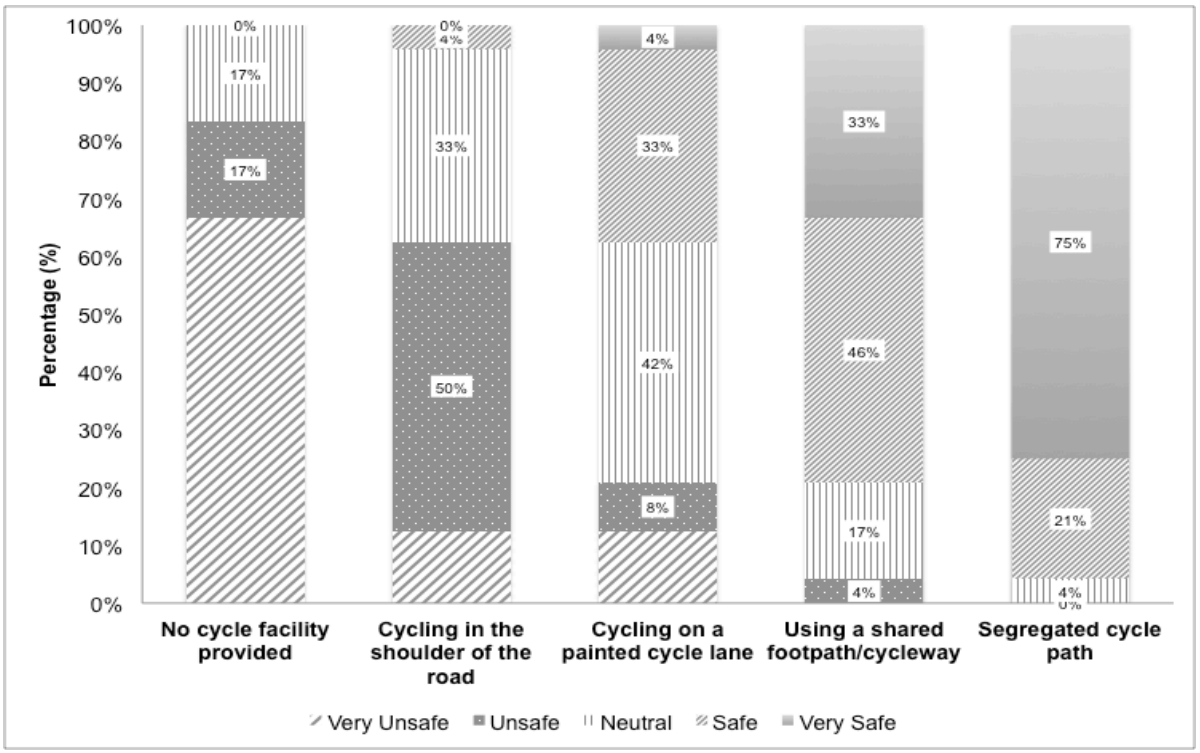


Figure 6.16 - Cycle Infrastructure Safety

The results are predictable with 67% of employees stating that they feel very unsafe cycling with vehicular traffic and no cycle facilities. Similarly, 75% stated that cycling on a segregated cycle path was perceived as very safe. Interestingly, using the shoulder of a road, which is required along Plattekloof Road, was deemed unsafe by 50% of employees. This percentage dropped to only 8% where a painted cycle lane is provided. It is therefore clear that commuters have a perception that painted cycle lanes are safer than road shoulders, despite being equally exposed to other road users.

Plattekloof Road is the nearest location of cycle lanes to the office and is part of the route the author would use to travel to the office. The author travels on this road daily, using a variety of modes including, private car, scooter, bicycle and walking. Plattekloof Road uses existing shoulders and has retrofitted cycle lanes by erecting appropriate signage and amended road markings to inform cyclists to use the shoulder for cycling. Plattekloof road has an 80 km/h speed limit and for the majority of its length the shoulder looks and behaves like a shoulder, rather than resembling a cycle lane. The speed limit is 80 km/h, and although the shoulder width is generous at 2.5 m, the speed differential between cyclist and motorist is high enough to raise concern to the cyclist.

6.7.4. Cycle Accidents

Figure 6.17 shows the percentage of employees who were involved in any type of cycling accident during the last 5 years. It is not known whether any fatal cycle-related accidents had occurred within the company. One employee (4%) reported to being in a serious cycling accident, while an additional 7 (27%) employees reported to being involved in a minor accident. No additional accident data was collected.

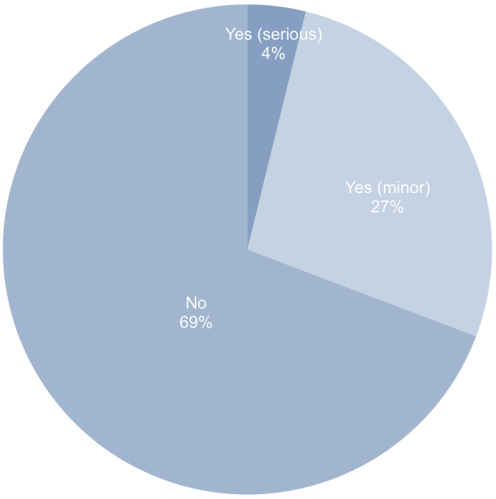


Figure 6.17 - Cycle Accidents

6.7.5. Interaction with Other Road Users

Hatch Goba employees were asked to express their safety concerns with regards to cycling with other road users in order to determine whether or not particular modes are perceived as more of a safety concern than others. Figure 6.18 indicates the employees "perceived" danger when interacting with other road users while cycling. The results confirm that the presence of pedestrians on the road is not a deterrent for those employees who wish to cycle to work. Buses and minibus taxis were perceived as being dangerous to cyclists and 48% answered that it prevents them from cycling to work. A further 50% answered that buses and minibus taxis were very off-putting. Similarly, employees expressed safety concerns with regards to cyclists interacting with HGV's on the road.

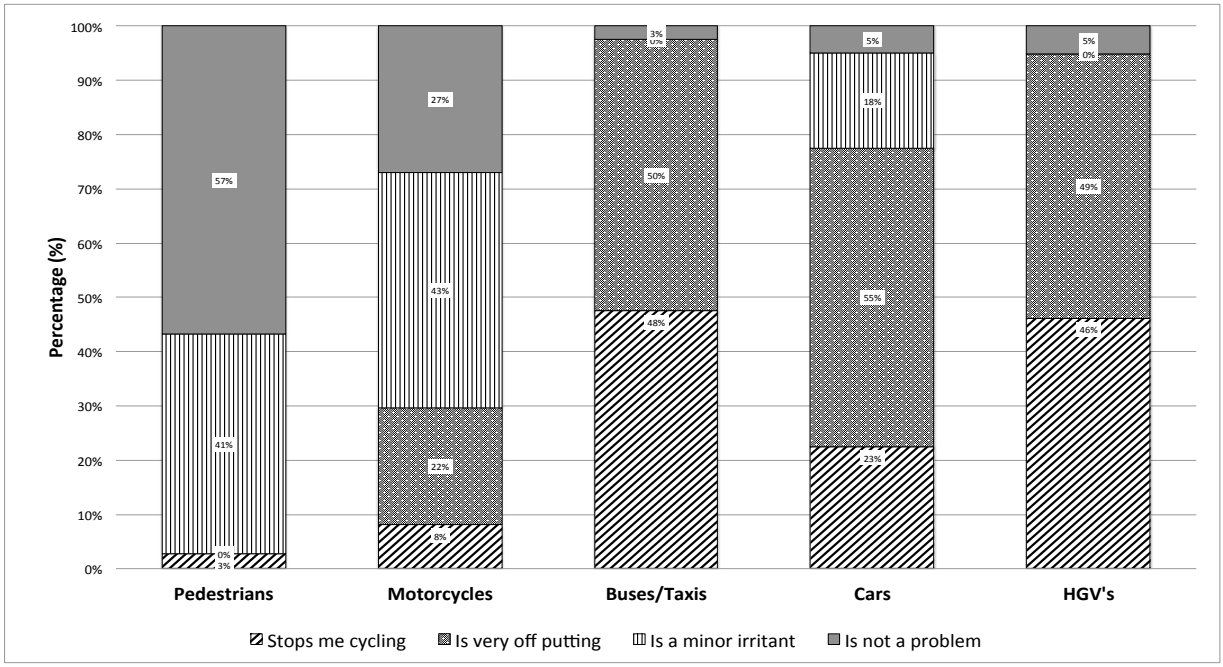


Figure 6.18 - Interaction with Other Road Users

6.7.6. Reasons for Not Cycling to Work

Employees were asked to provide reasons why they didn't cycle to work and to provide their level of discomfort for a variety of possible reasons. Six possible prohibitors were offered covering the most common reason deterring commuters from cycling to work and as shown in Figure 6.19.

