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An Investigation into the Pedestrianisation of City Streets:

A move towards pedestrian friendly spaces and their economic effects in the City of Cape Town

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Masters Thesis in the Department of Civil Engineering

Centre for Transport Studies

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Thesis is in fulfilment of the requirements for the degree of MSc Eng

ABSTRACT

The need for pedestrian spaces can be seen as far back as the roman times, but as the benefits of vehicular transport became more pronounced, and the mode was used more frequently, there was a dramatic increase in the confrontation between vehicles and people. Pedestrianisation has enjoyed a global resurgence in urban planning in recent years. Walking and pedestrianisation has the added benefits of improving the health of community, as well as far reaching economic and social benefits and an equitable use of resources.

During December (2007), Cape Town's peak tourism season, a pilot pedestrianisation project was run in the City of Cape Town. The 300 year old Greenmarket Square was pedestrianised and stakeholders on the square were surveyed six months after the implementation of the scheme to access the economic benefits, as well as the perception of predestination by the traders.

A SATURN dynamic assignment model was used to simulate the effect of certain road closures to traffic as part of an extension to the pedestrian network. These road are vital to start forming a formalise pedestrian network within the CBD. From the results, a pedestrian network for the Cape Town CBD has been proposed.

Key Words: Pedestrianisation, transport modelling, economic impacts

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SUMMARY

Pedestrianisation is not a new phenomenon, but has enjoyed a global resurgence in urban planning in recent years. This is due to a variety of reasons, ranging from using pedestrianisation as a traffic calming method to a means to revitalise historic centres and empower the pedestrian. Walking and pedestrianisation has the added benefits of improving the health of community, as well as far reaching economic and social benefits, and an equitable use of resources. Pedestrian precincts were the invention of the Europeans as a way to preserve historical centres. Cities in Asia, Latin America and North America have implemented successful pedestrianisation schemes.

European Cities have been implementing pedestrian precincts for over 80 years, but the design philosophy is still being adapted to ensure the success of this type of land use planning. In most cases, pedestrian precincts started with a single street or square being closed to vehicular traffic and redesigned to make it more appealing to pedestrians. Municipalities, then convert other streets and squares and add to the original pedestrianised area, to form a pedestrian network, which then evolved into a pedestrian zone. This process happens organically and is a result of having a long term vision and implementation, which takes several years.

Parking spaces in close proximity to these zones are gradually reduced and parking lots are converted to public squares. In this way traffic, as well as the opportunity to drive, can be reduced.

The most successful precincts are not just areas where shopping can take place, but have a mixture of activities and incorporate leisure, entertainment and cultural activities. They are attractive to not just visitors but to local residents alike and encourage locals to spend money in their own neighbourhoods instead of conventional shopping malls.

During the pedestrianisation process, it is important to keep the public informed and, when roads are closed, the public should be forewarned, so as to avoid congestion and chaos and allow travellers to change travel behaviour, including routes and times.

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Implementing a pedestrian scheme is not as simple as closing a street and adding retail outlets. It is a lengthy process lasting decades, and involves changing land use and urban form within the precinct. In most cases, successful pedestrian precincts started with a single street or square being closed to vehicular traffic and redesigned to make it more appealing to pedestrians.

Pedestrian zones have been a catalyst to improve economic activity within the zone. This does not happen overnight, but rather over a period of time, which can be as long as a year or two. In the first year, shop owners can expect a decrease in turnover. Another economic effect of pedestrian zones is the increase in property prices. This is due to the area being more attractive and attracting more foot traffic. The attractiveness of these precincts and high rentals are a big draw card and often national and international chain stores locate in these precincts.

In Cape Town, the first street to be pedestrianised was St Georges Mall in the early 1990s. This was part of the 1975 pedestrian vision for the City of Cape Town. This vision included the pedestrianisation of Greenmarket Square and Church Square among other areas within the CBD.

From this thesis, the transport model has shown that when certain segments of roads are closed, the result on the traffic is not as dramatic as expected. This thesis thus supports the idea of pedestrianising streets within the City of Cape Town.

The single infrastructure change scenario with the least big change in the traffic situation is when Long Street is closed from Wale Street to Strand Street. In creating a pedestrian network, the closing of Long and Waterkant Street bring the least amount of changes. This scheme also links better with Cape Town Station, the major transport interchange in the City of Cape Town. Waterkant Street is more important in linking the City with the new Football stadium in Green point, being built for the 2010 Soccer World Cup.

From the recent pedestrianisation of Greenmarket Square, survey results show that this project follows the international trend to a certain degree. As with other similar pedestrianised areas internationally, the restaurants and other eating establishments have experienced an increase in turnover, while shop owners and the informal traders on the square have experience a decrease in turnover.

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Overall, there are a higher percentage of stakeholders on the Square who have a positive sentiment on the pedestrianisation scheme.

The pedestrianisation of Greenmarket Square can be seen as the first step in creating a pedestrian network in the City of Cape Town. In order for the Square to be viable, it is important to diversify the type of goods and services on offer. The current problem with the traders is that they only cater for tourists, and they all sell a similar African curio. To diversify the type of goods sold, and make it attractive for locals, as well as tourist, will help in improve the economic outlook of the traders. Adding street furniture, better lighting and more greenery within the square, will make the area more attractive, as well as more utilised during the evenings.

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1 INTRODUCTION

1.1 Background to the Thesis

The need for pedestrian spaces can be seen as far back as the roman times when Julius Caesar had to ban carts and chariots from the streets of Rome from sunrise to sunset, due to the conflict between pedestrians and wheeled traffic. Similarly, the forum in Pompeii banned all modes of transport other than walking (Hass-Klau, 1990). But as the benefits of wheeled transport became more pronounced, and the mode was used more frequently, there was a dramatic increase in the confrontation between wheeled vehicles and people.

With the introduction of the automobile, a large amount of pedestrian spaces were being encroached. City centres were increasingly becoming car oriented and moved away from being people orientated. This was and still is a global phenomenon and a result of economic growth and industrialisation. No one could have predicted the explosive growth of car use.

By the late 1950s, European cities were suffering of congestion, pollution and a decrease in the state of the urban fabric significantly, due to their radial street geometry. It became increasingly clear that private vehicles had to be barred from entering the city, especially the historic core, which was characterised by narrow streets. In the 70's a movement started in Europe to reclaim public spaces from the private vehicle. By 1975, all major European Cities banned cars from historic and retail areas within the CBD. Public areas were revitalised and as a result cold and dormant cities become alive with people (Hass-Klau, 1990).

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In North America, the concept of pedestrianisation only started to become prevalent in planning in the early 1960s. With the motor vehicle boom in the United States, people were increasingly moving to the suburbs. The city centres lost liveliness, became increasingly dangerous at night and congested during the day. In the mid 1960s, American planners began to revive the concept of the "Main Street" as a centre for not only trading, but an area of social gathering in an effort to revive the inner city. Contributing to the success of inner city renewal projects in North America was the increases in fuel prices, oil shocks and a growing environmental movement concerned with impacts of vehicle emissions on the environment (Hass-Klau, 1990).

South Africa is not immune to the traffic problems, which have plagued other countries around the world. Car usage in South Africa has grown steadily, and congestion levels in major South African Cities, e.g. Johannesburg and Pretoria, rival those in US cities. South Africans, however, view cars as not only a means of transportation but more of a status symbol. In many instances, commuters in South African cities also have no alternative but to rely on private transport, as convenient and efficient public transport is not readily available.

In the 1970s, South African engineers and planners realised that congestion was a major problem in the City Centres and, as such put together plans to pedestrianise historic quarters, especially in the City of Cape Town. Included in these plans was to create Pedestrian Squares in the historic quarter, including Greenmarket Square. Unfortunately, these plans were never implemented and the only pedestrian precinct in the City of Cape Town was implemented in the early 1990s at St Georges Mall. In 1975, 34 160 cars were entering the City Centre in the peak hour, in 2007, there were over 170 000 cars entering the CBD in that period; an increase of almost 500%, leading to even greater congestion(Cordon Counts, Arcus Gibb, 2007; City for the People, 1975).

During December (2007), Cape Town's peak tourism season, a pilot pedestrianisation project was run in the City of Cape Town. The 300 year old area, earmarked for pedestrianisation, and known as Greenmarket Square, is located in the heart of the CBD and has a colourful history.

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Greenmarket Square first served as a slave market, then became a fruit and vegetable market and in the 1950's became a parking lot. In the 1980's its potential was recognized and was converted into an informal trading area, two days a week. Its potential grew, but it remained a parking lot on days when it was not occupied by the popular flee market.

This pedestrianisation scheme faced many critics. The streets around the square were barricaded to all vehicles, except delivery vehicles and guests of the hotel located on the square. Immediately, cafes around the square began to spill over into the cobblestone streets and the area has become a hub for both tourists and locals. The night time activity around the square has also increased after being dormant for a few years due to safety concerns within the CBD. Despite the success of the market and the increase in pedestrian activity in the square, there is still a strong resistance from some shop owners and office workers on the square towards pedestrianisation.

Pedestrian movements within the City of Cape Town are composed of three major flows; the morning peak flow (AM), the evening peak flow (PM) and the midday peak flow. During the AM and PM, pedestrian flows are mainly coming from and going to the railway station, bus termini, taxi rank and parking garages within the CBD. During the day, there are pedestrian movements to the main shopping areas with the peak during lunch time. Long Street in the heart of the CBD does experience addition pedestrian volumes during the latter part of the evening as many discos and restaurants are located on this street. For the most part, the rest of the CBD is dormant after the evening peak. This is due to a variety of reasons ranging from a lack of attractions throughout the CBD, the limited residential properties in the CBD, as well as the safety concerns in the CBD.

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1.2 Study area

The study area is located in the historic heart of The City of Cape Town's CBD, referred to as Mid City in **Figure 1**. The major land use is retail, as well as commercial use. There are also a few Boutique hotels. Furthermore, the area has a variety of restaurants and cafes. Within the study area, Greenmarket Square, St Georges Mall and Long Street, can be found, which are all popular destinations and form an integral part of the proposed schemes in this thesis. St Georges Mall is the oldest pedestrianised street in South Africa and forms the backbone to the any pedestrian network implemented in the City of Cape Town.

There are currently only 50 000 residents in the CBD, but approximately 400 000 people commute to the CBD every day. Two-thirds of these commuters use private vehicles (Cape Town Partnership, 2008). There has been a trend in recent years to draw more residents into the CBD by converting B and C- grade commercial buildings into City residential apartments. This has seen an increase in the number of residents; however, these apartments are expensive and are usually only afforded by the middle to upper income bracket. There has been a revitalisation of the Cape Town Inner City, with major Public Private Partnerships. As such, there has been a total investment by property owners in the Cape Town CBD of R150 million over the eight year period from 2000.

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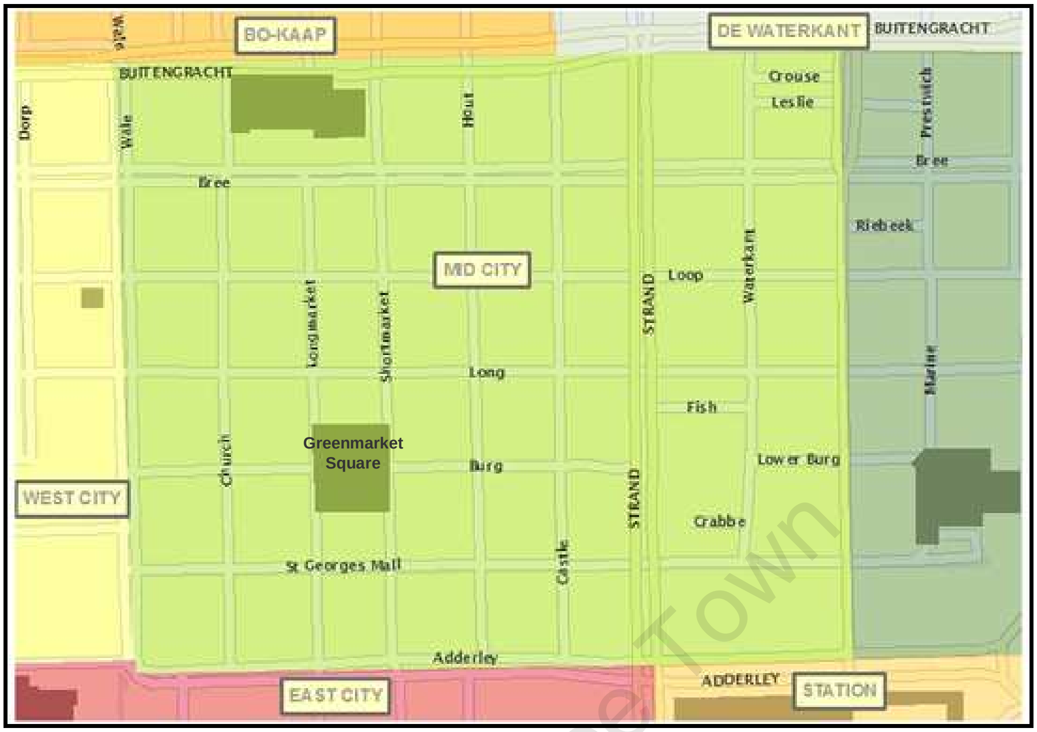

Figure 1: Location of Study Area (Cape Town Partnership, 2007)

Much of the CBD is dedicated to office space. There has been an increase in the price of office space over the last few years as can be seen in **Figure 2**. This figure shows the growth in value of office rental for the entire CBD per Quarter. The increase is especially significant in 2007.

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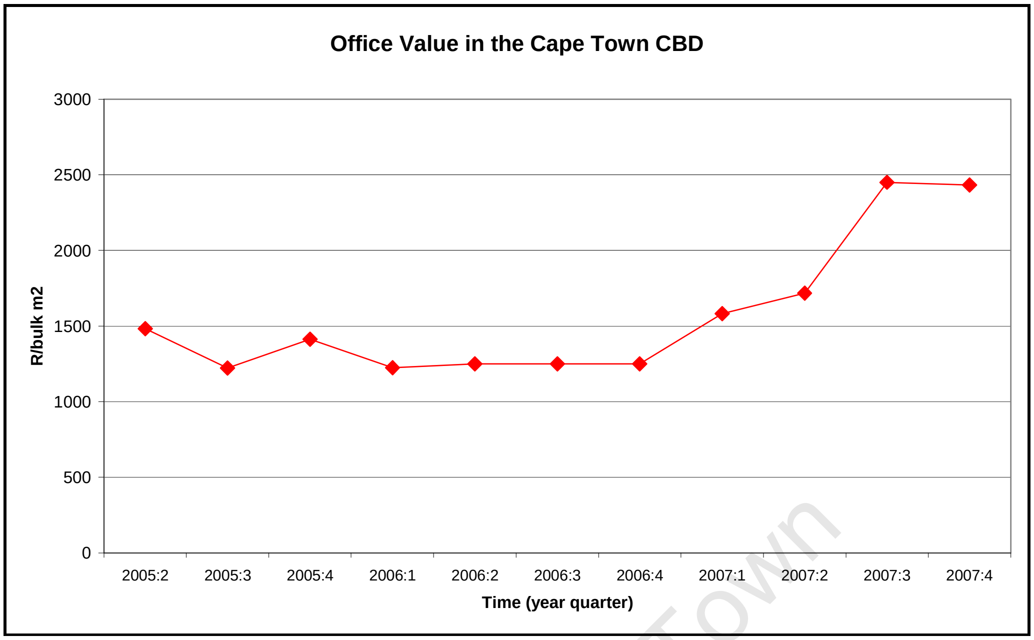

Figure 2: Growth in Value of Office Space in the Cape Town CBD (Rode, 2008)

1.2.1 Transport Usage in Cape Town

Even though the public transport system in Cape Town is not on par with European standards, it still has a high patronage. The main forms of public transport in Cape Town are rail, buses and minibus taxis. It is estimated that public transport enjoys about 50% of the modal split in the AM and PM peak periods (CPTR, 2004). The modal share between the various forms of public transport in Cape Town, is 54% rail, 33% mini-bus taxi and 13% bus (CPTR, 2000). About 35 000 people commute to the CBD by rail during the AM Peak. The number of people using the rail system during the AM Peak, has stayed about the same from 1991 -1997. The number of mini-bus taxi commuters to the CBD has increased from 7000 to 11 000 in 2002, while the number of bus commuters have decreased from 6000 to 4000 in the AM Peak. From the Cape Town Station, commuters can either walk to their final station or change mode. **Figure 3** shows the dispersion of pedestrians using public transport from Cape Town Station to the inner City.

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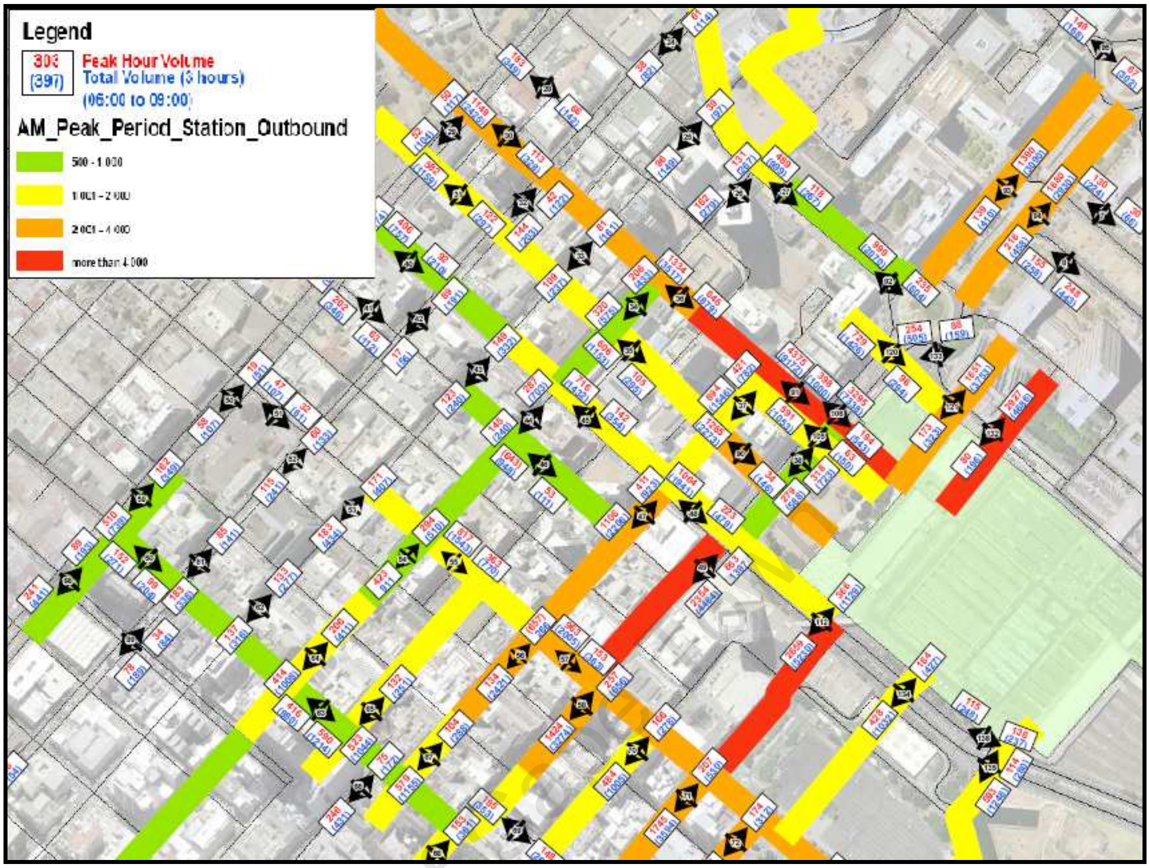

Figure 3: Pedestrian Volume in the AM Peak – Outbound from Cape Town Station (Arcus Gibb, 2007)

The transport modal split within the CBD, throughout the whole day, is a very different scenario as compared to the AM Peak, with a modal split of 67%:33% with regard to private vehicles vs. public transport. This major change in the mode share can be attributed to the decrease in the frequency of the public transport service. Even though the number of rail passengers during the AM Peak have remained constant, there has been a decrease of 2% per annum when one looks at rail usage over the entire day.

The private vehicle is still the preferred mode of choice within the City of Cape Town, as well as the greater Cape Metropolitan Area (CMA) with this mode sharing 50% of trips. This mode is used mainly by middle to high income groups, with the number of cars forecast to increase in the coming years according to **Figure 4**.

