Developing a Scorecard for Sustainable Transport: A Cape Town Application

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Declaration

By submitting this dissertation electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the owner of the copyright thereof (unless to the extent explicitly otherwise stated) and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

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Abstract

Globally, transport and its associated ills are creating urban landscapes that can best be described as unhealthy, unfriendly and unsustainable. The unsustainable nature of current transportation practices are most keenly displayed in four key areas, namely: the pending oil peak; global climate change; environmental degradation and social deprivation. South Africa is no exception to these impacts, but also suffers an extra disadvantage of demonstrating very little knowledge of more sustainable transportation option in terms of its planning regime.

This study endeavours to improve the state of sustainability in transportation planning by developing a user-friendly and pragmatic transportation sustainability appraisal mechanism and testing this mechanism on a real-life case. In order to develop such an appraisal mechanism, the theory of sustainable development is firstly examined to provide direction to the study, followed by an attempt to distil the most pertinent principles of sustainable transport from the literature. These principles form the objectives which the appraisal mechanism aims to measure sustainability against. Owing to the poor level of awareness regarding sustainable transport practices in South Africa, a discussion on selected benchmark sustainable transport practices is also included in the study and consequently added to the appraisal mechanism. To test its operability, the appraisal mechanism is finally applied to Cape Town's Draft Integrated Transport Plan (ITP) 2006-2011.

The study indicates that the ITP is a reasonably sustainable transport plan, with the exception of its affordability and public participation aspects. These exceptions are attributed to the ITP either not properly addressing these aspects, or due to the ITP not providing enough information on these aspects. Finally, the study found that the developed appraisal mechanism is operable in the field of transportation planning, but suggests that the mechanism be further developed and refined to improve its value and effectiveness. A transdisciplinary process involving the input of community stakeholders and specialists is identified as major area for such development

Opsomming

Vervoer en die geassosieerde negatiewe impakte daarvan skep wêreld-wyd stedelike landskappe wat die beste beskryf kan word as onvriendelik, ongesond en nie-volhoubaar. Die nie-volhoubare aard van huidige vervoergebruike word die sterkste uitgebeeld in vier sleutel areas, naamlik: die komende piek in olie produksie, globale klimaatsveranderings, omgewings vernietiging en sosiale verwaarlosing. Suid-Afrika is geen uitsondering nie, maar het die addisionele nadeel van baie min kennis oor meer volhoubare vervoeropsies ingevolge die land se beplanningstelsel.

Hierdie studie beoog om die toestand van volhoubaarheid in vervoerbeplanning te verbeter deur ʼn gebruikersvriendelike en pragmatiese vervoer volhoubaarheid-takseringsmeganisme te ontwerp en te toets op ʼn bestaande geval. Om hierdie takserings meganisme te onwerp, is die teorie van volhoubare ontwikkeling eers ondersoek om rigting aan die studie te gee. Hierna is gepoog om die mees pertinente beginsels van volhoubare vervoer uit die literatuur te identifiseer. Hierdie beginsels vorm dan ook die doelwit waarteen die volhoubaarheid van vervoerstelsels gemeet word. As gevolg van die lae vlak van bewustheid aangaande volhoubare vervoerpraktyke in Suid-Afrika, word ʼn bespreking van die mees toonaangewende volhoubare vervoerpraktyke in die studie ingesluit en word gevolglik ook aangeheg aan die takseringsmeganisme. Om die bruikbaarheid van die takserings meganisme te toets, word dit toegepas op Kaapstad se Konsep Geïntegreerde Vervoerplan 2006-2011.

Die studie bevind dat die Geïntegreerde Vervoerplan ʼn relatiewe volhoubare vervoerplan is, met die uitsondering van die bekostigbaarheid en publieke deelname aspekte van die plan. Hierdie tekortkominge word toegeskryf aan; of die Geïntegreerde Vervoerplan se gebrekkige hantering van hierdie aspekte, of ʼn tekort aan inligting oor hierdie aspekte.

Die studie vind dat die takserings meganisme wel bruikbaar is in die vervoerbeplannings praktyk, maar stel voor dat die meganisme verder ontwikkel en verfyn word om sodoende die waarde en effektiwiteit daarvan te verbeter. ʼn Transdissiplinêre proses wat plaaslike aandeelhouers en kenners insluit word aangedui as ʼn sentrale area vir verdere ontwikkeling.

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List of Abbreviations and Acronyms

BRT: Bus Rapid Transport

CBA: Cost Benefit Analysis

CBD: Central Business District

CO_2: Carbon Dioxide

dB: Decibels

FAME: Fatty Acid Methyl Ester

GDP: Gross Domestic Product

GHG: Greenhouse Gases

HC: Hydrocarbons

HOV: High Occupancy Vehicle lanes

IAP2: International Association for Public Participation

ITP: Integrated Transport Plan

LPG: Liquid Petroleum Gas

LRT: Light Rail Transport

MCA: Multi Criteria Analysis

MIPS: Material Input per Service Units

NATA: United Kingdom's New Approach to Appraisal

NGV: Natural Gas Vehicle

NMT: Non-motorised Transport

N_2O: Nitrous Oxide

NOx: Nitrogen Oxide

PM_5: Particulate Matter with 5 micrometer diameter

PM_{10}: Particulate Matter with 10 micrometer diameter

SST: Scorecard for Sustainable Transport

SQL: Structured Query Language

TDM: Transport Demand Management

TOD: Transport Oriented Development

VOC: Volatile Organic Compounds

WHO: World Health Organisation

UITP: International Association for Public Transport

ULR: Ultra Light Rail

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CHAPTER 1

INTRODUCTION

1.1 Motivation for this study

Introduction

The transport sector is a major role player in the creation of the urban landscape and character. However, in most instances this landscape is characterised by segregation, sprawl and an automobile oriented environment, while the urban character can best be defined as unfriendly, unhealthy and inefficient. A transport system creating and perpetuating such urbanities can hardly be sustainable.

Closer investigation of the most salient impacts of the transport sector reveals the unsustainable character of our current transport systems with startling clarity. These impacts, though integrated, can be loosely categorised into four main areas of impact, namely; firstly, the pending oil peak; secondly, global climate change; thirdly, environmental degradation; and fourthly, social degradation. The abovementioned impacts illustrate the following characteristics of transportation, deemed to be central to the aim of this study:

- Transportation is captive to a fuel source which is finite, but as of yet, humankind has no other viably alternative fuel source
- Transportations' dependence on a fossil fuel source is greatly contributing to altering the global climate, an alteration humanity should try to avoid at all costs

- Transportations’ use of a toxic fuel source and the physical manifestation of transportation infrastructure and use, is not only eroding the natural resource base on which life is dependent, but also directly impacts on human health an wellbeing

The pending oil peak, global climate change and environmental-and-social degradation are discussed in more detail below.

The pending oil peak

The depletion of oil as an energy source, also known as oil peak, poses profound implications to the world economy in general and to global transport in particular. This is due to the fact that oil can be refined into easily transportable and stored sources of energy, most notably petrol and diesel, which lends itself perfectly to use in the transport sector. In this regard, Wakeford (2007: 1) reports that up to 90% of global transport’s energy demand is presently completely dependent on oil. This results in transportation consuming a quarter of the world’s total energy budget and more specific, two thirds of annual global oil production (Newsweek, 2007: 37). This number is set to increase as car ownership in developed and developing countries are steadily increasing, with the European Union showing a 31% increase in car ownership (1984-1994) and developing countries experiencing rapid motorisation of 15%-16% per annum (Browne, 2005:1). Even in South Africa, the Western Cape Province’s transport sector is responsible for 34% of the province’s total energy consumption, (Draft Western Cape Integrated Energy Strategy, 2007: 4-5), and more particularly, in 2005 Cape Town’s transport sector consumed a startling 57% of the cities total energy use per annum (City of Cape Town Sustainability Report, 2005: 9).

Again, this figure is set to rise as motorisation increases in Cape Town at a rate of approximately 11 662 vehicles per year (2001 to 2003) (City of Cape Town Sustainability Report, 2005: 12).

Oil peak conventionally refers to the point where global oil production reaches maximum yield levels, and then starts to decline as oil reserves diminish and/or become uneconomical to exploit (Jackson, 2006: 2). At such a point, oil prices will steadily increase and eventually oil will become unavailable to many, spelling global economic and geopolitical catastrophe (McNamara, 2004: 3; Post Carbon Institute, 2004: 1 & Jackson, 2006: 1).

Scholars however differ substantially on when and how oil peak will occur. Jackson (2006: 1) sees no evidence that world oil production will peak before 2030 and maintains that a peak in global oil production will be followed by an “undulating plateau” rather than a sharp decline in production. Campbell (in Wakeford, 2007: 3), in contrast, postulates that a peak in oil production already started in 2005 and will reach maturity in 2010, while Deffeyes (in Jackson, 2006: 3 & Wakeford, 2007: 3) suggests a production peak in 2005, followed by a rather sharp decline in global production. As indicated in Table 1, a considerable number of experts however agree on a peak in oil production within the next decade (2000 to 2010).

Table 1: Predicted Dates of World Oil Peak

Source	Affiliation	Depletion Date	Notes
Kenneth Deffeyes	Princeton University	2005	Regular oil[1]
Richard Duncan	Institute for Energy and Man	2006	Regular oil
Ali Samsam Bakhtiari	Iranian National Oil Company	2006-2007	Regular oil
Chris Skrebowski	Oil Depletion Analysis Centre, UK	2007-2008	
Collin Campbell	ASPO, Ireland	2005	Regular oil
David Goodstein	Cal Tech University	Before 2010	
Michael Smith	Oil geologist & analyst	2011	Regular oil
Cambridge Economic Research Associates		After 2020	
US Geological Survey		2016 (high probability scenario) 2037 (median scenario)	

Source: Adapted from Wakeford (2007)

Projections concerning the possible depletion date of oil compel one to ask what proof exists of such an imminent peak. Wakeford (2007: 2) locates this proof in the persistent global decline in oil discoveries since the 1960's (see Figure 1). He indicates that since 1981 global oil demand has outstripped global oil supply, with a current consumption versus discovery rate of five barrels of oil consumed for each

[1] Regular or conventional oil can be distinguished from non-conventional oil. Conventional oil is extracted in liquid form in economically viable geographical locations. Non-conventional oil can be extracted as an ore or a liquid and is often located in economically unviable geographical locations. Non-conventional oil includes; oil sands, shale oil, deep water oil and polar oil (Wakeford, 2007; Campbell, 2000).

new barrel discovered (Lovins *et al*, 2005; Post Carbon Institute, 2005; Wakeford, 2007: 2).

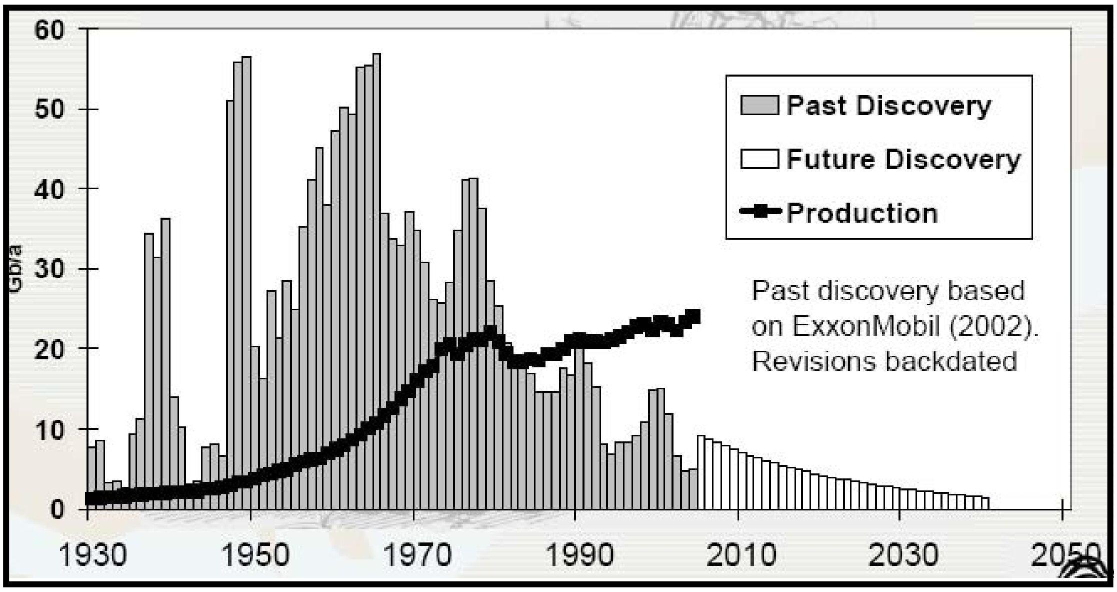


Figure 1: **Conventional Oil Discoveries and Production**

Source: Wakeford (2007)

This observation is shared by McNamara (2004:4), who reports global oil consumption to be at 28 Gb[1] per annum while global discoveries only equals 10 to 12 Gb per annum. Hirsch (in Wakeford, 2007:2) adds to the production/consumption debate by illustrating that thirty-three of the forty-eight major oil producing nations have already reached their individual production peaks. Other authors, such as Jackson (2006:2), argue that aboveground risks, such as war and political upheaval, will more likely cause a peak in oil production than any belowground factors. Such aboveground risks are well illustrated by the USA's occupation of Iraq and the UN Security Council's sanctions imposed against Iran due to its uranium enrichment program. Such occupation and sanctions could, in future, seriously affect global oil

[1] One Giga-barrel or Gb = 1 billion barrels of oil.The South African system of naming large numbers has been used in this thesis, according to which 1 milliard (1 000 000 000) equals 1 American billion.

production and consumption due to military and/or financial disruption of the local oil production facilities of two of the world's leading oil producing countries.

Global climate change

The Earth's average ambient temperature is increasing (Leggett, 1990; Lutgens & Tarbuck, 2004; Monbiot, 2006), with the twentieth century being significantly warmer than the preceding nine centuries (Lutgens & Tarbuck, 2004). Variation in temperature is normal given the Earth's natural cycle of cold ice ages and warmer interglacial periods, a cycle perpetuated primarily by variations in the Earth's orbital cycle[1] (Lutgens & Tarbuck, 2004). However, what is of major concern is how human actions are augmenting and/or disturbing the Earth's natural pattern of climate change.

Two types of climate change can be distinguished; namely: natural climate change and anthropocentric climate change (Lutgens & Tarbuck, 2004; Leggett, 1990). As stated previously, natural climate change is primarily a product of variations in the Earth's orbital cycle, but, one other factor also merits discussion. Volcanic eruptions are a major contributor of atmospheric carbon dioxide and sulphur dioxide (Lutgens & Tarbuck, 2004; Leggett, 1990). Carbon dioxide is a major greenhouse gas occurring naturally in the earth's atmosphere; it has the capacity to absorb infrared radiation emitted by the Earth and accordingly prevents temperatures from plummeting so low that most life on Earth will cease to exist. Volcanic activity however adds to existing atmospheric carbon dioxide, causing a very slight increase in ambient temperature. This natural temperature increase is however largely counteracted by suspended

[1] Known as Milankovitch cycles and refers to variations in; (a) the shape of Earth's orbit around the Sun, (b) changes in the angle that Earth's axis makes with the plane of Earth's orbit and (c) the wobbling of Earth's axis.

particles ejected by volcanic eruptions which cause an increased reflection of incoming solar radiation, and, the Earth's natural carbon cycle which sequesters carbon dioxide in the planet's biota, soil and oceans.