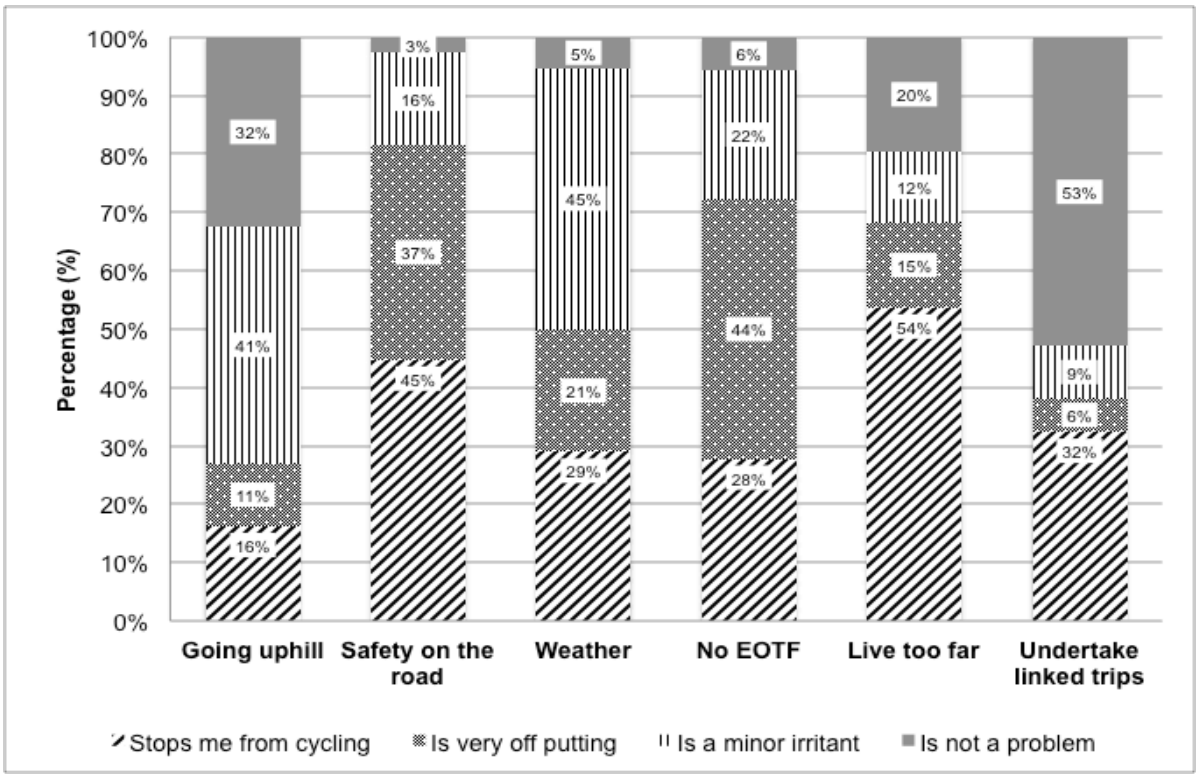


Figure 6.19 - Prohibitors to Cycling to Work

The reasons why some employees chose not to cycle to work include:

- Going uphill stops me from cycling (16%)
- Safety on the road stops me from cycling (45%)
- The weather stops me from cycling (29%)
- The lack of secure bicycle parking and inadequate changing facilities (28%)
- Living too far away to cycle (54%)
- Undertake linked trips (drop kids off or go to gym before work) (32%)

The results indicate that the primary reason preventing employees from cycling to work is the distance to the office. Unfortunately, this physical constraint is a limiting factor as no interventions (e.g. infrastructure provision, bike to work incentives or EOTFs) would enable these employees to cycle to work in the future. Therefore, future awareness campaigns should focus on those 6 employees who live nearby, but who choose not to cycle to work (10%) and those who use a bicycle, but not for work purposes (52%).

Safety on the road prevented 45% of employees from cycling to work and echoes the concerns raised in previous questions.

Interestingly, 26% of employees answered that the lack of EOTF's is currently preventing them from cycling to work, despite this questionnaire being undertaken after the official announcement informing employees of the availability of the EOTF. The questionnaire specifically mentioned the lack of secure bicycle parking, which is currently not available. The author is of the opinion that the employees who mentioned the lack of secure bicycle parking thought it important enough to prevent them from cycling.

Linked trips, (e.g. dropping child off at daycare/school en route to the office) accounted for 32% of employees stating that it prevents them from cycling to work.

6.7.7. Measures to Encourage Cycling to Work

Employees were asked to provide comments relating to initiative/measures that would encourage them to cycle to work. The answers varied but the 41 comments received were grouped accordingly and are presented in Table 6.5.

Table 6.5 - Measures to Encourage Cycling to Work

Comment	Number of comments received	%
More cycle lanes/well lit	9	22%
Safer roads/security	6	15%
Nothing	5	12%
Distance to work	5	12%
Better EOTF	2	5%
Free bike/ own a bike	2	5%
Self Motivation/Health Issues	2	5%
Lower vehicle volumes	2	5%
Safety awareness	2	5%
Pay for parking	1	2%
Electric bikes	1	2%
Public transport options	1	2%
Cycle buddy/group rides	1	2%
Required to drive for work	1	2%
Cost of petrol	1	2%
Total	41	100%

22% Employees suggested that the presence of more cycle lanes would encourage them to start cycling. Some employees emphasised that these cycle lanes needed to be of high quality and well lit for safety reasons for protection from both other road users as well as muggings.

The fact that employees perceive that the roads are not safe accounts for the second most popular issue needing to be addressed in order to persuade employees to begin cycling to work.

One female employee commented that a knee injury prevented her from cycling, indicating that health issues can be a limitation, preventing an employee's ability to cycle to work.

By reviewing the female responses, the results of the questionnaire confirmed that safety concerns are the primary measure that has to be addressed. Other measures include the option of cycling in a group and having high quality EOTF's. One employee mentioned a free bike as an incentive to cycle to work, which could be addressed through a cycle to work scheme as discussed in Section 3.7. Several incentives have emerged as companies continue to encourage employees to cycle to work. Some examples that have been implemented internationally include:

1) Providing Safe Bicycle Training – The employee survey has highlighted that safety is a major concern. Hosting a company-sponsored cycle safety training program could be a good way to install confidence in order for employees to start cycling to work;
2) Offering Free Bicycle Checks – Inviting a bike mechanic from the local bike shop to explain how to maintain your bicycle and check their bicycles and equipment to ensure helmets are adjusted correctly, brakes are sharp, etc.;
3) Cycle Buddy – Employees who cycle to work could offer to become a 'Buddy. These riders are all from the same area and accompany new riders for the first few rides to allow new cyclists to gain confidence and knowledge of the safest routes available. Company intranets and noticeboards can be useful for 'Buddy' connections;
4) Identifying Bike Champions – They are established bike-to-work employees and generally having a good knowledge of cycling in general, therefore they would be able to assist new cyclists with any questions they might have;
5) Marketing Cycle to Work Schemes – As discussed in Section 3.7 this scheme allows employees to purchase a bicycle and associated equipment;
6) Pool Car – Employers can provide car(s) for staff to share on days they might need a private vehicle;
7) Guaranteed Ride Home – Some employees are reluctant to cycle to work due to the weather, therefore some employers have offered a taxi ride home on days of inclement weather (i.e. heavy rain, strong winds);

7. CONCLUSIONS AND RECOMMENDATIONS

"I want to ride my bicycle bicycle bicycle; I want to ride my bicycle; I want to ride my bike; I want to ride my bicycle; I want to ride it where I like...; I don't believe in Peter Pan, Frankenstein or Superman; All I wanna do is bicycle, bicycle, bicycle..."

- Freddie Mercury, Queen (1978)

7.1. Conclusions

Globally cycling is on the increase. Cities are recognising the benefits that cycling can offer as a sustainable solution to reduce congestion, improve the health of those who cycle while at the same time reducing the impact on the environment. Cycling Cities have become synonymous with improved quality of life and cycling is no longer seen as transport for the poor, but rather transport for all. Since the 1940s cycling has slowly declined in favour of private cars and cheap fuel. In the last two decades however, regeneration and reurbanisation has helped citizens live closer to their destinations and reducing the need to travel long distances. This desire to live in urban areas provides a real opportunity to re-invent the bicycle as a primary mode of transport in cities and the time has come to 're-cycle' cities.

The objective of this thesis is to present the findings of a South African cycle to work case study and to highlight the importance of EOTFs.

Foremost, this thesis, in an attempt to focus on South African policies and practices, has highlighted the sheer lack of research that has been conducted on cycling in general in South Africa. In a country which hosts both the world's largest timed cycle race (Cape Town Cycle Tour) as well as one of the world's toughest mountain bike races (Cape Epic) it is untenable that such little data exists relating to cycling as a mode of transport. Furthermore, data where cycling information has been collected, cycling is rarely the primary focus of the study. This often results in only high level data being collected rather specifics, which in turn prohibits a deeper understanding of cyclists, their behaviour, and even latent demand.

It has been demonstrated that the current South African planning legislation lacks sufficient guidance and targets with regards to the promoting of cycling in South Africa and some shortfalls include:

<u>National Legislation</u>

- Draft National NMT Transport – Only a single policy exists that relates to cycling and merely requests that the environment be made cycle friendly. No action plan is provided that details how this policy is to be implemented and who is to made accountable for the promotion of this policy throughout South Africa;
- Department of Transport (DoT) NMT Facilities Guideline – although released in 2014, this guideline does not adequately promote EOTF's for cycling to work and does not provide guidance on the amount of bicycle parking for new building developments covering various land-uses;

- South African Parking Standards - Currently these standards only focus on vehicular parking and specifies a minimum parking provision. The international literature reviewed within this thesis demonstrated that numerous cities, in an attempt to encourage bicycle use, amended their car parking standards to limit car parking spaces associated with new developments by providing a maximum. Reducing the availability of car parking is one method, amongst a multitude of others, to promote a modal shift away from the private vehicle;

Provincial Guidelines

- Provincial NMT Strategy – It was highlighted that currently only 1 of the 9 provinces have an NMT Strategy in place to set long-term objectives for both Local and District Municipalities and to identify key NMT projects for further planning and funding;

Local Municipal Guidelines

- Car Parking Standards – All city car parking standards in South Africa currently require a minimum of parking for new developments. Only 1 municipality (City of Cape Town) have made provision to allow a reduction of car parking provision offset against bicycle parking provision;

General

- Green Building Council South Africa – Although not mandatory, bicycle parking standards do exist for those developments seeking Green Star accreditation. It was concluded that the requirements stipulated for Green Star accreditation are in line with international best practice and are reasonable;

It can be concluded that South African legislation relating to cycling needs to be updated and stricter obligations placed on municipalities to promote the cycling agenda where appropriate.

Currently in South Africa, 1.5% of all road deaths are cyclists, which does not support the perception that cycling in South Africa is dangerous. Safety concerns relating to interaction with other road users and well as personal safety while cycling were highlighted as part of the case study conducted in this thesis.

Internationally, cycle related research is being conducted around the world, not only in established cycle cities, but in cities such as Sydney and Sao Paulo, who has in recent years seen significant growth in cycling.

It is clear that cities that have successfully grown their cycling culture cannot attribute its success to a single change/project/intervention, but rather a combination of planning and policy changes along with the implementation of cycle specific projects and marketing/education.

The amendment of car parking guidelines and inclusion of bicycle parking standards of a variety of cities and countries has been discussed.