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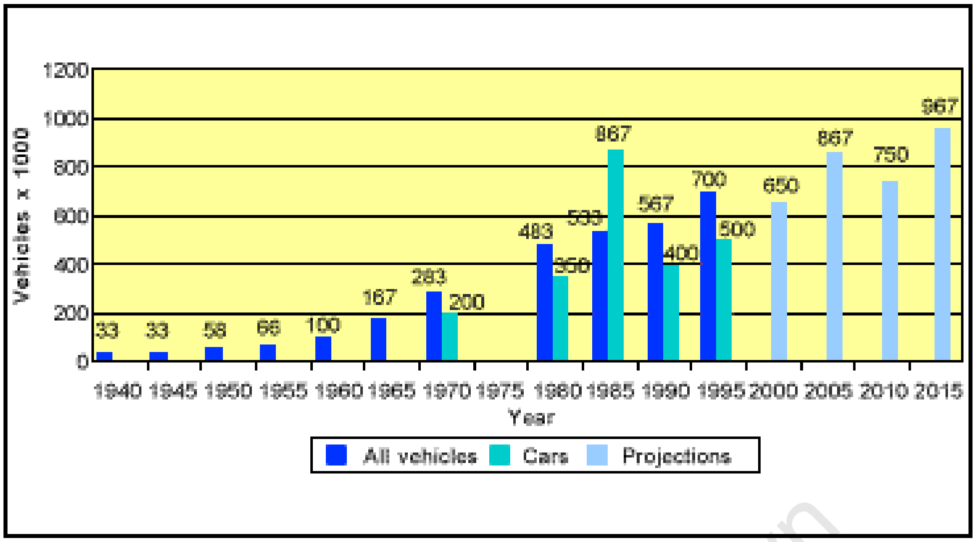

Figure 4: Vehicle Registrations in the Cape Metropolitan Areas (CMC, 1998)

1.3 Purpose of the Study

The purpose of the study is two-fold. Firstly, a computer dynamic traffic reassignment simulation model SATURN, will be coded for the City of Cape Town. This model will be used to model the effect of road closures on the current traffic. The results from the model will indicate the changes in traffic on major roads in the Cape Town CBD and identify areas where the bottlenecks are (road links and intersections that operate at overcapacity). The results from the model will also be used to identify roads that could be pedestrianised and form a pedestrian axis in the CBD. The pedestrian axis will allow any part of the CBD to be reached on foot.

The second component of the thesis research is a retrospective survey of the traders, shop owners and restaurateurs on Greenmarket Square. The aim is to look at the economic effects of pedestrianisation on the square. This thesis plans to prove that South Africa follows the global trend, which dispels the myth that pedestrianisation, leads to less economically desirable environments. Areas which are already pedestrianised, as well as areas with high pedestrian flow are more desirable retail businesses experience more turnovers in these areas due to the increase in foot traffic. The survey also investigates the above-mentioned stakeholder's perception of pedestrianisation, six months after the square has been pedestrianised.

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Greenmarket Square will be used as a case study in this thesis. This, combined with the modelling of road closures to create pedestrian spaces, is hoped to give an insight to the effects of pedestrianisation from a people and traffic perspective.

1.4 Research Objectives

There are two sets of objects, one relating to the SATURN transport model and the other set based on the pedestrianisation of Greenmarket Square.

1.4.1 SATURN Modelling

The main objective in the modelling category is to try and quantify the change in the volume of traffic, due to changes in road infrastructure to accommodate a pedestrianisation scheme. Various scenarios are modelled and indicators are used to quantify the changes in traffic. These key indicators include:

- the vehicle delay on a selected link,
- the link volume over capacity ratio,
- the average vehicle queue at an intersection along a link,
- the intersection volume over capacity ratio, and
- The journey time taken and average speed of a vehicle on a particular route.

The object of the modelling exercise is to examine the extent of the traffic changes on selected links, due to various proposed scenarios regarding road closures for pedestrianisation. From this data set, a recommendation can be made on which pedestrian scheme is one with minimal change to the existing traffic situation, while increasing the pedestrian network.

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1.4.2 Pedestrianisation of Greenmarket Square

The retrospective travel survey will be used to try and gain insight on the effectiveness of pedestrianisation in Cape Town. The main objective is to determine whether the Greenmarket Square scheme follows the same pattern as the European examples outlined in the literature review. From the review, an economic case has been made for pedestrianisation, where retailers experienced an increase in turnover and patronage, due to the creation of pedestrian precincts. The first objective is to determine whether the recent Greenmarket Square in Cape Town has followed the same trend. The second is to determine the perception of pedestrianisation amongst various stakeholders on Greenmarket Square.

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1.5 Limitations of the Study

1.5.1 Limited Research

South Africa is lagging behind the rest of the world when it comes to research in the field of pedestrianisation and the effects on traffic as well as the economy within the South African context. While this is slowly changing, the major source of information on pedestrianisation is through reports written by City engineers in 1975, as part of a report called City for the People (CoCT, 1975). This report outlines pedestrian schemes, which should have been implemented as a move to make Cities more people oriented. In subsequent years, these plans were cast aside. In recent years, the ideas have re-emerged in the planning philosophy for the City Cape Town, especially in light of 2010 transport planning and the transport legacy of Cape Town. With this new emergence towards pedestrianisation, there is still limited research and papers being written on this subject in South Africa.

1.5.2 Limitations of the Model

The SATURN simulation model used for the research is a ten year old model, provided by the City of Cape Town. This model has been updated to the 2007 base year. Unfortunately, a new origin-destination matrix was not designed as the City of Cape Town is still undergoing a process of data collection, and as such the matrix, is a 1997 matrix, factored to reflect the total numbers of vehicles entering and leaving the City, and not for individual origins and destinations. As a result, the traffic assignment may not reflect reality to 80% accuracy, which is usually accepted in modelling. Nonetheless, in the scope of comparing scenarios, the model should be accurate enough.

It should be noted that the results from the model cannot be used at the specific numerical value, but should rather be used as a comparative tool for the various scenarios.

The SATURN package only models vehicular traffic, using the term passenger car units (PCU) and as such, pedestrian flow cannot be analysed using the software.

Due to time and resource constraints, a SATURN model was coded for the AM Peak period only. Thus the Midday and PM traffic flow will not be discussed in this thesis.

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1.5.3 Limitations of the Survey

No survey was conducted before Greenmarket Square was pedestrianised and as such a change in the perception of pedestrianisation cannot be analysed.

The only stakeholders surveyed, are those that have been on the square for longer that one year. As such, the survey group is a small group.

The survey was conducted in the Cape Town Winter. During this period, the weather in Cape Town is often, cold and rainy. This plays a role in peoples perceptions of the scheme as there are fewer people on the square during the wet weather conditions. During the summertime, the full value of the square can be maximised.

1.6 Content of the Report

This report acknowledges all contribution to the thesis. It then summarises the main aspects of the thesis. Chapter 1 outlines the main aims and objectives of the research topic and indicates the limitations of the research and the research instruments used to obtain results. An extensive literature review is provided in Chapter 2, outlining major research findings and international best practice. Chapter 3 outlines the research methodology used in the study. This includes an explanation of the SATURN Modelling software and the key indicators used for analysis. The results of the SATURN modelling and the stakeholder's survey are presented in Chapter 4 and Chapter 5, with conclusions discussed in Chapter 6. The recommendations resulting from the research and modelling are presented in Chapter 7. Full lists of modelling results are presented in Appendix A.

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2 LITERATURE REVIEW

2.1 INTRODUCTION

The aim of this Literature review is to establish an understanding of the history of Pedestrianisation. The review will cover a general overview of congested cities and showcase the need for pedestrianisation. It will then look at European examples of pedestrianisation. There will be a special focus on Germany, researched during an international exchange with the University of Stuttgart. The literature review will then summarise pedestrianisation in South Africa, with a particular focus on planning and implementation in the City Cape Town.

2.2 REDUCING AUTOMOBILE DEPENDENCE

After World War II, falling oil prices and the availability and ease with which private vehicles could be purchased, resulted in a rise in private vehicle ownership. As such, many cities in the northern hemisphere became more spread, with low density suburbs, resulting in urban sprawl. These lower densities also lead to a decline in pedestrian accessibility and longer trip lengths. Today, few cities around the world have been successful in curbing the scourge of congestion, economic and social impacts resulting from the growth in automobile ownership and an increase of ease of personal mobility.

Lower densities result in municipalities facing the challenge of providing adequate public transport at economical prices. As such, it is not uncommon for the urban poor to spend, as much as 20 percent or more of their income on transport. For those people living on the peripheral, they can spend three to four hours a day travelling to and from work, due to the increased distance from the CBD, as well as congestion (Newman, 1996).

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A new school of though has developed; to design cities in such a way that automobile dependence is reduced, and in the case of historic cities, the historic core is preserved. This new and growing philosophy focuses on designing for the pedestrian, as well as to negate the negative impacts of the automobile, such as loss of urban quality, the increased ecological footprint and to increase in patronage of public transport systems. The design principles focus on making centres viable and vibrant. It has been realised that viable and sustainable urban centres cannot be automobile dependant. The domination of centres by automobiles and car parks defeats the walkability of the city. One of the ways of achieving a viable city centre is through pedestrianisation (Newman, 1996).

2.3 THE ECONOMIC VALUE OF WALKING

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Walking is the most common mode in transportation and everyone is a pedestrian during at least part of their journey. Walking plays a major role in all cities, but more so in European Cities. Recently, other Cities around the world are following the same trend to prioritise the value of this mode choice. Even with this new trend, lower value is still placed on walking as compared to driving and as such, spending on infrastructure to promote walking is much less than that of other modes (Litman, 2003).

Walking offers greater benefits to society and provides basic mobility and access to goods, activities and services for everyone, especially disadvantaged people. Unfortunately, walking is often undervalued in conventional transport evaluation practices. This disadvantages projects involving strong focus on walking, because transport decisions involve tradeoffs between different types of accessibility. Wide roads, high traffic speeds and large parking facilities, which create barriers to walking, are favoured, thus creating automobile dependent communities (Litman 2003).

The major benefits of walking and creating a walkability community, according to Litman (2003) are outlined in the sub-section 2.3.1.

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2.3.1 Accessibility and Transportation Costs

Walking is not just a major form of access on its own, but it is a form of access when used in conjunction with other modes. It is especially important to those members of society who are economically, physically and socially disadvantaged. With favourable walking conditions, consumers will opt to walk short distances and thus save on transport costs. McCann (2000) found that households in automobile dependant communities can spend up to 20% of household budget on transportation expenses, while those in more accessible and public transport orientated communities spend less (17%).

2.3.2 Health and Safety

Decreasing public health and the increases of obesity, heart diseases, hypertension, and other diseases associated with physical inactivity, is becoming a major topic of discussion. An increasing proportion of the population lack the necessary physical activity, recommended by health professionals, to lead a healthy life. There are many ways to be physically active, but walking is one of the most cost effective and popular means. Walking is especially important for the elderly, disabled and lower income who cannot afford to participate in formal sports or exercise programmes. Jackson and Kochititzky (2001) argue that a more balanced transportation system can contribute to improved public health by accommodating and encouraging active transportation.

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Each year, 1.2 million people are killed on roads worldwide, with this number set to increase by 83% in 2020 in low and middle income countries (WHO, 2004). The most vulnerable road users are the pedestrians. Fatalities are often people from the low income group, as they have no alternate means of transport. The percentage of fatalities per continent can be seen in **Figure 5**. The costs in developing countries alone appears to be more than $ 100 billion dollars per annum (New York Times, 2002). International research has shown that the modal shift to non-motorised transport has resulted in increased road safety (Litman, 2003)

Region	Pedestrian Fatalities (Percent of Total)
Europe & the United States	20%
Latin America	60%
Middle East	51%
Asia	42%
Africa	45%

Figure 5: Pedestrian Fatalities as a Percentage of Total Fatalities (Wright, 2006)

2.3.3 Reduction in Transport Externalities

The automobile imposes various external costs, which the user does not necessarily pay for. These include public costs for road and parking facilities, traffic congestion, accident risk, and various environmental impacts (McCubbin and Delucchi, 1996: ExternE, 2002). Other modes also impose external costs, but generally at a lower rate per trip. Walkability improvements that reduce automobile travel can reduce these external costs (Litman, 2000). **Figure 6** shows the comparison of external costs. From this, it can be seen that walking has almost negligible external costs compared to automobile usage.

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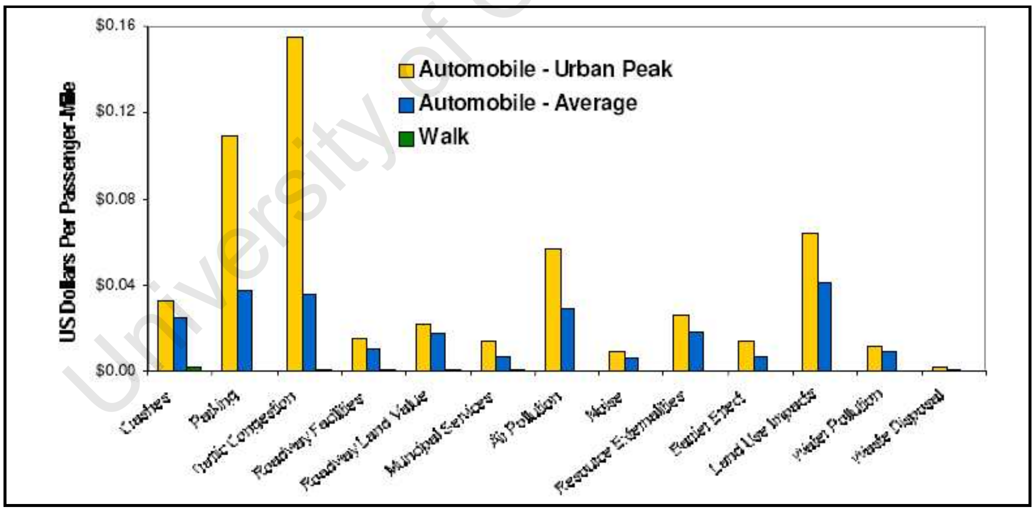

Figure 6: Estimated External Cost for Automobile Travel & Walking (Litman, 2002)

2.3.4 Equity and Economic Development

Walking can help achieve equity objectives, including a fair distribution of public resources for non-drivers, financial savings and improved opportunity for lower-income people, increased accessibility to people who are disadvantaged by automobile transportation, and improved basic access (Litman, 2004).

Retail and employment centers are affected by walking conditions. Pedestrianised commercial districts can be important for urban centre revitalisation (Tyler, 1999; Bohl, 2002). These pedestrian zones can help create lively and inviting environments that attract residents and visitors.

Improvements in the walking environment can also support regional economic development by shifting consumer expenditures. This is an indirect benefit from the transport cost savings described previously. Expenditures on automobiles, fuel and roadway facilities provide relatively little regional economic activity, because these goods are capital intensive and mostly imported from other regions (UTPI, 2002).

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2.4 PEDESTRIANISATION

2.4.1 A History

Some form of pedestrianisation can be found in records dating back as far as the times of Leonardo Di Vinci (Mumford, 1961). In Paris, covered shopping arcades were very popular in the 1800s (Geist, 1983). In the nineteenth centaury, European Countries built many pedestrian arcades. These precincts are, however, different to precincts today. The nineteenth century, Cities developed new traffic free areas. However, creating a pedestrian precinct involves the removal of existing vehicular traffic.

Throughout the 20th centaury, the space devoted to cars and car parks has grown steadily, with the result of higher traffic levels in all major cities throughout the world. A clear trend can be seen, as nations industrial strength grows and car ownership becomes more accessible, so does the dependence on the automobile and thus the large scale investments in road infrastructure. Cities became more car dependant, and are redesigned to make car travel easier. Such changes in the urban fabric are promoted at both a policy and government level. The "predict and provide" approach to transport was prevalent from the 1950's (Goodwin, 1997), where planners would predict the amount of motorised traffic, and provide infrastructure to meet the forecasted demand. When the demand increased, more infrastructure was built. This resulted in an extensive urban motorway system, and often the loss of the Old City Centres. During this development, the infrastructure demands of more vulnerable road users, pedestrians and cyclists, were also largely ignored.

The beginning of the modern pedestrianisation era, as we know it, started as far back as the 1920's and 1930's, but the biggest schemes were realised during the reconstruction of cities after they were bombed during the Second World War. Germany was a forerunner in modern pedestrianisation with thirty-five German Cities having at least one pedestrianised street by 1960. By 1984, Germany had more than 800 pedestrianised areas in city centres and sub-centres (Hall, 1985).

Pedestrianisation has, in recent years, become more of a topic for discussion worldwide, especially in light of the movement towards sustainable transportation, as well as the so-called green-transportation movements. However, these movements are very recent. Today, the percentage share of trips made by walking can range anywhere from 37% in a city of 100 000 people, to 28% in mega cities with populations of over 10 million people (Asija, 2005).

However, the trend in developing countries still exists to provide infrastructure for private car usage. This is still causing an increase in congestion and air pollution as well as serious road safety issues within the developing countries.

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2.4.2 Pedestrianisation around the world

European cities have been the forerunners in implementing pedestrianisation. Today, most cities in Europe, Asia and Latin America have at least one street that has banned cars. These pedestrianised areas are usually areas where walking reaches its highest intensity. Many cities with ancient historical centres have banned vehicles to promote tourism (Gehl, 2000). These areas also serve as shopping areas for locals and tourists who visit the region. Banning vehicles in historical cities have helped some cities receiving a UNESCO World Heritage Site Status. A list of these cities is included in **Figure 7**.

Region	Historical Car Free Centres
Europe	Salzburg & Vienna (Austria); Brugge (Belguim); Prague (Czech Republic); Tallinn(Estonia); Lyon & Strasbourg (France); Potsdam (Germany); Venice, Siena & Napoli (Italy); Riga (Latvia); Vilnius (Lithuania); City of Luxembourg (Luxembourg); Evora (Portugal); Santiago de Compostela & Segovia (Spain)
Asia	Nara and Nikko (Japan)
Africa	Islamic Cairo (Egypt); Medinas of Fez and Marrakech (Morocco)
Latin America	Antigua (Guatemala); Salvador and Sao Luis (Brazil); Cartagena (Colombia); Quito (Ecuador)

Figure 7: Historical Car Free Centres which are UNESCO World Heritage Sites (Wright, 2006)

Pedestrianisation in Europe was largely a step taken to stop the conflict between people and increasing numbers of vehicles, all vying for the same road space. Leonardo Da Vinci can be seen as one of the first “planners” to suggest that people be separated from the busy streets in Milan in the fifteenth century (Mumford, 1961). He recommended that traffic be put underground.

The City of London faced the same problem and was becoming increasingly notorious for traffic congestion in the nineteenth century. The rapid developments of Europe post World War II and the focus on the automobile (providing roads for the automobile), pedestrian spaces became increasingly encroached upon. It was not until the late 1960’s that the plight of the pedestrian came under the spotlight; with the result that majority of European towns became largely car free.

Heritage Sites are not the only good examples of successful implementation of pedestrianisation. Other cities around the world have converted major shopping streets into pedestrianisation precincts.

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Central Copenhagen is one of the best examples, as it began to pedestrianise its main street from 1962 and continued to transform streets and squares, over the next four decades into pedestrianised areas. Ghent in Belgium is one of the largest car free areas in Europe, while cities like Venice and Rhodes have always been car free. These cities, like a few others have been car free, due to narrow streets or some other geographical obstruction to vehicle flow.

The dramatic change that pedestrian precincts have brought to some cities in Europe can be inferred from high pedestrian volumes and from the new businesses and shopping malls developing in these city centres (Monheim, 2001). Pedestrianisation has a positive effect on the businesses in the area of implementation. The effect is usually in the form of increased turnover. According a study of 100 pedestrianised cities across the world, turnovers of shop owners in the city centres increased in 49% of the cities, while 25% had a stable turnover. Cities in Germany, Austria and Scandinavia experienced increases in turnover of more than 60% (Kumar & Ross, 2006).

Other effects of pedestrianisation are the increased property values and streets attracting the wealthier, thereby benefiting the overall retail sales and drawing economic advantage to the area (Sermons and Seredich, 2001; Hass-Klau, 1993). Pedestrianisation also encourages local people to buy utilities in their own neighbourhoods and attracts more customers from a wider area, increasing the community relations (Ross, 1999; Kumar, 2005).

Below follows four short description of pedestrianisation in global Cities. There is also a sub-chapter dedicated to pedestrianisation in Germany.

2.4.3 Denmark

Pedestrianisation in Europe cannot be discussed without mentioning Copenhagen. Copenhagen is Denmark's capital city, developed around its harbour. The inner city is the most important business area and still maintains its medieval street pattern (Gehl, 2000). In the years preceding 1962, the inner city streets and squares were extensively used for private vehicle traffic and parking, not unlike Cape Town today.

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In 1962, inspired by German pedestrian streets, built after the Second World War, the City's main street (Strogen) was converted into a pedestrian street. Strogen was a one-way street carrying large volumes of vehicular traffic with pedestrians having to use crowded sidewalks. Much public debate was generated even before the street was pedestrianised. Comments, such as "Pedestrian streets will never work in Scandinavia," "No cars means no customers, and no customers means no business" and "There is no tradition of outdoor public life in Scandinavia" were made (Gehl et al, 2003). It was noted that the last comment was especially true as the Danes, since the invent of the motorisation, never had the opportunity to develop a public life in public spaces and as such it was not part of their living culture.

Even with the above concerns, pedestrianisation of Strogen was implemented and within weeks the scheme proved to be a success. Turnovers for businessmen along the street increased and as such more pedestrian streets and squares were established over the next 38 years, gradually increasing the pedestrian network. Squares along the streets, which were used for parking, were converted into pedestrianised areas and recreational city activities began to develop.

Today, Strogen is the longest pedestrian shopping area in Europe (www.visitcopenhagen.com) and pedestrians are able to walk from one end of the city to the other. Foot traffic in the inner city of Copenhagen makes up about 80% of the traffic (Gehl et al, 2003). On an ordinary winter's day, Strogen can have as much as 25 000 pedestrians using the street between 10am and 6pm (Gehl & Gemzoe, 1996). This large pedestrian volumes is depicted in **Figure 8** Parking within the City centre was gradually reduced by 2-3% per annum over the 40 year period to allow a new city culture to develop organically and people's travel patterns and habits to change. Longer journeys are being made by bicycles, as well as an increasing use of public transport. Car traffic in the city has decreased due to, both reducing the number of parking bays and limiting the opportunities to drive (Gehl, 2000).