Anthropogenic climate change, on the other hand, is caused by burning fossil fuels which adds millions of tonnes of carbon dioxide and other greenhouse gases to the atmosphere. Monbiot (2006: 11) reports that manmade carbon emissions amount to an extra 22 milliard tonnes of carbon dioxide being added to the Earth's atmosphere per year. According to Leggett (1990: 25), the planet's carbon sinks sequesters enough carbon dioxide per year to allow for additional carbon emissions of approximately 4 milliard tonnes, which is crudely balanced by volcanic action. Even if one conceives of a year devoid of volcanic activity, humans are still producing 18 milliard tonnes of carbon dioxide in excess of the planet's sequestration capacity. As a result, global temperatures have risen by 0.6 degree Celsius over the past century (Monbiot, 2006: 5) and are expected to increase to between 1.4 and 5.8 degrees Celsius within this century (IPCC, 2001: 4).

The impacts of even a slight increase in global temperature are already staggering. Most of the world's glaciers are retreating, Alaska and Siberia's permafrost which remained frozen since the last ice age, is melting, while sections of the Amazonian rainforest is turning into savannah (Monbiot, 2006:6). The World Health Organisation reports that 150 000 humans per annum are dying due diseases spreading faster in higher temperatures. All these impacts happened with merely a 0.6 degree Celsius temperature increase (Monbiot, 2006: 6). Roaf, Fuentes and Thomas (2003: 7) sketch a bleak picture of future impacts in the event of a 3 degree Celsius increase in global temperature. Substantial risk of famine in Africa, the Middle East and India, sea level rise of 40 cm which increases the amount of people exposed to flooding from 13 million today to 94 million by 2080, and an estimated 290 million more people will be at risk from malaria by 2080 (Roaf et al, 2003:7); these are but a sample of the anticipated impacts.

The connection between anthropocentric climate change and transport is of major consequence. Combustion of fossil fuels in petrol and diesel engines accounts for approximately 50% of global greenhouse gas emissions (Whitelegg & Haq, 2003), with carbon dioxide making up 22% of this total (Hensher & Button, 2003: 52). This figure is however bound to increase, as global carbon dioxide emissions from road fright alone are expected to grow by 33% from 1990 to 2010 (Whitelegg & Haq, 2003). South Africa contributes 1.8% of total global greenhouse gases, making it one of the major greenhouse polluters in the world, especially for its level of development, (Trouble in the Air, 2005: 9), and, as stated earlier, the Western Cape Province's transport sector consumes 34% of the province's total energy consumption (Draft Western Cape Integrated Energy Strategy, 2007: 4-5). More particularly, Cape Town's transport sector devours a startling 57% of the cities total energy use per annum, resulting in approximately 24.5% of the city's total carbon dioxide emissions being generated by transport (City of Cape Town Sustainability Report, 2005: 9-10). Accordingly, Cape Town has a high carbon dioxide emission rate of 6.27 tonnes per capita, as opposed to the world average of 3.93 tonnes per capita (City of Cape Town Sustainability Report, 2005: 9-10).

Environmental degradation

When considering environmental degradation, it is instructive not take a narrow view of the environment as merely referring to natural or ecological components, but rather an extended view which includes the built environment and social and structural aspects, as the comprehensive impact of transport is best reflected in such an extended view. Transportation is regarded as the single greatest air polluting human activity on the face of the planet; contributing 22 % of the worlds CO_2 emission (Whitelegg & Haq, 2003: 16). Hääl, Hödrejärv and Rõuk, (2004: 1) reports that road traffic is a major contributor to soil and water pollution through heavy metals, while also causing reduced plant vitality and seriously disrupting animal communities (McGregor, Bender & Fahrig, 2008: 117). It is also instructive to investigate some of transport's indirect impacts. Ocean pollution due to tanker spillage amounts to approximately 13 litres of crude oil dumped in the ocean for every car on the road, while each car manufactured produces approximately 25 tonnes of waste (Whitelegg & Haq, 2003).

Transportation's resource consumption in terms of energy usage is staggering. Transport's current energy consumption accounts for 22% of global primary energy and 27% of global CO_2 emissions (De Ia Rue Du Can & Price, 2008: 1399), while Whitelegg and Haq (2003: 12) places transport's global CO_2 contribution at 22%. By 2020 transport's fuel demand is expected to account for 57% of total world oil consumption (Whitelegg & Haq, 2003). The Umwelt und Prognose Institut (UPI, 2008) predicts that car fuel consumption alone will increase from 650 million tonnes per year in the mid-1990, to 1.3 billion tonnes in 2030; constituting a GHG contribution of 10 billion tonnes of CO_2 equivalent[1].

Transport infrastructure is also a major consumer of space, with each manufactured vehicle requiring 200 m^2 of land allocation for operation and storage (Whitelegg & Haq, 2003). If current global car fleet growth is taken into account (currently 800 million wheeled vehicles and expected to double by 2050) we would require approximately 320 000 km^2 of open space just to accommodate vehicles by 2050; roughly the same surface area as the United Kingdom and Ireland combined (Gott, 2008: 2). In a recent study, a MIPS indicator (Material Input per Service Unit) was used to measure the lifecycle material requirements of roads and vehicles in Finland (Saari, Lettenmeier, Pusenius & Hakkarainen, 2007: 23). This study found that travelling with a car on a connecting road can consume up to 3.21kg of natural resources per person per kilometre travelled (See Figure 2) (Saari et al. 2007: 28).

Unfortunately, similar studies on a wider selection of countries are not available, but nonetheless, the Finland example provides an informative proxy for vehicular resource consumption.

[1] A measure that describes the global warming potential (GWP) for a given greenhouse gas, expressed as an equivalent amount of CO_2 that would have the same warming potential when measured over a specified timescale.

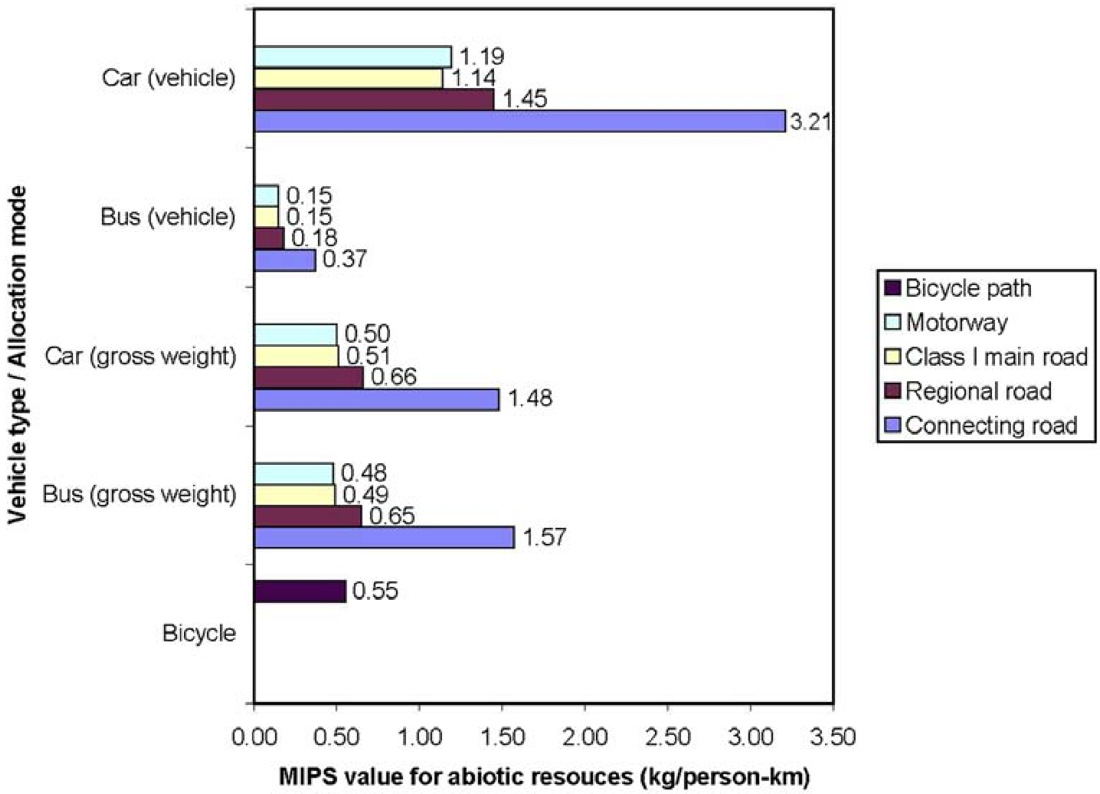


Figure 2: Kilograms of abiotic[1] resources consumed per vehicle type

Source: Saari *et al* (2007)

Social deprivation

The impact of traffic on the everyday lives of people appears to be multi-dimensional and contrasting, depending largely on one's level of income. These impacts falls within three broad categories pertaining to health, equity and community impacts, which together form a mosaic of the social landscape created and sustained by transportation systems.

Human health can be affected by transportation in various ways. Pacione (2005: 578) reports that road traffic accidents are the leading cause of death among adolescents globally, while Mohan (2008: 725) puts the global figure for road accident deaths at 800 000 to 1.2 million deaths per year. According to Whitelegg and Haq (2003: 23)

[1] Abiotic refers to non-living chemical and physical factors in the environment that underlie all biology, such as light, water, gases and soil (Wikipedia, 2008: abiotic)

research in Germany revealed that in a ten-year average life-span of a car, each car in Germany was responsible for 820 hours of lost life and 2 800 hours of handicapped life. The economic impact of such loss of life is significant, especially for developing nations. In 1998, road accident deaths already cost developing nations as much as the amounts of foreign aid it received (Heiberg: 1998). Furthermore, transport induced environmental pollution in terms of noise and air pollution causes severe human disturbance and morbidity. Traffic can produce 80-90% of air pollutants in busy urban areas resulting in 1.5 billion people worldwide being exposed to levels of air pollution exceeding the World Health Organisation's (WHO) recommended levels (Whitelegg & Haq, 2003). Transport is also regarded as the principle source of environmental noise on the face of the planet (Whitelegg & Haq, 2003), with noise levels in developing country cities reaching 75 to 80 dB[1] for 24 hours.

A striking feature of the above mentioned health impacts, is its unequal distribution in terms of socio-economic class and transportation mode. The existence of a steep social class gradient is illustrated by the fact that 85% of deaths and 90% of injuries due to road accidents are concentrated in middle to lower income groups, with cyclists and pedestrians bearing the brunt of injuries (Roberts; Mohan and Abbasi, 2002: 1107). In the United Kingdom, a child from the lowest socio-economic strata is six times more likely to be killed or injured by traffic than a child from the highest strata, while in Hong Kong 70% of road accident fatalities are pedestrians (Whitelegg & Haq, 2005: 22). This unequal distribution is mainly attributed to transportation planning catering almost exclusively for the needs of motorists; forcing poorer members of society, not able to afford a private vehicle, to compete for road-space

[1] The maximum noise level recommended by the World Health Organisation is 55dB over a 24 hour period.

with high-speed motorised transport (Woodstock; Banister; Edwards; Prentice and Roberts, 2007: 1080). Exposure to transport induced pollution is also higher among poorer sections of society, especially in lower-income cities, where slum dwellers and informal traders are forced to live and work next to busy roads (Woodstock et al, 2007: 1081). As a rule, the full health impacts generated by motorised transport are not bourn by motorists, but by the poorer section of society who utilises motorised transport the least.

Inequality also extends to accessing transportation benefits. Behrens and Wilkinson (in Harrison; Huchzermeyer and Mayekiso, 2003:157) indicate that South African commuter’s dependent on public transport modes encounter longer trip times and distances than motorists. Their study further indicates that lower income Black and Coloured commuters start their trips significantly earlier than higher income White commuters. This argument is supported by De Saint-Laurent (in Freeman & Jamet, 1998: 47) who illustrates that in the South African context there are three times more Black (32%) commuters than White (10%) commuters spending in excess of 1.5 hours per day commuting. Such longer trip times and distances are related to public transport modes travelling at slower speeds than cars, but also due to poorer community’s peripheral urban location (Harrison et al, 2003: 158). Peripheral housing is often located in areas with high transportation costs, resulting in communities spending up to 25% of their income on transportation in automobile dependent societies (Littman, 2008: 13). Put simply, poorer communities pay more in terms of time and money to access basic transportation benefits than richer communities.

Traffic furthermore has the potential to damage community life by reducing the liveability of neighbourhoods. Research by Appelyard (1981: 243) shows that social contact is reduced in heavily trafficked communities due to busy streets “severing” neighbourhoods. Such streets prevent easy and safe movement from one area to another and change the character of the street from a sociable, public domain, to an impersonal, noisy and dangerous automobile domain (Appelyard, 1981: 243). Whitelegg and Haq (2003: 19) warn that such isolation is not merely a passing sociological fact, but that it seriously degrades the urban fabric by reducing the attractiveness of urban living and in so doing contributes to economic decline, increased crime and marginalised people groups.

Why these impacts matter to South Africa

Oil peak, global climate change, environmental degradation and social deprivation constitute not only the three main impacts of transport, but also the key drivers for making transport more sustainable. Unfortunately, even in the face of these imminent threats, the state of transport planning with regard to sustainability in South Africa is appalling (Kruger, Dondo, Kane & Barbour, 2003: 34). A study conducted by Kruger et al (2003: 34); assessing the state of current practice in South African transport planning, decision making and assessment, made the following disturbing discoveries:

- *“There is a general lack of understanding of the linkages between transport planning and sustainable development. The lack of understanding is hindering the application of integrated planning. The lack of interest and understanding of sustainability issues may also hinder the implementation of an effective training and support programme aimed at improving practice of transport planning;*

- *Environmental concerns do not receive a high priority in the decision-making process;*
- *There exists a lack of communication and integration between the departments of transportation and environment affairs; and*
- *There is a recognized need amongst practitioners for the development of guidelines for integrated and sustainable transport planning."* (Kruger et al, 2003: 34)

This state of affairs lead Barbour and Kane (2003) to develop a checklist for measuring the sustainability of transport in the South African context, and was released as the Integrated and Sustainable Transport Checklist (ISTC) (See Appendix A). The ISTC was designed primarily as an awareness raising mechanism (Barbour & Kane, 2003: vi), to ensure that sustainable development principles was considered early in the planning phase of transport plans. Barbour and Kane (2003: 19) used the sustainable livelihoods principles as a theoretical base for the ISTC, while South African legislation acted to guide the questions asked by the checklist. These questions has simple "yes" or "no" answers which drew on easily accessible and available information, and aimed to add to the checklist's non-academic and pragmatic character (Barbour & Kane, 2003: 24). According to Barbour and Kane (2003) their ISTC promised not only to greatly impact transport planning in South Africa, but also created a unique opportunity to improve upon this "no-nonsense" approach to sustainability appraisal in the transport sector. According to the authors, such a pragmatic approach to appraisals is vital to sustainability in the transport sector; as transport planners and decision-makers rarely have the time to engage with complex and academic decision support systems. It is also likely that transportation decision-makers will revert to archaic and unsustainable appraisal mechanisms if they are confronted with decision support systems that requires a lot of time, data that is not easily obtainable and is of such complexity that only a select few can correctly use and interpret it.