Cycling to work has been shown to offer a multitude of benefits not only to the employee but also the employer. Some general benefits of cycling include:

1) Health – cycling not only improves fitness, but also reduces health related conditions such as obesity, stress, high blood pressure, diabetes and depression;
2) Safety – although road safety is one of the primary deterrents prohibiting commuters from cycling to work, the available accident statistics do no support the perception that cycling is dangerous. International studies have shown that cycling could become safer as more people cycle;
3) Cost – Cycling offers cost savings to the employee as it is a cheap form of transport when comparing the cost of a private car. Cycling infrastructure is also significantly cheaper to construct if compared to the cost of constructing a road;
4) Quality of Life – Noise pollution negatively affects the quality of life of those working and living within cities and cycling can reduce the number of cars moving through a city. Cycling also allows users to feel more connected to the community they live/commute within;
5) Environmental – Cycling is one of the cleanest modes of transport, thereby helping to reduce air pollution and carbon emissions;
6) Space – Bicycles occupy significantly less space than cars both on the road and when parked.

Undertaking a benefit to cost analysis for cycling to work proved difficult as evaluating the indirect benefits such as health and space for example required economic statistics which could not be obtained.

The case study undertaken at a business complex in Cape Town was used to monitor commuter behaviour relating to cycling to work through the introduction of an EOTF and associated marketing. The case study observed the following:

- At the time the survey commenced none of the Hatch Goba employees were aware that an EOTF was available for use in an adjacent building;
- No Hatch Goba employees cycled to work prior to the start of the survey;
- Employees of other organisations (non-Hatch Goba) were aware that an EOTF was available and it was in daily use prior to the survey commencing;
- Announcing the availability of an EOTF to Hatch Goba employees encouraged 8 of the 58 Hatch Goba employees (14%) to cycle to work (with varying frequency) who prior to the survey used their private vehicle to drive to work;
- Of the 8 Hatch Goba employees (14%) who live within a 5 km radius of the office, 3 employees cycled to work occasionally. They represent 37% of all Hatch Goba employees who are considered to live within a reasonable cyclable distance to the office;
- Data relating to temperature, wind speed, humidity and precipitation was obtained for all days during the survey period from a nearby weather station and indicated that weather played a significant role as a deciding factor if an employee chose to cycle to work;

  - Temperature – Maximum and minimum daily temperatures were compared with the number of users of the EOTF on a daily basis. Generally hot and cold days correlated with lower usage of the EOTF;
  - Wind speed – Maximum morning win speeds were compared with the EOTF daily usage. Generally days when wind speeds were high correlated with days when fewer employees used the EOTF;
  - Humidity – no correlation could be found between this weather informant and EOTF usage;
  - Precipitation – days on which precipitation occurred was compared with EOTF usage and indicated that a good correlation exists between the two.
- The variations in topography was measured for all employees living within a 5km distance of the business complex who did not attempt to cycle to work during the study period (5 employees). The results indicated that all employees would need to negotiate steep gradients in excess of 16% which far exceeds the recommended maximum of 5%. Topography was therefore considered one of the reasons prohibiting some employees from cycling to work.

A questionnaire survey was conducted for all Hatch Goba employees to identify personal information as well as perceptions relating to cycling to work and some key conclusions identified:

- 82% of employees are between the ages 25 to 55;
- 56% of employees own or use a bicycle;
- No employees used a bicycle to accompany their child to school;
- 62% of employees who owned a bicycle used it for fitness purposes more than once a week and similarly 50% used their bike for recreation purposes;
- 67% of employees stated that sharing the road with vehicular traffic without some sort of protection made them feel very unsafe. 75% Stated that cycling on a segregated cycle path was perceived as very safe;
- One employee reported a serious cycling accident while an additional 7 employees reported to being involved in a minor cycling accident;
- Buses and minibus taxis were perceived as being the most dangerous vehicles on the road that could be a danger to cyclists and 48% mentioned that this particular reason stops them from cycling to work;
- Employees were asked to categorise the reasons that prevents them from cycling to work. The findings indicate that 45% of employees consider safety on the road as their primary deterrent, while distance accounted for 54% of employees not cycling to work. 28% of employees stated that the lack of a secure lockup facility deterred them from cycling to work;
- 22% Employees suggested that more cycle lanes would encourage them to cycle to work.

To conclude, the introduction of an EOTF has benefited the 8 employees who attempted to cycle to work and they nowhave the option to choose whether to drive or cycle to work.

7.2. Recommendations

The following recommendation are made:

Realignment of Current Legislation

- Car Parking Standards to be reviewed, compared to international standards and updated accordingly to reflect
    - Changes in vehicle sizes;
    - Changes in town planning –For example mixed use developments which offer opportunities to share car parking spaces, or developments promoting working from home opportunities;
    - Inclusion of bicycle Parking Standards within the car parking standards and for the new standard to refer to all forms of parking, not specifically car or bicycle parking;
    - Amend minimum car parking provision to either a maximum or provide a minimum and maximum range to provide opportunities to reduce car parking when motivated;
    - Review parking standards every 5 years to ensure best practice principles are promoted on an ongoing basis.
- Development of a Cycling Strategy for all major cities who have, through their planning legislation, demonstrated their willingness to promote cycling. It is further recommended that National Government provide financial support for development of these strategies to ensure that the necessary surveys and research are undertaken to achieve the objectives and goals set within the strategy;
- EOTFs should be legislated as a mandatory requirement for all new office developments. The level of provision should depend on the size of the development and number of employees. It is further recommended that the bicycle parking numbers and EOTF requirements set out by the Green Building Council be adopted rather than have different standards which would conflict and undermine the excellent work that the Green Building Council has done relating to the promotion of cycling;
- The minimum provisions are
    - Bicycle Parking - Secure storage for 3% of building staff (based on one person per 15 m^2);
    - Changing Rooms - Changing facilities adjacent to showers
    - Lockers - 1 secure locker per bicycle space in the changing facilities
    - Showers - Accessible showers based on 1 per 10 bicycle spaces
    - Signage – Suitable and clear signage should be provided from the public road to the secure lockup facility
- Appropriate guidance should be made available showcasing examples of good practice together with minimum facilities to encourage high quality facilities;
- It is essential that bicycle parking design and EOTFs should be included in the early planning stages of any new office development to ensure sufficient

space requirements, access by bicycle and integration within the building are considered;

- Recommended and minimum EOTFs should be included in the Draft National NMT Transport Policy and the relevant municipal guidelines.

The research presented was not meant to cover all aspects of cycling. Rather, in the absence of very little cycling data in South Africa it should be treated as a starting point for further research. Future research areas include:

- Commissioning of cycle to work surveys at multiple developments to obtain a wider sample selection;
- Development of a cycle specific Benefit-Cost analysis for South Africa to evaluate the benefits of cycling quantitatively.

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APPENDIX A – MASTERS THESIS PROPOSAL

END-OF-TRIP FACILITIES FOR CYCLISTS AND REALIGNMENT OF CURRENT SOUTH AFRICAN BICYCLE LEGISLATION

G. RANDALL

PROBLEM STATEMENT

The Department of Transport[1], Provincial Governments[2] and Municipalities[3] have all either developed or are in the process of developing, a Non-Motorised Transport Plan/Policy/Strategy/Masterplan in response to addressing Travel Demand Management and to promote the use of Public Transport and NMT. Current building codes and planning legislation[4] require all new developments to provide vehicular parking[5] to cater for the anticipated use. However, at present, no legislation exists to encourage/compel new developments to provide any cycle parking or cycle facilities (shower, changing room, lockers). In this thesis, it is postulated that any NMT infrastructure or awareness project is limited, as potential cyclists do not have suitable End-of-trip facilities[6], which would discourage them from undertaking this journey and they would therefore be more inclined to continue to use their private vehicle.

This thesis therefore explores the current South African legislation and highlights potential inhibiters to creating a modal shift towards NMT. A review of international best practice is used for comparative purposes.

A case study of an existing business complex without end-of-trip facilities is given, and the behavioural change measured following the introduction of some end-of-trip facilities is analysed.

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[1] Draft National Non-Motorised Transport Policy, December 2008

[2] Non-Motorised Transport in the Western Cape Draft Strategy, March 2009

[3] City of Cape Town Inner City Transport Plan, June 2014

[4] City of Cape Town Zoning Scheme, Planning and Building Development Management, November 2012

[5] Parking Standards that can work in South Africa, Prof Bester, July 2012

[6] End-of-Trip Facilities for Bicycle Riders, Queensland Government, June 2006

APPENDIX B – EXAMPLE OF BENEFITS AND COST FOR CYCLING

Direct Cost Savings

'Commuter A' decides to cycle to work; by cycling he calculates that over the year he would save approximately 3000 km of car travel kilometres using the following calculation.

- Distance to work = 5km
- Number of working days in 2015 = 251days
- Distance travelled for errands = 10km per week

$$Distance = (5 * 2 * 251) + (10 * 52) = 2510 + 520 = 3030 km\ per\ year$$

1) Insurance - The reduction is kilometres travelled reduced and no longer requiring his/her car to be parked in a public car park each day, thus reducing the risk of break-in or theft, reduced his/her insurance by R100/month;
2) Petrol savings – The average price for a litre of petrol in South Africa is R12.46 (Automobile Association South Africa, 2015a). Typical fuel consumption for a 2015 Volkswagen Golf is 6.0 litres/100 km (NAAMSA, 2015). This equates to R2265 per year saving;
3) Parking costs – Daily parking cost is R20/day (Parkopedia, 2015) so a R5020 per year saving;
4) Car servicing – The Average Running Cost was used which estimates a R1.60/km maintenance cost, equating to a R4848 per year saving (Automobile Association South Africa, 2015b).

The total savings to 'Commuter A' therefore totals R13 333 per year. This example, although rudimentary, shows the likely direct savings to a commuter. They exclude the indirect benefits cycling offers such as health, time and the environment.

Reduction in CO_2 Emissions

In addition to his financial savings and improved health his carbon emissions are significantly reduced as a result of cycling. The 2015 Volkswagen Golf has a claimed CO_2 emission of 139g/km CO_2 (NAAMSA, 2015), equating to 421kg of CO_2 per year (based on 3030 km travelled per year).

Carbon Tax Savings

The National Treasury suggests a tax of R75 per ton of CO_2 be appropriate should carbon taxing be implemented in South Africa. Commuter A would therefore only save R31.50 (421 x 75) per year in addition to the over savings mentioned above.