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Figure 8: Copenhagen's main pedestrian street, Strogen (Drever, 2003)

Pedestrianisation in Copenhagen has resulted in increase use of public transport, non-motorised transport and a more pleasant pedestrian environment. This case study shows that a mind set change can be made, but must be done in a gradual manner to allow travel behaviour to change.

2.4.4 England

As was the case with Germany, the period after World War II was used for tremendous planning in land use and transport. Since private motor vehicle use in Britain was still relatively low, there was a focus on the pedestrian and it was recognised that separation between the motor vehicle and the pedestrian was necessary. From as early as 1923, British transport planners recommended the separation between people and vehicles and the introduction of pedestrian precincts. However, few pedestrian schemes were implemented and only minor streets in British towns were closed to vehicles and became known as play streets. These were more areas for children to play in the absence of playgrounds. These play streets were still in existence until the 1960s (Hass-Klau, 1990).

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Norwich was the first British city to close its main commercial street to vehicle traffic. Towards the beginning of the 1960s, Norwich began to experience major problems regarding the clash between vehicles and pedestrians. Automobile ownership had more than doubled over the last ten years and, as such severe congestion was experienced along the main commercial street, London Street (Hass-Klau, 1990). London Street has significant importance to Norwich as it connects the City Hall, the Market Place and the Cathedral District; the last two being areas which are frequented by tourists and locals alike. London Street was also used as a shortcut for commercial vehicles through the City. As such the road combination of a road and sidewalks became increasingly dangerous (Hass-Klau, 1990).

In 1965, a major sewer pipe burst resulted in the closure of London Street temporarily for repairs. Instead of the drop in sales, which shop owners predicted, the reverse happened. The area became livelier with people and the authorities decided to close the road for a trial period of three months, which was extended to six months. In 1968, parts of London Street were permanently closed to vehicle traffic. With the success of the London Street Closure, smaller streets nearby were also closed to vehicular traffic to make pedestrian walkways. Restaurant owners experienced increases in turnover between 5 – 20 percent (Hass-Klau, 1990). The entire area became more livelier with markets and activities (**Figure 9**). Even with the success of Norwich and other German cities, the British have been reluctant to pedestrianise street. However, this trend is slowly changing, with more schemes being implemented in the last few years.

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Figure 9: Market on London Street (www.magazinewood.co.uk)

2.4.5 Thailand

Bangkok, Thailand, has a rich cultural past and is a famous tourist destination. Like many of the other Asian Cities with growing economies, the improved economic growth has led to an improvement in lifestyle and an increase in vehicle numbers. Areas in Bangkok are filled with noise and emissions from automobiles. In Bangkok, nearly 600 new cars are added to the roads everyday, making an extra 3 kilometres of bumper-to-bumper traffic (Kenworthy, 2003).

Bangkok has a mixture of land use compared to similar western cities with high car dependency. Commercial, residential and retail facilities are usually within a walkable distance (Newman and Kenworthy, 1989). Bangkok, however, has high motor friendly infrastructure, with generous parking facilities, wide roads and flyovers, which act as a catalyst for increasing car dependency (Poboon, 1997) creating a car orientated urban environment.

Walking and cycling characteristics in Bangkok are very low with only 13% of the work trips on these modes. This is significantly less than other Asian Cities, which have an average of 34% (Newman and Kenworthy, 1999). The low levels of walking and cycling are, due to the safer and more pleasant conditions for car travel (Kumar, 2006).

To initiate a modal shift, a strategy to develop pedestrian areas Bangkok Metropolitan Authority (BMA), initiated pedestrianisation schemes in some commercial areas. One such area is in the Khao San Road. It is a popular destination for many locals, foreign travellers and backpackers. Apart from the motels, Khao San Road has food stalls, travel agencies, souvenir and music shops. The project was implemented in 2001 (Kumar, 2006).

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Studies from the Khao San Road, Bangkok, Thailand, have shown that traffic calming through pedestrianisation has had a positive economic benefit for the retailing and commercial community (Kumar, 2006). After the implementation of the scheme, the sales volume of shop owners increased. There has also been an increase in property/rental values and business activity. Stated preference surveys conducted post implementation indicated that consumers thought the liveability of the area improved and retailers were positively inclined towards further pedestrianisation in the area.

2.4.6 United States of America

The American Example is an interesting case, as the American culture is very car orientated. However, American planners followed the global trend in the late fifties to create pedestrian spaces, as such pedestrian malls and skywalks were created. Pedestrian malls are a concept developed in America and is based on the European Concept of pedestrian shopping streets. In 1959, Kalamazoo, Michigan, implemented the first downtown pedestrian mall in the United States. By the late 1970s, over two hundred American downtowns possessed pedestrian malls, the majority in small- and medium-sized cities (Robertson, 1993).

The main reason for development of pedestrian malls was to help the downtown centres to compete with the growing number of suburban shopping centres, which were drawing increasing numbers of middle-class shoppers. The aim of the pedestrian malls was to replicate the appeal of suburban shopping centres with regard to safe shopping environment, which is free from automobiles. The shopping malls were landscaped park like corridors in the centre of town and forbade automobile traffic (Robertson, 1993).

Three basic types of pedestrian malls were constructed in the United States (Robertson 1990), the most common being the traditional pedestrian street. Here automobiles are strictly forbidden. Most malls constructed during the 1960s and 1970s were for pedestrians only. The main problem with these types of malls was when pedestrian volume was light; these malls lacked liveliness and became dormant. To increase activity levels, some cities implemented shared malls or transit malls.

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A shared mall permits limited automobile use, usually one lane of one-way traffic; the remainder of the right-of-way is for pedestrians. A transit mall features a pedestrian corridor that also allows transit vehicles. Successful examples of transit malls are in Minneapolis; Madison; Portland (**Figure 10**), Oregon; and Denver (Robertson, 1993).

Since 1980, only a few of these malls have been constructed and most of these pedestrian malls were deemed as failures in the respect that they cut off automobile traffic from retailers and failed to spur revitalization of downtown areas. Most were re-converted to accommodate automobile traffic within twenty years and, as such only about 30 pedestrian malls remain. There is once again a growing urban renewal movement in the US, who want to bring back pedestrianised zones in major urban areas (Robertson, 1993).

Figure 10: Concept of a Transit Mall, Portland (www.portlandmall.org)

2.4.7 Germany

Germany started introducing pedestrianised streets first in Northern parts of the country in the early 1930's starting in Essen and Cologne, while southern Germany remained largely car-orientated. During the reconstruction of city centres, which were destroyed during the World War II air raids, cities like Chemnitz, Kassel, Kiel, Magdeburg and Stuttgart introduced pedestrian precincts. By 1955 twenty one cities in Germany had car-free streets, but these streets were short; on average between 400-900m (Monheim, 2001). Most of these streets were not designed as pedestrian streets, but merely had the stretch of road closed to vehicular traffic. By the 1977, there were approximately 370 pedestrian precincts in West-Germany. East-Germany lagged behind with only 120 precincts, due to state policy in East-Germany, which hindered the expansion of these areas (Monheim, 2001).

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During the 1970s, state policy outlined new goals for pedestrian precincts, which resulted in the steady expansion of these zones, which formed pedestrian networks which were 4-9km in length. These were most notably found in cities such as Munich, Nuremberg, Stuttgart, Freiberg, Essen, and Cologne, with many more cities in Germany following suit (Monheim, 2001).

2.4.7.1 Pedestrian Volumes in Germany

In Germany, pedestrian streets were initially introduced only in areas where high pedestrian volumes exceeded the capacity of sidewalks or where it was economically profitable to exclude car traffic. This normally resulted in an increase of pedestrian volumes, mainly during noon and afternoon when the new pedestrian street encouraged leisure-oriented usage (Monheim, 2001). Improved accessibility to these areas by means of new and efficient public transport, as well as new parking garages, and new retail offerings saw an increase in the use of these precincts.

A drawback of these precincts was that small precincts caused problems, due to the streets becoming overburdened and shop rents becoming exorbitant. This increase in rental prices caused many of the smaller local retailers to close shop, especially those making marginal profits. These smaller shops could not survive the competition from national or international chain stores pushing into the pedestrian street. The high pedestrian densities resulted in complaints about overcrowding and low levels of service for the pedestrians on the street (Monheim, 2001).

The main pedestrianised shopping street in Munich is a worldwide acknowledged success, and has experienced overcrowding and a lower level of service for visitors to the zone. In an open question about the most disliked aspects in the city centre, approximately 33% spontaneously mentioned the hectic pace and crowding. In Nuremberg, due to a more equal distribution of pedestrian flows, these are mentioned only by 7% (Monheim, 2001). **Table 1** shows the different volume of pedestrians during the Tuesday and Saturday. Counts from the various German Cities can be compared to other International Cities. Most of the International Cities are considered leading International Cities, but their pedestrian volumes fall below those counted in local German Cities (Monheim, 2001).

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Germany			Other Countries		
City	Tuesday	Saturday	City	Tuesday	Saturday
Frankfurt	14925	21241	Milan	8402	25995
Munich	13747	20507	Hong Kong	9981	13938
Hamburg	7307	12829	Warsaw	11892	14351
Cologne	7838	12127	London	8065	12895
Dortmund	5640	12222	Paris	7815	-
Hanover	6168	8793	Sydney	6380	11890
Stuttgart	5856	8981	Madrid	8382	11134
Berlin	4635	8683	Barcelona	8267	8415
Mainz	3838	9468	Tokyo	6661	7645
Essen	4438	8064	Brussels	4906	8092
Nuremburg	3356	8236	Amsterdam	3494	8188
Wisbaden	4314	6937	Zurich	4495	5572
Heidelberg	4943	6138	New York	7028	4586
Bremen	3660	7246	Copenhagen	4078	6385
Dresden	4035	6767	Moscow	4936	3376

Table 1: Pedestrian Volumes in Pedestrianised Precincts (Monheim, 2001)

2.4.7.2 The Use of Pedestrian Precincts

The high usages of pedestrian zones in Germany can be attributed not only to their appeal to local residents, but also residents from suburban areas, thus having a greater catchment area. Most visitors to these precincts come not just for shopping but also for entertainments and other leisure activities. **Figure 11** is a summary of survey of visitors to German Cities. From the survey, it can be concluded that a significant proportion of visitors found the townscape as well as the pedestrian precincts appealing (Monheim, 2001).

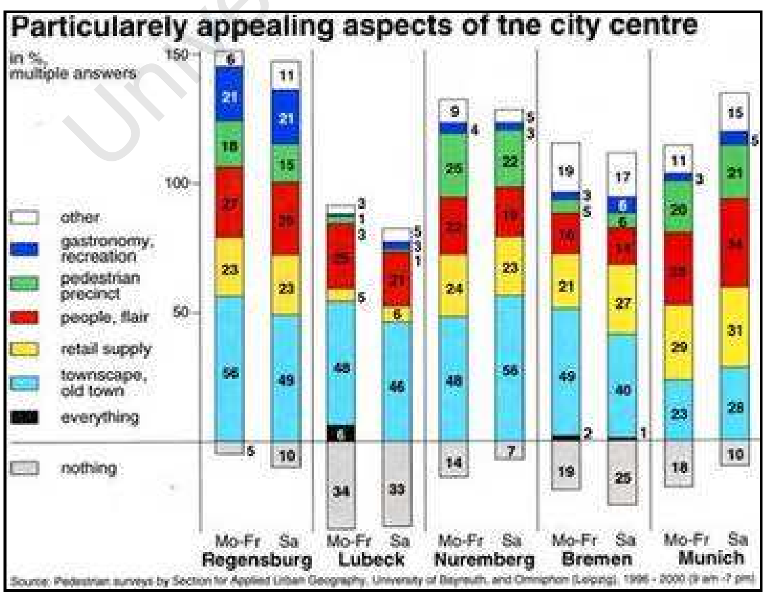

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Figure 11: Appealing Aspects of German Cities (PPS, Accessed 2008)

In Munich, for example, on Saturdays 38 % of the visitors of the main retail area live within the city boundaries, 24 % in the region and 39 % beyond the „normal" catchment; in Nuremberg, the respective proportions are 48%, 22% and 30%. From Monday through Friday, on the other hand, a trend can be observed which is also typical for American downtown's, when a large proportion of passers-by come from their place of work or education. In Munich, this is approximately: 39%, while in Nuremberg, it is 37% (Monheim, 2001).

2.4.7.3 Accessibility of Pedestrian Precincts

Many lobbyists against the implementation of pedestrian precincts have argued that the restriction of access of the City Centre by car, puts the entire City Centre in danger of losing vitality and becoming a dormant area. However, the attractiveness of the City Centre is not, due to the accessibility by cars but, due to the desire of the consumer to visit this location. In many instances, the percentage of visitors using private vehicles is small, compared to the total number of visitors (Monheim, 2001).

In the most successful example (Munich) only 16 % of the visitors come by car, while 72% use public transport; interestingly, the others walk or cycle. Nearly the same figures were obtained in Melbourne in 1991 (Monheim, 2001). In smaller Germany Cities, however, the percentage of visitors coming by private cars is larger. In most cases, they are still in the minority. On average, in West German City Centers, only 31% of shoppers came by car (Monheim, 2001).

More people, including car owners prefer, a further reduction of car traffic than those wishing improved car accessibility. Even in cities with 5-9 km pedestrian streets, many more respondents are in favour of their expansion, than opposing it; the plurality amounts to 67% in Bremen, 59% in Munich and 39% in Nuremberg, which has the most complete pedestrian network among the three (Monheim, 2001).

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2.4.7.4 The Case of Freiburg

Freiburg was the first Southern German city to pedestrianise its streets. Over 80% of Freiburg had to be rebuilt after World War II, due to the extensive damage to the City. The City was rebuilt in accordance with its original historic character and a lot of consideration was given to transport and pedestrians. Freiburg kept it medieval street design, including its narrow curving street network and cobblestones, and opted not to widen roads for motor vehicles as many other German Cities did during the rebuilding phase post World War II (Hass-Klau, 1990).

Freiburg first pedestrianised its main shopping streets in 1957, eight years after it was suggested. In 1968, streets around the cathedral and Town Hall were closed to vehicular traffic and up to 1973, more streets were pedestrianised, forming a continuous network, encompassing the entire core of the old city. Today, the pedestrian areas is popular with both locals and tourist alike and the area in front of the church is converted to a market on the weekend (**Figure12**)

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Figure 12: Saturday Market in Freiburg (Moosajee, 2008)

2.4.7.5 The Case of Nuremberg

The old town of Nuremberg was almost totally destroyed by air strikes during World War II. During the rebuilding process, the city's identity was preserved by maintaining the street pattern and building proportions. What was unique was that Nuremberg opted not to copy buildings which were lost, except for some public monuments (Hass-Klau, 1990).

One important contribution to this success of the redevelopment of Nuremberg was the development of a pedestrian precinct up to about 9 km in street length. The first pedestrian street, Breite Gasse, was closed to cars in 1966 and redesigned for pedestrians in 1970. In 1972, the City Council opted to adopt a far-reaching pedestrianisation plan. In the following decades it was implemented in stages together with a new subway running under the main shopping district and the addition of new parking garages (Hass-Klau, 1990).

Contrary to the fears of retailers, traffic calming did not reduce the attraction of the city centre. In fact visitor numbers and shop rents increased. This was not only an immediate effect of pedestrianisation but also, due to several improvements: increased accessibility by the new subway, additional parking garages and parking management, marketing activities and numerous events (Monheim, 2001).

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Figure 13: Pedestrian Street in Nuremberg (www.nuernberg.de)

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2.4.7.6 Conclusions on Pedestrian Precincts in Germany

Germany can be considered as one of the founders of pedestrian precincts. The pedestrian zones in Germany are old, compared to the rest of the world, but city and district centres in Germany are still plagued by traffic while the pedestrian precincts in most of Germany are incomplete (Monheim, 2001). On average, 81% of all Germans rate pedestrian precincts as good, as compared to the 5% who rate them as bad (Monheim, 2001).

The pedestrian precincts consist of a network of connected streets and squares, where vehicular traffic has been restricted or banned altogether. In many German Cities, these networks can span for 5-10km.

The success of the German pedestrianisation zone is that it provides a variety of functions and is not just a shopping area. It is a place of leisure, entertainment, concentrated retail shopping, restaurants, and areas of cultural and historic significance. These areas are meeting places and places of interests for tourist and locals alike. Good examples of Cities with well functioning and attractive pedestrian precincts are Munich, Nuremberg and Freiburg to name but a few.

Even though Germany has a proven track record of success with regards to pedestrian zones, retailers and car lobbies always oppose the expansion or introduction of new precincts.

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2.5 GENERAL IMPACTS OF PEDESTRIANISATION

From pedestrianisation schemes around the globe, there are definitive trends that can be observed. It must be noted, however, that not all pedestrianisation schemes are effective and yield positive outcomes. The success of any scheme is dependant on numerous factors including the location, the ability to draw people to the space and the appropriate mix of land use around the pedestrian area.

Usually, when pedestrianisation schemes are being implemented, the media in the proceeding days predict gridlocked streets, major congestion and chaos. But from other schemes, it was noted that when the public was forewarned, there was only a short term disruption in traffic lasting a few days. This is, due to people having the ability to familiarise themselves with alternative routes, make changes in travel time, as well as change the mode.

When pedestrian schemes have been implemented, it has been noted that there is a short term negative effect on trade, which lasts about a year or two, but this timeframe can be much shorter, but as the pedestrian area grows, there is a growth in turnover in the long term. It has been noted that property prices in these areas usually increase to such at an extent that small retail stores make marginal profits and can no longer survive in these areas. As a result, the smaller stores close and make way for bigger retail chains.

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2.6 IMPLEMENTING PEDESTRIAN SCHEMES

With Europe already having implemented many successful pedestrianisation schemes, it is helpful to look at their example and to tailor make the process to the local situation. It must be noted that pedestrian precincts cannot be created as generic zones, but must be tailored to meet the needs of all users especially, the elderly, children and people with disabilities.

One of the leading experts on pedestrianisation today, is Jan Gehl, and below is the general process of implementing the pedestrianisation scheme based on the Copenhagen experience, one of the best pedestrian cities in the world. The process is based on more than 20 years of research, creating a space that is four times more pedestrian friendly (Makovsky, 2002). It should be also noted that implementation of a pedestrian scheme is a long term process over many phases and with a long implementation time.

From the Copenhagen experience, the following can be observed (Makovsky, 2002):

- Convert the desired street into a pedestrian thoroughfare,
- Reduce traffic and parking gradually,
- Convert newly freed up parking lots onto public squares,
- Honour the human scale,
- Populate the City Centre Core,
- Adopt the Cityscape to the changing season,
- Promote cycling as a major mode of transport, and
- Make bicycles readily available in the pedestrian

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2.7 CONCLUSIONS BASED ON INTERNATIONAL EXPERIENCE

Pedestrianisation has been around in European Cities for over 80 years, but the design philosophy is still being changed and adapted to ensure the success of this type of land use planning. In some cities, pedestrianisation is used as a traffic calming mechanism.

In most cases, pedestrian precincts started with a single street or square being closed to vehicular traffic and redesigned to make it more appealing to pedestrians. Municipalities, then convert other streets and squares and add to the original pedestrianised area, to form a pedestrian network, which then evolved into a pedestrian zone. This process happens organically over several years.

Parking spaces in close proximity to these zones are gradually reduced and parking lots are converted to public squares. In this way traffic can be reduced as well as the opportunity to drive. This was successfully done in Copenhagen, with parking spaces reduced by 2-3% per annum.

In over 100 pedestrianised cities around the world, 49% of shop owners experienced an increase in turnover. Even though this is a strong motivator to convert areas into pedestrian zones, it should be noted that not all zones have been a success. In many cases, the increase in turnover was not overnight, and was only realised a year or two after the precinct was pedestrianised. In some cases, during the first year, there was a slight decrease in turnover. The later increases were a result of expansion of the pedestrian precinct.

Another economic effect of pedestrian zones is the increase in property prices. This is due to the area being more attractive and attracting more foot traffic. This is positive for property owners, but smaller stores surviving on marginal profits cannot afford the increase in prices. Often these stores have been there for a long period of time, before the precinct was pedestrianised and, as such the owners and part of the anti-pedestrian zone lobby. The attractiveness of these precincts and high rentals are a big draw card and often national and international chain stores locate in these precincts.

The most successful precincts are not just areas where shopping can take place, but have a mixture of activities and incorporate leisure, entertainment and cultural activities. They are attractive to not just visitors but to local residents alike and encourage locals to spend money in their own neighbourhoods instead of conventional shopping malls.

During the pedestrianisation process, it is important to keep the public informed and, when roads are closed, the public should be forewarned so as to avoid congestion and chaos and allow travellers to change travel behaviour, including routes and times.

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2.8 PEDESTRIANISATION IN CAPE TOWN

The trend in South Africa, as other countries in the developing world, indicates that there is a growing use of private vehicles. As soon as people have the economic ability to buy an automobile, they switch modes, resulting in a reduction in the use of public transport and non-motorised transport. This is due to a number of factors, including that motor vehicles are seen as a status symbol; efficient public transport is not readily available; public transport is deemed as unsafe and unreliable and pedestrian infrastructure is of poor quality. This results in motor vehicles being used to travel, even for short distances.