Accordingly, the motivation for this study originates from a desire to change the negative transportation realities created by the abovementioned key impacts of transportation, namely: the pending oil peak; global climate change; environmental degradation and social deprivation. This study aspires to mitigate such negative realities by developing an uncomplicated and pragmatic sustainability appraisal mechanism to inform decision-makers on the state of transportation plans, with the aim of affecting positive change.

1.2 Purpose of this study

The purpose of this study was to develop a pragmatic ex ante[1] appraisal mechanism to assess the sustainability of transportation policies, programmes and plans; and is called the Scorecard for Sustainable Transport (SST). This appraisal mechanism is presented in the shape of a scorecard; aiming to facilitate a simple means of ensuring that sustainable development factors have been considered in planning; and is supplemented with benchmark sustainable transport practices to provide alternatives to existing unsustainable practices. The word “scorecard” is used, rather than “checklist”, as the appraisal mechanism combines qualitative aspects with quantitative awareness raising features. It should however be noted that the appraisal mechanism does not claim to be either an alternative for an in-depth decision making framework, or a rigorous assessment procedure, but rather aims to be an awareness raising

[1] Pre-implementation

instrument. An added benefit of the study was the creation of transdisciplinary knowledge, or new knowledge. Max-Neef (2005: 5; 10) identifies transdisciplinary knowledge not as an accumulation of knowledge (multi-disciplinary knowledge), but as an integration of knowledge of different disciplines in a non-linear and complex fashion to produce new ways of knowing and understanding the world. Determining whether transdisciplinary knowledge was created is obviously difficult to determine, but the measure of the scorecard's success or failure is taken to be an indication of the existence such new knowledge.

In order to test the appraisal mechanism's operability, it was applied to analysing Cape Town's Integrated Transport Plan (ITP). The purpose of the test case was to see whether the appraisal mechanism designed in this study, was practically operable in the field of transportation planning.

1.3 Research methodology

This study is descriptive in nature and is based primarily on an extensive literature review. Where necessary, unstructured interviews were conducted with specialists in the field of urban planning and engineering to compliment the literature review and broaden the author's understanding of applicable resources and insight into the research problem. These methods are discussed in more detail below.

1.3.1 Literature review

Hart (1998: 13) defines a literature review as; *"The selection of available documents (both published and unpublished) on the topic, which contain information, ideas, data, and evidence written from a particular standpoint to fulfil certain aims or* *express certain views on the nature of the topic and how it is to be investigated, and the effective evaluation of these documents in relation to the research being proposed.”*. Accordingly, documented sources were selected to ensure appropriate breadth and depth, rigour and comprehensiveness. Resulting from the diverse nature of the research topic, a multi-disciplinary approach was applied to source selection, including documents from the following disciplines and fields;

- sustainable development theory
- existing sustainable transport strategies
- renewable energy technologies
- urban planning
- sustainability modelling and indicator construction, and
- governmental policy documents and reports

In keeping with Hart’s (1998:13) definition of a literature review, all documents were evaluated “*in relation to the research being proposed*”. The type of research employed in this study can best be described as applied research, as it endeavours to answer a specific and practical question (Hart, 1998: 46; Muller, 2005: 1). As a result, documents were evaluated using “how”, “what” and “when” questions (Hart, 1998: 46; Muller, 2005: 1). According to Mouton (2001: 179), literature reviews are useful to analyse trends and debates; providing the researcher with a good understanding of the definitions, theoretical thinking and issues of a specific study area.

Literature reviews do however present certain limitations. Literature reviews cannot validate or produce new empirical research and, at best, can only summarise existing scholarship (Mouton, 2001: 180). Further sources of error when conducting a literature review is pointed out by Mouton (2001: 180), who warns against treating authors unfairly and selective interpretation of texts to suit the researcher own point of view. Other common mistakes include poor integration of the literature review and misunderstanding of sources covered in the review (Mouton, 2001: 180).

1.3.2 Interviews

The interviews conducted for the purposes of this study flowed from the notion that an interview constitute an open-ended conversation between the researcher and participant and is not in need of *"massive amounts of detailed technical (and moral) instruction on how to conduct qualitative interviews."*, as is the view of Rapley (in Seale, Gobo, Gubrium & Silverman, 2007: 16). Accordingly, unstructured interviews were conducted with interviewees with an aim to gain in-depth knowledge of the research topic (as stated in section 1.2), rather than interviews with a high level of structure and control. Punch (2005: 170) indicates that unstructured interviews has no pre-planned and standardized questions, but rather general questions to initiate the interview and maintain momentum, while specific questions will emerge as the interview unfolds.

Four interviews were conducted for the purposes of this study. The aim of all the interviews was to broaden the author's understanding of transport planning and appraisal, as well as gaining insight into Cape Town's Draft integrated Transport Plan (ITP) 2006-2011. The following is a list of the interviewees and the topics discussed:

- Mr Gershwin Fortune (Senior Transport Planner at the City of Cape Town): The aims and objectives of Cape Town's ITP and how the municipality intends to implement it.

- Mrs Nicky Covery (Sustainable Transport Specialist at the City of Cape Town): The appraisal mechanism planned for the ITP and how it was developed.
- Mr Theuns Kok (Senior Spatial Planning and Urban Design Officer at the City of Cape Town): How the ITP aims to function in practice, it limitations and strengths, and
- Prof. Roger Behrens (Senior Lecturer, Department of Civil Engineering at the University of Cape Town): Differences between appraisal and evaluation in transport planning and the United Kingdom’s New Approach to Appraisal (NATA).

Interaction during interviews was guided by the ideals of rapport and neutrality. Rapport can be defined as establishing a relaxed and encouraging relationship with the interviewee to ensure comfortable and easy communication (Seale et al, 2007: 19), while neutrality refers to the interviewer not being unduly bias in order not to contaminate data gained from the interview (Ackroyd & Hughes, 1992). It should be noted that rapport and neutrality are ideals; the realisation of these ideals can only be strived towards. Limitations inherent in failure to realise these ideals are noted by the researcher and due diligence was taken to minimize data contamination.

1.4 Scope of this study

The study focuses exclusively on land-based transport and does not include air and water transport in its review of sustainable transport practices, nor in the design of the appraisal scorecard. The appraisal scorecard furthermore aims to measure the sustainability of passenger transport, not freight transport; and is directed at the urban rather than the rural environment. These exclusions are based both on the complexity of effectively combining all modes of transport in an appraisal methodology and the time requirement of such a study.

1.5 Structure of this study

This thesis consists of six chapters. **Chapter 1** introduces and outlines the motivation and purpose of this study, the research methodologies employed and the scope of the study; while also describing the structure of the thesis. **Chapter 2** commences with a review of theoretical perspective on sustainable development, in order to shed light on this often ambiguous topic, and also indicates the theoretical approach employed throughout this study. The chapter concludes with a discussion of the concept of sustainable transport. **Chapter 3** identifies the principles which underlie a sustainable transport system and briefly discusses each principle. **Chapter 4** presents the findings of a literature review conducted with the aim to identify benchmark sustainable transport practices which can be utilised as alternatives to traditional unsustainable practices. **Chapter 5** describes the aims and objectives of the appraisal scorecard, as well as its design and interpretation; while **Chapter 6** provides background on the transport realities of Cape Town, giving insight into city form, socio-spatial and socio-economic transport inequality. This chapter also introduces the ITP, providing background information on the plan, as well as its aims and objectives. In **Chapter 7** the appraisal scorecard is applied to the proposed ITP; and the conclusions and recommendations of the thesis are drawn in **Chapter 8**. This is followed by the **References** section and **Appendices**.

1.6 Diagrammatic representation of the study

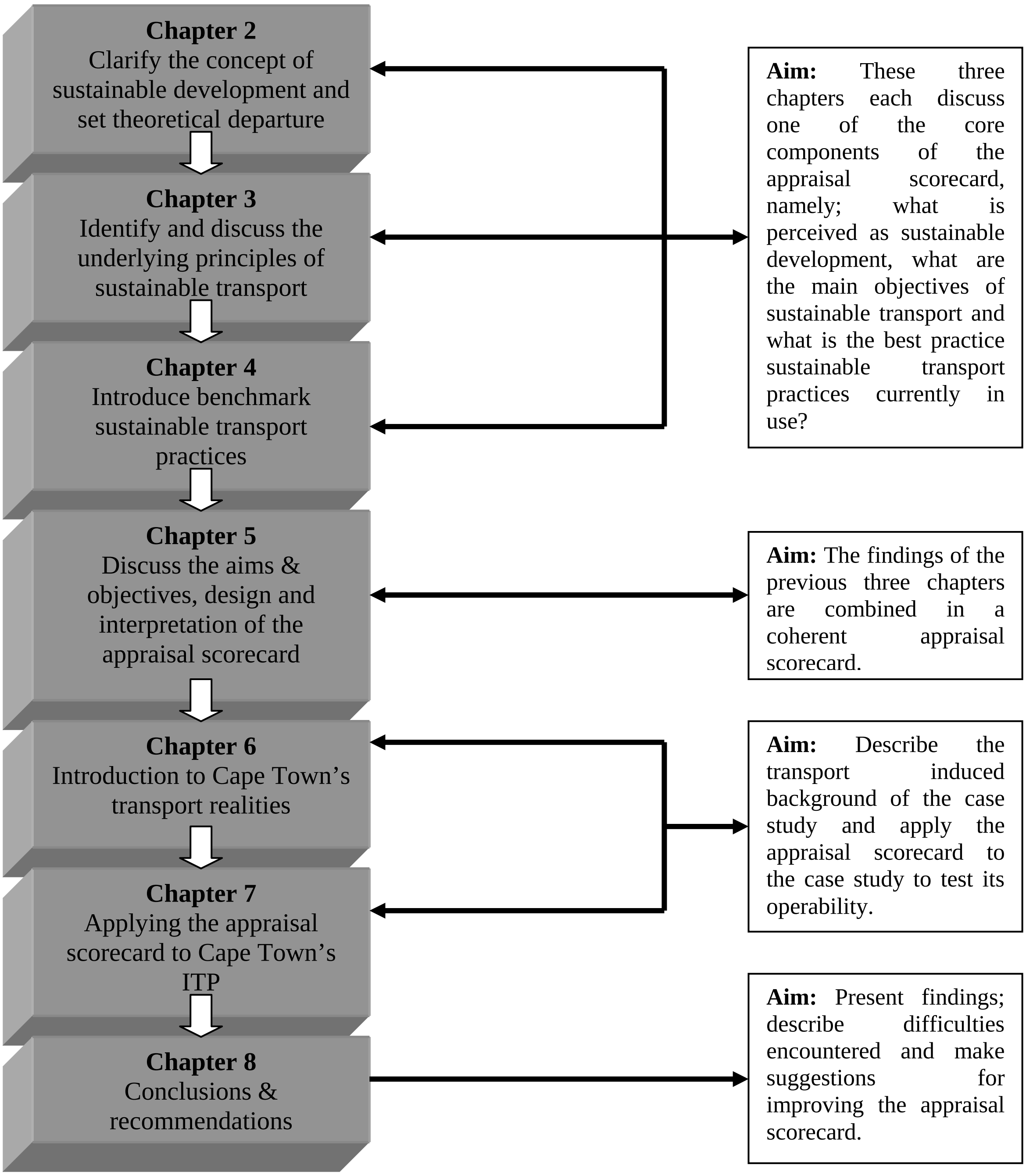


Figure 3: Diagrammatic representation of the study

Source: Drafted by author

CHAPTER 2

THEORETICAL PERSPECTIVES ON SUSTAINABLE DEVELOPMENT AND RATIONAL PLANNING THEORY

2.1 Introduction

Reference to sustainable transport would hardly carry any meaning if the underlying values and theories of the concept of sustainable development are not first investigated. Furthermore, as the aim of this study is the design of an evaluative scorecard; the relation of evaluative tools to rational planning theory must also be considered in order to identify this theory's assumptions, strengths and weaknesses. Exploring the theoretical grounding of sustainable development and rational planning is central to the success of this study. A proper theoretical understanding provides this study with a normative landmark to steer towards, while also creating an awareness of possible limitations inherent to the subject matter and the selected theory. With this aim in mind, the chapter will commence with a discussion of the theory of sustainable development, followed by a concise investigation of rational planning theory. In conclusion, the theoretical approach applied throughout this study will be illustrated.

2.2 The theory of sustainable development

The theory of sustainable development[1] is fraught with contradictions and apparent impasses, causing it to be best understood when viewed from different perspectives. General consensus on the definition of sustainable development appears to be that no explicit definition currently exists. This open-ended nature may well prove useful in generating creativity within the field of sustainable development, but a measure of caution is called for. In this regard, Hattingh (2001: 2) warns that sustainability and sustainable development are often viewed as "empty concepts" which are too vague and ill defined to be of any practical use. However, rather than defining sustainable development, the literature aims to clarify what it is *not* (Mebratu, 1998; Dresner, 2002; Elliot, 1999; Gallopin, 2003). Dresner (2002:64) argues that agreement about the precise meaning of sustainable development is not found in consensus regarding its definition, but rather agreement about the values that underlie sustainable development. Hattingh (2001:8) identifies these values as; inter-generational justice[2], intra-generational justice[3] and environmental protection and respect for life[4].

Traditionally, these values are divided into economic, social and environmental spheres or pillars (See Figure 4). This traditional model of sustainable development is based on the famous definition of sustainable development as development that: *"meets the needs of the present without compromising the ability of future generations to meet their own needs."* (UN Conference on Environment &

[1] Sustainable development and sustainability is used interchangeably in this study. This study does however take note of the fact that sustainable development and sustainability can have different meanings.

[2] Inter-generational justice is defined as not compromising future generations' ability to meet their needs.

[3] Intra-generational justice refers to concern for the poor by ensuring a more equitable distribution of resources and participatory decision making concerning such distribution.

[4] Environmental protection & respect for live is conceptualised as valuing nature not in terms of its human utility, but because it possesses intrinsic value.

Development, 1992) and coined by the Brundtland Commission in the "Our Common Future" report on the Rio Earth Summit of 1992.

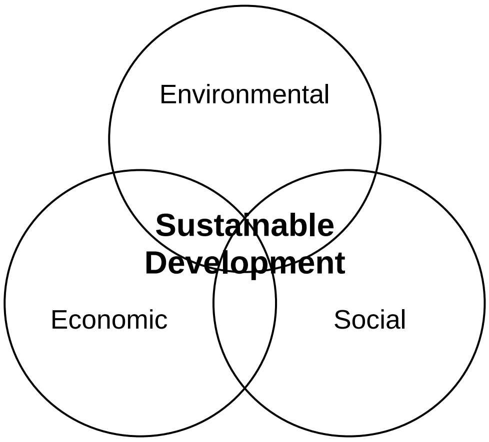


Figure 4: Traditional sustainable development model
Source: Adapted from Swilling (2006a)

This model, though useful as a conceptual tool, may be misleading. Swilling (2006a) warns that this traditional model of sustainable development creates the impression that a balance can always be struck between the different spheres, while in practice this may be impossible. This is due mainly to two factors; firstly, the three spheres of sustainable development are potentially competing notions which leaves little room for balance (Gibson, Hasan, Holtz, Tansey & Whiteman, 2005: 56), and secondly, any form of development always happens at the expense of the environment, as development requires natural resources, and hence the environment cannot be one of the spheres of sustainable development, but rather the sphere on which sustainable development is dependent. This gave rise to an alternative view of sustainable development; the so-called "nested model" (See Figure 5) (Gibson et al, 2005: 56).