APPENDIX C – CHANGING ROOM AND SHOWER LOGBOOK

Entry	Entry for month	Date	Time Period	Name	Company	Mode
1	1	01 August 2014	AM	External 1	DR Power	Walk
2	2	01 August 2014	AM	Employee 44	Hatch	Cycle
3	3	03 August 2014	AM	External 1	DR Power	Run
4	4	05 August 2014	AM	External 1	DR Power	Walk
5	5	06 August 2014	AM	External 1	DR Power	Walk
6	6	07 August 2014	AM	External 1	DR Power	Walk
7	7	09 August 2014	AM	External 5	Transnet	Cycle
8	8	11 August 2014	AM	Employee 6	Hatch	Cycle
9	9	12 August 2014	AM	External 1	DR Power	Walk
10	10	12 August 2014	AM	Employee 6	Hatch	Cycle
11	11	15 August 2014	AM	External 1	DR Power	Walk
12	12	18 August 2014	AM	External 1	DR Power	Walk
13	13	19 August 2014	AM	External 1	DR Power	Walk
14	14	20 August 2014	AM	External 1	DR Power	Walk
15	15	21 August 2014	AM	External 1	DR Power	Walk
16	16	22 August 2014	AM	External 1	DR Power	Walk
17	17	25 August 2014	AM	External 4	Transnet	Walk
18	18	25 August 2014	AM	Employee 44	Hatch	Cycle
19	19	26 August 2014	AM	External 1	DR Power	Walk
20	20	27 August 2014	AM	External 1	DR Power	Walk
21	21	28 August 2014	AM	External 1	DR Power	Walk
22	22	29 August 2014	AM	External 1	DR Power	Walk
23	1	01 September 2014	AM	External 1	DR Power	Walk
24	2	03 September 2014	AM	External 4	Transnet	Other
25	3	04 September 2014	AM	External 1	DR Power	Walk
26	4	04 September 2014	AM	Employee 6	Hatch	Cycle
27	5	05 September 2014	AM	External 1	DR Power	Walk
28	6	06 September 2014	AM	External 1	DR Power	Run
29	7	08 September 2014	AM	External 1	DR Power	Walk
30	8	09 September 2014	AM	Employee 6	Hatch	Cycle
31	9	10 September 2014	AM	External 1	DR Power	Walk
32	10	11 September 2014	AM	External 1	DR Power	Walk
33	11	11 September 2014	AM	Employee 6	Hatch	Cycle
34	12	15 September 2014	AM	External 1	DR Power	Walk
35	13	17 September 2014	AM	External 1	DR Power	Walk
36	14	19 September 2014	AM	External 1	DR Power	Walk
37	15	23 September 2014	AM	External 1	DR Power	Walk
38	16	26 September 2014	AM	External 1	DR Power	Walk
39	17	29 September 2014	AM	External 1	DR Power	Walk
40	18	29 September 2014	AM	Employee 44	Hatch	Cycle
41	19	30 September 2014	AM	Employee 44	Hatch	Cycle

Entry	Entry for month	Date	Time Period	Name	Company	Mode
42	1	01 October 2014	AM	External 1	DR Power	Walk
43	2	01 October 2014	AM	Employee 6	Hatch	Cycle
44	3	01 October 2014	AM	Employee 44	Hatch	Cycle
45	4	02 October 2014	AM	External 1	DR Power	Other
46	5	03 October 2014	AM	External 1	DR Power	Other
47	6	06 October 2014	AM	External 1	DR Power	Other
48	7	06 October 2014	AM	Employee 44	Hatch	Cycle
49	8	09 October 2014	AM	External 1	DR Power	Walk
50	9	10 October 2014	AM	External 1	DR Power	Other
51	10	13 October 2014	AM	External 1	DR Power	Other
52	11	13 October 2014	AM	Employee 6	Hatch	Cycle
53	12	14 October 2014	AM	Employee 6	Hatch	Cycle
54	13	14 October 2014	Lunchtime	Employee 37	Hatch	Run
55	14	15 October 2014	AM	External 1	DR Power	Other
56	15	20 October 2014	AM	External 1	DR Power	Other
57	16	20 October 2014	AM	Employee 47	Hatch	Cycle
58	17	21 October 2014	AM	Employee 47	Hatch	Cycle
59	18	22 October 2014	AM	Employee 44	Hatch	Cycle
60	19	22 October 2014	AM	Employee 47	Hatch	Cycle
61	20	23 October 2014	AM	External 1	DR Power	Other
62	21	23 October 2014	AM	Employee 47	Hatch	Cycle
63	22	23 October 2014	Lunchtime	Employee 37	Hatch	Run
64	23	24 October 2014	AM	External 1	DR Power	Other
65	24	28 October 2014	AM	Employee 47	Hatch	Cycle
66	25	28 October 2014	AM	External 1	DR Power	Other
67	26	29 October 2014	AM	Employee 6	Hatch	Cycle
68	27	29 October 2014	Lunchtime	Employee 37	Hatch	Run
69	28	31 October 2014	AM	Employee 37	Hatch	Cycle
70	1	10 November 2014	AM	Employee 6	Hatch	Cycle
71	2	10 November 2014	AM	Employee 44	Hatch	Cycle
72	3	11 November 2014	AM	External 1	DR Power	Other
73	4	14 November 2014	AM	External 1	DR Power	Other
74	5	17 November 2014	AM	External 1	DR Power	Other
75	6	18 November 2014	AM	Employee 6	Hatch	Cycle
76	7	19 November 2014	AM	External 1	DR Power	Other
77	8	21 November 2014	Lunchtime	Employee 37	Hatch	Run
78	9	26 November 2014	AM	External 1	DR Power	Other
79	10	26 November 2014	Lunchtime	Employee 37	Hatch	Run
80	1	01 December 2014	AM	External 1	DR Power	Other
81	2	02 December 2014	AM	Employee 6	Hatch	Cycle
82	3	05 December 2014	AM	External 1	DR Power	Other
83	4	06 December 2014	AM	External 1	DR Power	Other
84	5	08 December 2014	PM	External 2	Paratus	Run
85	6	12 December 2014	AM	External 1	DR Power	Other

Entry	Entry for month	Date	Time Period	Name	Company	Mode
86	7	15 December 2014	AM	External 1	DR Power	Other
87	1	05 January 2015	Lunchtime	Employee 10	Hatch	Run
88	2	07 January 2015	AM	External 1	DR Power	Other
89	3	07 January 2015	Lunchtime	Employee 10	Hatch	Run
90	4	08 January 2015	AM	External 1	DR Power	Other
91	5	09 January 2015	AM	Employee 44	Hatch	Cycle
92	6	12 January 2015	AM	External 1	DR Power	Other
93	7	13 January 2015	AM	Employee 6	Hatch	Cycle
94	8	14 January 2015	AM	Employee 3	Hatch	Cycle
95	9	14 January 2015	AM	Employee 6	Hatch	Cycle
96	10	14 January 2015	AM	Employee 44	Hatch	Cycle
97	11	15 January 2015	AM	Employee 3	Hatch	Cycle
98	12	15 January 2015	AM	Employee 44	Hatch	Cycle
99	13	16 January 2015	AM	External 1	DR Power	Other
100	14	16 January 2015	Lunchtime	Employee 10	Hatch	Run
101	15	19 January 2015	AM	External 1	DR Power	Other
102	16	19 January 2015	AM	Employee 3	Hatch	Cycle
103	17	20 January 2015	AM	Employee 6	Hatch	Cycle
104	18	20 January 2015	AM	Employee 3	Hatch	Cycle
105	19	20 January 2015	Lunchtime	Employee 10	Hatch	Run
106	20	15 January 2015	AM	Employee 3	Hatch	Cycle
107	21	22 January 2015	AM	External 1	DR Power	Other
108	22	27 January 2015	AM	External 1	DR Power	Other
109	23	28 January 2015	AM	Employee 10	Hatch	Cycle
110	24	29 January 2015	AM	External 1	DR Power	Other
111	25	30 January 2015	AM	External 1	DR Power	Other
112	1	02 February 2015	AM	External 1	DR Power	Other
113	2	03 February 2015	AM	External 1	DR Power	Other
114	3	04 February 2015	AM	External 1	DR Power	Other
115	4	04 February 2015	AM	External 3	Paratus	Cycle
116	5	05 February 2015	AM	External 1	DR Power	Other
117	6	10 February 2015	AM	External 1	DR Power	Other
118	7	11 February 2015	AM	Employee 44	Hatch	Cycle
119	8	12 February 2015	AM	External 1	DR Power	Other
120	9	12 February 2015	AM	Employee 44	Hatch	Cycle
121	10	16 February 2015	AM	External 1	DR Power	Other
122	11	16 February 2015	AM	Employee 44	Hatch	Cycle
123	12	19 February 2015	AM	External 1	DR Power	Run
124	13	23 February 2015	AM	External 1	DR Power	Other
125	14	25 February 2015	AM	External 1	DR Power	Other
126	1	02 March 2015	AM	Employee 6	Hatch	Cycle
127	2	06 March 2015	AM	External 1	DR Power	Other
128	3	11 March 2015	AM	External 1	DR Power	Other
129	4	23 March 2015	AM	External 1	DR Power	Other

Entry	Entry for month	Date	Time Period	Name	Company	Mode
130	5	23 March 2015	AM	Employee 8	Hatch	Cycle
131	6	24 March 2015	AM	Employee 8	Hatch	Cycle
132	7	25 March 2015	AM	Employee 8	Hatch	Other
133	8	26 March 2015	AM	Employee 8	Hatch	Cycle
134	9	27 March 2015	AM	Employee 8	Hatch	Cycle
135	10	27 March 2015	AM	Employee 44	Hatch	Cycle
136	11	30 March 2015	AM	External 1	DR Power	Other
137	12	30 March 2015	AM	Employee 8	Hatch	Cycle
138	13	31 March 2015	AM	Employee 27	Hatch	Cycle
139	14	31 March 2015	AM	Employee 8	Hatch	Cycle
140	1	01 April 2015	AM	External 1	DR Power	Run
141	2	01 April 2015	AM	Employee 8	Hatch	Cycle
142	3	02 April 2015	AM	Employee 8	Hatch	Cycle
143	4	03 April 2015	AM	Employee 8	Hatch	Cycle
144	5	09 April 2015	AM	External 1	DR Power	Other
145	6	09 April 2015	AM	Employee 44	Hatch	Cycle
146	7	14 April 2015	AM	Employee 37	Hatch	Cycle
147	8	15 April 2015	AM	External 1	DR Power	Other
148	9	16 April 2015	AM	Employee 37	Hatch	Cycle
149	10	23 April 2015	AM	External 1	DR Power	Other
150	11	24 April 2015	AM	External 1	DR Power	Run