South Africa has been slow in recognising the concept of pedestrianisation, but it was noted back in the 1970's that South Africa would have to pedestrianise important city centres if they were going to play a major role as metropolis of the future (Gasson, 1975). Within the City Centre, walking is the most efficient form of transport, and pedestrianisation of these precincts brings numerous benefits. The impacts these schemes have on the general traffic has to be considered, and as such, implementation of pedestrian schemes should never be considered in isolation.

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The recognition of pedestrianisation as an important mode of transport is being seen at a legislative level, with the Green Paper on Transport (National Department of Transport (NDoT), 1996), a national transport strategy contained in Moving South Africa (NDoT,1998), the National Land Transport Transition Act (RSA, 2000) and the Rural Transport and Development Strategy for South Africa (NDoT, 2002) all stating the importance and benefits to an improved pedestrian network in South Africa. Within Cape Town, the Provincial legislation within the White Paper on Western Cape Provincial Transport Policy (Provincial Administration: Western Cape (PAWC), 1997) and delivery strategies (PAWC, 2003) also emphasis the promotion of NMT, as well as implement projects to provide the necessary infrastructure to support these modes.

2.8.1 City for the People – A Historic Overview

In 1975, as part of a report called City for the People, pedestrian schemes were proposed to recreate historic pedestrian routes. Included in these plans were widening of sidewalks within the CBD, closures of streets to create pedestrian malls and trying to eliminate conflicts between vehicles and pedestrians.

The problem facing Cape Town and indeed most cities in the world is that its environment as a place for people is deteriorating, due to the loss of space for pedestrians, noise, pollution, and the physical conflict with pedestrians arising from the general use of the motor vehicle in areas of the city that was never designed for it (Speed, 1975).

Cape Town was seen as an ideal candidate city for pedestrianisation, due to its compactness, making it ideal for walking. The City is also the oldest in South Africa and is characterised by narrow streets, many parks and squares, as well as its historic character. The main objectives of the scheme were to:

- Improve the economic and physical pedestrian environment without significantly impacting the present transport system and isolating pedestrians.

- Improve the pedestrian environment without impacting on the urban form of the City.

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The above objectives would be met by the following proposed changes to the urban environment (Speed, 1975):

- Managing traffic, in such a way that pedestrians would benefit through reducing through traffic in the city, devising a new parking policy, with no new parking garages being built in the core, erecting pedestrian signals where streets cross proposed malls, restrict all loading vehicles entering the mall to 10km/hr and restricting very large vehicles from the city centre.

- Widening sidewalks to make pedestrian movement easier, specifically on Adderley Street, Plein Street, Burg Street, Waterkant Street, St Georges Street and Strand Street as these have the highest volume of pedestrian traffic.

- Road closures to form pedestrian malls: Along with closures of major roads including Church, Longmarket, Castle, Waterkant and Parliament Streets, new alternative traffic routes, alternative parking, and an improved public transport system had to be developed. Within these pedestrian malls, the road surface had to be repaved and streets refurnished to accommodate the pedestrian. Certain Streets were also ear-marked to be pedestrian streets, but opened to traffic during certain times of the day to accommodate delivery vehicles, with these streets having a maximum speed limit of 10km/hr.

- Developing City Squares for pedestrians, three squares were proposed, Greenmarket Square, Church Square and Riebeek Square. All these square are located in areas of historic importance within the City of Cape Town.

- Through landscaping malls, sidewalks and squares, the main vision was to make the inner city more green, by lining sidewalks with trees, as well as preserve the surrounding historical and culturally significant buildings in the pedestrian environment.

- Preserving historically and culturally significant buildings and areas in relation to the pedestrian environment – this included implementing legislation which prohibited the demolition of these buildings and maintain these buildings through perseverations funds set up for this purpose. These areas included the Castle and Grand Parade, Church Street, Civic Square and the then Malay Quarter.

2.8.2 Extent of Pedestrianisation in 2007

Unfortunately, the Cape Town Pedestrian Renewal Project schemes, proposed in the 1975, were never implemented within the Cape Town CBD. The major projects implemented were an underground pedestrian mall under Adderley Street, as well as the pedestrianisation of St Georges Street, a once congested street (Cape Town Partnership, 2008).

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The area, now known as St Georges Mall, forms the heart of the pedestrian backbone of the City of Cape Town as can be seen in **Figure 14**. In the 1693, this street was one of the most desirable residential streets in Cape Town. It was one of the first streets to link the beach front with the gardens. In the nineteenth centaury, it developed into a major financial a commercial street. The street was pedestrianised in the 1990's and is within walking distance from Cape Town Train Station (Cape Town Partnership, 2008).

Today, St Georges Mall is a vibrant area lively with activity ranging from live entertainment, from drummers, musicians and other performers, to sidewalk coffee shops and restaurants. St Georges Mall is also a great place to shop, with large retail clothing stores, smaller stalls, informal traders, art galleries and African curio shops providing a variety of goods and souvenirs. Also known as Cape Town's jewellery route, there are a number of jewellers based in St George's Street Mall. St George's Mall stretches from Thibault Square near Cape Town train station, up to St George's Cathedral.

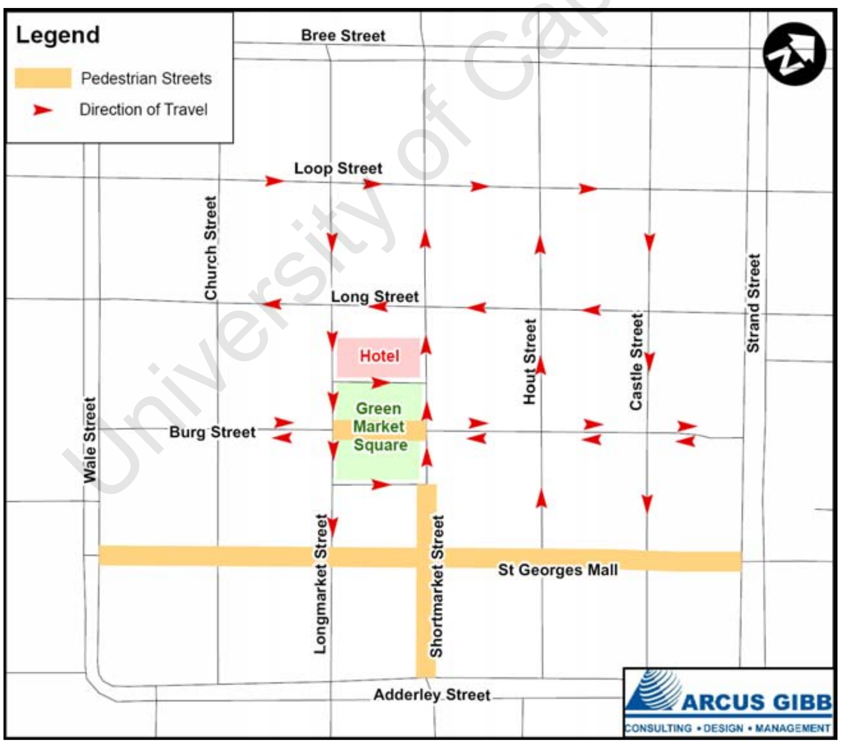

Figure 14: Pedestrian Streets in Cape Town (Arcus Gibb, 2008)

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In 2001, the City of Cape Town initiated the Foreshore Pedestrianisation Programme. The major focus of this project was to upgrade the main pedestrian routes from the foreshore to Cape Town's City Centre, making the route safer and more attractive. These routes included pedestrian movement between Cape Town Station, the Cape Town International Convention Centre and the V&A Waterfront (Cape Town Partnership, 2008).

Routes from Cape Town Station to the Cape Town International Convention Centre and the V&A Waterfront, are important not just for local commuters, but also link the City Centre with major tourist hubs, and are used by visitors and tourist alike. Although no road closures were part of this project, the project included the upgrading of the Heerengracht and Hertzog Boulevard's central islands. This project started in 2003 and included the erection of a water feature on Heerengracht's central island that resembles the historical channels in Adderley Street, tree planting and the addition of lights and benches (CCID website, Accessed 2008).

During December (2007), Cape Town's peak tourism season, a pilot pedestrianisation project was run in the City of Cape Town. The 300 year old area earmarked for pedestrianisation, known as Greenmarket Square, located in the heart of the CBD and has a colourful history. Greenmarket Square first served as a slave market, then became a fruit and vegetable market and in the 1950's became a parking lot. In the 1980's its potential was recognised and was converted into an informal trading area two days a week. Its potential grew, but it stilled remained a parking lot on days when it was not occupied by the popular flee market (Cape Town Partnership, 2008).

There are about one hundred traders on Greenmarket Square, and their stalls are tightly packed on the centre of the square as can be seen in **Figure 15**. They bring in their goods at 5am and take their goods away again in the evening. There is currently no storage facility on the square for these traders. Many of them sell the same African curios as the traders cater rather for the tourist market than the locals. Other items on sale include clothing, glassware and jewellery.

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Figure 15: Greenmarket Square shortly before pedestrianisation scheme (SA Tourism, 2007)

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In December 2007, the square was closed to traffic, as well as a short stretch of Shortmarket Street, which connects Greenmarket Square with St Georges Mall, forming the pedestrian route (Cape Town Partnership, 2008). A more in depth discussion on Greenmarket Square and the new pedestrian precinct can be found later in this thesis. In 2009, upgrades to the appearance of Greenmarket Square will take place. Millions of Rand have been set aside for this upgrade, which includes a new market layout, accommodating the traders better, as well as new public toilet facilities.

With regard to property prices within the Cape Town CBD, there is already an increasing trend, specifically for office property, as can be seen in **Figure 16,** courtesy of the Rode Retail Report (2008).

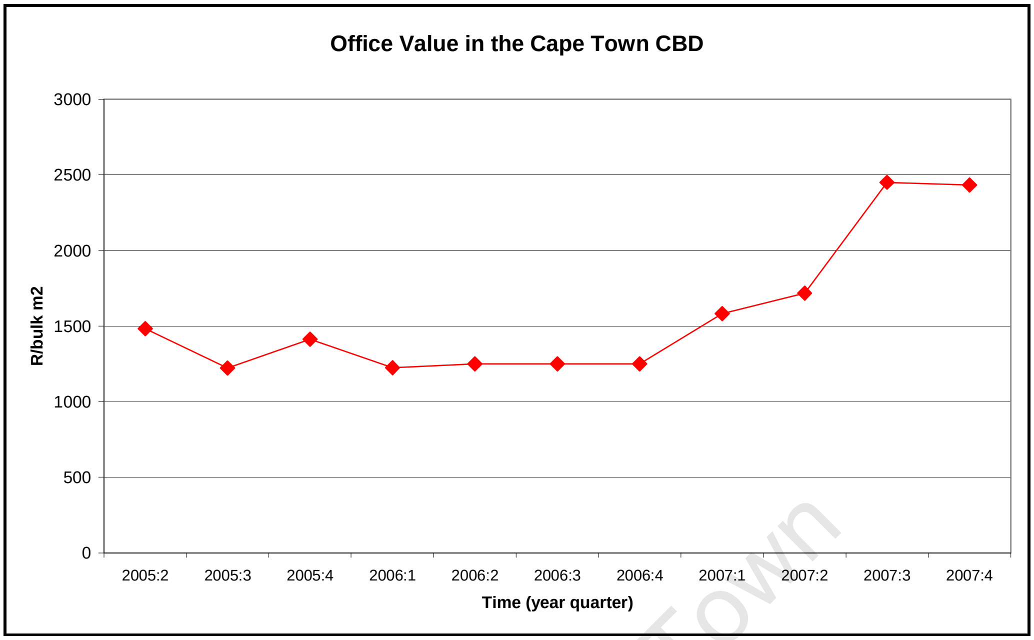

Figure 16: Office Land Value in the Cape Town CBD per quarter (Rode Retail Report 2008)

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3 RESEARCH METHODOLOGY

3.1 SATURN MODELLING

3.1.1 Background to SATURN

SATURN (Simulation and Assignment of Traffic to Urban Road Networks) is a network analysis program, developed at the Institute for Transport Studies, University of Leeds in 1981.

SATURN has over 300 users worldwide in some 30 countries over all six continents and has been tested and applied by Local Authority planners, consultants and universities for the evaluation of road schemes. It is also widely used for research projects, e.g. for the evaluation of road charging and route guidance systems (SATURN user manual, 2004).

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As a combined simulation and assignment model, SATURN is most suitable for the analysis of relatively minor network changes, such as the introduction of one-way streets, changes to junction controls and road closures, which can be loosely categorised as “traffic management measures”. SATURN is primarily a traffic assignment model. There are two general inputs:

- **the network**, which specifies the physical structure of the roads upon which trips take place, and

- **The trip matrix,** which specifies the number of trips from each zone to each other zone, in the study area, during the time period modelled.

These may be thought of as the “supply” and “demand” inputs, the information of which is provided by the user. Both the matrix and network are input to a “route choice” model, which allocates trips to “routes” through the network, as a result of which total flow along links in the network may be summed and the output can then be analysed. The output can be viewed graphically through SATURN P1X function.

3.1.2 SATURN Network Coding

In SATURN, each junction is represented by a node in the simulation network. These are sub-divided into 'internal' and 'external' nodes. The most common types of internal nodes are traffic signals, priority junctions and traffic circles. A priority junction includes all form of 'give-way' junctions including, for example, merges and uncontrolled junctions. External simulation nodes represent intersections on a cordon surrounding the simulation network and are used to identify links entering and/or leaving the simulation network. Each external node is connected to a centroid connector (or zone) representing external Origins or Destinations. Roads between intersections are represented by "links". Each node or zone in the network is assigned a geographical X, Y co-ordinate in order to graphically present the network. Network data requirements can be summarised as follows:

- New Universal parameters such as minimum gap acceptance;
- Universal Junction data - type of junction (signals/priority/roundabout); co-ordinates;
- Link data - distance, time or speed, number of lanes;
- Turn data - a saturation flow, lanes available, a priority marker indicating give ways, etc;
- Traffic signal data - stage lengths, offsets, cycle time, priority.

Capacities of turns are determined from saturation flows, defined as the maximum number of passenger car units (pcu's) per hour, which could make that particular turning movement provided there were no other vehicles on the road or no red lights to oppose it. The only restrictions to be taken into account in specifying the turn saturation flow are the physical characteristics of the junction such as the number of lanes, their widths, turn radii, give-way or not. The model then simulates the reductions to the turning capacities from all other effects.

A 1997 AM peak base network was provided by the City of Cape Town. In order to upgrade the network to 2007 (the base year), the following was done:

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- New intersection counts were undertaken at major intersection in the Cape Town CBD. These where then coded and inserted into the network file. This is used for validating the model and comparing observed flows with actual flows to ensure there is a goodness of fit,

- Intersections were all checked and signal times were changed to the 2007 base year signal timing. The number of lanes and capacity were also changed to reflect the existing situation,

- New intersections were added to the model, as well as developments which occurred post 1997,

- All geographical co-ordinates were checked and co-ordinates for the new nodes coded,

- Existing bus routes were updated,

- Link lengths were checked against maps, and the speed and saturation, were changed to reflect the 2007 situation,

As a result of the changes, the model has the following network parameters:

- 93 external nodes,

- 220 priority nodes,

- roundabouts,

- 124 traffic signals,

- 193 zones, and

- 1148 simulation links

The node coordinates and lengths of the links were extrapolated from the GIS and Arc view maps. Link speeds were obtained from the peak travel time surveys. The traffic signal information was supplied by the City of Cape Town or measured on site. The default gap acceptance parameters were used, adjusted at individual intersection where necessary to better model observed behaviour.

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3.1.3 Matrix Estimation

The derivation of the origin-destination matrix requires base information to provide traffic movements in and through the study area on which to build the base year model. At the time of coding the model for the thesis, The City of Cape Town, was still in the process of gathering land-use information in order to update the matrix. As such this information was not yet available and the1997 AM origin-destination matrix developed by the City of Cape Town were used as base matrices. Over the last ten years, traffic into the city has increased from 57065 to 170 000 cars in the peak hour. These values were obtained from cordon counts outside the City. As such, the entire matrix was factored to reflect the 2007 total traffic entering the City of Cape Town.

3.1.4 SATURN Assignment / Simulation

Once the network coding and the trip matrix and bus and routes are complete, Saturn's assignment / simulation loops are run iteratively. Thus the assignment sub-stage supplies the link flows, which are needed by the simulation, which in turn supplies the flow-delay curves for simulated turning movements, which the assignment requires.

The primary objective of the simulation is to determine junction delays resulting from a given pattern of traffic. The information on delays is input to the assignment which selects appropriate routes through the network for each element in the trip matrix, bearing in mind relationships between travel time and flow as determined by the simulation.

The model uses an 'equilibrium' technique based on an optimum combination of all-or-nothing assignments, so that for a given Origin-Destination (O-D) pair a range of routes is normally used but each has the same minimum O-D cost. The flows generated by the assignment model are then returned to the simulation model, which in turn re-calculates junction delays for re-input to the assignment.

The procedure terminates when the re-assignment of traffic is sufficiently small or a (user-specified) maximum number of iterations is exceeded. Normally the sequence concludes with a run of the simulation. The output of the SATURN Assignment / Simulation is then analysed.

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3.1.5 Model Validation and Calibration

Model calibration is an important component in setting up simulation model as is a fine-tuning of the model to be more representative of what happens in reality, as well as to deduce the "goodness of fit of the model", i.e. how well it already depicts reality. Traffic counts and journey time data are used in this process. A second, more qualitative approached is also used, where the modeller uses knowledge about the traffic situation, or does a site inspection to determine whether the model results are plausible. An example of this is when long queues always forms at a specific junction. The modeller can then check if the model is depicting the same situation as witnessed in reality.

In validating and calibrating the model, it is assumed that the process the model uses for calculations are correct, i.e. the method the model uses to calculate delays to turning movements at junctions is realistic and, therefore, any disparity between observed and modelled phenomena is due to errors in the data coded in the model.

Other errors can be introduced in the modelling process, including human coding errors. The major coding errors can be summarised as follows:

- The global parameter values (e.g. minimum gap acceptance values),
- The network data coding (e.g. incorrectly calculated saturation flows, wrongly coded signal data, insufficiently well observed junction performance leading to coding of too few lanes at a junction etc.)
- The matrix, and
- The observed data (counts and journey time data).

The observed data is very prone to errors as this is where there is the biggest room for human error. Especially with the traffic counts, a variation of at least 10% can be experienced. This is due to a variety of factors, such as:

- Counts are often done on different days of the week and, in some cases, (as with the historic counts) in a different year,

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- For the Cape Town SATURN model being such a large model, counts were conducted between 2005, and 2008. Spot 5 minute counts were also conducted on locations where counts were done in 2005, to validate the older count data,

- There is a change in traffic flow, due to the recent developments and constructions taking place at Green Point Stadium, the Waterfront, as well as other new developments, such as the Cape Town International Convention Centre, which cause a change in traffic flow, due to road closures and diversion of traffic, and

- Traffic Signals are changed within the Inner city, and although these were updated according to the latest 2008 information, as well as signal timings carried out, changes to signals are on going.

It should be noted that there is no South African guidelines for acceptable validation and calibration.

3.1.6 Scenarios

A total of eight scenarios were coded for the SATURN model. All scenarios cover supply-side management. This is where the network supply is restricted in some way. For each of the scenarios, the base model needed to be recoded to reflect the new changes.

In all scenarios, movement is restricted by means of road closures. These roads are then used for pedestrians only. The outcome of the model is the re-assignment of traffic on the other routes. The change in traffic on important routes is then calculated, by comparing the base network and traffic flow with each of the scenarios. From this information, a recommendation regarding the routes to be closed to traffic can be made.

The aim is to recommend a pedestrian axis. This involves the closure of a road running north-south, as well as a road running east-west. In the tested scenarios, roads are closed individually, and then run through SATURN. Finally, roads are closed in combinations and run through SATURN. Key indicators are used to measure the networks performance and the effect the road closures have on the traffic.

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Scenario 1: Long Street Closure: Strand Street to Wale Street

The first scenario (S1) is closing Long Street, from Strand Street to Wale Street (**Figure 17**). This street runs from east to west of the City. This particular segment was planned as part of the City of Cape Towns Pedestrianisation Scheme in 1975, but was never implemented (CoCT, 1975). Both during the day and at night, Long Street is bustling with people and is the heart of the Cape Town CBD. It is the many restaurants and cafes along the street, as well as clubs, backpacker lodges and clothing stores, making it a hot spot for both locals and tourist alike. It is currently a one-way couplet scheme with Loop Street (**see Figure 17**). It has parking on either side of the road and pedestrians often have to compete with speeding vehicular traffic. During the day, Long Street is used as a shortcut through the City.