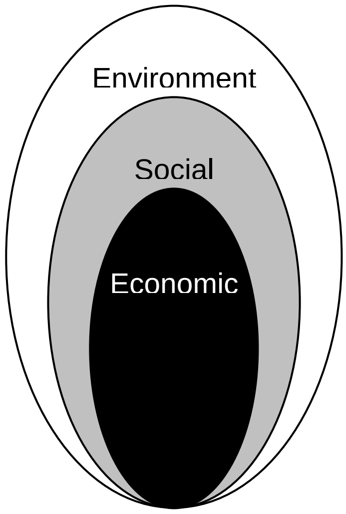


Figure 5: The "nested model" of sustainable development
Source: Gilbert *et al* (2005)

This perspective places the traditional overlapping spheres inside of each other, with the ecological sphere being the largest, the social sphere the second largest and the economic sphere nested within the social sphere. Or stated differently, the economy is immersed in society and society is immersed in the ecology. The value of this model lies in its communication of limits and non-negotiable thresholds which is conspicuously absent from the traditional model of sustainable development (Swilling, 2006a). The implication of the "nested model" is simply that if actions in a smaller sphere undermine a larger sphere, it is in fact eroding its own basis of existence (Gibson et al, 2005: 56). The "nested model" however encounters the impasse of human interference and manipulation of various biophysical systems, which calls into question the simplistic dependence of one sphere upon another (Gibson et al, 2005: 56). A more pragmatic critique of the "nested model" springs from its inherent lack of universality and built-in bias towards developed nations. Developing countries can hardly be expected to subscribe to a notion of sustainable development which dictates that industrialisation may not be pursued due to limited natural resources, when industrialised nation already consumed the bulk of available natural resources to reach their developed state (Goodland & Daly, 1996: 1004).

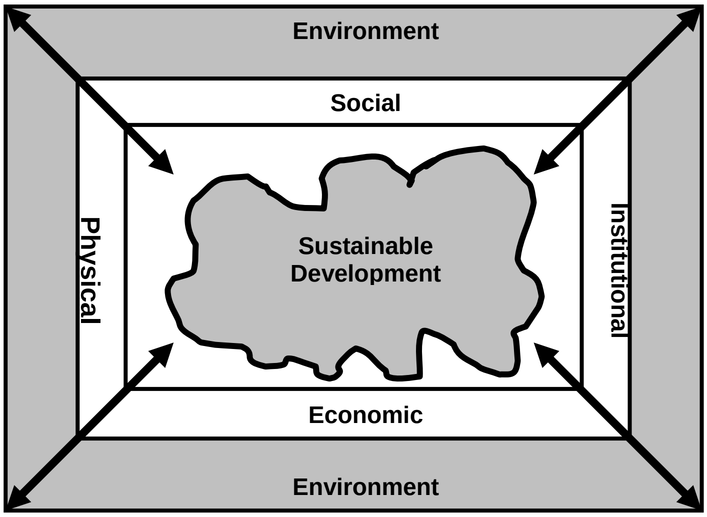


Figure 6: The flexible, multi-domain model of sustainable development
Source: Adapted from Allen & You (2002) and Muller (2007)

Allen & You (2002) and Muller (2007), address this shortcoming by categorizing the environmental, social and economic spheres into five interdependent domains, identified as; social, economic, environmental, institutional and physical (including the techno-structure and build environment) (See Figure 6). In this model, sustainable development is able to assume different meanings, as the various domains surrounding it expand and contract, while still bounded by the physical limitations of the ecosystem. While not being perfect, this flexible multi-domain model represents a more realistic view of sustainable development, especially in terms of a systems approach to the complexity of sustainability. Clayton and Ratcliff (1996: 13), in their discussion of sustainability and the systems theory, illustrates the value of a flexible multi-domain approach by indicating that: *"[t]he size and complexity of the earth system indicates that there could be , at any one time, a very large number of potential development paths and possible outcomes…there could be a number of states that are sustainable in varying degrees, there may be a number of ways to reach such states, and that there will therefore be more than one possible policy for transition to a more sustainable way of life."*

Regardless of the model one utilises to conceptualise sustainable development; the values underlying it remains unchanged; namely: inter-generational justice, intra-generational justice and environmental protection and respect for live (Hattingh, 2001:8). The integration of these values as a means of informing development is central to most concepts of sustainable development, while grossly sacrificing or discounting one or more of these values are viewed as expressly unsustainable development (Mebratu, 1998; Dresner, 2002; Elliot, 1999). Accordingly, the question problematising sustainable development is how much emphasis each value should receive, how to integrate these values and how critical trade-offs should be made between them.

Gallopin (2003: 13) indicates that the ethical departures used to conceptualise the underlying values of sustainable development may help to answer these questions. It should be noted, that "ethical departure" here refers to a normative decision regarding the state of natural entities as having intrinsic value and thus being worthy of sustaining or not sustaining.

According to Gallopin (2003: 13) the ethical conceptualisation of development can be broadly categorised as either anthropocentric or eco-centric[1]. The anthropocentric approach to development regards human needs as paramount and values the environment only in terms of the natural resources and services it provides to humans. Natural capital is perceived to be completely substitutable by manufactured capital, thus placing socio-economic values above environmental values. Rees (in

[1] Other ethical departures includes; pathocentric, zoocentric and biocentric. However, for the purposes of this study, only the anthropocentric and ecocentric departures will be discussed.

Satterthwaite, 1999: 28-30) regards the anthropocentric approach to sustainable development as consistent with the expansionist paradigm, which considers market related price as the only trustworthy indicator of scarcity. According to this paradigm, higher prices will lead to the conservation of scarce resources and the search and creation of alternatives via technological expansion.

Imbedded in this assumption is the conviction that the economy is a self-generating circular system free from environmental constraints (Rees in Satterthwaite, 1999: 28, Wackernagel & Rees, 1996: 42). Development as perceived from the anthropocentric approach can be defined as sustainable growth[1] in terms of economic throughput, activity and size of the economy (Goodland & Daly: 1996: 1004; Munasinghe *et al.*, 2001: 23; Satterthwaite, 1999: 28-29).

The eco-centric approach to development rejects the notion that humans are the ultimate measure of value and holds that the human race lives in an interdependent relationship with all life forms on earth (Marcy & Young-Brown, 2002: 45-46; Gallopin, 2003: 14). Attaching a price to the environment is completely rejected, as is the notion of the substitutability of natural capital with anything else. Value of natural capital is regarded as intrinsic and spiritual and not determined by the value humans ascribe to it due to its utility value. Development from the eco-centric perspective constitutes ecological sustainability, even if such sustainability excludes the development needs of humans, and argues that human development happens at the expense of nature (Gallopin, 2003: 15; Mebratu, 1998: 506). Gallopin (2003: 15-16)

[1] It is important to distinguish between "growth" and "development" as these terms are often wrongly used as synonyms. "Growth", grammatically related to the concept increase, refers to increases in the size of the economy or increased throughput rate, while "development" is grammatically related to the concept of improvement and essentially refers to improving the quality of life.

places these two ethical approaches on a sustainability continuum with the eco-centric approach to development representing “very strong” sustainability and the anthropocentric approach being “very weak” sustainability. Swilling (2006a) conceives such a sustainability continuum as consisting of a larger matrix of five continuums, which would differ according to the realities and development agendas of different parties (See Figure 7). This matrix divides sustainable development into the following categories: Firstly, the anthropocentric or ecocentric tendencies of a specific development are determined by classifying it as either “weak” or “strong” sustainability respectively. The next category identifies the level of equality present in a given development and is expressed as “non-egalitarian”, if focus is placed on the living standards of the rich and middle-class, or “egalitarian”, if the development focuses on the living standards of the poor. How much participation a given development allows and how power is distributed is measured as either “top-down” development, which views participation as a means to an end, or “participatory” development, which accepts participation as an end in itself. The breadth of a development’s focus is determined in the second last category. If a development tends to focus exclusively on environmental protection, it is described as “narrow”, whereas a focus on social, economic and environmental issues places a development on the “broad” side of the matrix. Finally, the life-value perception of a development is identified. If a development is biased towards the sacredness of human life, it is viewed as “shallow”, while viewing all life as sacred affords the development “deep” status.

Weak sustainable development: Nature's value is determined by human utility	↔	**Strong sustainable development:** Nature has intrinsic value
Non-egalitarian sustainable development: Maintenance of Rich to middle-class living standards	↔	**Egalitarian sustainable development:** Focus on the living standards of the poor
Top-down sustainable development: Participation only useful for strategic purposes	↔	**Participatory sustainable development:** Participation has intrinsic value
Narrow sustainable development: Environmental protection is the dominant aim of sustainable development	↔	**Broad sustainable development:** Environmental protection is only one of many goals of sustainable development
Shallow sustainable development: Human life is sacred	↔	**Deep sustainable development:** All life is sacred

Figure 7: Sustainable development matrix
Source: Adapted from Swilling (2006a)

The development paradigm of developed countries favours the left-hand side of the matrix, while the development agenda of developing countries tend to be skewed towards the right-hand side of the matrix (Swilling, 2006 a). The matrix unpacks most of the implicit values inherent to any ethical departure within sustainable development and clearly illustrates how sustainable development can mean different things to different people. Essentially, one is however still left with a very complex decision between purely anthropocentric-or-ecocentric ethical approaches to sustainable development.

Mebratu (1998: 507) deconstructs this complexity by describing the moderate position on this continuum or matrix as ecologically oriented social development which seeks the sustainability of the whole socio-ecological system. This moderate position should be both consistent with strong sustainability, which states that any reduction in natural capital due to development fails to be sustainable even if other types of capital increase, and with weak sustainability which holds that essential natural capital should be protected, but manufactured capital of equal value can act as an acceptable substitute (Mebratu, 1998: 507; Gallopin, 2003: 15-16).

Such a moderate approach to development is consistent with the so-called "steady-state" paradigm. Rees (as cited in Satterthwaite, 1999: 31) defines the rational of the "steady-state" paradigm as being imbedded in the notion of an economy which exists in a quasi-parasitic relationship with the ecosystem. The economy is viewed as dependant on natural systems to provide the energy and resources to be transformed into useful goods and services, but such transformation subjects natural resources to the second law of thermodynamics (Satterthwaite, 1999:31- 32, Munasinghe *et al*., 2001: 30 & Wackernagel & Rees, 1996: 41). Subject to this law, every material or energy transformation causes an increase in net entropy, thus permanently degrading resources and causing pollution. The economy can therefore not be seen as an isolated circular flow of money, but rather as a unidirectional subsystem utilizing useful energy and material from the ecosphere and returning such energy and material to the ecosphere in a degraded form (Wackernagel & Rees, 1996: 43-44).

As such, the market cannot be trusted to accurately reflect scarcity and value, as it is blind to the ecological life support services that it is using and abusing (Wackernagel & Rees, 2001: 42 & Satterthwaite, 1999: 32). Accordingly, the "steady-state" paradigm maintains that not all forms of natural capital can be substituted and that when the economy reaches maximum sustainability levels, rates of energy and material throughput must be held constant. The "steady-state" paradigm thus defines development as expansion with limits.

Pathways suggested in achieving expansion with limits aims to reduce the ratio of resource use per unit of gross domestic product (GDP). Strategies to attain this goal includes; balancing increased throughput growth in the South by negative throughput growth in the North, reduction of the energy and material contents of goods and services and increased government intervention via policy controls (Goodland & Daly, 1996: 1004 & Satterthwaite, 1999: 39-41).

2.3 Rational planning theory

The design of evaluative models, such as a scorecard, appears to be rooted in the tradition of rational planning theory. Lawrence (2000: 610) for example, argues that the environmental impact assessment (EIA) planning process generally parallels rational planning theory, while Taylor (1998: 68) indicates that evaluative techniques such as cost-benefit analysis (CBA) developed within rational planning theory as a decision support technique. The very action of assigning perceived value-free evaluative power to a decision support tool clearly illustrates the rational method and history of evaluation models (Tribe, 1972: 75). As such, a concise discussion of rational planning theory is merited.

Western thinking is built upon the cornerstone of rationality; a product of the Greeks identifying rationality as the supreme human characteristic (Lawrence, 2000:608; Faludi & Van der Valk, 2001: 272). Knowledge is perceived as power and provides an alternative to blind faith in what Popper (1963: 297) calls "*the demonic powers beyond ourselves*". Accordingly, rationality permeated western society in various forms for centuries. However, rationality as a planning theory only emerged in the 1960's in the shape of rational comprehensive planning, also known as blueprint planning (Taylor, 1998: 60; Lawrence, 2000: 608). Rationality, as used in planning, is defined by Faludi (1973a: 36), as the standards society appeals to when attempting to give reasons for deciding upon a given course of action or, a decision process which aims to identify the best action in a given situation (Faludi as cited in Paris, 1982: 5). Thomas (in Paris, 1982: 5) indicates that such rationality must give society the means to take control of their environment and direct it on a chosen path of development; as such, it falls within the positivist tradition seeking technical control over one's environment. The belief that rationality in planning could achieve 'control' over the environment illustrates the modernist origins of rational planning theory, based on the fundamental belief that science could improve the quality of human life by providing us with control over nature (Taylor, 1998: 47).

Control over any subject matter can be divided in at least two focus areas, namely: how control is to be exercised, and understanding the subject well enough to exercise control over it. The latter belongs to the systems theory of planning (which falls beyond the scope of this study), while the former is the domain of rationality (Taylor, 1998: 73-74). In this regard, Faludi (1973b: 116) remarks that: "*It is only as a* *normative model that the rational planning process has any meaning at all.*" Rational planning theory can thus be seen as a normative theory concerned more with "how" planning should ideally be done, than with "what" the specific plan is for (Faludi, 1973a: 3; Taylor, 1998: 66). Faludi (1973a: 3) illustrates this normative stance by differentiating between *procedural* and *substantive* planning theory, with procedural theory describing the process *of planning* and substantive theory focussing on the *object of* the plan.

Such separation of the planning process from the object of planning, endows rational planning theory with some of its most positive attributes. Lawrence (2000: 610) argues that rational planning theory adds logic, consistency and simplicity to planning models, providing decision-makers with clear justification for decisions. Faludi (1973b: 120) also points out that rationality in decision-making provides a place for science and objectivity to prevail over the fickleness of human emotion. Ironically, it is also rational planning theory's severance from the object of planning which attracts its greatest criticism. Flyvbjerg (1998: 228) questions the objectivity of rational planning, indicating that power relations within the planning subject often acts to corrupt rationality in decision-making. Yiftachel (2001: 254) agrees with Flyvbjerg on the fact that, in planning, the powerful often 'rationalise' rationality to protect their interests. Rational planning's lack of contact with the environment in which it is applied is highlighted by Alexander (2001:312) and Lindblom (as cited in Faludi, 1973b: 158), who questions the role and place of values and communication in rational decision-making. In this regard, it is argued that rational means-ends decisions can only be reached if values are agreed upon and reconcilable. In reality, such consensus rarely exists, calling into question rational planning's applicability in practice. The work of Chadwick (1971: 120) on goal formulation in planning, demonstrates the view that planners could be technically more competent than members of the public in determining the goals, and therefore, the underlying values of planning. His contention that: "*…one of the most forceful arguments for placing primary responsibility for goal formulation on the planner…[is] the assumption, traditional to professionals, that , in some way, they 'know more' about the situations on which they advise than do their clients.*" (Chadwick, 1971: 120-121) clearly illustrates the danger of 'rationalising' the planner's values as more professional and valid than the possibly conflicting values of local communities. Finally, rational planning is criticised for two very practical reasons. Firstly, Lindblom (as cited in Faludi, 1973b: 160) correctly asserts that the ideal comprehensiveness in rational decision-making could never be achieved, even though such comprehensiveness is assumed in rationality. Secondly, the practicality or actual implementation of rational planning is strongly criticised, due to the fact that the rational planning process tends to view planning and implementation as two separate activities (Friedmann, 1969: 311).