SUMMARY OF LOGBOOK DATA

Month	Total Trips	Trips by Other Organisations	Trips by Hatch Staff	Total Cycle Trips	All Other Trips	Cycle Trips by Other Organisations	Hatch Cycle Trips	% Cycle Use
August '14	22	18	4	5	17	1	4	23%
September '14	19	14	5	5	14	0	5	26%
October '14	28	12	16	13	15	0	13	46%
November '14	10	5	5	3	7	0	3	30%
December '14	7	6	1	1	6	0	1	14%
January '15	25	9	16	12	13	0	12	48%
February '15	14	11	3	4	10	1	3	29%
March '15	14	4	10	9	5	0	9	64%
April '15	11	5	6	6	5	0	6	55%
TOTAL	**150**	**84**	**66**	**58**	**92**	**2**	**56**	**39%**

APPENDIX D – EMPLOYEE QUESTIONNAIRE

QUESTIONS 1 TO 4

Respondent Number	Distance to Work	Gender	What is your age?	Do you ever use a bicycle? (If No please move to Q7)	You use your bike for?				
					Going to work	Taking the kids to school	Going to the shops	For fitness	For recreation
Employee 1	2,2	Female	45 to 54	No					
Employee 2	17	Male	35 to 44	Yes					Rarely (once a month)
Employee 3	4,3	Male	45 to 54	Yes	Often (more than 2 a week)	Never	Never	Often (more than 2 a week)	Often (more than 2 a week)
Employee 4	9,6	Male	35 to 44	Yes	Never	Never	Never	Rarely (once a month)	Rarely (once a month)
Employee 5	132	Male	35 to 44	Yes				Rarely (once a month)	
Employee 6	13,9	Male	35 to 44	Yes	Often (more than 2 a week)			Often (more than 2 a week)	Often (more than 2 a week)
Employee 7	25	Female	55 to 64	No					
Employee 8	17,1	Male	35 to 44	Yes				Often (more than 2 a week)	Sometimes (once a week)
Employee 9	10,7	Male	35 to 44	No					
Employee 10	12,4	Male	25 to 34	No	Rarely (once a month)	Never	Sometimes (once a week)	Sometimes (once a week)	Sometimes (once a week)
Employee 11	3,5	Male	25 to 34	Yes	Often (more than 2 a week)			Rarely (once a month)	
Employee 12	13	Female	25 to 34	Yes	Never	Never	Rarely (once a month)	Sometimes (once a week)	Sometimes (once a week)
Employee 13	10,4	Male	45 to 54	Yes	Never	Never	Never	Never	Rarely (once a month)
Employee 14	9,5	Male	35 to 44	Yes	Never	Never	Never	Often (more than 2 a week)	Often (more than 2 a week)

Respondent Number	Distance to Work	Gender	What is your age?	Do you ever use a bicycle? (If No please move to Q7)	You use your bike for?				
					Going to work	Taking the kids to school	Going to the shops	For fitness	For recreation
Employee 15	5,2	Male	55 to 64	No					
Employee 16	18,9	Male	55 to 64	No					
Employee 17	31,1	Female	45 to 54	Yes					Rarely (once a month)
Employee 18	21,3	Male	35 to 44	No					
Employee 19	95	Male	65 to 74	Yes				Often (more than 2 a week)	Sometimes (once a week)
Employee 20	22,9	Male	55 to 64	Yes	Never	Never	Sometimes (once a week)	Sometimes (once a week)	Sometimes (once a week)
Employee 21	8,1	Male	45 to 54	No	Never	Never	Never	Never	Never
Employee 22	7,3	Male	35 to 44	Yes	Never	Never	Sometimes (once a week)	Often (more than 2 a week)	Often (more than 2 a week)
Employee 23	25,6	Male	45 to 54	Yes				Often (more than 2 a week)	Sometimes (once a week)
Employee 24	6,5	Female	25 to 34	No					
Employee 25	1,8	Female	45 to 54	No	Never	Never	Never	Never	Never
Employee 26	6,9	Female	45 to 54	No					
Employee 27	15,7	Male	45 to 54	Yes	Rarely (once a month)	Never	Rarely (once a month)	Often (more than 2 a week)	Rarely (once a month)
Employee 28	7,4	Female	25 to 34	No					Rarely (once a month)
Employee 29	24,3	Male	55 to 64	Yes	Never	Never	Never	Never	Rarely (once a month)
Employee 30	17	Male	25 to 34	No					

Respondent Number	Distance to Work	Gender	What is your age?	Do you ever use a bicycle? (If No please move to Q7)	You use your bike for?				
					Going to work	Taking the kids to school	Going to the shops	For fitness	For recreation
Employee 31	9,5	Male	45 to 54	No	Never	Never	Never	Never	Never
Employee 32	4,4	Female	35 to 44	No					
Employee 33	20,8	Male	25 to 34	No					
Employee 34	13,8	Male	25 to 34	No					
Employee 35	9,3	Male	45 to 54	Yes			Rarely (once a month)		Rarely (once a month)
Employee 36	14,4	Male	35 to 44	Yes					Rarely (once a month)
Employee 37	12,8	Male	25 to 34	Yes	Rarely (once a month)	Never	Never	Often (more than 2 a week)	Often (more than 2 a week)
Employee 38	4,1	Female	45 to 54	No					
Employee 39	12,7	Male	65 to 74	No					
Employee 40	151	Male	65 to 74	Yes					Rarely (once a month)
Employee 41	8,5	Male	25 to 34	No					
Employee 42	7,8	Male	25 to 34	Yes	Sometimes (once a week)				Often (more than 2 a week)
Employee 43	22,6	Female	25 to 34	No					
Employee 44	6,5	Male	35 to 44	Yes	Sometimes (once a week)	Never	Never	Often (more than 2 a week)	Often (more than 2 a week)

QUESTIONS 5 TO 7

Respondent Number	How safe do you feel cycling on the following at any time of the day?					Have you had a cycle accident in the last five years?	What puts you off Cycling? Sharing space with:				
	No cycle facilities provided	Cycling in the shoulder of the road	Cycling on a painted cycle lane	Using a shared footpath/cycle path	Segregated cycle path		Pedestrians	Motorcycles	Buses/Taxis	Cars	HGV's (Trucks)
Employee 1							Is a minor irritant	Is very off putting	Is very off putting	Is very off putting	Is very off putting
Employee 2	Not safe at all				Very safe	No	Is a minor irritant	Is a minor irritant	Is very off putting	Is a minor irritant	Is very off putting
Employee 3		Not safe at all				Yes (serious)	Is a minor irritant	Is a minor irritant	Is very off putting	Is a minor irritant	Is very off putting
Employee 4						No	Is a minor irritant	Is a minor irritant	Is very off putting	Is very off putting	Is very off putting
Employee 5				Very safe	Very safe	No	Is not a proble m	Is a minor irritant	Is very off putting	Is very off putting	Is very off putting
Employee 6	Not safe at all			Very safe	Very safe	No	Is a minor irritant	Is very off putting	Is very off putting	Is very off putting	Is very off putting
Employee 7							Is not a proble m	Stops me cycling	Stops me cycling	Stops me cycling	Stops me cycling
Employee 8	Not safe at all			Very safe	Very safe	Yes (minor)	Is not a proble m	Is a minor irritant	Stops me cycling	Is very off putting	Stops me cycling
Employee 9							Is a minor irritant	Is not a proble m	Is very off putting	Is very off putting	Is very off putting
Employee 10				Very safe	Very safe	Yes (minor)	Is a minor irritant	Is very off putting	Stops me cycling	Is very off putting	Stops me cycling
Employee 11			Very safe	Very safe	Very safe	Yes (minor)	Is not a proble m	Is a minor irritant	Is very off putting	Is very off putting	Is very off putting
Employee 12							Is a minor irritant	Is very off putting	Is very off putting	Is very off putting	Is very off putting
Employee 13	Not safe at all				Very safe	No	Is not a proble m	Is a minor irritant	Stops me cycling	Stops me cycling	Stops me cycling
Employee 14	Not safe at all				Very safe	No	Is not a proble m	Is not a proble m	Is very off putting	Is very off putting	Is very off putting
Employee 15							Is not a proble m	Is not a proble m	Is very off putting	Stops me cycling	Is very off putting

Respondent Number	How safe do you feel cycling on the following at any time of the day?					Have you had a cycle accident in the last five years?	What puts you off Cycling? Sharing space with:				
	No cycle facilities provided	Cycling in the shoulder of the road	Cycling on a painted cycle lane	Using a shared footpath/cycle path	Segregated cycle path		Pedestrians	Motorcycles	Buses/Taxis	Cars	HGV's (Trucks)
Employee 16											
Employee 17	Not safe at all				Very safe	No	Is not a problem	Is not a problem	Is very off putting	Is a minor irritant	Is very off putting
Employee 18							Is not a problem	Is a minor irritant	Stops me cycling	Is very off putting	Stops me cycling
Employee 19	Not safe at all					Yes (minor)	Is not a problem	Is not a problem	Is very off putting	Is very off putting	Is very off putting
Employee 20					Very safe	No	Is a minor irritant	Is a minor irritant	Stops me cycling	Is a minor irritant	Is very off putting
Employee 21						No			Stops me cycling		Stops me cycling
Employee 22	Not safe at all		Not safe at all	Very safe	Very safe	Yes (minor)	Is a minor irritant	Is a minor irritant	Stops me cycling	Stops me cycling	Stops me cycling
Employee 23	Not safe at all	Not safe at all			Very safe	Yes (minor)	Is a minor irritant	Is very off putting	Is very off putting	Is very off putting	Stops me cycling
Employee 24							Is not a problem	Is very off putting	Is very off putting	Stops me cycling	Stops me cycling
Employee 25							Is not a problem	Is a minor irritant	Stops me cycling	Stops me cycling	Stops me cycling
Employee 26										Stops me cycling	
Employee 27				Very safe	Very safe	No	Is not a problem	Is not a problem	Is very off putting	Is very off putting	Is very off putting
Employee 28	Not safe at all				Very safe	No	Is a minor irritant	Is very off putting	Stops me cycling	Is very off putting	Stops me cycling
Employee 29	Not safe at all					No	Is not a problem	Is very off putting	Stops me cycling	Is a minor irritant	Stops me cycling
Employee 30							Is a minor irritant	Is a minor irritant	Stops me cycling	Is very off putting	Stops me cycling
Employee 31						No	Stops me cycling	Stops me cycling	Stops me cycling	Stops me cycling	Stops me cycling