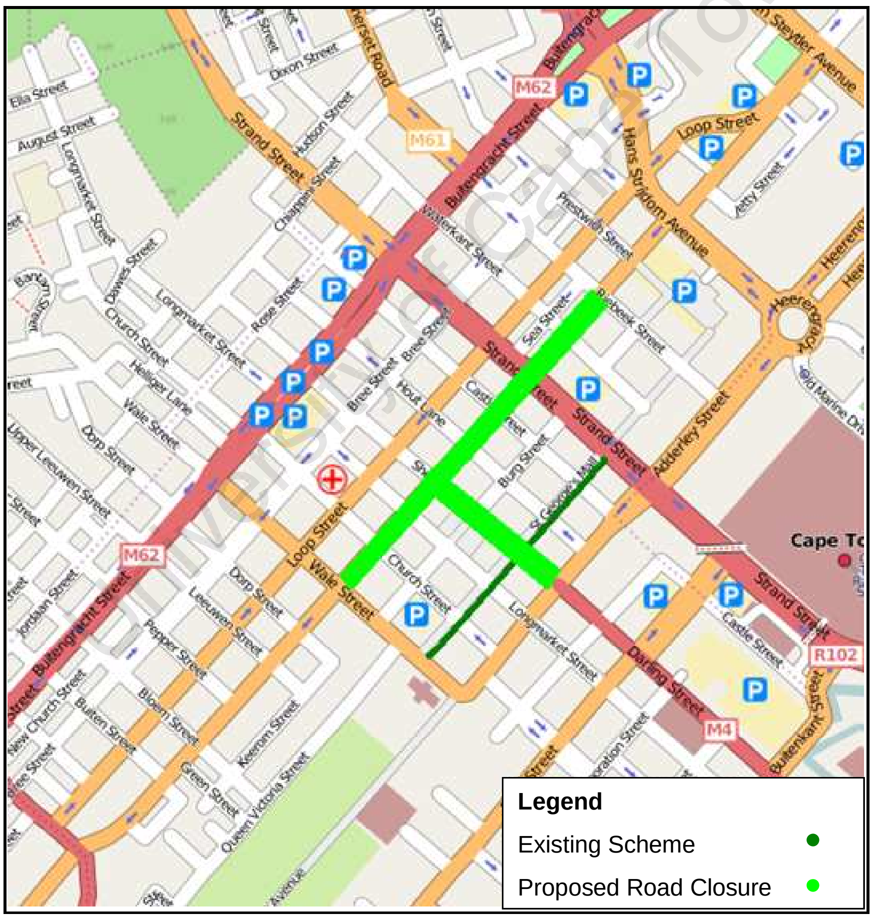

Figure 17: Proposed closures for Scenario 1 (S1)

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Long Street has also been identified as a possible pedestrian route for the 2010 Soccer World Cup, and is planned to closed and converted into a transit mall for the City of Cape Town's new Bus Rapid Transit System. The intention of the modelling exercise was to test how traffic is reassigned on the network, due to the closure of Long Street. The model was used to identify hotspots and predict the extent of the congestion due to the closure of Long Street.

Scenario 2: Greenmarket Square Street Closures

The closure of streets around Greenmarket Square (S2), (**Figure 18**) was also proposed in the 1975 planning document *City for the People*. These closures include a short segment of Shortmarket Street up to Long Street, a segment of Burg Street an a segment of Longmarket Street from St Georges Mall to Long Street. The Shortmarket Street Closure would connect the Square with the already pedestrianised St Georges Mall. This scenario is a slight extension of the current pedestrianised scheme implemented by the City of Cape Town in December 2007. This scenario, however, includes Longmarket Street, which is not part of the current scheme.

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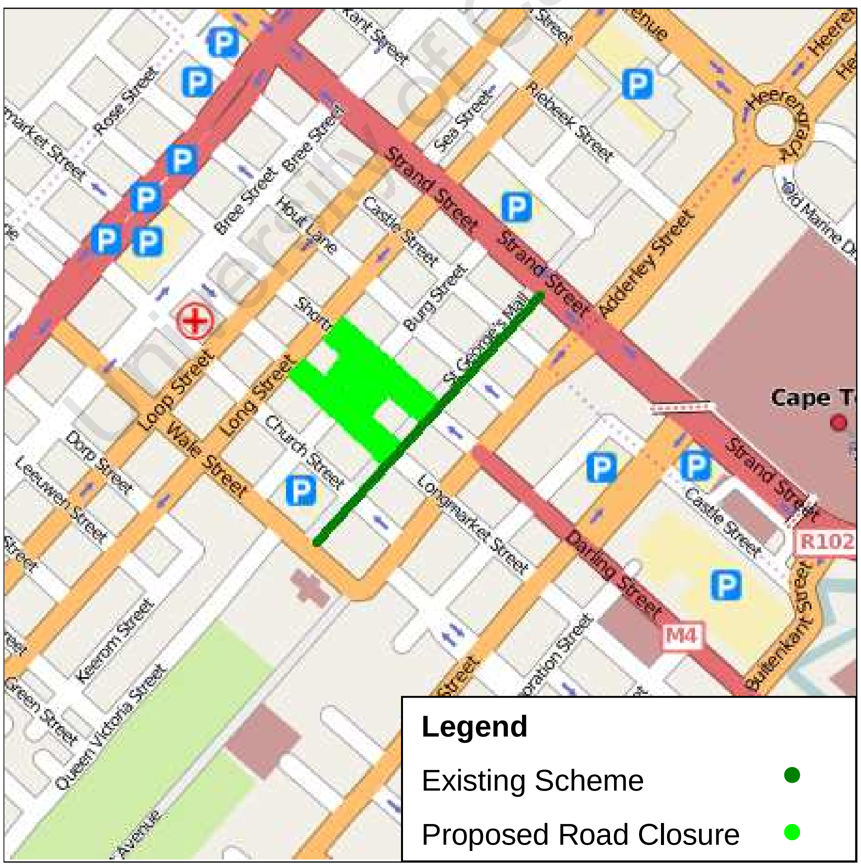

Figure 18: Proposed closures for Scenario 2 (S2)

Scenario 3: Long Street Closure: Wale Street to Riebeek Street

The closure of Long Street, from Wale to Riebeek Street (S3), is an extension of scenario 1 (**Figure 19**). The road closure includes a busy segment from Strand to Riebeek Street. This scenario also tests the sensitivity of the model, and how much a small extension to the pedestrian precinct can change the overall traffic situation. Stand Street is a very busy street in Cape Town and is used as a north-south link to the City and Green Point for vehicular traffic. The aim of the scenario is to test how traffic is then reassigned, due to the traffic restriction in the east-west direction.

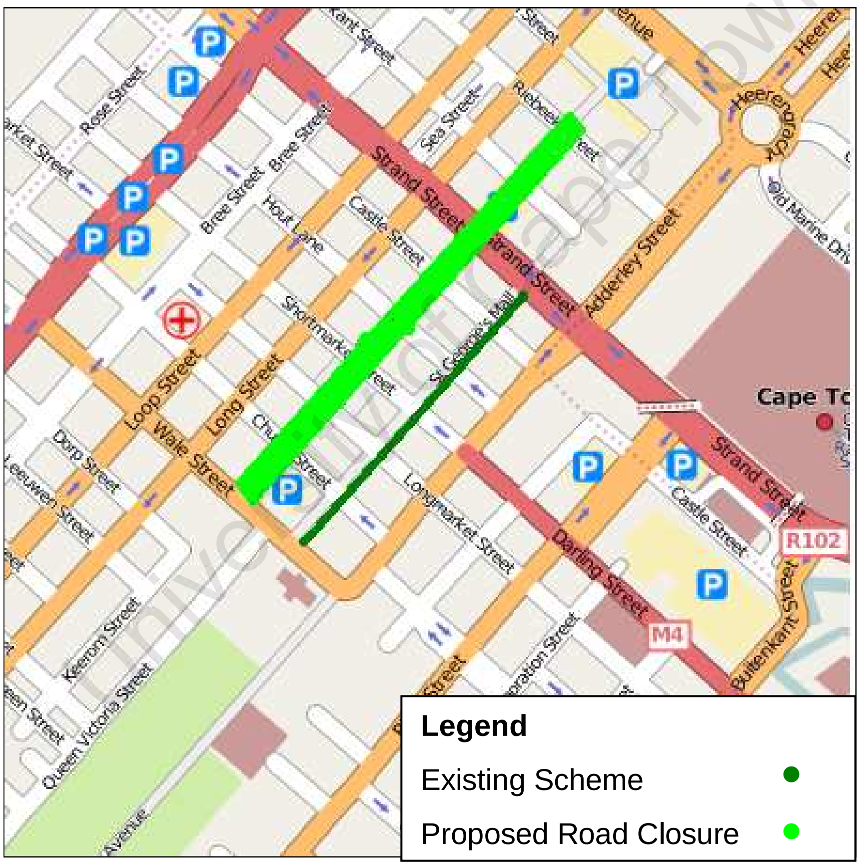

Figure 19: Proposed closures for Scenario 3 (S3)

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Scenario 4: Shortmarket Street Closure: Adderley Street to Buitengracht Street

Closing the entire Shortmarket Streets, from Adderley Street all the way to Buitengracht Street (S4) (**Figure 20**) will create a north-south pedestrian corridor across the Cape Town CBD. This scenario is part of a proposal for the City of Cape Town's Pedestrian Scheme.

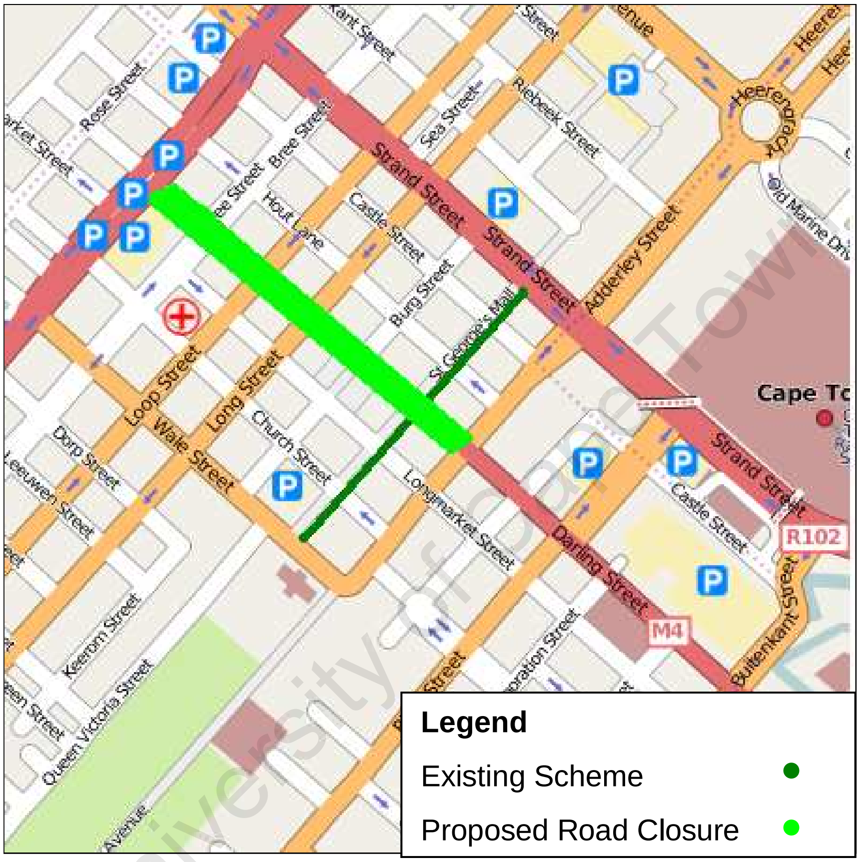

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Figure 20: Proposed closures for Scenario 4 (S4)

Scenario 5: Waterkant Street Closure: Burg Street to Buitengracht Street

The closure of Waterkant Street from Burg to Buitengracht Street (S5) (**Figure 21**) will create a north-south pedestrian corridor across the Cape Town CBD. This scenario is part of a proposal for the City of Cape Town's FIFA 2010 World Cup possible scenarios for the FIFA Fan Mile. The advantage of closing this road is the closer proximity to Cape Town Station; where over 35 000 commuters arrive in the morning peak. This is the main terminal for trains, local buses as well as long distance buses and mini-bus taxis.

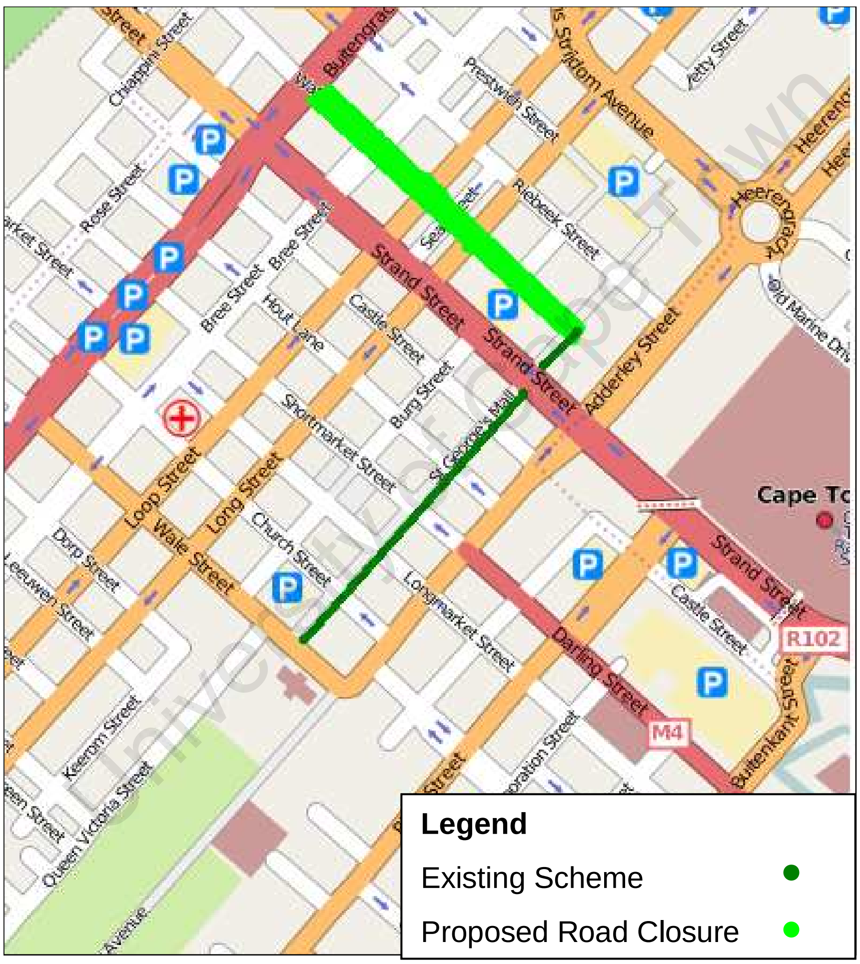

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Figure 21: Proposed closures for Scenario 5 (S5)

During the modelling process, three network scenarios were coded. These network scenarios are combinations of road closures in the north-south and east west directions to form a continuous pedestrian network.

Pedestrian Network Scenario 1: Long Street (Wale to Riebeek) and Shortmarket Street

Closing Long and Shortmarket Streets (N1), (**Figure 22**), creates a pedestrian axis right in the historic quarter of the CBD. It also connects the already pedestrianised St Georges Mall to the pedestrian network.

Figure 22: Proposed closures for Network Scenario 1 (N1)

Pedestrian Network Scenario 2: Long Street (Wale to Riebeek) and Waterkant Street

Closing Long and Waterkant Streets (N2), (**Figure 23**), creates a pedestrian axis close to the location of public transport stops including the bus and taxi ranks and the train station.

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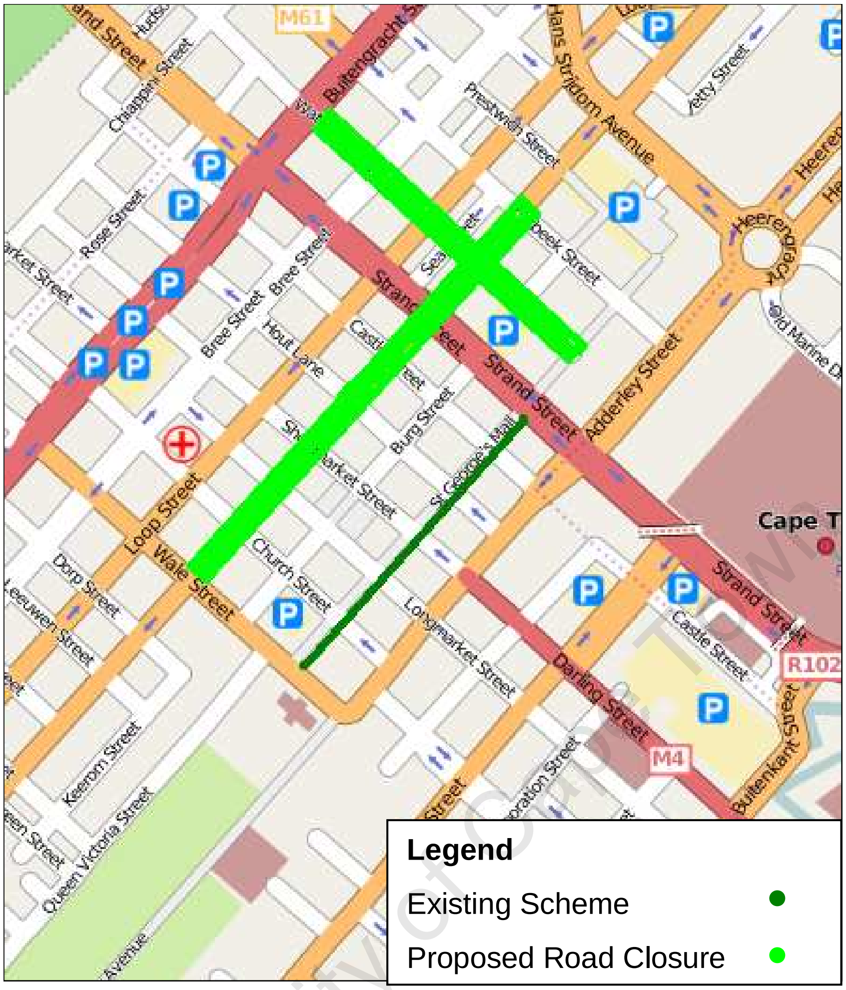

Figure 23: Proposed closures for Network Scenario 2 (N2)

Pedestrian Network Scenario 3: Long Street (Wale to Riebeek), Waterkant Street and the Streets Surrounding Greenmarket Square

Combining part of scenario 1 with scenario 2 will create an ideal pedestrian network (S3), (**Figure 24**). Greenmarket Square and the already pedestrianised St Georges Mall will be connected to the new pedestrian network. This network will provide pedestrians with safe access to public transport facilities as well.

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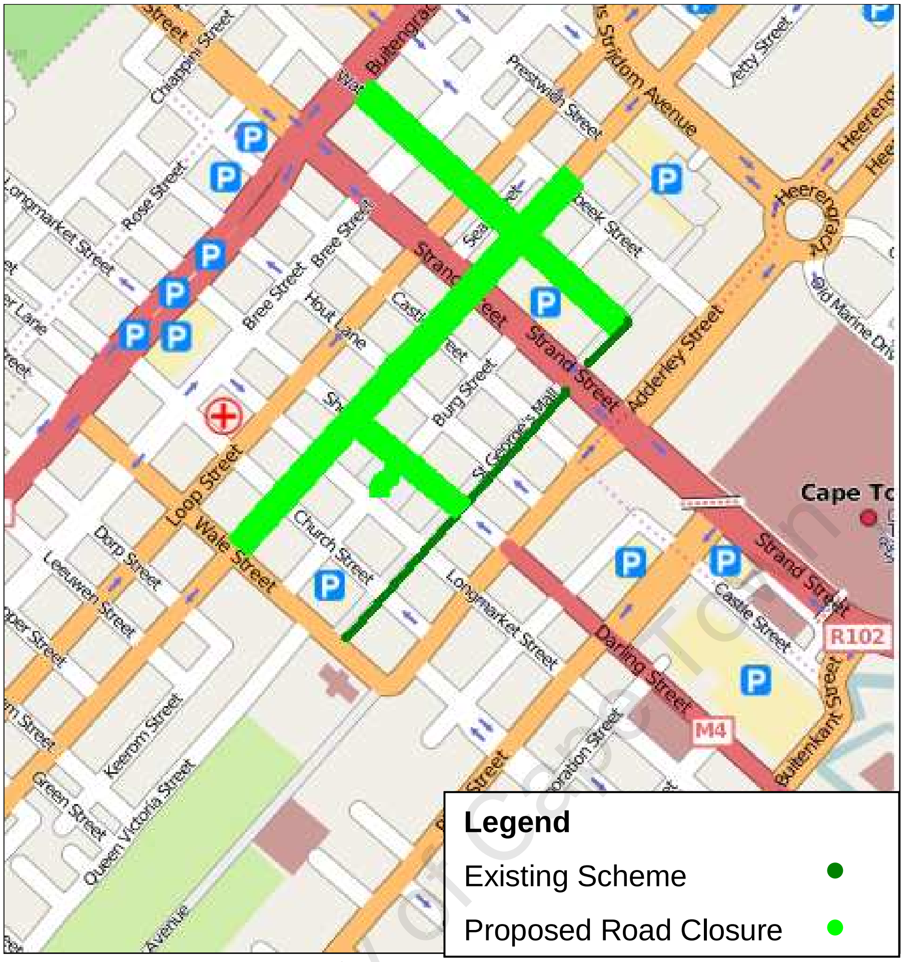

Figure 24: Proposed closures for Network Scenario 3 (N3)

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3.1.7 Key Performance Indicators

SATURN is able to provide the user with various data sets on the traffic on the network including delay, CO emissions, queuing and a variety of other outputs. For the purpose of comparing the different scenarios, six key indicators were used:

- **Delay**, measured in seconds, gives an indication of the total time spent for a Passenger Car Unit (PCU) to progress and is composed of the time spent in transient queues, delays occurring as a result of a link being overcapacity, as well as an delays as a result of capacity restraint on the simulation link.