2.4 Theoretical perspective informing this study

The theoretical perspective employed throughout this study consists of; (a) a structural view of sustainable development as consisting of five interdependent domains (Allen & You, 2002; Muller, 2007), (b) the steady-state paradigm as an ethical departure (Satterthwaite, 1999: 31), and (c) a moderate position on the sustainability matrix to identify desirable objectives to be met in terms of transport. From a planning theory perspective; this study takes cognisance of the inherent weaknesses of rational planning theory, but chooses to employ it as a guiding theory. This is done because rational planning theory appears to be the most applicable choice to meet the studies aims of simplifying complex information in a logical manner, in order to produce an evaluative scorecard.

2.5 Summary

No consensus exists on the precise meaning of sustainable development and notions on its definition will largely depend on each individual country and/or social group's developmental needs. As such, the ethical departure used to construct an explanation of sustainable development has a strong bearing on its definition. In this regard, anthropocentric or ecocentric ethical departures will skew definitions towards weak and strong sustainability respectively. An intermediate position between these two extremes is the so-called "steady-state" paradigm; and is also the theoretical departure of sustainable development employed in this study. The notion of what sustainability means in terms of transport now needs to be established. This investigation is conducted in the next chapter.

CHAPTER 3

SUSTAINABLE TRANSPORT PRINCIPLES

3.1 Introduction

Sustainable transport, much like the concept of sustainable development, presents considerable difficulty in defining. A plethora of definitions for sustainable transport exists. Arguably, the most comprehensive definition is that of the European Council of Ministers of Transport (Transportation Research Board, 2008: 4), which states that a sustainable transport system comprises of the following:

- *"Allows the basic access and development needs of individuals, companies and society to be met safely and in a manner consistent with human and ecosystem health, and promotes equity within and between successive generations.*
- *Is affordable, operates fairly and efficiently, offers a choice of transport mode and supports a competitive economy, as well as balanced regional development*
- *Limits emissions and waste within the planet's ability to absorb them, uses renewable resources at or below their rates of generation, and uses non-renewable resources at or below the rates of development of renewable substitutes, while minimizing the impact on the use of land and the generation of noise*."

However, in keeping with Dresner (2002: 64), it proves to be of most value to identify the underlying principles of sustainable transport rather than attempting to define its specific meaning, especially if one considers that such a definition will depend on the unique location and goals of each sustainable transport strategy. Investigation of pertinent literature in the field of sustainable transport reveals the presence of distinguishable and recurrent building blocks or themes which authors regard as fundamental to the success of sustainable transport. These themes can be condensed and summarized into seven guiding principles for sustainable transport. These principles are; universal access, social equity, ecological limits, health and safety, public participation, affordability and institutional capacity, and a broad overview are given in this chapter. Table 2 below indicates how each transport principles relates to the broader notion of sustainable development by linking each principle to both the relevant domain of sustainable development and the sustainability matrix mentioned in Chapter 2.

Table 2: Linking sustainable transport principles with the notion of sustainable development

Sustainable Transport Principle	Domains of Sustainable Development	Sustainability Matrix
Universal Access	**Build Environment & Social**	**Egalitarian:** Catering for the transport needs of both rich and poor.
Social Equity	**Social**	**Egalitarian:** Transport should reflect the needs of the marginalised. **Broad:** Focus not only on transport but the welfare of the marginalised.
Ecological Limits	**Environmental & Physical**	**Strong:** Sets explicit ecological limits. **Egalitarian:** Levels the playing field between rich and poor.
Safety & Security	**Social & Economic**	**Egalitarian:** Transport externalities should not be distributed unequally. **Broad:** Focus not only on transport but on the health, safety and liveability of individuals and neighbourhoods.
Public participation	**Social & Institutional**	**Participatory:** Participation in transport planning at grassroots level. **Broad:** Focus on empowering communities and not just improving transport.
Affordability	**Economic & Social**	**Egalitarian:** Transport must be affordable to all and one should pay according to ones income and generation of pollution.
Institutional Capacity	**Institutional**	**Broad:** Development of capacity and partnerships is fostered. **Participatory:** Grassroots participation required

Source: Drafted by author, based on matrix of Swilling (2006a)

3.2 Universal Access

Central to the sustainable transport debate is the concept of accessibility. Access is the ultimate goal of almost all transport trips, and, as a result, is the main motivator for trip generation and distance (Munier, 2007: 356). Littman (VTPI, 2008) defines access as the measure of ease with which destinations can be reached, while Vasconcellos (2001: 53) views access as a high measure of flexibility in selecting mode of transport to respective destinations. Straatemeier (2008: 129) conceives accessibility simply as the potential for interaction. Accordingly, access can be understood as an attribute of a given good, activity, service or product and may either be poor (inconveniently placed or unreachable) or good (conveniently placed). Access is often confused with mobility; which merely refers to the ability to move and which is largely a product of income and physical health (Munier, 2007: 356; Vasconcellos, 2001: 53). Unfortunately, current transport planning tends to favour mobility as a measure for modelling transport efficiency and planning (Straatemeier, 2008: 127; Munier, 2007: 357), resulting in an urban spatial arrangement that benefits middle to high income, healthy citizens at the expense of the poor and disabled by perpetuating the use of private automobiles and encouraging urban sprawl (VTPI, 2008; Munier, 2007: 357; Herala, 2003: 92; Vasconcellos, 2001: 53). Non-motorised transport modes become unviable in such urban areas, as travel distances becomes too far and actual travel condition deteriorates to dangerous levels. As cheap and unoccupied land is frequently located on the urban periphery, most poor communities will also locate in such areas (Department of Transport, 1998:63). This factor, combined with a sprawling automobile-oriented city, effectively cuts-off poor communities' ability to access economic opportunities and services spread throughout the city. Even in cities well endowed with public transport; sprawl induces journeys which are exorbitant to the poor in terms of time and cost. Ironically, middle-and-high income groups suffer the same fate. In this regard, Newman and Kenworthy (1991) indicates that private cars are the fastest land-based transport mode and thus the most popular, which in turn causes increased levels of traffic congestion and energy use as evermore cars fill created road space. Accordingly, its is clear that transport planning needs to be informed by a principle that integrates transport and land-use planning (Curtis, 2008: 105); aiming to " *focus on the desired connectivity of places and improvements in the quality of life, rather than focusing on predicting future congestion levels*" (Straatemeier, 2008: 128) Littman (in Munier, 2007: 356) conceives access as being influenced by four factors:

1. *Transport mode option,* including walking, cycling, public transport, cars, trucks, taxi's and other modes

2. *Mobility substitutes*, such as telecommunications and delivery technologies and services

3. *Land use*, referring to the spatial distribution of activities and destinations

4. *Connectivity of transport systems*, that is, the density of connection in a road network and the directness of road links

Drawing on the abovementioned information, access as a sustainable transport principle can be defined as follows: *A process of maintaining and encouraging the viability of diverse transportation options, while keeping destinations within easy reach of transport users and promoting access rather than mere mobility.*

3.3 Social Equity

Transport systems, much like any other service provided to people, tend to reflect the needs and wants of the majority of its client base. The vast majority of vehicles on our roads today are private cars, the vehicle of choice of the middle-and-high socio-economic strata. The middle-class also represents the bulk of global taxpayers, hence exerting strong influence on public decision making in terms of transport planning. As a result, the majority of global transport systems serve the needs of a privileged few. A possible exception to this rule, in the South African context, is mini-bus taxis. However, mini-bus taxis' high tariffs and low passenger comfort (on average 16 people per 9 seats) (De Saint-Laurent, 1998: 47), as well as the fact that taxis seldom service low demand routes, should be taken into consideration (Shaw, 1998: 102).

Unfortunately, transport systems not only discriminate against the poor, but inadvertently targets specific groups within society at large. Gender-based discrimination within transport are well documented, (see: Torrance, 1992; The World Bank, 2002; Hine & Grieco, 2003; Casas, 2007) and contributes to transport inequality in various ways. Woman's differentiated transport needs, due to their "double burden" of running a household and family and holding a regular job, places them at a disadvantage in terms of the need to access spatially distant locations, requiring transport in off-peak times and facing long travel times (Todes in Harrison et al, 2003: 112). Historically, fewer women hold drivers licences than men, and, single parent, women headed household earn less than single parent, male headed households, thus leaving women with less disposable income available for travel (Oelofse in Harrison et al, 2003: 100). Women also typically report higher levels of fear of crime in public spaces and in using public transport services, especially at off-peak times when interchanges and vehicles are deserted (Transportation Research Board, 2004: 102). Accordingly, women's travel patterns are often affected by fear; causing it to be biased against public transport systems. This is of particular importance in South African cities, as a large proportion of low-income woman are captive to the public transport market.

Disability also accounts for significant marginalisation in transport systems (Casas, 2007). Defined as: *"having an impairment, including difficulty standing or walking, being in a wheelchair or using a cane, being deaf or blind, or having a mental illness"* (Casas, 2007: 2), disability poses a major challenge to public transport-users as disabled passengers are both highly dependent on public transport, while simultaneously struggling to make effective use of these services due to poor design. It should be noted that poor design refers not only to rolling stock (busses, trains and taxi's) but also to transport infrastructure and planning. Closely related to disability is the effect of age structure on transport equity. Lucas (2006:3) reports that elderly people make fewer trips by car in general and particularly after the age of 60. It can also be reasonably expected that the elderly will eventually become unable to drive (Lucas, 2006:3). If effective public transport is lacking, the older portion of a population will face transport discrimination. The same holds true for children who do not yet qualify for a drivers licence (Casas, 2007: 1). In this regard Casas (2007:1) found that being young, having a licence and holding a permanent job are all factors that strongly influences access to transportation and should be included in the transport planning process. Transport externalities tend to affect the poor more than other groups within urban systems, which represent the final aspect of transport equity. The urban poor experiences the brunt of transport's environmental and health impacts (World Bank, 2002: 39) due to, amongst other, their marginal residential location and being captive to non-motorised transport, placing them in direct competition with motorised transport in terms of road space.

Accordingly, equity as a sustainable transport principle can be defined as: *The equitable access and distribution of transport benefits, with special emphasis being placed on the transportation needs of the poor, elderly, woman and children, while also mitigating biased distribution of traffic pollution and accidents.*

3.4 Ecological Limits

The severe impact of traffic on the environment necessitates the setting of ecological limits which traffic may not infringe on. Traffic's impacts on the natural environment can be summarised as resource use, soil-and-water contamination, air pollution and loss of biodiversity.

In terms of resource use, cars are grossly inefficient (Whitelegg & Haq, 2003: 10). Whitelegg and Haq (2003: 10) asserts that *"[t]he technological system that requires at least 1 tonne of metal and plastic to move one person (weighing less than 100kg) a couple of kilometres on a journey to work or to buy a litre of milk is grossly inefficient."* The construction of an average car requires approximately 1.14 tonnes of materials, is responsible for 25 tonnes waste and globally consumes 650 million tonnes of fuel (in the mid-1990s). This figure is however expected to reach 1.3 milliard tonnes by 2030 (Whitelegg & Haq, 2003: 10). Pollution and motor traffic are also intimately connected. Soil contamination by heavy metals such as Iron, Zinc, Cadmium and Cobalt are reported to be closely linked to the occurrence of motor traffic and volume of traffic (Hääl, Hödrejärv, & Rõuk, 2004: 1). This contamination is due to the wear of motor vehicle components, leaking fuel tanks, damaged batteries and vehicular emissions (Hääl et al, 2004: 1).

Water pollution due to transport activity is caused both directly and indirectly. Direct causes relates to contaminated run-off water from heavily trafficked roads which drains into surface or ground water sources, while indirect pollution is a function of vehicular emissions which dissolves in rainwater, snow or ice, which in turn pollutes surface and ground water sources (Polkowska, Grynkiewicz, Zabiegaµa, & Namiesnik, 2001: 352). Traffic related water pollution appears to cause high levels of benzene, a carcinogen, in water, due mainly to its use as an octane booster in unleaded fuel (Polkowska et al, 2001: 360). Other known pollutants include NO_3 and SO_4. Transport is also one of the fastest growing sources of GHG emissions and air pollution (Whitlegg & Haq, 2003: 12). The worldwide transport sector currently contributes 22 percent of global CO_2 emissions and is a growing source of N_20, NO_x, hydrocarbons and PM^5 & PM^{10} (Whitlegg & Haq, 2003: 16). This poses serious ramifications in terms of climate change and loss of ecosystem health. Biodiversity is affected by transport in various ways; three of which will be discussed here briefly. Loss of plant vitality is caused by traffic emissions, leading to, amongst others, the build-up of heavy metals in plant leafs and soils. Research indicates that heavy metal accumulation in plants close to heavily trafficked roads is 27 to111 percent more than those of plants growing in urban parks (Li, Kang, Gao, Hua, Yang & Hei, 2007: 473). Animals are also affected by traffic, in terms of it being hit by vehicles and by the existence of roads (McGregor, Bender & Fahrig, 2008: 117). According to McGregor et al (2008: 117), roads act as barriers which negatively impacts on animal populations by preventing migration and recolonization of habitats. It was further found that dislocated animals have a 50 percent reduced probability of relocating with each intervening road it has to cross, causing reduced population persistence (McGregor et al, 2008: 117). Birds offer a further indication of transport's disruptive impacts. Slabberkoorn & Ripmeester (2008:72) demonstrates that high noise levels associated with especially highways disrupts avian acoustic signals related to territory defence and mate attraction. This in turn reduces bird numbers and reproductive success, while also causing the homogenization of bird species in urban areas due to the fact that some bird species adapts better to such noisy environments, hence reducing biodiversity (Slabbekoorn & Ripmeester, 2008: 72).

As such, ecological limits as a sustainable transport principle can be defined as: *Setting, maintaining and respecting maximum sustainable ecological limits pertinent to transport.*

3.5 Safety and security

Safety and security as a sustainable transport principle aims to address two negative externalities of transport which asserts particularly severe impacts on humans. Safety refers to human vulnerability to transport accidents and transport pollution, while security refers to transport users' vulnerability to criminal or antisocial acts.

Safety

The World Health Organization (WHO) estimated that 1.171 million people were killed in road accidents in 1999, while 25 to 30 million people were injured in road accidents worldwide (World Bank, 2002: 65). The majority of these victims are poor pedestrians and bicyclists, which displays a strong relation to the principle of "equity" (section 3.3) discussed previously (World Bank, 2002: 65). Such deaths and injuries accounts for between 1 and 2 percent of worldwide GDP (World Bank, 2002: 65). Whitelegg and Haq (2003: 15) report that globally 1.5 billion people are exposed to air pollution levels that exceeds WHO recommended levels which causes approximately 400 000 deaths each year. Transportation noise is the foremost source of noise pollution in urban areas, leading to, amongst others, hearing impairment, learning disability and high blood pressure (Whitelegg & Haq, 2003: 16). The WHO recommends that noise levels should not exceed 55 decibels (dB), but cities in developing countries routinely experience noise levels of 75 to 80 dB along busy roads (Whitelegg & Haq, 2003: 16). The UITP (International Association of Public Transport, 2003:30) estimates that 30 percent of Europeans are exposed to high levels of road noise, while 20 percent are exposed to dangerously high levels of noise pollution, illustrating that noise is not only a developing country problem. The third and last safety impact of transport relates to community severance or loss of neighbourhood liveability. Community cohesion and interaction are often severed by busy roads, while simultaneously constituting a loss of safe neighbourhoods for children to grow up in.