Respondent Number	How safe do you feel cycling on the following at any time of the day?					Have you had a cycle accident in the last five years?	What puts you off Cycling? Sharing space with:				
	No cycle facilities provided	Cycling in the shoulder of the road	Cycling on a painted cycle lane	Using a shared footpath/cycle path	Segregated cycle path		Pedestrians	Motorcycles	Buses/Taxis	Cars	HGV's (Trucks)
Employee 32									Is very off putting		
Employee 33							Is a minor irritant	Is a minor irritant	Stops me cycling	Stops me cycling	Stops me cycling
Employee 34							Is not a problem	Is not a problem	Stops me cycling	Is not a problem	Is not a problem
Employee 35	Not safe at all	Not safe at all	Not safe at all		Very safe	No	Is not a problem	Is a minor irritant	Stops me cycling	Is very off putting	Stops me cycling
Employee 36	Not safe at all		Not safe at all		Very safe	No	Is not a problem	Is not a problem	Stops me cycling	Is very off putting	Is very off putting
Employee 37	Not safe at all			Very safe	Very safe	No	Is a minor irritant	Stops me cycling	Stops me cycling	Is very off putting	Stops me cycling
Employee 38							Is not a problem	Is not a problem	Is very off putting	Is very off putting	Is very off putting
Employee 39							Is not a problem	Is not a problem	Is not a problem	Is not a problem	Is not a problem
Employee 40						No				Is a minor irritant	
Employee 41									Is very off putting	Is very off putting	Is very off putting
Employee 42	Not safe at all					Yes (minor)	Is not a problem	Is a minor irritant	Stops me cycling	Is a minor irritant	Stops me cycling
Employee 43											
Employee 44	Not safe at all				Very safe	No	Is not a problem	Is a minor irritant	Is very off putting	Is very off putting	Is very off putting

QUESTIONS 8 TO 9

Respondent Number	Which of the following puts you off cycling?							
	Going uphill	Safety on the road	The weather	No secure parking, inadequate changing facilities	I live too far	I undertake linked trips (i.e. drop kids off or go to gym before work)	Other (please specify)	What would encourage you to cycle more?
Employee 1	Is very off putting	Stops me cycling	Is very off putting	Is a minor irritant	Is not a problem	Is not a problem		Nope have a car
Employee 2	Is a minor irritant	Is very off putting	Is a minor irritant	Stops me cycling	Is very off putting	Is not a problem		
Employee 3	Is not a problem	Is not a problem	Is a minor irritant	Is very off putting	Is a minor irritant	Is not a problem		
Employee 4	Is not a problem	Is very off putting	Is a minor irritant	Stops me cycling	Is a minor irritant	Stops me cycling		Dedicated cycle lanes and more considerate road-users
Employee 5	Is a minor irritant	Is very off putting	Is very off putting	Is very off putting	Stops me cycling	Is not a problem	Laptop, security risks	
Employee 6	Is not a problem	Is a minor irritant	Is a minor irritant	Is very off putting	Is not a problem	Is not a problem	Safe and secure bike storage facilities at the office would be appreciated.	Longer weekends , more leave days , shorter working hours.
Employee 7					Stops me cycling			
Employee 8	Is a minor irritant	Stops me cycling	Is very off putting	Is very off putting	Is very off putting	Stops me cycling		Segregated cycle lanes
Employee 9	Is very off putting	Is a minor irritant	Stops me cycling	Is very off putting	Is very off putting	Is a minor irritant		The petrol price.
Employee 10	Is not a problem	Is a minor irritant	Is a minor irritant	Is very off putting	Stops me cycling	Is very off putting		Not having to go out during the day (site visits) or having to carry a laptop to work.
Employee 11	Is very off putting	Is a minor irritant	Stops me cycling	Is a minor irritant	Stops me cycling	Is a minor irritant		Living close to work, and downhill all the way to work.
Employee 12	Is a minor irritant	Is very off putting	Is a minor irritant	Stops me cycling	Stops me cycling	Is not a problem		Parking and Safety
Employee 13	Is not a problem	Stops me cycling	Is a minor irritant	Is very off putting	Stops me cycling	Stops me cycling		Better safety, but it would not work for me to use it to come to work.
Employee 14	Is not a problem	Is very off putting	Is a minor irritant	Stops me cycling	Is not a problem	Stops me cycling		I live to close for decent exercise. Would need to stay further. Wouldn't cycle for a reason other than exercise.

Respondent Number	Which of the following puts you off cycling?							
	Going uphill	Safety on the road	The weather	No secure parking, inadequate changing facilities	I live too far	I undertake linked trips (i.e. drop kids off or go to gym before work)	Other (please specify)	What would encourage you to cycle more?
Employee 15	Stops me cycling	Stops me cycling	Is not a problem	Is very off putting	Is not a problem	Is not a problem		Commuting to and from work in the AM and PM peak periods is extremely unsafe. I would only consider commuting on a cycle if there is a separate cycle facility provided.
Employee 16					Stops me cycling			
Employee 17	Is not a problem	Is very off putting	Is a minor irritant	Stops me cycling	Stops me cycling			If I lived closer
Employee 18	Is a minor irritant	Stops me cycling	Is very off putting	Is a minor irritant	Is very off putting	Is not a problem		Safer roads
Employee 19	Is not a problem	Is very off putting	Is very off putting	Is very off putting	Stops me cycling	Is not a problem		Not much - I do several hours a week but its too far to cycle to work (90km!!)
Employee 20	Is not a problem	Stops me cycling	Stops me cycling	Is very off putting	Stops me cycling	Is not a problem		Nothing
Employee 21					Stops me cycling			If I worked less than 2km away from home.
Employee 22	Is not a problem	Stops me cycling	Is a minor irritant	Is very off putting	Is not a problem	Stops me cycling		More dedicated cycle lanes
Employee 23	Is a minor irritant	Is very off putting	Is a minor irritant	Is a minor irritant	Stops me cycling	Is a minor irritant		Lunch time or after work MTB group rides
Employee 24	Is a minor irritant	Stops me cycling	Stops me cycling	Is very off putting	Is a minor irritant	Is not a problem		Safety on road, dedicated cycling lanes.
Employee 25	Stops me cycling	Stops me cycling	Is very off putting	Is very off putting	Is not a problem	Stops me cycling		If I had no health problems (knee and ankle injury)
Employee 26	Stops me cycling		Stops me cycling				Unfit	Cycle with someone
Employee 27	Is not a problem	Is very off putting	Is a minor irritant	Is very off putting	Is a minor irritant	Stops me cycling		Fully fledged City Wide separate bike lanes that are maintained and are safe (and lit at night)
Employee 28	Is a minor irritant	Stops me cycling	Stops me cycling	Is very off putting	Is a minor irritant	Stops me cycling		Personal safety and security and better cycling facilities on the road.
Employee 29	Is a minor irritant	Is very off putting	Stops me cycling	Is a minor irritant	Stops me cycling	Is not a problem		Nothing really
Employee 30	Is a minor irritant	Is very off putting	Is very off putting	Is very off putting	Stops me cycling	Is not a problem		BRT station to cycle to and lock up bicycle and then take Myciti bus to work.
Employee 31	Stops me cycling	Stops me cycling	Stops me cycling	Stops me cycling	Stops me cycling			

Respondent Number	Which of the following puts you off cycling?							
	Going uphill	Safety on the road	The weather	No secure parking, inadequate changing facilities	I live too far	I undertake linked trips (i.e. drop kids off or go to gym before work)	Other (please specify)	What would encourage you to cycle more?
Employee 32		Stops me cycling			Stops me cycling		car pool	if I had bicycle
Employee 33	Is a minor irritant	Stops me cycling	Stops me cycling	Stops me cycling	Stops me cycling	Stops me cycling		
Employee 34	Stops me cycling	Is a minor irritant	Is a minor irritant	Is not a problem	Stops me cycling	Is not a problem		I doubt anything would encourage me to cycle
Employee 35	Is very off putting	Stops me cycling	Is a minor irritant	Is a minor irritant	Stops me cycling	Is not a problem		Electric assistance bicycle.
Employee 36	Is a minor irritant	Stops me cycling	Is a minor irritant	Stops me cycling	Stops me cycling	Stops me cycling		Safer and less busier roads
Employee 37	Is a minor irritant	Stops me cycling	Is very off putting	Stops me cycling	Is very off putting	Is not a problem		I you have to pay for parking at work
Employee 38	Stops me cycling	Is very off putting	Stops me cycling	Stops me cycling	Stops me cycling	Stops me cycling	personal fitness level	Good Changing Facilities at work and dedicated cycle lanes with barriers between the cycle lane and the traffic lane
Employee 39							I do not like it	Nothing
Employee 40	Is a minor irritant	Is a minor irritant	Is a minor irritant	Is not a problem	Is very off putting	Is not a problem		If I had more time to spend at home.
Employee 41		Stops me cycling	Stops me cycling					Reduced vehicle traffic and improved awareness of safety of cyclists
Employee 42	Is not a problem	Is very off putting	Is not a problem	Is a minor irritant	Is not a problem	Is very off putting		Self motivation
Employee 43					Stops me cycling			A free bike
Employee 44	Is a minor irritant	Is very off putting	Is a minor irritant	Is a minor irritant	Is not a problem	Is not a problem		Better work facilities, more cycle lanes

APPENDIX E – WEATHER DATA

General Forecast Explained		
 Sunny	 Mostly Sunny	 Partly Cloudy
 Mostly Sunny, Light Rain	 Mostly Cloudy	 Overcast
 Mostly Cloudy, Drizzle	 Mostly Cloudy, Light Rain	 Mostly Cloudy, Moderate Rain

The image symbols used above represent to overall forecast for a specific day. The general description has been used to describe the forecast in the tables below.