- **Link Vehicle over Capacity,** this ratio can easily be defined as the total volume on the simulation link, divided by the actual capacity of the simulation link. This indicator is graphically displayed proportional to the length of the link.

- **Average Link Queue** can be defined as queues, which build up for movements in excess of capacity – a permanent queue builds up which is unable to clear in a single cycle. Simulated permanent queues increase linearly from a zero initial queue to a maximum at the end of the time period

- **Intersection Vehicle over Capacity** ratio can easily be defined as the total volume of PCU's at an intersection, divided by the actual capacity of the intersection. This indicator is used to show whether the intersection is operating at a good level of service.

- **Journey Time**, which specifies the physical structure of the roads upon which trips take place and gives the value of time taken for a vehicle to travel from one defined point to another.

- **Journey Speed**, which specifies the average speed of the PCU along the predefined route as the PCU travels from one defined point to another.

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4 SATURN MODELLING

4.1 CHOICE OF DATA SET

SATURN results are in graphical format and can be found in Appendix A. These results are for the entire network and the selected indicators are described for every link and intersection. This information is separated per scenario. There is a large volume of data available, however, to be able to make comparisons of the results, only certain links will be analysed and interpreted. A link is a small segment of road, between two intersections, along a road. These include the effects of the changes in infrastructure on a selected link on Buitengracht Street, and Strand Street. These two streets are very important transport axis within the City of Cape Town. The Delay, link V/C and Average Queue lengths will be analysed on links on Buitengracht and Strand Streets

Five intersections will be analysed. These intersections, shown in **Figure 25** include Long/Kloof Street (I1), Buitengracht/Strand Street (I2), Strand/Long Street (I3), Adderley/Riebeek Street (I4) and Buitengracht/Waterkant Street (I5).

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Figure 25: Location of Intersections for analysis in SATURN

For the journey time runs, there are six different routes that will be compared in each of the scenarios. These routes can be better seen in **Figure 26**. Along these different routes, the time taken to travel the route, as well as the average speed of PCU along the route will be compared for the various scenarios.

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The routes are as follows:

- Long Street (R1), which forms the east west axis,
- Shortmarket Street (R2),
- Buitengracht Street (R3),
- Strand Street (R4),
- Riebeek Street (R5), and
- Adderley Street Circle, along Adderley Street, left into Wale Street and all the way to Buitengracht Street (R6).

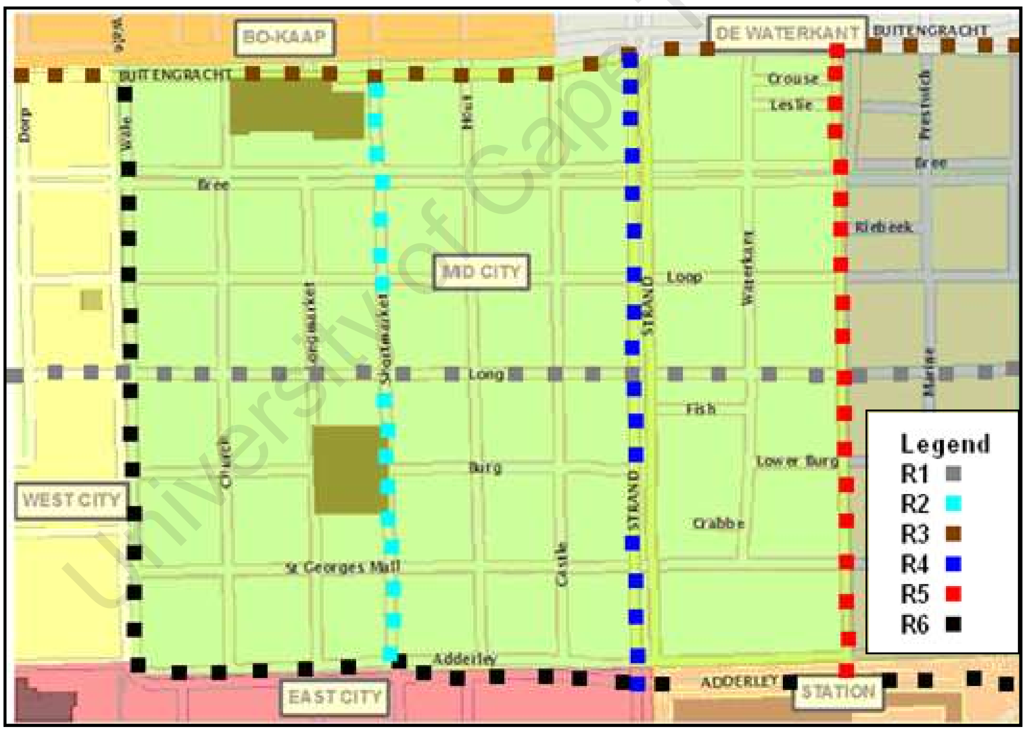

Figure 26: Routes for the Journey Runs in SATURN

4.2 OVERALL NETWORK ANALYSIS

4.2.1 Link Analysis

The link analysis focuses on comparing the five infrastructure changes as well as the three proposed pedestrian networks, with the base scenario. The three main indicators used for the link analysis are the delay, V/C ratio and the average ambient queue. The other indicators, including intersection V/C ratio and Journey time speed and time change will be explored in separate sub-chapters. The specific link used to compare the effects on Buitengracht Street is between the intersections of Buitengracht/Hout Street and Buitengracht/Castle Street. On Strand Street, the intersection chosen for analysis is between the intersections of Strand/Long Street and Strand/Loop Street.

4.2.1.1 Link Delay

The delay is defined as the time delay experienced by the average PCU on the specified link on Buitengracht and Strand Street respectively. **Figure 27** depicts the link delay on Buitengracht and Stand Streets.

From **Figure 27**, it can be concluded that the introduction of any scheme results in reduced delay on Buitengracht Street, but an increase in the delay experienced by PCU's on Strand Street. Although the change in delay in Buitengracht and Strand is not unexpected, the degree to which the delay in Buitengracht Street has decreased is surprising.

The drastic changes on the Buitengracht Street Link show that the bottlenecks from Buitengracht Street are moved onto Strand Street. Vehicles are taking longer to turn onto Buitengracht Street, and the delay on Buitengracht is shorter as there is one less link adding traffic onto the Buitengracht link. It must be noted however, that the condition does not improve this drastically over the entire Buitengracht Street, but merely the selected link used in the analysis.

The delays on Strand Street are worse when closing roads in the North-South direction. As a result, traffic is relocated on Strand Street. The worse is Scenario 5, when Waterkant Street is closed. There is less impact when closing Shortmarket Street as compared to Waterkant Street. The delays on Strand Street are similar for the combination scenarios.

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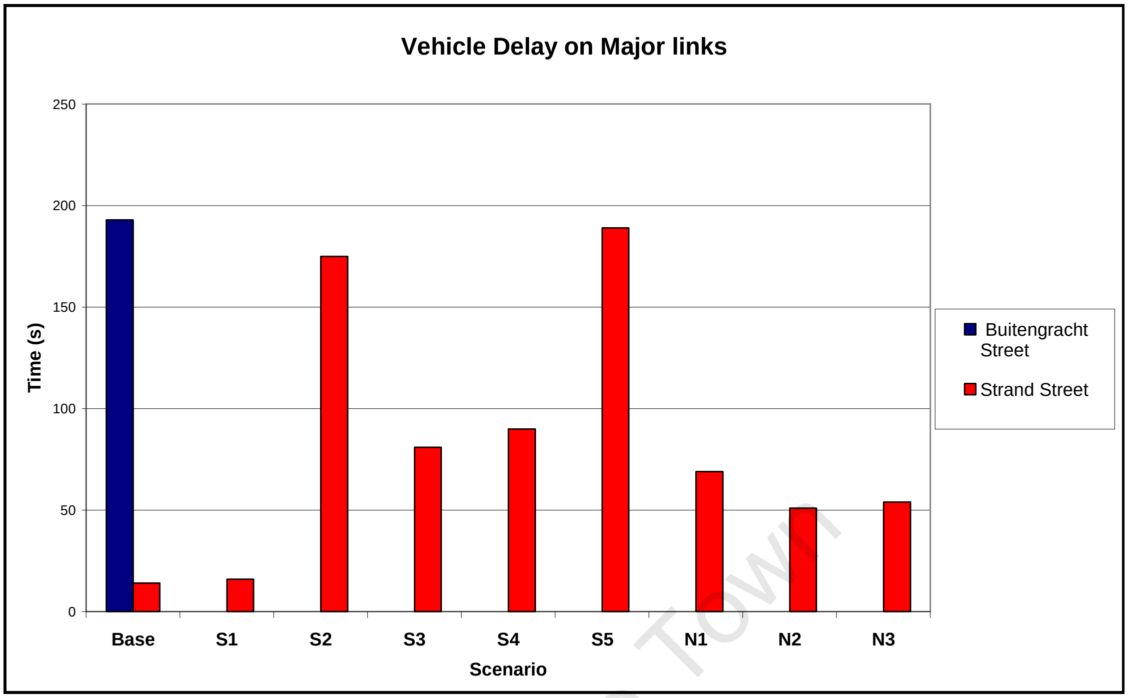

Figure 27: Delay on Buitengracht & Strand Street due to various scenarios

4.2.1.2 Average Vehicle Queue

The next indicator is the average vehicle queue that is formed on the link, when the vehicles are unable to be cleared during the simulation cycle. The trend continues with this indicator, where there is a drastic improvement on the Buitengracht link, but there is a drastic increase in the queues on Strand Street as depicted in **Figure 28**.

With all the scenarios, the traffic along the link on Buitengracht Street is now able to clear within the cycle and there is thus no vehicle queue. For Strand Street, the closures of Scenario 2 and Scenario 5 create unacceptable queues. This is, due to more vehicles on the North South Axis, will be diverted onto Strand Street and thus increasing the vehicle queue on the link. The vehicles are not able to clear within the cycle and as such there is a major increase in queuing vehicles on the link. The best solution is Scenario 1, where the conditions on Strand Street are only marginally worse than in the Base Scenario and the Situation on the Buitengracht link is vastly improved as in all the other scenarios.

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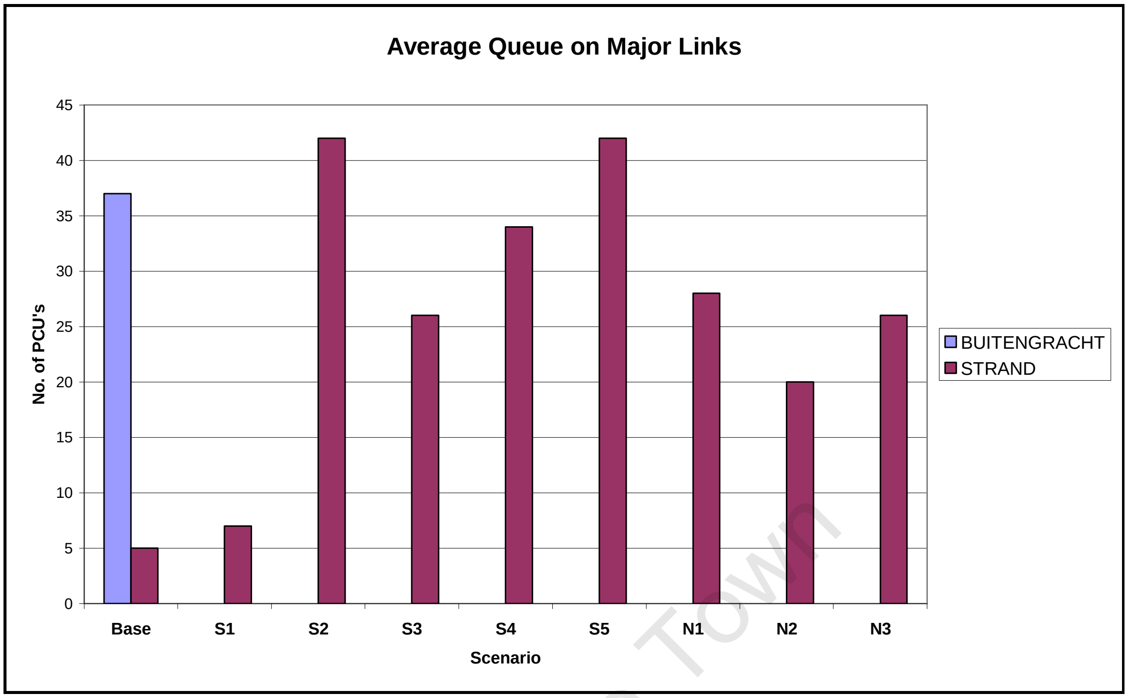

Figure 28: Average Queues on Buitengracht and Strand Streets

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4.2.1.3 V/C Ratio

The V/C ratio depicts whether links are operating over capacity once the supply of infrastructure has been changed. This is summarised in **Figure 29**.

From **Figure 29**, the Buitengracht link is already operating overcapacity. Once a change is made to the supply of infrastructure, however, we notice a similar trend as in **Figure 27**, where conditions on Buitengracht Street are improved, due to the infrastructure changes. This is true for almost all, except Scenario 1. Buitengracht Street is an over congested road in the transport network, but once links are closed, especially on the North-South Axis, the link becomes less congested.

The changes in V/C ratios on Strand Street are not as dramatic as the changes in delay. Strand Street is still operating within the capacity of the link. The worse case is Pedestrian Network 3, where the situation on Strand Street is 40% worse than the Base Scenario for Strand Street, but the situation on Buitengracht Street is almost 90% better. Overall, the best scenario would be Scenario 2, where the changes as compared to the Base Scenario are not as great as with the other scenarios.

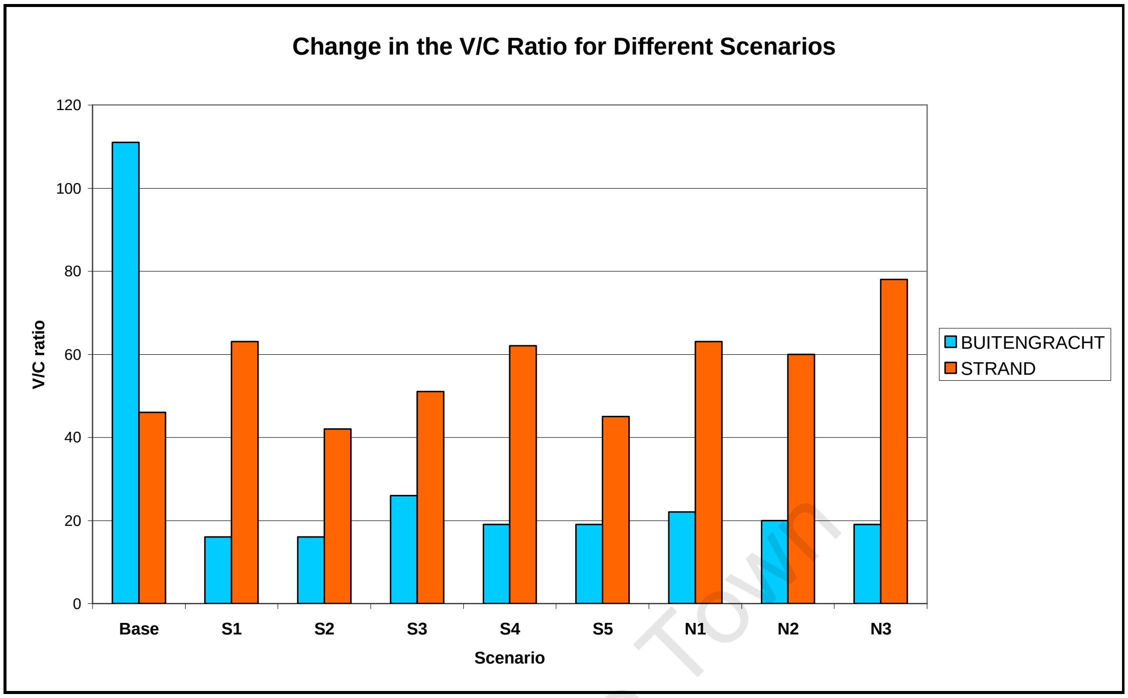

Figure 29: Link V/C ratios for Buitengracht and Strand Streets

4.2.2 Intersection Analysis

The intersectional analysis focuses on five key intersections within the study area. These are Long/Kloof Street, Buitengracht/Strand Street, Strand/Long Street, Adderley/Riebeek Street and Buitengracht/Waterkant Street. The location of these intersections can be seen in **Figure 25**. The volume over capacity ratio is used to analyse whether the intersections are coping with the changes in traffic or whether it is over-capacity, leading to poor performance. Poor performance results in delays at the intersection, as well as low levels of service.

Figure 30 shows the change to the base scenario in the V/C ratio at the intersections. A negative change in V/C ratio indicates an improvement in the V/C ratio of the intersection.

It can be seen that changes, due to Scenario 3, results in all intersections, except for Strand/Long Street having a higher V/C ratio than the Base Scenario. The negative change in the V/C ratio is, due to closure of Long Street, and, as such, there is one less arm of the intersection adding to the overall traffic situation at the intersection.

Scenario 2 and Scenario 4 shows an overall worsening of all the intersections, except for the Adderley/Riebeek Street intersection. Network scenario, N1, shows the greatest changes compared to the Base Scenario, whereas N3, has only a slight change to the V/C ratio, as compared to the Base Scenario, although are not as pronounced as in the N1 Scenario.

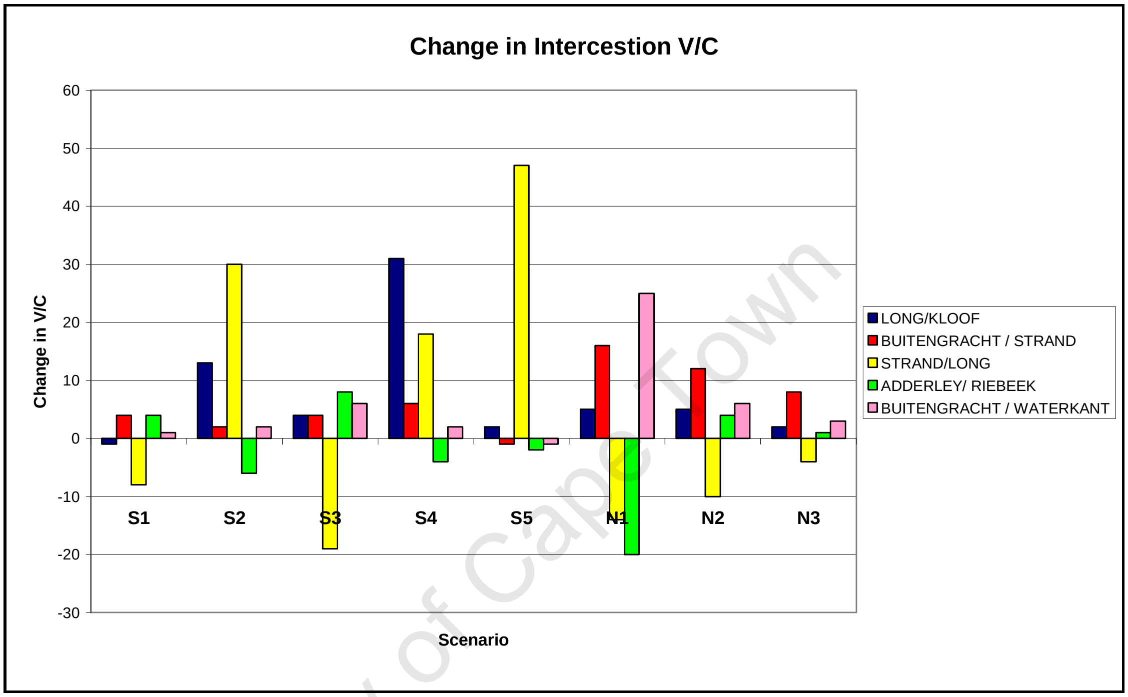

Figure 30: Change in Intersection V/C Ratio

4.2.3 Journey Run Analysis

For the journey run analysis, two indicators were used to compare the different scenarios, these are the change in speed of the average vehicle travelling along a specified route, and the time saving that the average vehicle experiences travelling on that route, as compared to the Base Scenario. The routes can be found in **Figure 26**.

Figure 31 shows the percentage change in the vehicle speed along the route. It can be concluded that in every scenario, there is an increase in the vehicle speed on the Buitengracht link. This result is in line with the trend seen in the other indicators. Along the Buitengracht route, the average vehicle speed improved from 6km/h to an average of 30km/h. The average vehicle speed on the Strand Street route also shows an increase in speed in all the scenarios, with the average speed changing from 4km/h to an average of 20km/h in all scenarios but Scenario 5. The speed of the average vehicle travelling on the Riebeek Street Route remains almost unchanged as compared to the Base Scenario, for all Scenarios.

Overall, network scenario N2, shows the most overall improvement in average vehicle speed along the different routes, while Scenario 1, shows the most improvement, compared to the other individual road closure scenarios.