Security

Personal security, while making use of public transport facilities, is a growing problem throughout the world (World Bank, 2002: 72). Unfortunately, unavoidable travel necessities, such as work and health care, forces many people to place themselves at risk of possible harm with limited ability to reduce their vulnerability.

The World Bank (2002: 73) classifies transport related security risks into four categories.

1. *Theft by stealth*, which is associated with acts such as "pick pocketing" and bicycle theft, which can occur in both crowded and deserted public transport facilities.
2. *Theft by force*, including acts of vandalism and violent physical attacks which can happen in crowded areas but is more likely in isolated environments.
3. *Sexual harassment*, which may occur with different degrees of violence and is likely in both crowded and isolated situations.
4. *Political and social violence*, where the transport vehicle simply acts as an opportune location to act out political or social grievances.

The absolute minimisation of traffic induced pollution and accidents, while personal safety of passengers utilizing public transport services and the safety and liveability of neighbourhoods must be achieved.

3.6 Public participation

Davids, Theron and Maphunye (2005: 113) assert that public participation has become a development buzzword, devoid of real meaning and relegated to a form of window dressing, akin to the concept of sustainable development which is widely advocated but rarely practiced. In light of public participation's capacity to affect empowerment, social learning and sustainable development (Davids et al, 2005: 20-22 & Manila Declaration, 1989), it is imperative that participation should be an authentic process. It is widely accepted[1] that if the public actively participates in development programmes, such programmes will be seen as legitimate and will empower

[1] See: Burkey, (1993); Chambers, (1997) and Korten, (1990)

stakeholders in the process to become more self-reliant, hence making development more sustainable. According to the International Association for Public Participation (IAP2, 2002) the core values of public participation can be formulated as follows;

1. The public should have a say in decisions about actions that affect their lives
2. Public participation includes the promise that the public's contribution will influence the decision
3. The public participation process communicates the interest and meets the process needs of all participants
4. The public participation process seeks out and facilitates the involvement those potentially affected
5. The public participation process involves participants in defining how they participate
6. The public participation process communicates to participants how their input affects the decision
7. The public participation process provides participants with the information they need to participate in a meaningful way.

Transport planning also suffers from poor or absent public participation processes, as clearly illustrated by the previous sections on "equity" (3.3) and "safety and security" (3.5). Accordingly, participation as a sustainable transport principle can be defined as: *A process whereby transport planning is no longer the exclusive domain of "experts", but a method that empowers members of the public to participate in setting and planning their "own" transport agenda in order to ensure sustainability.*

3.7 Affordability

The affordability of transport is a function of various factors. Some of these factors are expressly beyond local control, such as fuel price increases and inflation, but the majority of affordability influencing factors are a product of local planning. Transport affordability's planning imperative is clear from Littman's (2008: 3) notion that apart from income, or lack thereof, transport affordability is influenced by the following factors:

- *Daily household and work responsibilities*: These would differ greatly between men and women, and according to income level or employment. The greater the amount of trips executed, the higher the transport cost to individuals and families would be.
- *Special needs*: This includes the need to regularly access medical services and taking care of a disabled person. Again, a higher frequency of trips causes a higher financial burden, especially if more than one person is required to travel together.
- *Physical and mental disability*: Disabilities that prevents people from using the most affordable transit modes, such as walking and bicycling, and precludes them from using public transit causes higher transport costs.

Behrens and Wilkinson (in Harrison et al, 2003: 157) add residential location to this list, indicating that peripheral housing location causes longer trip distances in South Africa (20 km on average) than in other parts of the world (e.g. Europe 11 km on average and 9 km in developing Asian countries). This in turn has a financial implication, with peripheral households spending up to 25 percent and more (Littman, 2008: 12) of their income on transport, which in turn offsets financial gains made by utilising peripheral housing. Housing subsidies often exacerbates the peripheral location of housing, with low-cost peripheral land attracting subsidised housing schemes (Behrens & Wilkinson in Harrison et al, 2003: 154). This leads Littman (2008: 12) to assert that housing and transport costs should be combined in order to measure the *affordability* of transport. A clear correlation can here be seen between affordability and the principle of "access" (Section 3.2) mentioned previously. Affordability of transport is also influenced by the manner in which government recovers transport related expenses and how it goes about making transport more affordable. If costs are recovered by increasing general taxes, or, if motorised transport is subsidised by reduced fuel costs or free parking which is in turn funded by increased general taxes, vehicle travel affordability may increase, but at the expense of other costs (Littman, 2008: 13; Munier, 2008: 365). These so-called indirect costs, while being borne by high and low income groups, have differential impacts in terms of the poor paying for services they gain the least benefit from, while the rich do not pay the true price for their travel behaviour (see Table 3). In effect, attempts to make transport more affordable can in fact make it more expensive.

Table 3: Difference between income and expenditure in terms of car transportation in selected German cities

City	Income from car transport (€)	Expenditure on car transport (€)	Difference (€)
Heidelberg	13 137 822	30 634 581	17 496 759
Rotenburg	693 380	3 094 252	2 400 872
Ludwigsburg	9 090 874	19 293 557	10 202 683
Düsseldorf	24 699 867	167 106 878	142 407 011
Lüneburg	3 411 848	9 194 623	5 782 775
Augsburg	21 046 353	47 766 056	26 719 703
Aschaffenburg	3 041 045	11 366 940	8 325 895

Source: Adapted from ICLEI (2005)

As result, affordability as a sustainable transport principle can be summarised as: *Transport services and strategies which are affordable to the lowest income group, taking into account the full cost of transport, and, being progressive according to income and/or mode of transport utilised.*

3.8 Institutional capacity

The current transport reality of competing and conflicting goals, and continued pressure to integrate various interdependent sectors; results in a planning environment that is characterised by complexity (Hatzopoulou & Miller, 2008: 149). The state, as primary provider and custodian of transport, is placed in the unenviable position of mastering such complexity in the context of sustainable development. It fails to succeed in various ways. Theron (in Davids et al, 2005: 141) reports that the flexibility and internal integration required by the state to plan and manage transport sustainably rarely happens in practice. He indicates that government departments tend to function as "silos"; rigidly demarcated groups which focus solely on their duties while working in isolation. This causes a lack of strategic coordination and holistic, integrated planning which makes sustainable transport a pipedream (Davids et al, 2005: 141). In terms of South Africa, Barbour and Kane (2003:4) confirm that integrated transport planning is not being undertaken as directed by legislation and indicates that poor communication and integration exists between the departments of transport and environmental affairs. Hatzopoulou and Miller (2008: 149-150) ascribes such political and institutional barriers to different departmental cultures, competing strategic goals and a distribution of legal powers. According to the Commission for Integrated Transport (2006: 31), these barriers extend both horizontally between departments and vertically between different levels of government. Lack of governmental integration is however not the only culprit. Research by Short and Kopp (2005: 363) identifies the following deficiencies in institutional capacity:

- A lack of funds to implement transport plans is often experienced. This is due to an outright lack of money, or more frequently, due to government agencies only providing resources to plans that are aligned with their own policies.

- Transport policy appraisal is not based on objective evaluation tools, but on discussions and professional judgement; leading to a lack of transparency and accountability in decision-making.

- A general lack of reliable and detailed transportation data prevents informed decision-making.

- Ex post monitoring and evaluation of transport projects is sourly lacking; again inhibiting informed decision-making.

- The absence of a generally accepted set of best-practice benchmarks to measure the performance of transport plans against.

Barbour and Kane (2003: 4) ads that a highly politicised planning environment can also negatively impact transport by forcing planning decisions based on a political agenda, rather than objective facts. A final and striking lack of capacity relates to poor public participatory processes which fail to articulate the transportation needs of marginal communities.

Institutional capacity as a sustainable transport principle can thus be defined as: *The capacities to plan, implement, integrate and maintain transport policies and plans,* *which requires the necessary skills, integration and co-operation within and between relevant sectors.*

3.9 Summary

Sustainable transport defies simple definition and it proves to be more beneficial to rather identify its universal underlying principles than to develop a restrictive "one-liner" definition. Following from this approach, seven sustainable transport principles are identified as being universal to most sustainable transport strategies, namely; universal access, social equity, ecological limits, safety and security, affordability, participation and institutional capacity. Having determined these principles, the following chapter will now identify and discuss international best practice transport strategies which directly address one or more of these sustainable transport principles.

CHAPTER 4

REVIEW OF BEST PRACTICE STRATEGIES WITHIN SUSTAINABLE TRANSPORT

4.1 Introduction

The transport principles mentioned in the previous chapter provide a value-based criterion for assessing the sustainability of transport policy and planning. The practical manifestation of such transport practices is demonstrated in this chapter by providing a brief overview of key transport strategies which are considered to represent best practice benchmarks in the field of sustainable transport. Each relevant strategy will be discussed to clarify its definition and to illustrate its positive and negative aspects. An overview and basic understanding of these transport strategies is of particular importance, as research by Barbour and Kane (2003: 34) indicates that transportation practitioners, at least in the South African context, requires guidance on sustainable alternatives to current transportation planning.

For the sake of clarity, these transport practices are sub-divided into Transport Demand Management strategies; pertaining mainly to spatial planning and urban form, and Fuel Technologies; dealing exclusively with less environmentally degrading fuel sources. It should be noted that the list of strategies discussed in this chapter is by no means exhaustive, but rather represents the most salient specimens. The table below (Table 4) illustrates how best practice transport strategies are related to the sustainable transport principles mention in the previous chapter.

Table 4: The relation between best practice transport strategies and sustainable transport principles

Best-practice Transport Strategies	Sustainable Transport Principle Enforced
Transport Demand Management:	
Population Density	Access, Equity & Affordability
Compact Cities	Access & Equity
Corridors	Access, Equity & Affordability
Pedestrian Precincts	Access, Equity, Ecological Limits & Health & Safety
Walking	Access & Ecological Limits, Equity
Cycling	Access & Ecological Limits, Equity
Integration of systems	Access & Equity
Traffic Calming	Health & Safety & Ecological Limits
Parking	Equity & Ecological Limits
Social Marketing	Participation
Provision of Road Space	Equity & Ecological Limits
Road & Fuel Pricing	Equity & Ecological Limits
High Occupancy Vehicle Lane (HOV) & carpooling	Ecological Limits & Health &Safety
BRT	Ecological Limits & Health &Safety
LRT	Ecological Limits & Health &Safety
URT	Ecological Limits & Health &Safety
Fuel Technologies:	Ecological Limits & Health &Safety

Source: Drafted by author

4.2 Transport Demand Management (TDM)

Transport Demand Management (TDM), also known as mobility management, refers to the specific application of transport related policies and strategies to manipulate travel behaviour; aiming to redistribute travel patterns in time and space, while simultaneously reducing private automobile usage.

4.2.1 Population density

Large-scale migration out of central city areas are directly linked to increased automobile use and urban sprawl (Newman & Kenworthy, 1991: 110-111). Such out migration, also known as suburbanisation, is characterised by the formation of new urban nodes outside of a city's traditional central business district (CBD) and is fuelled by variety of reasons summarised in Table 5 (Waugh, 2000: 364). Suburbanisation however erodes the viability of public transit services, to the determent of non-car owners, and soon develop similar traffic problems to that of the inner city. As a result, re-urbanisation is regarded as a crucial element in achieving sustainable urban transport.

Table 5: Causes of migration from inner cities to suburbs

Inner city	Suburb
Housing: Poor quality; lacking basic amenities; high density; crowded	Modern; high quality; basic amenities, low density
Traffic: Congestion; noise & air pollution; narrow, unplanned streets, parking problems	Less congestion & pollution; well planned road system; close to motorways & ring roads
Industry: Decline in older secondary industries; cramped sites with poor access on expensive land	Growth of modern industrial estates; hypermarkets & regional shopping centres; new office blocks on spacious sites
Jobs: High unemployment; lesser skilled jobs in traditional industries	Lower unemployment; cleaner working environment; often more skilled jobs in newer high-tech industries
Open space: Limited parks & gardens	Individual gardens ; more and larger parks, closer to countryside
Environment: Noise & air pollution from traffic and industry; derelict land and buildings, higher crime rate; vandalism	Cleaner; less noise & air pollution; lower crime rate; less vandalism
Social factors: Fewer & older services e.g. schools and hospitals; ethnic and racial problems	Newer and more services; fewer ethnic and racial problems
Planning & investment: Often wholesale redevelopment/clearance ; limited planning and investment	Planned, controlled development; public and private investment
Family status/wealth: Low incomes; often low status	Improved wealth and family/professional status

Source: Waugh (2000)

The concept of population density mitigating automobile use appears to be grounded in at least two principles. Firstly, it is recognised that public mass transit requires a minimum population density or critical mass, in order to be economically viable (Warren, 1998: 31 & 60-66). This also holds true for non-automated forms of transit such as walking and cycling, as provision can only be made for such travel (e.g. walkways and cycle lanes) if sufficient amounts of people can make meaningful trips in such a fashion. Clearly, the residential location of the urban workforce, in close proximity to their place of employment will support non-motorised transit. The second principle is imbedded within the correlation between employment and population density. Newman and Kenworthy (1991: 114-115) illustrate that the amount of jobs per hectare is linked to population density per hectare within central city areas. A higher concentration of jobs and population, supported by proper zoning, can result in mix-use areas (see section 4.2.4) which enable citizens to make multi-purpose trips, thus reducing the amount and overall distance of trips, which in turn reduces the need for automobile use (Warren, 1998: 30; Calthorpe, 1989: 12). Optimal population density will vary according to cities' spatial layout and the public transport mode/s employed, though a general average density of approximately 3 500 to 4 000 people per km^2 appears to be optimal. Population density can however be deceptive. Cape Town's population density is 1 207 persons per km^2 while Khayelitsha's population density is 1 000 people per km^2; illustrating that density can greatly differ within a single urban centre (CoCoon, 2005: 1).

4.2.2. Liveable streets

Closely linked to population density is the liveability of streets. Appelyard (1981: 243) in his groundbreaking book "Liveable Streets" describes the street as the most important part of the urban environment. This notion is simply drawn from the fact that the street is a public domain and a key facilitator for meaningful interaction. If the street is however changed into an automobile domain, it becomes impersonal, noisy and dangerous, losing its social character. Maintaining a "sense of place" thus becomes important. Pacione (2005: 372) defines "sense of place" as the subjective or cognitive structure of a built environment, which is formed by either its intrinsic character or ascribed character constructed by human attachment. Appelyard (1981: 37 & 243) indicates that residents and pedestrians of heavy trafficked streets feel that their quality of life is reduced, which, if not improved, cause migration out of the area. This is the result of environmental selection, described by Appelyard (1981: 37) as follows: "*an environment tends to be selected by those groups who find it most amenable and to be rejected by those who find it least amenable*". Accordingly, the ability to increase central city population is directly dependent on creating liveable environments conducive to human interaction.