WEEKDAY

Date	Day	Observed High (°C)	Observed Low (°C)	Max Wind Speed (m/s)	General Forecast
01 August 2014	Friday	18	10	3,1	Partly Cloudy
04 August 2014	Monday	16	12	8,2	Mostly Cloudy, Light Rain
05 August 2014	Tuesday	16	11	7,2	Mostly Cloudy, Light Rain
06 August 2014	Wednesday	15	10	7,2	Mostly Cloudy
07 August 2014	Thursday	19	6	8,8	Mostly Sunny
08 August 2014	Friday	23	8	3,6	Unknown Sky
11 August 2014	Monday	17	13	6,2	Mostly Cloudy
12 August 2014	Tuesday	20	13	5,1	Mostly Cloudy
13 August 2014	Wednesday	17	14	12,9	Mostly Cloudy, Light Rain
14 August 2014	Thursday	17	12	3,1	Partly Cloudy
15 August 2014	Friday	18	13	8,8	Mostly Sunny
18 August 2014	Monday	20	14	10,8	Mostly Sunny
19 August 2014	Tuesday	17	14	10,3	Mostly Cloudy
20 August 2014	Wednesday	16	10	9,8	Mostly Cloudy, Light Rain
21 August 2014	Thursday	16	9	9,8	Mostly Cloudy, Moderate Rain
22 August 2014	Friday	17	10	3,6	Mostly Cloudy
25 August 2014	Monday	23	8	12,4	Mostly Cloudy

WEEKDAY					
Date	Day	Observed High (°C)	Observed Low (°C)	Max Wind Speed (m/s)	General Forecast
26 August 2014	Tuesday	18	12	7,7	Mostly Cloudy, Light Rain
27 August 2014	Wednesday	17	11	9,3	Mostly Cloudy, Light Rain
28 August 2014	Thursday	13	7	10,8	Mostly Cloudy, Light Rain
29 August 2014	Friday	16	7	8,8	Partly Cloudy
01 September 2014	Monday	30	8	4,1	Unknown Sky
02 September 2014	Tuesday	29	10	6,7	Mostly Sunny
03 September 2014	Wednesday	18	9	7,2	Mostly Sunny
04 September 2014	Thursday	29	11	2,6	Mostly Sunny
05 September 2014	Friday	19	13	6,7	Partly Cloudy
08 September 2014	Monday	19	13	8,2	Mostly Sunny
09 September 2014	Tuesday	22	12	9,8	Mostly Sunny
10 September 2014	Wednesday	18	13	10,3	Mostly Sunny
11 September 2014	Thursday	19	13	9,3	Mostly Sunny
12 September 2014	Friday	18	10	4,6	Mostly Sunny
15 September 2014	Monday	19	12	7,7	Partly Cloudy
16 September 2014	Tuesday	23	13	7,7	Partly Cloudy
17 September 2014	Wednesday	19	13	10,3	Mostly Cloudy
18 September 2014	Thursday	15	10	10,8	Mostly Cloudy, Light Rain
19 September 2014	Friday	16	8	6,7	Partly Cloudy
22 September 2014	Monday	29	11	8,2	Partly Cloudy
23 September 2014	Tuesday	19	13	10,3	Partly Cloudy
24 September 2014	Wednesday	19	13	10,3	Mostly Cloudy
25 September 2014	Thursday	19	13	6,7	Mostly Cloudy
26 September 2014	Friday	16	11	6,7	Mostly Cloudy
29 September 2014	Monday	17	9	7,2	Mostly Sunny
30 September 2014	Tuesday	19	6	8,2	Mostly Cloudy
01 October 2014	Wednesday	23	14	8,8	Mostly Sunny
02 October 2014	Thursday	26	13	8,8	Sunny
03 October 2014	Friday	23	14	10,3	Mostly Sunny
06 October 2014	Monday	32	12	10,3	Mostly Cloudy
07 October 2014	Tuesday	21	13	4,6	Mostly Cloudy
08 October 2014	Wednesday	17	9	9,8	Mostly Cloudy, Light Rain
09 October 2014	Thursday	15	7	6,2	Partly Cloudy
10 October 2014	Friday	24	9	8,8	Mostly Sunny
13 October 2014	Monday	28	15	9,3	Mostly Sunny
14 October 2014	Tuesday	25	13	9,3	Mostly Sunny
15 October 2014	Wednesday	22	15	7,7	Partly Cloudy
16 October 2014	Thursday	20	14	12,4	Partly Cloudy
17 October 2014	Friday	26	8	7,7	Unknown Sky
20 October 2014	Monday	28	14	8,2	Mostly Sunny
21 October 2014	Tuesday	25	14	6,2	Mostly Sunny
22 October 2014	Wednesday	23	13	5,7	Partly Cloudy
23 October 2014	Thursday	23	15	11,3	Partly Cloudy

WEEKDAY					
Date	Day	Observed High (°C)	Observed Low (°C)	Max Wind Speed (m/s)	General Forecast
24 October 2014	Friday	25	17	12,4	Mostly Sunny
27 October 2014	Monday	24	13	7,7	Mostly Sunny
28 October 2014	Tuesday	27	14	7,2	Mostly Sunny
29 October 2014	Wednesday	24	15	10,8	Mostly Cloudy
30 October 2014	Thursday	19	13	9,3	Mostly Cloudy
31 October 2014	Friday	25	13	8,2	Sunny
03 November 2014	Monday	19	15	7,2	Mostly Cloudy, Light Rain
04 November 2014	Tuesday	21	14	6,2	Mostly Cloudy, Light Rain
05 November 2014	Wednesday	22	16	9,8	Mostly Cloudy
06 November 2014	Thursday	25	13	8,2	Sunny
07 November 2014	Friday	30	17	6,2	Sunny
10 November 2014	Monday	25	15	12,9	Mostly Sunny
11 November 2014	Tuesday	24	15	5,7	Partly Cloudy
12 November 2014	Wednesday	23	15	14,9	Mostly Cloudy
13 November 2014	Thursday	21	14	9,3	Partly Cloudy
14 November 2014	Friday	20	10	12,4	Partly Cloudy
17 November 2014	Monday	23	15	12,4	Mostly Sunny
18 November 2014	Tuesday	25	15	11,8	Sunny
19 November 2014	Wednesday	23	16	15,4	Sunny
20 November 2014	Thursday	21	16	14,4	Partly Cloudy
21 November 2014	Friday	24	15	12,4	Sunny
24 November 2014	Monday	25	16	8,2	Mostly Sunny
25 November 2014	Tuesday	31	16	8,2	Sunny
26 November 2014	Wednesday	24	17	12,4	Mostly Cloudy
27 November 2014	Thursday	22	16	7,7	Mostly Cloudy
28 November 2014	Friday	24	15	8,2	Mostly Sunny
01 December 2014	Monday	24	17	11,8	Mostly Sunny
02 December 2014	Tuesday	24	18	15,4	Mostly Sunny
03 December 2014	Wednesday	27	17	11,8	Mostly Sunny
04 December 2014	Thursday	24	16	13,4	Mostly Sunny
05 December 2014	Friday	26	17	10,3	Mostly Sunny
08 December 2014	Monday	27	15	7,7	Mostly Sunny
09 December 2014	Tuesday	26	15	9,8	Mostly Cloudy
10 December 2014	Wednesday	24	17	13,9	Mostly Sunny
11 December 2014	Thursday	24	16	9,8	Mostly Sunny
12 December 2014	Friday	22	16	9,3	Partly Cloudy
15 December 2014	Monday	24	16	14,4	Mostly Sunny
16 December 2014	Tuesday	24	17	14,9	Mostly Sunny
17 December 2014	Wednesday	26	16	11,3	Mostly Sunny
18 December 2014	Thursday	25	17	10,3	Mostly Sunny
19 December 2014	Friday	23	16	7,2	Partly Cloudy
22 December 2014	Monday	26	17	7,7	Mostly Sunny

WEEKDAY					
Date	Day	Observed High (°C)	Observed Low (°C)	Max Wind Speed (m/s)	General Forecast
23 December 2014	Tuesday	23	19	8,2	Partly Cloudy
24 December 2014	Wednesday	25	15	7,7	Mostly Sunny
25 December 2014	Thursday	22	18	10,8	Mostly Cloudy, Drizzle
26 December 2014	Friday	23	15	13,9	Mostly Sunny
29 December 2014	Monday	29	19	8,2	Mostly Sunny
30 December 2014	Tuesday	27	20	11,8	Mostly Sunny
31 December 2014	Wednesday	31	20	9,3	Mostly Sunny
01 January 2015	Thursday	27	17	8,8	Mostly Sunny
02 January 2015	Friday	27	18	7,2	Mostly Sunny
05 January 2015	Monday	23	18	7,7	Mostly Cloudy, Light Rain
06 January 2015	Tuesday	24	18	12,9	Partly Cloudy
07 January 2015	Wednesday	32	18	10,3	Mostly Sunny
08 January 2015	Thursday	26	19	12,4	Mostly Sunny
09 January 2015	Friday	26	18	12,9	Mostly Sunny
12 January 2015	Monday	27	18	8,2	Mostly Sunny
13 January 2015	Tuesday	26	17	12,4	Mostly Sunny
14 January 2015	Wednesday	32	20	6,7	Mostly Sunny
15 January 2015	Thursday	26	19	12,4	Partly Cloudy
16 January 2015	Friday	23	15	8,2	Mostly Cloudy, Light Rain
19 January 2015	Monday	27	18	12,9	Mostly Sunny
20 January 2015	Tuesday	31	16	10,3	Unknown Sky
21 January 2015	Wednesday	30	19	10,8	Mostly Sunny
22 January 2015	Thursday	29	18	8,2	Mostly Sunny
23 January 2015	Friday	28	19	8,2	Mostly Sunny
26 January 2015	Monday	26	17	7,2	Mostly Sunny
27 January 2015	Tuesday	25	19	14,9	Mostly Sunny
28 January 2015	Wednesday	28	18	7,2	Mostly Sunny
29 January 2015	Thursday	34	19	5,7	Sunny
30 January 2015	Friday	25	19	10,8	Mostly Sunny
02 February 2015	Monday	30	16	7,7	Unknown Sky
03 February 2015	Tuesday	27	14	6,7	Mostly Sunny
04 February 2015	Wednesday	25	16	6,7	Mostly Cloudy
05 February 2015	Thursday	26	17	8,2	Mostly Sunny
06 February 2015	Friday	26	17	9,8	Mostly Sunny
09 February 2015	Monday	25	17	9,3	Mostly Sunny
10 February 2015	Tuesday	23	16	10,8	Partly Cloudy
11 February 2015	Wednesday	24	13	11,3	Mostly Sunny
12 February 2015	Thursday	24	18	9,8	Mostly Sunny
13 February 2015	Friday	23	15	7,7	Mostly Sunny
16 February 2015	Monday	30	12	9,8	Sunny
17 February 2015	Tuesday	33	14	4,9	Unknown Sky
18 February 2015	Wednesday	25	15	10,3	Mostly Sunny
19 February 2015	Thursday	23	17	13,9	Mostly Sunny