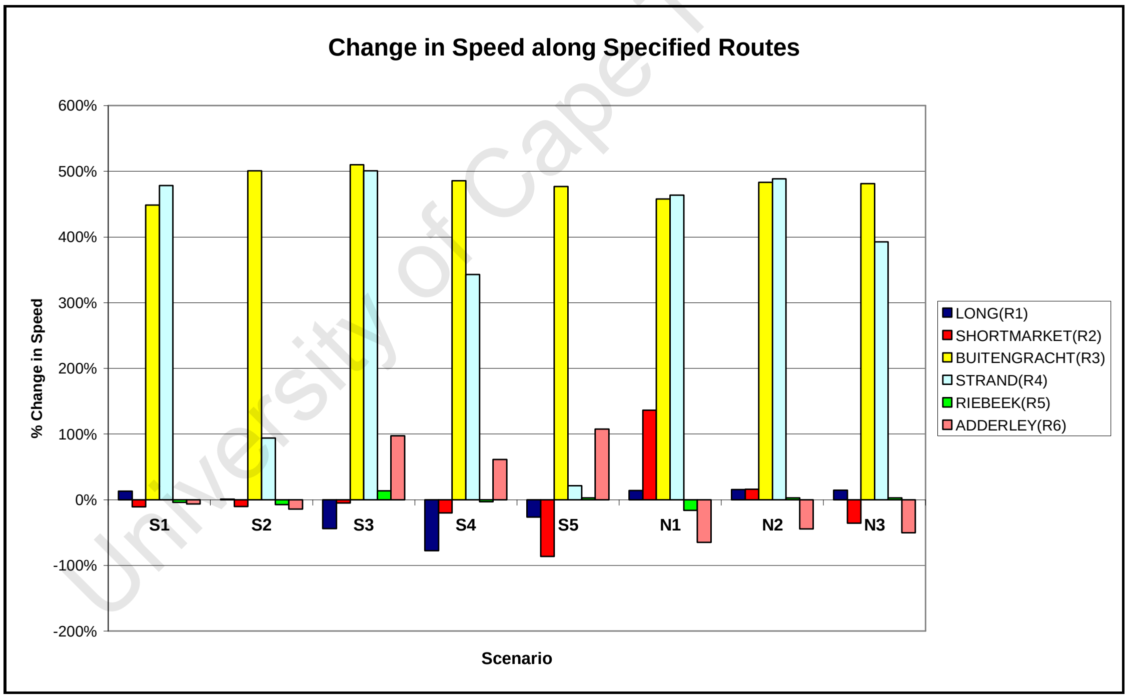

Figure 31: Change in Speed along the Journey Routes

Time saving for a journey is often a key indicator when evaluating traffic infrastructure projects and, as such used in the analysis of different journey routes. The saving in time is shown in **Figure 32**. The overall trend on improved conditions on the Buitengracht route results in a significant time saving of on average 9 minutes across all scenarios, with similar time savings experienced on the Strand Street link.

A pronounced loss of time can be seen in Scenario 5, with the average journey along Shortmarket Street taking over an hour longer. This is, due to traffic being diverted from Waterkant Street onto Strand Street and onto Shortmarket Street.

From the network scenarios, it can be seen that the journey along Adderley Street takes on average 10 minutes longer as compared to the Base Scenario. Scenario 1 and the Network Scenario N2, seem to yield the best time savings, as well as routes where there are increases in journey times, increase in time is not as pronounced.

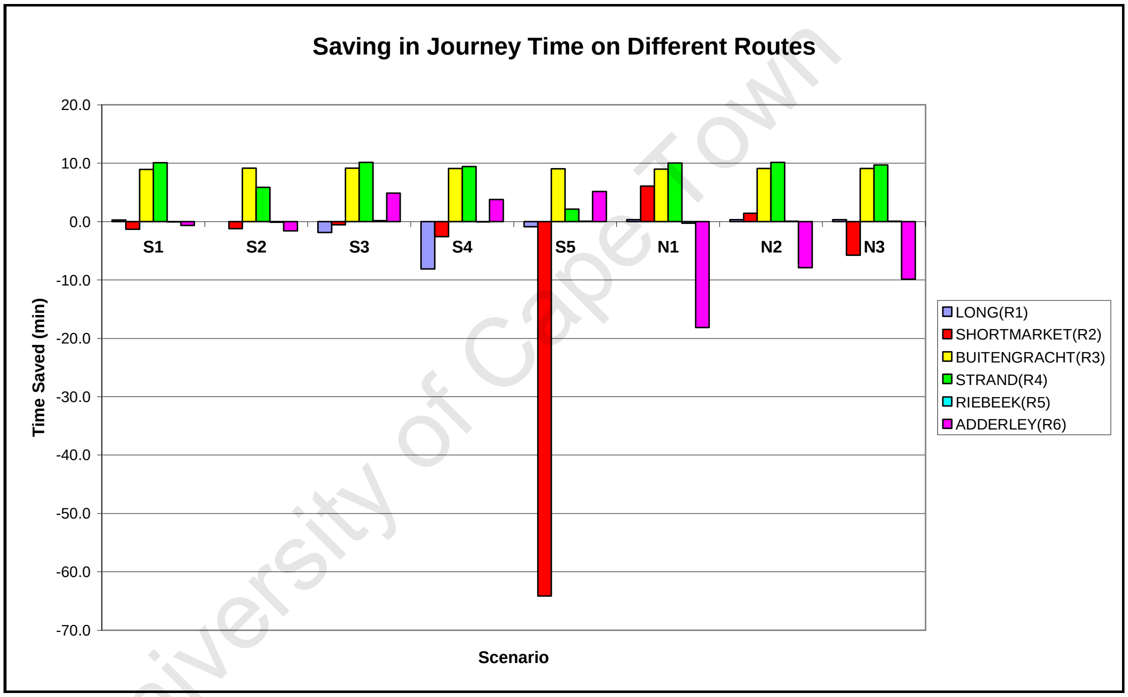

Figure 32: Time Savings along the Journey Routes

From **Table 2**, the total time savings is displayed along all the different routes for each of the scenarios. Overall, closing Long Street from Wale to Riebeek (S3), shows the greatest time saving, while Network Scenario 2 shows the greatest time saving across all routes for the network cases.

Table 2: Cumulative Time Savings per Scenario for the average PCU

SCENARIO	TOTAL TIME SAVING (min)
Closing Long Street: Strand to Whale	17.3
Closing Streets around Greenmarket Square	12.2
Closing Long Street: Whale to Riebeek	22.0
Closing Shortmarket: Addreley to Buitengracht	11.5
Closing Waterkant: Buitengracht to Burg	-48.6
Closing Long & Shortmarket Street	7.0
Closing Long and Waterkant Street	13.1
Closing Long, Waterkant and Streets around Greenmarket Square	3.5

4.2.4 The Most Favourable Solution

When looking at the overall situation, its important to see, which scenario has had the least negative impact. **Table 3** summarises the major results from the model. It can be concluded that the best single road closure is that of Scenario 1, the closure of Long Street from Strand to Wale Street.

This is the historic segment of Long Street and the same closure was proposed in the 1975 report City for the People. What is interesting to note, is that Scenario 1 and Scenario 3, both involve the closure of Long Street. Scenario 3 is an extension of Scenario 1 and includes the busy segment Strand to Riebeek Street. From the link analysis, specifically, there were stark differences between the two scenarios. With the time savings, there is just a difference in time saving of approximately 5 minutes.

Table 3: Summary on the Best and Worse Scenarios

	Best Case		Worse Case	
Indicator	**Single Scenario**	**Network Scenario**	**Single Scenario**	**Network Scenario**
Link Delay	S1	N2	S5	N1
Link V/C	S2	N2	S4	N3
Link Queue	S1	N2	S2/S5	N1
Intersection V/C	S1	N3	S4	N1
Average Speed	S1	N2	S5	N1
Greatest Time Saving	S3	N2	S5	N3

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When looking at the Network Scenarios, it can be concluded that Network Scenario 2 is the best. In almost every indicator, it proves to be the best. This scenario involves closing Long Street with Waterkant Street to form the pedestrian axis. From **Figure 33**, it can be seen what the new pedestrian network could look like. It encompasses the heart of the city centre and is ideal to expand the network and add other streets, to create a pedestrian zone that will rival those in European countries.

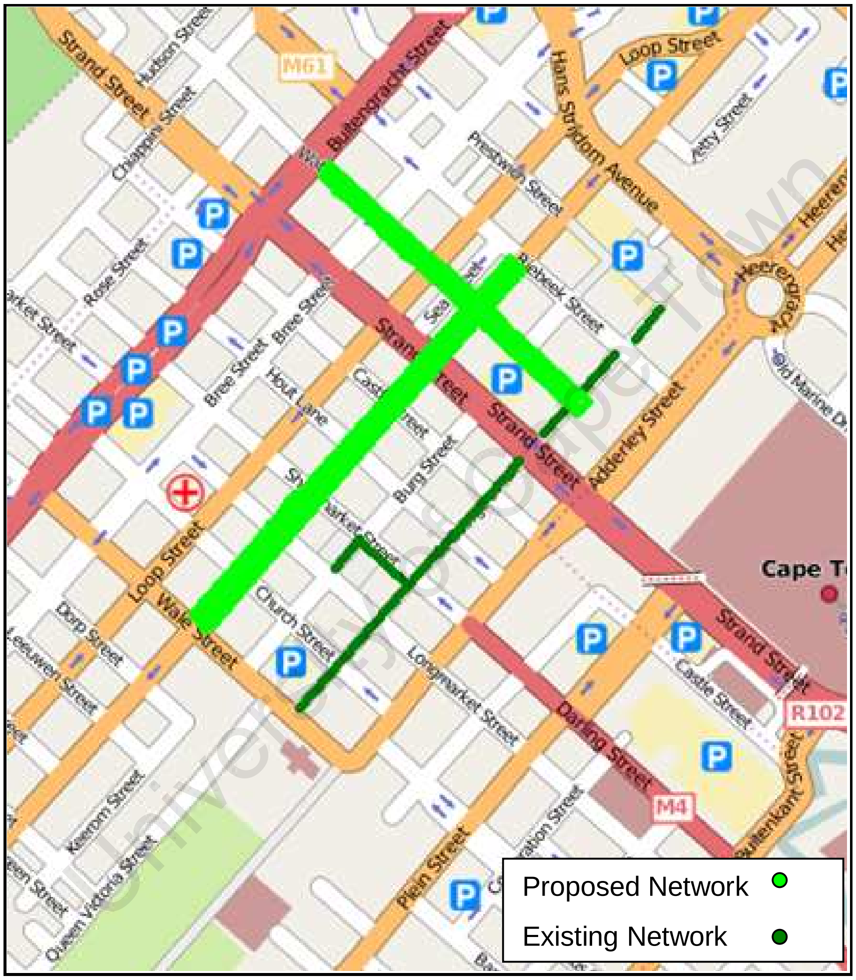

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Figure 33: Proposed Pedestrian Precinct for the City of Cape Town

5 STAKEHOLDERS SURVEY

A survey was conducted six months after the initial pedestrianisation scheme was implemented. The survey was done in June 2008. The survey group included all formal business owners and restaurateurs around the square as well as a random selection of informal traders which currently trade daily on the square. A sample size of n =13 was used for the survey with the traders. The number of participants in the survey can be seen in **Table 4**.

All surveys were conducted on the same day. The traders on Greenmarket Square sell anything from African Curios to T-shirts and CDs and cater more for the tourist rather than the locals. A pre-requisition to be part of the survey, was that the traders and restaurateurs had to be trading on the square for at least one year.

Table 4: Number of Participants in the Survey per Sector

Sector	Number of Participants
Fast Food/Restaurant	6
Goods/Service	4
Informal Trader	13
Overall	23

The aim of the survey was to gather information on two issues. The first was to establish if there were any direct economics benefits due to pedestrianisation. The indicator used to measure the economic benefits was a percentage change in turnover from a year ago, as compared to the survey date. Respondents also gave what they felt were the attributing factors to changes in their turnover. Respondents were asked to identify in which quartile the change in turnover occurred, rather than give an exact percentage as this data is more sensitive and respondents were reluctant to give more detailed financial information.

The second aim of the survey was to establish what the perception of pedestrianisation was by the various stakeholders on Greenmarket Square. A main indicator was whether they felt that the pedestrianisation scheme had a positive or negative impact on the square as well as how they personally felt about the pedestrianisation scheme (positive, negative or indifferent).

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5.1 SURVEY RESULTS

For the stakeholder's survey, questionnaires answered by the various stakeholders can be found in Appendix B. The results from the survey will be represented in the form of summary tables.

5.1.1 Changes in Turnover

Table 5 shows of the percentage change in turnover for vendors on and around the square. The results of the survey are given in **Table 5** show that not all traders on Greenmarket Square have economically benefited from the pedestrianisation scheme. The worst affected are the informal traders, where only 14% experienced an increase in turnover, while 43% experienced no change and 43% a decrease in turnover. Traders attribute the decrease in turnover to fewer tourist buses coming to the square due to the road closures.

Table 5: Summary Table for the Change in Turnover of Vendors on the Square

Sector	Decrease	No Change	0-25%	26-50%	51-75%	76-100%
Fast Food/Restaurant	0%	0%	50%	17%	17%	17%
Goods	50%	50%	0%	0%	0%	0%
Informal Trader	43%	43%	14%	0%	0%	0%
Overall	30%	39%	17%	4%	4%	4%

The group that has benefited the most from the scheme is the fast food and restaurant establishments around the square. All owners experienced an increase in turnover, with the majority experiencing an increase in the first quartile range. Owners attribute the increases in turnover to the ability to provide seating on the sidewalks and square outside their restaurants. In the absence of vehicles, this makes the restaurants more attractive, especially on days when the weather is good. This is the same trend as in Cities in Europe that have implemented pedestrianisation schemes.

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The store owners, who trade in goods, either experienced no change or a decrease in turnover. They attributed this decrease to the lack of parking and the restriction of vehicles on the square, which has caused customers to find similar establishments where vehicles have access and parking is available. Looking at the overall situation, more traders are worse off since the pedestrianisation scheme has been implemented. It should be noted, however, that the results are skewed towards the informal traders as they make up a significantly larger part of the survey group.

5.1.2 Perception of Pedestrianisation

Table 6 shows the results perception of pedestrianisation amongst vendors on the square. The results are shown by category, according to the type of good or service being provided by the vendor on Greenmarket Square.

Table 6: Summary Table for the Perception of Pedestrianisation

Sector	Positive	Indifferent	Negative
Fast Food/Restaurant	100%	0%	0%
Goods	50%	0%	50%
Informal Trader	23%	23%	54%
Overall	48%	13%	39%

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The overall perception of pedestrianisation, as well as the specific pedestrianisation of Greenmarket Square is positive as shown in **Figure 34**. It is not surprising that all restaurant and fast food establishments feel positive about the changes on the square. The majority of informal traders felt negative about pedestrianisation, while an equal amount felt positive or indifferent about the changes to the square. Half of the goods traders around the square felt positive, while the rest felt negative about the changes on the square. Surprisingly, trades who did not experience a change in turnover, still felt positive about pedestrianisation of Greenmarket Square.

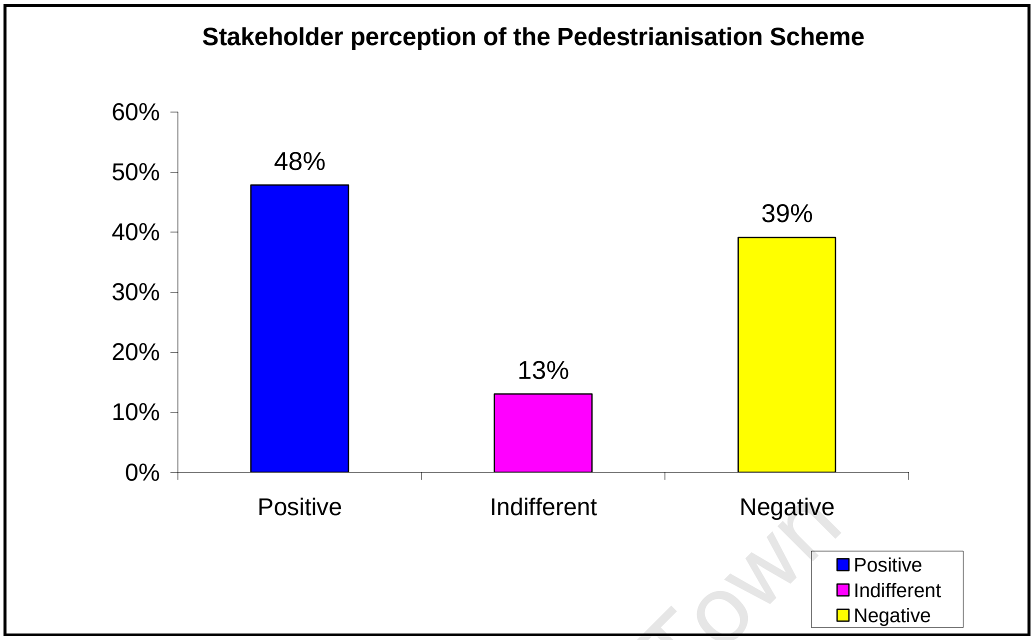

Figure 34: Perception of Pedestrianisation of various stakeholders

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6 CONCLUSIONS

Pedestrianisation is not a new phenomenon. It has enjoyed a global resurgence in urban planning in recent years. This is, due to a variety of reasons, ranging from using pedestrianisation as a traffic calming method, to a means to revitalise historic centres and empower pedestrians. Walking and pedestrianisation has the added benefits of improving the health of community as well as far reaching economic, and social benefits and a more equitable use of resources.

Pedestrian precincts were the invention of the Europeans as a way to preserve historical centres. Most notably, they started in Germany during post World War II reconstruction of German towns. The most successful case is in Munich, where the pedestrian precinct has the highest number of foot traffic, compared to other similar precincts around the globe. Cities in Asia, Latin America and North America have also implemented successful pedestrianisation schemes.

Copenhagen is a city that has made great strides in pedestrianisation of the historic core of the city. The dependence on automobiles was gradually decreased over a number of years through parking restrictions, the promotion of public transport and the conversion of parking lots into public spaces. The result is an increase in the use of public transport, non-motorised transport and a revitalisation of public spaces.

The United States of America is an interesting case as most of the pedestrianisation schemes implemented in the form of shopping malls were deemed a failure, as they failed to revitalise dying city centres. Other countries have also introduced schemes, which have failed. Implementing a pedestrian scheme is not as simple as closing a street and adding retail outlets. It is a lengthy process lasting decades, and involving changes in land use and urban form.

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In most cases, successful pedestrian precincts started with a single street or square being closed to vehicular traffic and redesigned to make it more appealing to pedestrians. This is done by changing the urban furniture, greening the area, improving street lighting and walking environment. Municipalities, then convert other streets and squares, adding to the original pedestrianised area, to form a pedestrian network, which evolves into a pedestrian zone. Parking spaces in close proximity to these zones are gradually reduced and parking lots are converted to public squares. In some cases, underground parking is created.

Pedestrian zones have been a catalyst to improve economic activity within the zone. This does not happen overnight, but rather after a year or two. In the first year, shop owners can expect a decrease in turnover. The economic situation improves as the pedestrian precinct grows and more people are attracted to the area. In over 100 pedestrianised cities around the world, 49% of shop owners experienced an increase in turnover, while the rest either experienced a decrease or no change in turnover.

Another economic effect of pedestrian zones is the increase in property prices. This is, due to a more attractive area and increases in turnover. This is, generally, positive for property owners, but smaller stores battle to survive on marginal profits. The attractiveness of these precincts and high rentals are a big draw card and often national and international chain stores locate in these precincts. Smaller local shops, who have been in the area, cannot compete with prices and services offered by these chain stores and as a result have to close down. This is an unfortunate outcome, but should not be blamed on pedestrianisation, but rather on the way free market systems work.

The most successful pedestrian precincts are not just areas where shopping can take place. They have a mixture of activities and incorporate leisure, entertainment and cultural activities. They are attractive not too just visitors but also to local residents alike, and encourage locals to spend money in their own neighbourhoods instead of conventional shopping malls.

During the pedestrianisation process, it is important to keep the public informed. When roads are closed, the public should be forewarned so as to avoid congestion and chaos, and allow travellers to change travel behaviour, including travel routes and departure times.

Planning to create a pedestrian network in Cape Town can be found as far back as 1975, but these schemes were never implemented. In the early 1990s, in Cape Town, the first street to be pedestrianised was St Georges Mall. This scheme was the first in Cape Town, and in 2007, the closure of Shortmarket Street linked the pedestrianised Greenmarket Square with St Georges Mall.

For this thesis, the transport model has shown that when certain segments of roads are closed, the negative impact on traffic is not as dramatic as expected. What does, however, happen is that the bottlenecks are moved to a different road.

The single infrastructure change scenario with the least change in the traffic situation is when Long Street is closed from Wale Street to Strand Street. From the results, changes in the link indicators, i.e. the delay of links, V/C ratio and the average queue on the Strand Street link is only 10 to 15 percent worse than in the Base Scenario. The situation on the Buitengracht link is improved.

For the network scenarios, closing Long and Waterkant Street bring the least amount of changes according to the link indicators. This scheme also improves the link with Cape Town Station, the major transport interchange in the City of Cape Town. Waterkant Street is also more important than Shortmarket Street in linking the City with the new Football stadium in Green point, being built for the 2010 Soccer World Cup.

From the recent pedestrianisation of Greenmarket Square, it can be seen that this project follows the international trend to a certain degree. As with other similar areas internationally, the restaurants and other eating establishments have experienced an increase in turnover. This has been attributed to being able to provide seating on the square. There are also entertainers on the square, which makes it livelier.