Safety plays a pivotal role in the construction of liveable streets. Such safety refers to firstly reducing the impacts of traffic to such an extend that walking and interaction on or next to the street is safe and, secondly, street environments should be healthy, free of excessive noise and exhaust fumes (Appelyard, 1981: 243-244). Urban greening also plays a major role in improving the liveability of streets, by providing citizens with a link to nature and by creating a pleasant environment, conducive to social interaction.

4.2.3 Compact cities

Central to the sustainable transport debate is the notion of a compact, mixed-use urban form with high density centres, as opposed to low density sprawling cities (Kenworthy, 2006; Satterthwaite et al, 2004). Newman and Kenworthy (1991) associates a compact city form with reduced energy consumption per capita due its strong relationship with reduced urban sprawl and greater orientation towards transit based urban transport (Kenworthy, 2006: 69). Kenworhty (2006: 70) suggests that the natural environment should permeate the compact city, as this would restrict automobile use, while simultaneously creating more pleasant areas to walk and cycle through. Access is also improved via interlinking networks of parks and green belts, which allows for quick, straight-line routes favoured by pedestrians as opposed to congested channelled routes used by automated transport. Dewar and Todeschini (2004: 47) indicates that pedestrian movement tends to be dendritic, which, if combined with interlinked parks, can result in greater flexibility of walking as a transport mode. Compacting the form of the city according to Dewar and Uytenbogaardt (1991: 43) means ensuring that the city can operate well at a pedestrian scale. This is due to pedestrians' increased levels of equity and convenience in terms of access to services, as well as access to a greater *variety* of services in a compact city. Such access is optimised by mixed use area's consisting of a combination of social and economic functions, regarded as being able to save time and energy while also reducing journey lengths (Breheny, 1992: 149; Kenworthy, 2006: 69). High densities achieved through population density (see section 3.2.1); infill and brown-field development is required by the compact city paradigm to sustain mixed use areas while also ensuring the viability of public transport.

4.2.4 Transport Oriented Development

Transport Oriented Development (TOD) is a planning strategy aimed at creating a city-wide network of key nodes which are connected with public transport-based corridors and is closely associated with compact city paradigm (Wilkinson, 2006: 224). TOD is based on an open grid road network, featuring extensive non-motorised transport provision and is often combined with traffic calming measures. At the heart of these road networks is transport interchanges, generally rail or bus stations, with a surrounding neighbourhood extending to a radius of approximately 400m to 800m. These neighbourhoods comprises of a mixture of residential, employment and retail activities at medium to high densities, and is designed to maintain a human scale while offering ample public space (Wilkinson, 2006: 224).

TOD promises to reduce motorised vehicle travel as well as curb congestion levels, which in turn will improve travel times and reduce fuel consumption and emissions (Lin & Gau, 2006: 353). Such reductions are based on the assumption that TOD neighbourhoods are more likely to make use of public transport services. Increased ridership is also self-reinforcing in that it would reduce operating costs and fares (Cascetta & Cervero, 2002: 277; Pagliara, 2008: 81) Wilkinson (2006: 224) points out that TOD neighbourhoods' land value may increase as a result of higher levels of accessibility. Increased land value can however lead to increased service costs and place such property beyond the reach of the urban poor.

4.2.4 Mixed use areas

Lau, Giridharan and Ganesan (2005: 527) defines mixed use areas as an: *"intensification of land use through mixing residential, commercial and other uses at* *higher densities at selected urban locations, while being supported by an efficient public transport and pedestrian network.”*. Mixed use areas holds the promise of reducing the need for travel, and is hailed by professionals as holding strong sustainable development potential due to its energy saving capacity (Lau et al, 2005: 527). Breheny (1992: 150) however questions the energy saving capacity of mixed use areas. He reports that journey lengths will not necessarily be reduced by mixed use areas, due to the need for specialist destinations; such as specialist goods and particular jobs. Rather, he argues, journey lengths will be influenced by the propensity to travel which is directly related to the cost of travel. Lin & Yang (2006) argues that claims of a compact urban form contributing to the sustainability of cities has not been verified sufficiently, indicating that a compact form positively impacts economic sustainability at the expense of social and environmental sustainability. Schoonraad (2000: 222) sustains this argument, reporting that the urban poor in South Africa cannot afford to live in a compact city. Single family dwellings located on medium sized plots on urban fringes is regarded as encouraging sprawl and unsustainable use of space, but more available land in the ownership of the poor enables families to generate informal income through actions such as backyard-rental and urban agriculture. Not only does this supply valuable income to the poor, but also satisfies the need for rental housing stock, not sufficiently provided by government (Schoonraad, 2002: 223). She adds that daily living costs of inner city areas are too high for the urban poor, who prefer the semi-rural outskirts of urban areas where one formal sector salary can sustain a whole family (Schooraad, 2002: 224). Todes (in Harrison *et al*, 2003: 118-119) concludes that urban compaction is not without use in the South African context, provided that such compaction allows for a diversity housing needs, which includes larger plots on peripheral areas and cheap accommodation in city centres, while also accommodating informal solutions to housing needs. Breheny (in Banister, 1995: 90-91) suggests three tests in determining the usefulness of compaction, namely; veracity, feasibility and acceptability. Veracity tests whether significant transport energy savings can be achieved through urban compaction, while feasibility investigates the practicability of halting urban decentralisation. Finally, acceptability, closely related to veracity, asks how acceptable the social and economic implications of compaction are, as measured against the environmental gains resulting from compaction.

4.2.3 Activity Corridors

Activity corridors refers to the symbiotic relationship between intensive flows of traffic (automated and non-automated) and human intensive activities which results in corridors of heightened activity (Dewar & Uytenbogaardt, 1991: 49). Such symbiosis results in sufficient threshold densities for viable public transport operation along these corridors while simultaneously improving equity of access to services (See Figure 8).

Dewar and Todeschini (2004: 66-67) describes corridors as being porous, allowing for frequent entry and exit points, which ensures that the corridor does not become a limited access route. This will allow for both small-and large-scale activities to locate in the corridor. Associated with the attraction of activities is the degree of congestion in the corridor. Dewar and Todeschini (2004: 67) indicate that a level of congestion which results in frequent stop-start traffic behaviour is vital to the success of corridors, as this enables greater access to a greater variety of services, making the corridor attractive as a location for services. The physical form of the corridor should adapt to its given context, but in general the corridor needs to operate as a system on both sides of the traffic flow around which it is formed, allowing for pedestrians to cross these flows frequently and easily (Dewar & Todeschini, 2004: 67).

Dewar and Todeschini (2004: 67) warn that corridors cannot be artificially imposed, but that vital pre-conditions must be in place for corridors to develop with success. Accordingly, it is imminent that corridors as a sustainable transport strategy is a long-term approach, or way of thinking, rather than a quick-fix solution (Dewar & Todeschini, 2004: 67).

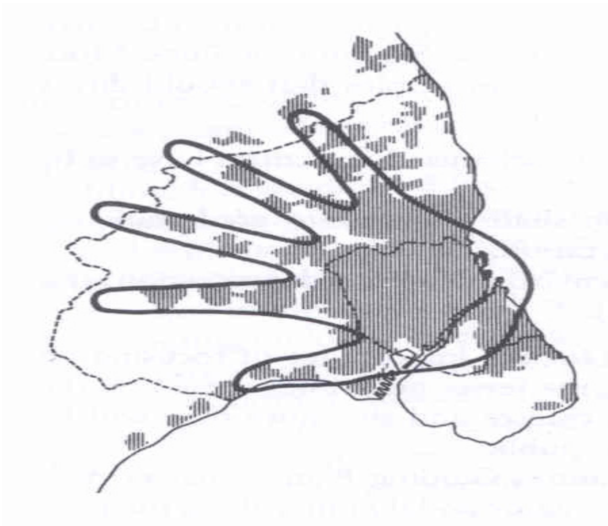


Figure 8: The Copenhagen "Finger Plan"; locating new developments along major transit lines

Source: Cahasan & Clark (2008)

4.2.4 Pedestrian precincts

The creation of car-free urban areas where people can walk safely and have face-to-face interaction is increasingly considered as essential to the vitality of city centres and neighbourhoods alike (Kenworthy, 2006:76-77; Hall, 1997: 89; Appelyard, 1981: 243-244). This vitality refers to the increased liveability of public and private spaces as a result of reducing or prohibiting the use of automobiles in such areas. Pedestrian precincts creates areas where people want to spend time and through which they prefer to travel by generating dramatic reductions in ambient air pollution, constructing secure areas free of traffic tension and noise, conducive for social interaction and economic vibrancy and by making transit more time-efficient, easy and attractive (Warren, 1998: 45-46 & 60; Richards, 2001: 30-31). In this regard Warren (1998: 45-46) reports a 70% reduction in air pollution recorded in the pedestrian zone of central Vienna, while Knoflacher (2006: 389) indicates that pedestrian zones in the city centre of Einstadt, Austria, changed transport from 10 000 cars and 6 000 pedestrians per day, to between 26 000 and 40 000 pedestrians and no cars per day, boosting both pedestrian accessibility and business in the city centre. Increased mobility due to walking is attributed to the quality of the walking environment, with people in a car-free district being willing to undertake trips of up to 70% longer than in car-oriented districts (Knoflacher, 2006: 392), but also due to travel in the city being opened to people without car licenses or those not able to afford public transport.

Vasconcellos (2001: 263) warns that prevention of direct automobile access could change the nature of activities as well as rent levels and land value, which may result in built environments that are perceived as “poor” areas where the higher-and middle-income classes are no longer welcome. This has an obvious negative economic impact which forces various pedestrian precincts to reopen some space to vehicular traffic (Vasconcellos, 2001: 263). Beatley and Manning (1997: 169) support this notion, indicating that most pedestrian precincts are only frequented for a few hours per day, normally over lunchtime, when workers leave their offices, making precincts economically unviable. They however do *not* support the reopening of pedestrian precincts to automobiles, but rather suggests the use of public transport in stimulating economic development through increased access to services (Beatley & Manning, 1997: 169).

4.2.5 Walking

Walking is an essential means of transport within cities, constituting the primary and most equitable form of transport. Greenberg (in Dittmar & Ohland, 2004: 58) observes that every transit trip begins and ends with a walking trip. Yet, necessary planning for walking is severely neglected, especially in developing countries (Vasconcellos, 2001: 111; Pacione, 2005: 268).

According to Vasconcellos (2001: 12), the provision and quality of pavements is a vital factor influencing pedestrian activity and safety. If no pavement is provided, or if existing pavements are narrow, pedestrians are forced to share the road-bed with other forms of transport, which makes walking dangerous and uncomfortable. Similarly, poorly maintained and designed pavements exposes pedestrians to noise and air pollution, poses a threat to children and creates unsafe spaces at night (Pacione, 2005: 268). The safety and time constraints posed by poor or absent road crossings also add to frustrating walking as a transport medium (Vasconcellos, 2001: 113). Vasconcellos (2001: 113) warns that children, the elderly and the disabled suffer the most due to poor walking conditions. Pedestrian friendly areas should be designed for people rather than solely for vehicles (Taylor in Neal, 2003: 105). Accordingly, pavements should be large enough to accommodate high volumes of pedestrian traffic, be well maintained and designed in such a way as to reduce direct noise and pollution impacts. In this regard greening of walkways and pavements plays an important role, as trees and shrubs can form a physical barrier between the pedestrian and traffic, while also creating a pleasant space to travel through. Safety proves to be vitally important in encouraging walking, as such, proper street lighting needs to be provided at pavement level and care should be taken to create streetscapes that are vibrant. Greenberg (in Dittmar & Ohland, 2004:71-72) argues that vibrancy can be increased by building placement and orientation. By bringing the retail base on buildings to the edge of the pavement, the streetscape is defined and an active pedestrian environment is created. Main entrances to buildings should also open onto pavements, ensuring easy access for pedestrians (Greenberg in Dittmar & Ohland, 2004: 71). The urban block size pedestrians are comfortable covering on foot is of obvious importance when encouraging walking as a transport mode, and is widely accepted as 200-250 feet (Beatley & Manning, 1997: 67; Dittmar & Ohland, 2004: 72)

Finally, local climatic conditions needs to be considered when pavements are designed, taking into account whether pedestrians will encounter extreme weather conditions (Vasconcellos, 2001: 113). Richards (2001: 50) shows that rainy weather can reduce pedestrian traffic by up to 30%, while Vasconcellos (2001: 113) indicates that sandy pavements in African cities become too hot for bare-footed pedestrians to use during summer.

4.2.6 Cycling

According to Beatley and Manning (1997: 68) bicycling can play a major role in reducing automobile transport. As with walking, cycling offers a reduction in air pollution and noise, but also compliments walking as it moves at safer speeds and takes up less space than automobiles. Richards (2001: 92) argues that cycling offers a particular advantage over cars in terms of economic use of space, indicating that cycling requires one tenth of the surface area required by cars for parking, or put differently, 100 bicycles can be parked in the space of 10 cars.

Making cycling a viable form of transport in urban localities requires planning for slow moving traffic, protected and dedicated bike lanes and secure bicycle parking at key locations (Beatley & Manning, 1997: 68). Experience in the Netherlands point towards the importance of allowing bicycles onto trains and streetcars as well as provision of a bicycle rental system to provide for greater transport flexibility (Richards, 2001: 92 & 121; Beatley & Manning, 1997: 68).

4.2.7 Telecommuting

Telecommuting refers to working from a remote location and being connected electronically through phone lines or cables to the workplace (Black, 2001: 3). This leads Black (2001:3) to contend that telecommuting should rather be described as teleworking, as this activity aims to reduce commuting activity. Telecommuting promises to reduce travel times, travel costs and energy consumption. Safirova (2002: 26-27) even indicates that telecommuting could improve family relations and worker productivity, resulting in approximately 28 million people telecommuting in the United States. These advantages are however often taken for granted by policy makers warns Safirova (2002: 26-27). Research suggests that telecommuting could reduce chances of teleworker promotion, increase the cost of earning to employees and could potentially worsen family relations due to a conflict of family and work responsibilities (Safirova, 2002: 27). Atkyns, Blazek, Roitz & AT&T (2002: 277) disagrees with Safirova, reporting that the majority teleworkers involved in a study conducted at AT&T in 2000 , experienced improved family life. AT&T also reported the following environmental savings due to telecommuting:

- CO_2 savings of 48 450 tonnes/annum
- CO savings of 606 tonnes/annum
- NO_x savings of 242 tonnes/annum
- VOC savings of 121 tonnes/annum (Atkyns, Blazek, Roitz & AT&T, 2002: 282)

Black (2001: 4) however suggests that available time created by telecommuting create the potential to generate trips that could not have been executed if the individual was commuting to work. He draws from the work of Hagerstrand (1970) regarding space-time prisms, which follows that an increase in potential activity space will lead to additional travel (Black, 2002: 4). Figure 9 indicates the activity space and travel behaviour of a commuter on the left-hand side and a telecommuter on the right-hand side, with the size of the rectangles indicating the distance of travel executed in time.