WEEKDAY					
Date	Day	Observed High (°C)	Observed Low (°C)	Max Wind Speed (m/s)	General Forecast
20 February 2015	Friday	23	16	12,1	Mostly Sunny
23 February 2015	Monday	27	17	9,8	Mostly Sunny
24 February 2015	Tuesday	28	20	12,9	Mostly Sunny
25 February 2015	Wednesday	27	18	9,3	Mostly Sunny
26 February 2015	Thursday	24	17	10,8	Mostly Sunny
27 February 2015	Friday	25	18	11,3	Mostly Sunny
02 March 2015	Monday	33	20	7,2	Mostly Sunny
03 March 2015	Tuesday	41	15	6,1	Unknown Sky
04 March 2015	Wednesday	23	16	8,8	Partly Cloudy
05 March 2015	Thursday	22	16	10,8	Mostly Sunny
06 March 2015	Friday	25	14	8,8	Mostly Sunny
09 March 2015	Monday	29	16	7,7	Mostly Sunny
10 March 2015	Tuesday	23	17	11,8	Mostly Sunny
11 March 2015	Wednesday	29	14	6,2	Mostly Sunny
12 March 2015	Thursday	24	15	7,7	Mostly Sunny
13 March 2015	Friday	23	18	12,4	Mostly Sunny
16 March 2015	Monday	26	13	12,9	Mostly Sunny
17 March 2015	Tuesday	28	17	9,3	Mostly Sunny
18 March 2015	Wednesday	27	15	6,2	Mostly Sunny
19 March 2015	Thursday	24	15	6	Mostly Sunny
20 March 2015	Friday	22	15	10,3	Mostly Sunny
23 March 2015	Monday	26	19	9,8	Mostly Sunny
24 March 2015	Tuesday	26	16	9,8	Mostly Sunny
25 March 2015	Wednesday	26	17	9,3	Mostly Sunny
26 March 2015	Thursday	24	17	6,7	Mostly Cloudy
27 March 2015	Friday	27	16	10,3	Mostly Sunny
30 March 2015	Monday	27	16	5,7	Mostly Sunny
31 March 2015	Tuesday	28	16	5,7	Mostly Sunny
01 April 2015	Wednesday	25	14	10,3	Mostly Sunny
02 April 2015	Thursday	21	17	12,4	Mostly Sunny
03 April 2015	Friday	20	16	8,2	Mostly Sunny
06 April 2015	Monday	26	12	6,9	Partly Cloudy
07 April 2015	Tuesday	29	16	10,6	Mostly Sunny
08 April 2015	Wednesday	26	16	7,2	Sunny
09 April 2015	Thursday	31	14	4,1	Mostly Sunny
10 April 2015	Friday	26	13	9,3	Mostly Sunny
13 April 2015	Monday	25	13	6,2	Mostly Cloudy
14 April 2015	Tuesday	20	11	7,2	Partly Cloudy
15 April 2015	Wednesday	18	10	8,8	Partly Cloudy
16 April 2015	Thursday	19	8	10,8	Mostly Sunny
17 April 2015	Friday	25	14	7,2	Sunny
20 April 2015	Monday	22	11	10,3	Partly Cloudy
21 April 2015	Tuesday	24	14	8,8	Mostly Sunny

WEEKDAY					
Date	Day	Observed High (°C)	Observed Low (°C)	Max Wind Speed (m/s)	General Forecast
22 April 2015	Wednesday	21	13	12,4	Mostly Sunny
23 April 2015	Thursday	22	15	8,2	Sunny
24 April 2015	Friday	28	9	3,6	Sunny
27 April 2015	Monday	23	11	6,2	Mostly Sunny
28 April 2015	Tuesday	20	10	8,8	Mostly Sunny
29 April 2015	Wednesday	20	13	6,1	Mostly Cloudy
30 April 2015	Thursday	19	13	5,1	Mostly Cloudy

WEEKEND					
Date	Day	Observed High (°C)	Observed Low (°C)	Max Wind Speed (m/s)	General Forecast
02 August 2014	Saturday	16	11	9,3	Mostly Cloudy
03 August 2014	Sunday	18	13	9,8	Mostly Cloudy
09 August 2014	Saturday	21	12	6,2	Mostly Sunny
10 August 2014	Sunday	24	12	4,1	Sunny
16 August 2014	Saturday	21	12	4,6	Unknown Sky
17 August 2014	Sunday	29	11	4,6	Sunny
23 August 2014	Saturday	17	7	8,2	Mostly Sunny
24 August 2014	Sunday	22	4	3,6	Mostly Sunny
30 August 2014	Saturday	21	5	5,1	Unknown Sky
31 August 2014	Sunday	25	7	4,1	Unknown Sky
06 September 2014	Saturday	18	10	5,7	Partly Cloudy
07 September 2014	Sunday	20	9	6,7	Mostly Sunny
13 September 2014	Saturday	19	7	5,7	Mostly Sunny
14 September 2014	Sunday	19	13	6,2	Partly Cloudy
20 September 2014	Saturday	17	5	9,8	Mostly Sunny
21 September 2014	Sunday	24	11	7,7	Mostly Sunny
27 September 2014	Saturday	17	9	9,8	Mostly Sunny
28 September 2014	Sunday	21	6	6,7	Mostly Sunny
04 October 2014	Saturday	27	11	5,7	Unknown Sky
05 October 2014	Sunday	29	11	5,1	Mostly Sunny
11 October 2014	Saturday	24	11	6,2	Mostly Sunny
12 October 2014	Sunday	22	12	10,8	Mostly Sunny
18 October 2014	Saturday	28	10	7,2	Unknown Sky
19 October 2014	Sunday	28	14	12,4	Mostly Sunny
25 October 2014	Saturday	28	16	12,4	Mostly Sunny
26 October 2014	Sunday	28	16	6,7	Sunny

WEEKEND					
Date	**Day**	**Observed High (°C)**	**Observed Low (°C)**	**Max Wind Speed (m/s)**	**General Forecast**
01 November 2014	Saturday	26	11	10,3	Sunny
02 November 2014	Sunday	28	15	8,2	Mostly Sunny
08 November 2014	Saturday	20	14	10,8	Mostly Sunny
09 November 2014	Sunday	23	14	11,3	Mostly Sunny
15 November 2014	Saturday	18	8	9,8	Partly Cloudy
16 November 2014	Sunday	20	10	11,8	Mostly Sunny
22 November 2014	Saturday	26	16	7,2	Mostly Sunny
23 November 2014	Sunday	23	13	9,8	Partly Cloudy
29 November 2014	Saturday	26	17	6,7	Partly Cloudy
30 November 2014	Sunday	30	14	7,7	Sunny
06 December 2014	Saturday	26	17	8,8	Mostly Sunny
07 December 2014	Sunday	30	17	6,7	Partly Cloudy
13 December 2014	Saturday	26	16	12,9	Unknown Sky
14 December 2014	Sunday	24	16	11,3	Mostly Sunny
20 December 2014	Saturday	23	16	7,7	Partly Cloudy
21 December 2014	Sunday	23	16	5,1	Mostly Cloudy
27 December 2014	Saturday	24	15	13,4	Mostly Sunny
28 December 2014	Sunday	28	15	8,8	Mostly Sunny
03 January 2015	Saturday	25	17	9,8	Partly Cloudy
04 January 2015	Sunday	25	18	11,3	Mostly Sunny
10 January 2015	Saturday	25	17	12,9	Mostly Sunny
11 January 2015	Sunday	26	18	11,3	Mostly Sunny
17 January 2015	Saturday	24	13	8,8	Mostly Sunny
18 January 2015	Sunday	24	17	11,8	Partly Cloudy
24 January 2015	Saturday	28	17	11,3	Mostly Sunny
25 January 2015	Sunday	26	17	8,2	Mostly Sunny
31 January 2015	Saturday	23	16	8,2	Partly Cloudy
01 February 2015	Sunday	26	16	13,4	Mostly Sunny
07 February 2015	Saturday	31	17	6,7	Sunny
08 February 2015	Sunday	25	16	11,8	Mostly Sunny
14 February 2015	Saturday	23	18	10,8	Mostly Sunny
15 February 2015	Sunday	24	15	13,9	Mostly Sunny
21 February 2015	Saturday	21	15	12,4	Mostly Sunny
22 February 2015	Sunday	26	9	7,2	Mostly Sunny
28 February 2015	Saturday	26	17	10,8	Mostly Sunny
01 March 2015	Sunday	28	18	12,4	Mostly Sunny
07 March 2015	Saturday	24	15	9,8	Mostly Sunny
08 March 2015	Sunday	23	16	11,3	Mostly Sunny
14 March 2015	Saturday	30	16	5,7	Mostly Sunny
15 March 2015	Sunday	25	16	5,1	Partly Cloudy
21 March 2015	Saturday	26	16	11,3	Mostly Sunny
22 March 2015	Sunday	25	14	9,8	Mostly Sunny

WEEKEND					
Date	**Day**	**Observed High (°C)**	**Observed Low (°C)**	**Max Wind Speed (m/s)**	**General Forecast**
28 March 2015	Saturday	28	14	6,7	Sunny
29 March 2015	Sunday	25	15	6,7	Unknown Sky
04 April 2015	Saturday	20	15	11,8	Mostly Sunny, Light Rain
05 April 2015	Sunday	24	13	9,8	Mostly Sunny
11 April 2015	Saturday	15	15		Sunny
12 April 2015	Sunday	28	14	4,6	Sunny
18 April 2015	Saturday	25	10	5,7	Sunny
19 April 2015	Sunday	25	8	6,2	Mostly Cloudy
25 April 2015	Saturday	20	12	7,2	Partly Cloudy
26 April 2015	Sunday	23	13	8,2	Mostly Sunny