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Many traders on Greenmarket Square have experienced a decrease in turnover. This is, due to the traders mostly catering for the tourists and the range of goods on sale not being diverse. The shop owners on Greenmarket Square are also experiencing a decrease in the turnover since the implementation of the pedestrian scheme. This is to be expected, as based on international experience; shop owners can feel a decrease in turnover within the first year. Overall, there is a higher percentage of stakeholders on Greenmarket Square who have a positive sentiment on the pedestrianisation scheme. Even traders who have not experienced an increase in turnover have a positive sentiment towards the pedestrianisation scheme.

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7 RECOMMENDATIONS

It is important to learn from international experience. Thus, it is necessary, not just to close the proposed roads, but to ensure there is a diverse land use, including residential, retail and leisure and entertainment, in order to create successful pedestrian precinct.

In the last forty years, private vehicles entering the City of Cape Town have increased by 500%. In order for Cape Town to be a sustainable City, without the deterioration of the urban fabric, it is important to curb the increase of private vehicles. It is, however, impossible to decrease the total use of private vehicles. Nonetheless, the City can make public transport more attractive, as well as create public spaces to walk within the inner city.

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This thesis has tested various North-South pedestrian axes within the heart of the Cape Town CBD. These routes cover some of the historic parts of the City, and are a good base to develop a pedestrian precinct within the heart of the City of Cape Town. **Figure 35** shows the recommended pedestrian axis within the City based on the modelling results. This scheme includes the closure of Long Street, from Strand to Wale Street, as well as Waterkant Street. This not only creates an area where pedestrians can cross the City of Cape Town easily, but also provides an area where the city's residents can interact and engage in social and leisure activities, without being in conflict with the motor vehicles.

In some instances, road closures are not necessary, but traffic calming measures, as well as upgrades to pedestrian facilities should be implemented, including better crossing facilities. These areas are indicated in red in **Figure 35**. These changes can help promote a better walking environment. These include an improved pedestrian crossing on across Strand Street, as well as a better link with Cape Town Station.

With South Africa hosting the 2010 FIFA Soccer World Cup, it is important to connect the City with the main transport hub, Cape Town Station. The proposed precinct not only connects the CBD with the main transport hub, but also with the Green Point Area. The pedestrian precinct also creates an ideal area to have a fan park. This is a place where fans can gather and watch the football matches together on large screens.

Long Street is already a place of leisure and entertainment, but residential density in the city is still low. Waterkant Street, at night, is also dormant. It is important to improve safety and lighting in these areas to make it attractive and draw visitors and residents alike, throughout the day and at night. The city is already in the process of transforming old office space into residential units and as such, the CBD is ideal for the type of scheme proposed in this thesis.

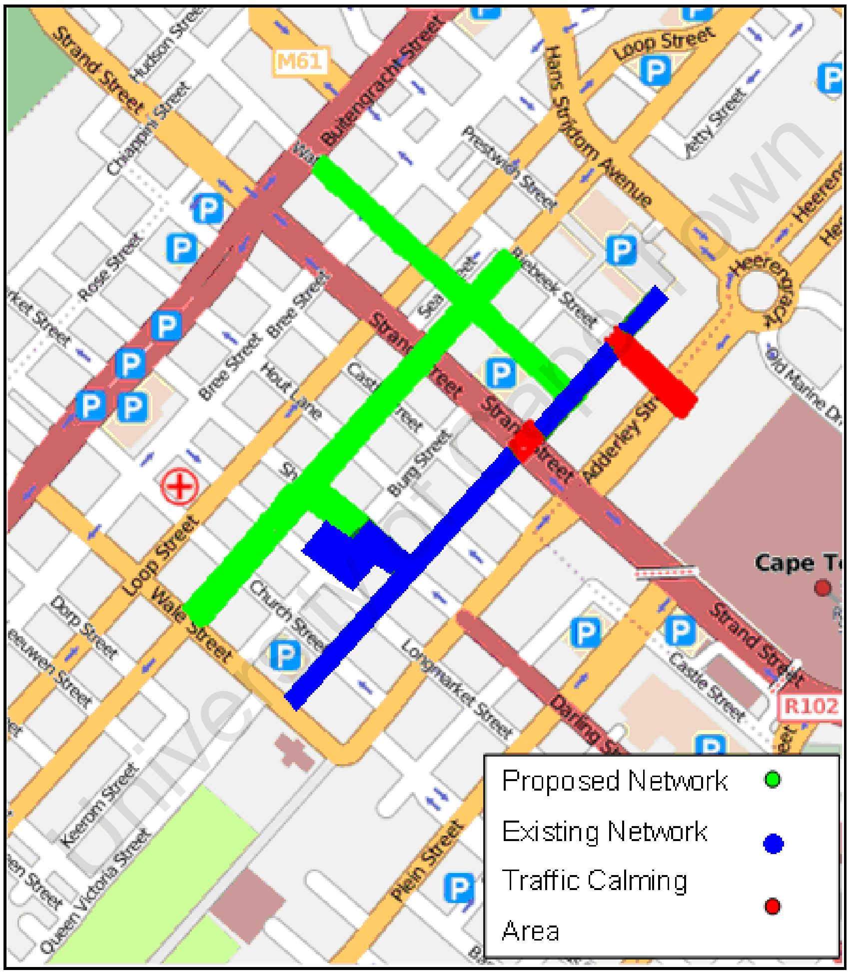

Figure 35: The Proposed Future Pedestrian Precinct

The pedestrianisation of Greenmarket Square can be seen as the first step in creating a pedestrian network in the City of Cape Town. In order for the Square to be viable, it is important to diversify the type of goods and services on offer. The current problem with the traders is that they only cater for tourists, and they all sell similar African curio. To diversify the type of goods sold, and make it attractive for locals as well as tourist, will help in improve the economic outlook for the traders.

In order to draw more people to the square and make a more efficient use of the space, entertainment activities should be implemented. There is already the famous egg man on the square. Street musicians also add to the liveliness and appeal of the square.

Adding street furniture, better lighting and more greenery within the square will make the area more attractive, as well as well as used more during the evenings.

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APPENDIX A: SATURN Analysis

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BASE SCENARIO RESULTS

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Scenario 1: Closure of Long street from strand street to Wale street

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Scenario 2: greenmarket square road closures

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Scenario 3: long street closure extension - Wale to riebeek street

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Scenario 4: closure of shortmarket street – adderley to buitengracht street

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Scenario 5: closure of waterkant street: burg to buitengracht street

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Network scenario 1: long street and shortmarket street closure

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Network scenario 2: closure of long and waterkant street

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Network scenario 3: closure of long and waterkant streets as well as streets around greenmarket square

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APPENDIX B: Greenmarket Square Survey Form

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Results from the greenmarket square survey

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An Investigation into the Pedestrianisation of City Streets: A move towards pedestrian friendly spaces and their economic effects in the City of Cape Town

The need for pedestrian spaces can be seen as far back as the roman times, but as the benefits of vehicular transport became more pronounced, and the mode was used more frequently, there was a dramatic increase in the confrontation between vehicles and people. Pedestrianisation has enjoyed a global resurgence in urban planning in recent years. Walking and pedestrianisation has the added benefits of improving the health of community, as well as far reaching economic and social benefits and an equitable use of resources.

During December (2007), Cape Town's peak tourism season, a pilot pedestrianisation project was run in the City of Cape Town. The 300 year old Greenmarket Square was pedestrianised and stakeholders on the square were surveyed six months after the implementation of the scheme to access the economic benefits, as well as the perception of predestination by the traders.

A SATURN dynamic assignment model was used to simulate the effect of certain road closures to traffic as part of an extension to the pedestrian network. These road are vital to start forming a formalise pedestrian network within the CBD. From the results, a pedestrian network for the Cape Town CBD has been proposed.

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THE PEDESTRAINISATION OF CITY STREETS: A MOVE TOWARDS RECLAIMING PUBLIC SPACES IN THE CITY OF CAPE TOWN, SOUTH AFRICA

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Abstract:
The need for pedestrian spaces can be seen as far back as the roman times but as the benefits of vehicular transport became more pronounced and the mode was used more frequently, there was a dramatic increase in the confrontation between vehicles and people. With the introduction of the automobile, a large amount of pedestrian spaces were being encroached. City centres were increasingly becoming car orientated and moved away from being people orientated. This was and still is a global phenomenon and a result of economic growth and industrialisation. No one could have predicted the explosive growth of car use.

South African Cities was not immune to the traffic problems which plagued other countries around the world. Car usage in South Africa has grown steadily; South Africans however view cars as not only a means on transportation but more of a status symbol. Commuters in South African cities also have no alternative but to rely on private transport as convenient public transport is not readily available. During December 2007, Cape Town's peak tourism season, a pilot pedestrianisation project was run in the City of Cape Town. The roads surrounding the 300 year old Greenmarket Square was pedestrianised. Initial success of the six week scheme motivated council authorities to permanently close the square to traffic. Roads closed around the square included a short stretch of Shortmarket Street, connecting the already pedestrianised street St Georges Mall to the square as well as a small stretch of Burg Street, which ran through the Greenmarket Square. The pedestrianisation of Greenmarket square has dealt benefits mainly for the restaurants and coffee shops around the square. Changes in turnover range between 15 - 80%. These changes are attributed to the ability for restaurants to provide seating on the sidewalks and square and provide a safe environment for people to interact with each other. The overall feeling on pedestrianisation was a positive one. The traders and shop owners do have the expectation that business will improve once the square has been fully upgraded.

A SATURN dynamic assignment model was used to simulate the effect of certain road closures to traffic as part of an extension to the pedestrian network. These road are vital to start forming a formalise pedestrian network within the CBD. From the results, the better road closure is that of Long Street, a vibrant road within the CBD, which has both an active night life as well as large foot traffic during the day. The road is currently being used as a shortcut through the City and is ideal for pedestrianisation.

Key Words: Pedestrianisation, transport modelling, economic impacts

1 Introduction

The need for pedestrian spaces can be seen as far back as the roman times when Julius Caesar had to ban carts and chariots from the streets of Rome from sunrise to sunset due to the conflict between pedestrians and wheeled traffic. Similarly, the forum in Pompeii was banned to all modes of transport other than walking (Hass-Klau, 1990). But as the benefits of vehicular transport became more pronounced and the mode was used more frequently, there was a dramatic increase in the confrontation between vehicles and people.

With the introduction of the automobile, a large amount of pedestrian spaces were being encroached. City centres were increasingly becoming car oriented and moved away from being people orientated. This was and still is a global phenomenon and a result of economic growth and industrialisation. No one could have predicted the explosive growth of car use.

By the late 1950s, European cities were suffering significantly due to their radial street geometry, with an increase in congestion, pollution and a decrease in the state of the urban fabric. It became increasingly clear that private vehicles had to be barred from entering the city, especially the historic core, which was characterised by narrow streets. In the 70's a movement started in Europe to reclaim public spaces from the private vehicle. By 1975, most major European Cities banned cars from historic and retail areas within the CBD. Public areas were revitalised and as a result cold and dormant cities become alive with people.

South African Cities was not immune to the traffic problems which plagued other countries around the world. Car usage in South Africa has grown steadily, and congestion levels rival those in US cities. South Africans however view cars as not only a means on transportation but more of a status symbol. In many instances, commuters in South African cities also have no alternative but to rely on private transport as convenient public transport is not readily available.

In the 1970s, South African engineers and planners realised that congestion was a major problem in the City Centres and as such put together plans to pedestrianise historic quarters, especially in the City of Cape Town. Included in these plans was to create Pedestrian Squares in the historic quarter and link the squares with pedestrian walkways. One of the proposed pedestrian squares was Greenmarket Square,

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with adjacent Shortmarket and Longmarket Streets being closed to vehicular traffic. Unfortunately, these plans were never implemented and the only pedestrian precinct in the City of Cape Town was implemented in the 1980s at St Georges Mall, a short pedestrianised street in the heart of Cape Town.

During December 2007, Cape Town's peak tourism season, a pilot pedestrianisation project was run in the City of Cape Town. The 300 year old area earmarked for pedestrianisation, known as Greenmarket Square, is located in the heart of the CBD and has a colourful history. Greenmarket Square first served as a slave market, then became a fruit and vegetable market and in the 1950's became a parking lot. In the 1980's its potential was recognized and was converted into an informal trading area two days a week and its potential grew, but it stilled remained a parking lot on days when it was not occupied by the popular flee market. Initial success of the six week scheme motivated council authorities to permanently close the square to traffic. Roads closed around the square included a short stretch of Shortmarket Street, connecting the already pedestrianised street St Georges Mall to the square as well as a small stretch of Burg Street, which ran through the Greenmarket Square as shown in **Figure 1**.

The City of Cape Town has earmarked a total of R300 million to uplift the square, including formalising and downsizing the informal traders, constructing better ablution facilities, street furniture and constructing a stage on the square for night time concerts and other events.

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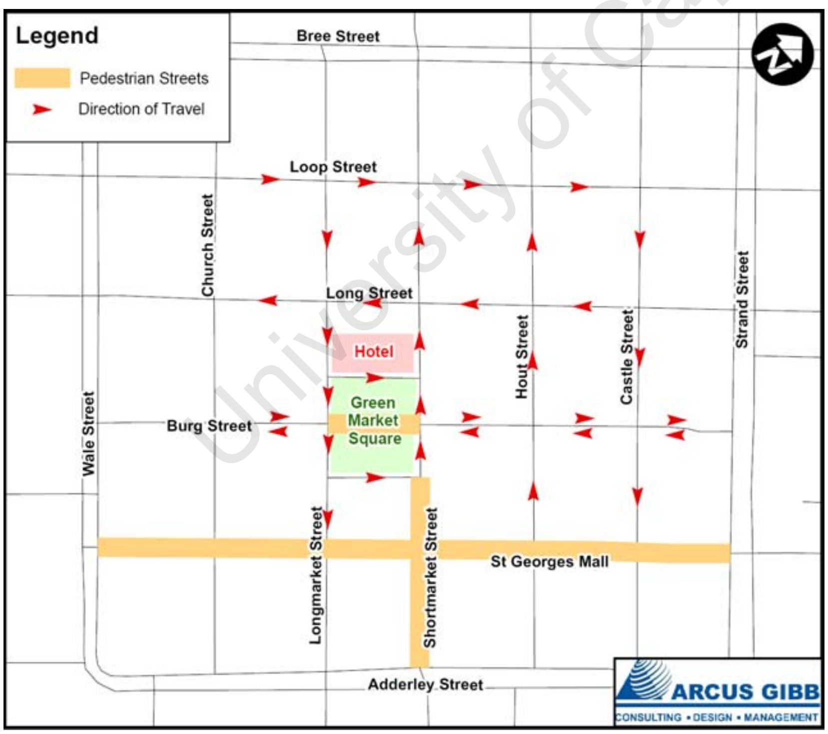

Figure 1: Extent of Road Closures in the City of Cape Town

One of the most important points arising from the report in 1975 was that pedestrian schemes cannot be effective if existing traffic is ignored. In 1975, 34160 cars were entering the City Centre in the peak hour, in 2007, there were over 170 000 cars entering the CBD, leading to even greater congestion. The City of Cape Town still has no effective public transport and vehicular traffic in the CBD has increased by about 500% over the last 25 years. One cannot merely close internal CDB roads without knowing the impact on the rest of the network. As such a Saturn dynamic reassignment model was set up for the entire Cape Town CBD to determine the effect on the Inner City road network as well as the effect an extension of the scheme will have on the traffic in the CBD. A survey of the traders on the square and shop owners, with frontages on the square, was conducted six months after the initial scheme to determine the effect pedestrianisation had on their turnover as well as their perception pedestrianisation of Greenmarket Square.

2 Stakeholder Survey and Transport Modelling

2.1 Stakeholder Survey

A survey was conducted six months after the initial pedestrianisation scheme was implemented. The survey group included all formal business owners and restaurateurs around the square as well as a random selection of informal traders which currently trade daily on the square. These traders sell anything from African Curios to T-shirts and CDs and cater more for the tourist rather than the locals. Everyone in the survey group was on the square for longer than one year.

The survey was designed to establish if there were any direct economics benefits due to pedestrianisation as well as the perception of pedestrianisation of the various stakeholders on the square. The indicator used to measure the economic benefits was a change in turnover. Respondents also gave what they felt were the attributing factors to changes in their turnover. The Respondents were also asked how they felt about pedestrianisation of the square and if they thought it was positive change or a negative change.

2.1.1 Results from the Stakeholder Survey

The results of the survey are given in Table 1 and 2 show that there is the scheme has not benefited everyone on Greenmarket Square. The worst affected are the informal traders.

Table 1: Percentage change in turnover for businesses on Greenmarket Square

Sector	Decrease	No Change	0-25%	26-50%	51-75%	76-100%
Fast Food/Restaurant	0%	0%	50%	17%	17%	17%
Goods	50%	50%	0%	0%	0%	0%
Informal Trader	43%	43%	14%	0%	0%	0%
Overall	30%	39%	17%	4%	4%	4%

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Table 2: Perception of Pedestrianisation for businesses on Greenmarket Square

The group that has benefited the most from the scheme is the fast food and restaurant establishments around the square. Owners attribute the increases in turnover to the ability to provide seating on the sidewalks and square outside their restaurants. During the summer months this area is vibrant, and attracts a lot of locals and tourists alike. In this aspect, Cape Town's pedestrianisation scheme does follow the global trend.

There are about one hundred traders on Greenmarket Square, and their stalls are tightly packed on the centre of the square as can be seen in **Figure 2**. They bring in their goods at 5am and take tier goods away again in the evening. There is currently no storage facility on the square for these traders. Many of them sell the same African curios and there is little diversity in the goods on sale. The traders cater rather for the tourist market than the locals. Traders attribute the decrease in turnover to fewer tourist buses coming to the square due to the road closures.

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Sector	**Positive**	**Indifferent**	**Negative**
Fast Food/Restaurant	100%	0%	0%
Goods	50%	0%	50%
Informal Trader	23%	23%	54%
Overall	48%	13%	39%

Figure 2: Greenmarket Square shortly before pedestrianisation scheme (SA Tourism, 2007)

2.2 Saturn Modelling

A SATURN dynamic reassignment model was coded for the entire CBD for the City of Cape Town. The model was used to test various road closure scenarios including the current pedestrianisation scheme on Greenmarket Square. There were two scenarios tested, the first scenario is closures of Longmarket and Shortmarket Streets. These streets run adjacent to the square. There are also fewer access garages on Shortmarket Street and as such access and deliveries would not be adversely affected. Both these streets link the already pedestrianised St Georges Mall with Greenmarket Square.

The model was also used to test the effect on the inner city traffic if the pedestrianisation scheme was extended to include Long Street and the Long Street was closed from Strand Street to Whale Street. This particular segment was planned as part of the City of Cape Towns Pedestrianisation Scheme in 1975. Both during the day and at Night, Long Street is bustling with people and is the heart of the Cape Town CBD. It was many restaurants and cafes along the street as well as many clubs, making it a hot spot for both locals and tourist alike. It is currently a one-way couplet scheme with Loop Street (see Figure 1). It has parking on either side of the road and pedestrians often have to compete with speeding vehicular traffic. During the day, Long Street is used as a shortcut through the City.

Long Street has also been identified as a possible pedestrian route for the 2010 World Cup, and is planned to closed and converted into a transit mall for the City of Cape Town's new Bus Rapid Transit System. The intention of the model was to test the closure of Long Street and how traffic is then reassigned on the network. The model was used to identify hotspots and predict the extent of the congestion due to the closure of Long Street.

2.2.1 Results from the Transport Modelling

Three key indicators were used to compare the base model with the two scenarios. These are the average delay experienced by a vehicle on the link, the vehicle / capacity ratio on the link, which indicates a level of congestion and the level of operation of the link and the average vehicle queue measure in passenger car units (PCU). These are summarised in Table 3.

Scenario	**DELAY(s)**		**V/C**		**AVE QUEUE (PCU)**	
Link	Buitengracht	Strand	Buitengracht	Strand	Buitengracht	Strand
Base Year	56	5	102	31	14	1
Shortmarket/Longmarket	250	129	112	70	74	35
Long Street	117	10	58	77	28	4
Change due to Shortmarket/Longmarket Closure	446%	2580%	110%	226%	529%	3500%
Change due to Long Street Closure	209%	200%	57%	248%	200%	400%

From the results, the closure of Shortmarket and Longmarket Street show a greater delay for vehicles on the links, an increase in links being overcapacity as well as more cars queuing on a link. The CBD is worst affected by those road closures

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rather than the closure of the historic stretch of Long Street. In both scenarios, road closures result in a dramatic change to the congestion levels on Strand Street.

3 Conclusions

From the Cape Town experience, the pedestrianisation of Greenmarket square has dealt benefits mainly for the restaurants and coffee shops around the square. Changes in turnover range between 15 - 80%. These changes are attributed to the ability for restaurants to provide seating on the sidewalks and square and provide a safe environment for people to interact with each other. However, for informal traders, some of whom have been on the square for more than ten years, a decrease in turnover was experience. The overall feeling on pedestrianisation was a positive one. The traders and shop owners do have the expectation that business will improve once the square has been fully upgraded.

A SATURN dynamic assignment model was used to simulate the effect of certain road closures to traffic. These road are vital to start forming a formalise pedestrian network within the CBD. From the results, the better road closure is that of Long Street, a vibrant road within the CBD, which has both an active nights life as well as large foot traffic during the day. The road is currently being used as a shortcut through the City and is ideal for pedestrianisation.

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