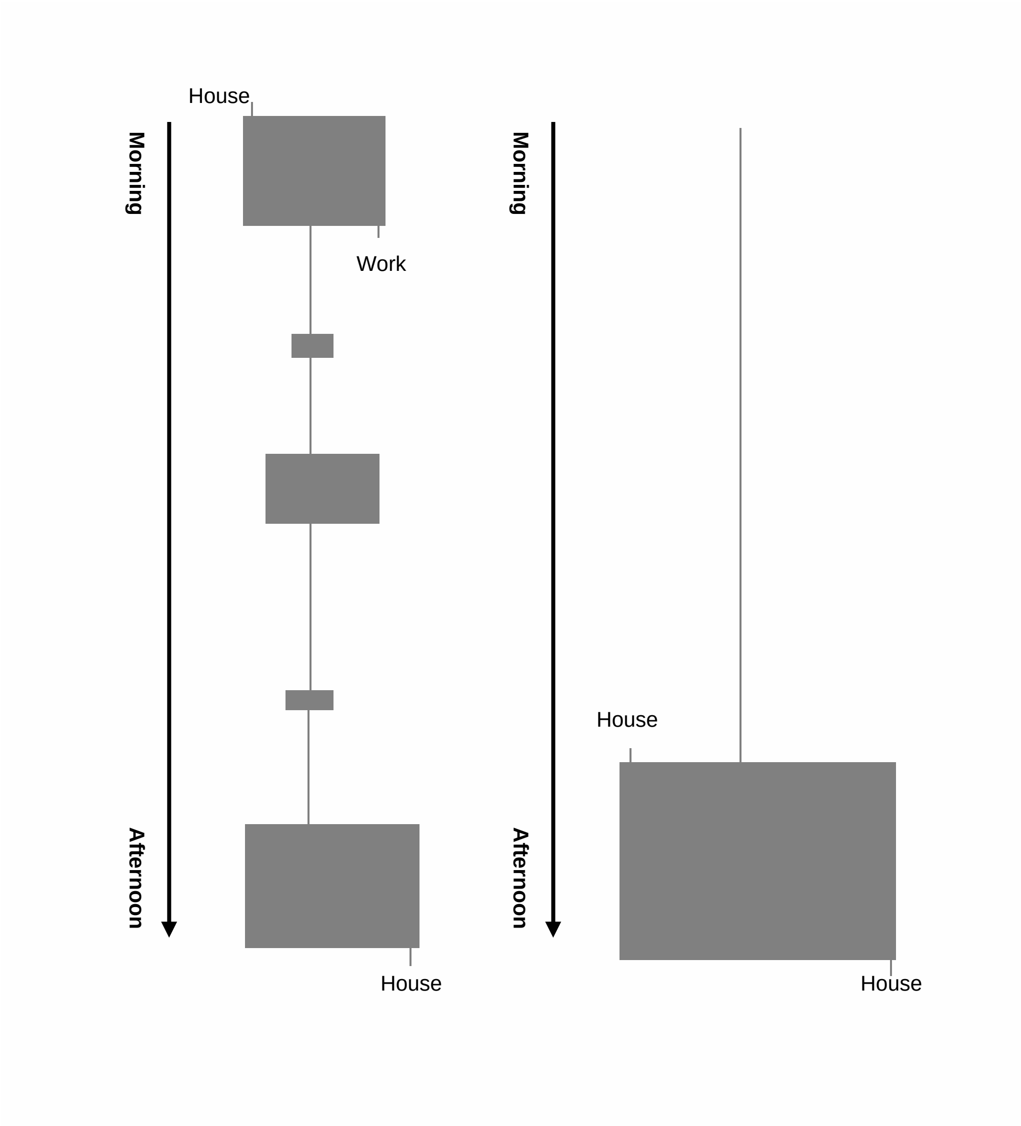


Figure 9: Time-space prisms of commuters versus telecommuters
Source: Adapted from Black (2001)

4.2.7 Integration of transit systems

A precondition to the success of pedestrian precincts and urban bicycle travel is its integration with other modes of transit. Integration allows for people to efficiently access pedestrian zones, cycle ways and public transit while also providing for greater flexibility to normally inflexible transit routes, thus increasing transit's door to door competitiveness over automobile transport (Newman & Kenworthy, 1991: 139; Warren, 1998: 60; Richards, 2001: 151).

According to research by Bowden *et al* (as cited in Newman and Kenworthy, 1991: 139), catchment areas for train transit can be doubled if properly integrated with cycling routes. As a result, most successful pedestrian zones and cycle ways are situated very close to train stations and other major interchanges (Warren, 1998: 60). Richards (2001: 151) adds that integration between different modes of transit should be seamless and easy in order to achieve minimum waiting times and maintaining overall time efficiency.

4.2.8 Traffic calming

Traffic calming, or the "Woonerf" technique, represents an attempt to control the flow of traffic in specific urban areas in order to slow it down and reduce its volume, by means of physical design features incorporated into the street. Unlike dedicated pedestrian zones, traffic calming do not completely exclude the automobile but partially restrains it to a safe and human level, while giving priority to other modes of transit (Newman & Kenworthy, 1991: 139-140; Warren, 1998: 57).

The "Woonerf" technique utilizes street design restraints such as, cul-de-sac's, traffic circles, speed-bumps, raised pedestrian crossings and rough-textured driving surfaces to induce what Newman and Kenworthy (1991: 140) refers to as planned congestion. The added utility of this technique however lies in its simultaneous "greening" of the city, as vegetation, most notably trees, are often used as physical barriers in the roadbed. Traffic calming used in conjunction with pedestrian zones and cycle lanes as in the city of Freiburg caused a reduction in travel time of up to 50% (Warren, 1998: 57).

4.2.9 Parking

One of the principle ways of controlling traffic flow into central city areas is by regulating the availability of parking space. Research conducted by Newman and Kenworthy (1991: 122-127) indicates an inverse relationship between surface area devoted to parking and the population density of central city areas. Accordingly, increased amounts of parking space causes reduced population density and reducing parking space increases attractiveness to people. Knoflacher (2006: 387 & 397) also warns that the wholesale availability of parking motivates people to drive their cars rather than use public transport, but also restructures cities by removing the relationship between workplace, home and community thus encouraging sprawl and reducing liveability.

Daisa (in Dittmar & Ohland, 2004: 121) reports that large surface areas devoted to parking is a major impediment to walking and creates the feeling that automobiles dominates an area, this view is shared by Knoflacher (2006: 392) who argues that public space are turned into privileged space for motor vehicles as a result of parking. Accordingly, parking should be oriented away from pedestrian zones, being located preferably underground or outside of the city centre so as to make better use of limited space in the CBD.

Reducing parking space and charging for available parking appears to be one of the most effective means to regulate automated traffic (Daisa in Dittmar & Ohland, 2004: 121; Shoup, 2004). Such a reduction includes free parking provided by the workplace and free road-side parking. Shoup (2004) introduces the concept of “cruising” for free parking space. According to him, if drivers are faced with paying for off-street parking or waiting for free road-side parking to become available, they will happily "cruise" or drive around for up to 8 minutes to locate free road-side parking. Shoup (2004) estimates that "cruising" in the city of Westwood, USA, (where he conducted his research) alone contributes 1 million vehicle miles travelled per year, with all the associated emissions. Alternative parking can be provided in parking districts situated adjacent to major interchanges in residential areas, a system known as park-and-ride, with frequent express transit services connecting residential parking districts to transit stations (Daisa in Dittmar & Ohland, 2004: 122). Knoflacher (2006: 395) goes as far as suggesting that if the walking distances to the nearest public transport stop is further than to a personal automobile, the average person will rather use the automobile, and therefore parking should be located in such a fashion as to encourage public transport use.

4.2.10 Social Marketing

Anderson (in Frame, 2004: 526) defines social marketing as "*The application of commercial marketing technologies to the analysis, planning, execution and evaluation of programs designed to influence the voluntary behaviour of target audiences in order to improve their personal welfare and that of their society*". Weinreich (1999: 3-4) states that the distinguishing difference between commercial marketing and social marketing is located on its purpose, with benefits accruing to the individual and society rather than to a company in the case of social marketing. The application of social marketing in shaping sustainable urban transport appears to be very limited, with existing projects being localised and segregated from national strategies.

Auckland's "*0800-Smoky*" and "*Big Clean Up*" is a case in point (Frame, 2004). These two campaigns attempted to reduce air pollution caused by motor vehicles and foster sustainable living habits among its citizens. A shock and peer pressure strategy was employed to firstly make citizens aware of the effect of their actions and secondly to supply social leverage for changing behaviours. This strategy was executed by using television media, print media, billboards and providing for citizens to actively participate in the campaign by becoming members and through supplying a telephone hotline to report polluters (Frame, 2004: 526-528). These two campaigns provide valuable information regarding what Weinreich (1999: 9) refers to as the social marketing mix. She argues that successful social marketing campaigns firstly require that the target audience know what product or behaviour is being promoted and secondly the price of adopting such behaviour needs to be communicated. Thirdly, such marketing should be located at the place where desired behaviour can be practiced or measured, which links to how the message is communicated to the target audience (promotions, special events, media advocacy). Fourthly, the importance of partnerships and supportive policy is stressed in reaching complex social change. The Auckland campaign communicated its desired behaviour and the price for adopting such behaviour by shocking the target audience with statements such as *"Auckland's air is killing 250 people every year"* and *"If you want to help prevent air pollution you can start by tuning your car"* (Frame, 2004). Marketing material was located on road sides at traffic intersections where drivers had to stop and wait for traffic. Strategically placed mirrors next to the road enabling drivers to see if their vehicles were smoking and caption was added to the mirror stating: "*If your exhaust is smoking for more than 10 seconds you are poisoning Auckland"* (Frame, 2004). Finally, strategic partnerships with major oil companies enabled Auckland to distribute cleaner fuel even before it was required to do so by national legislation, while a supporting policy environment was drafted by enabling citizens to report polluters and through the provision of by-laws to fine polluters (Frame, 2004).

4.2.11 Provision of road space

The subsidisation and provision of road space is viewed by Vasconcellos (2001: 162) as public asset primarily consumed by the rich and middle class, which perpetuates inequality in terms of transport access. Such inequality is further exacerbated by the fact that the main consumers of road space also determine its location and the modal application on such roads (Saint-Laurent in Freeman & Jamet, 1998: 49). Accordingly, it is widely accepted that providing road space for private cars (the preferred vehicle of the middle-and upper-class) is at the heart of increased congestion, urban sprawl and unsustainable urban pollution generation and energy consumption (Warren, 1998; Dittmar & Ohland; 2004; Beatley & Manning, 1997; Kenworthy, 2006, Gomez-Ibanez & Meyer in Banister, 1995).

It is however important to note that investment in road infrastructure is still required, especially in developing countries. In this regard Vasconcellos (2001: 28) reports that road provision in urban areas of developing countries vary from 6% to 21%, with poor quality road surfaces and inadequate drainage being a common problem. Furthermore, he also holds that road widths in most developing cities are too narrow, forcing traffic onto pavements and into alleys (Vasconcellos, 2001: 28).

Chakravarty & Jachdeva (in Freeman & Jamet, 1998: 66) maintains that the provision of adequate road infrastructure increases vehicular speeds and decreases fuel consumption by 15% to 40%, which also translates in reduced emissions. They also argue that journey lengths/times can be reduced through road provision, thus curbing congestion. This argument is however in stark contrast with that of Newman and Kenworthy (1991) who indicates that an increase in speed of a specific mode of transport will elevate its competitiveness and attractiveness over other modes of transport. Accordingly, private car use will be stimulated by a transport system allowing increased speeds, as it is the fastest mode of land transport available, thus, in the longer term, increasing congestion and resultant fuel consumption and emissions.

As such, road provision and subsidisation should be approached with care, taking into account the developmental needs of a specific city, the difficulty of quantifying the negative externalities generated by increased traffic and contrasting these against natural resource constraints.

4.2.12 Road and fuel pricing

The notion of road and fuel pricing is based on the market principle of demand and supply (Vasconcellos, 2001: 292). The actual costs of using roads and burning fuel is however usually not carried by the consumer, but is shared by the environment and other people who are not consuming these products. These costs include pollution, congestion and accidents. The market logic leads that if road and fuel prices are adapted to reflect actual costs of externalities to the consumer, traffic flow will decrease and equilibrium will be reached (Vasconcellos, 2001: 292; Chakravarty & Jachdeva in Freeman & Jamet, 1998: 66). This market principle is widely acknowledged, but very few governments implement road pricing schemes due to its technical difficulty and political undesirability (Vasconcellos, 2001: 292). Complex systems are required to prevent unfairness in road pricing and preventing traffic from using parallel routes to those being priced, which will lead to congestion on these parallel routes and even damage to the road surface (Vasconcellos, 2001: 292). The political undesirability of road pricing is simply due to its ability to completely destabilize entire transport systems (Vasconcellos, 2001: 292).

4.2.13 High Occupancy Vehicle lanes (HOV) and carpooling

High Occupancy Vehicle lanes (HOV) are exclusive right of way lanes designated for use by busses, taxis and in some instances, vehicles with more than one occupant (Yang & Huang, 1999: 140). An obvious corollary to HOV lanes is a carpooling system, whereby physical ownership of vehicles is substituted for the services it renders in order to capitalise on the transport benefits offered by exclusive lanes. This results in individual, informal drive clubs, and/or highly structured and sophisticated carpooling systems; such as the Seattle Smart Traveller Rideshare Database[1] (Daily, Loseff & Meyers, 1999: 31). The rationale behind HOV lanes is its apparent capacity to reduce traffic congestion, increase average travelling speeds and increasing ridership per vehicle (Prettenthaler & Steininger, 1999: 445; Yang & Huang, 1999: 140); leading Yang and Huang (1999: 140) to contend that: "*The total vehicle demand for scarce road capacity is … reduced and the person-movement efficiency of the roadway is thus increased.*" Kwan and Varaiya (2008: 98) however warn that the benefits of HOV lanes should not be overstated. In their study of California's 1171 miles of HOV lanes, they identify the following weaknesses:

- 81% of HOV lanes are underutilized

[1] The Seattle Smart Traveller makes use of the World Wide Web and structured query language (SQL) to facilitate immediate and dynamic ride-matching. For more information see: Daily; Loseff and Meyers, (1999)

- Most of the HOV lanes operate at lower speeds and lower capacity than general purpose lanes; with HOV lanes achieving 1600 vehicles per hour per lane at 45 miles per hour, versus general purpose lanes; achieving 2000 vehicles per hour per lane at 60 miles per hour
- As a result, HOV lanes offers a marginal travel time saving of on average 1.7 minutes on a 10 mile route, but, HOV travel times appears to be more reliable than general purpose lanes', and
- HOV lanes reduce congestion slightly, only if general purpose lanes are allowed to become congested (Kwan & Varaiya, 2008: 113)

Kwan and Varaiya (2008: 113) do point out at least two areas where HOV lanes performs well when compared to general purpose lanes. Generally, HOV lanes claims only one lane on a given stretch of road, but if this is increased to two lanes, the carrying capacity of the HOV lane system improves, as slow travelling vehicles using the HOV lane can be overtaken. Secondly, if the HOV lane is used primarily by busses or vans (as opposed to fully loaded sedans), the per person throughput of the HOV lane improves dramatically (Kwan & Varaiya, 2008: 113).

4.2.14 Bus Rapid Transport

Wright (2005: 1) defines Bus Rapid Transport (BRT) as: *"[A] bus-based mass transit system that delivers fast, comfortable and cost-effective urban mobility."* In operation, BRT emulates a collection of characteristics normally associated with rail-based transit, but at a radically reduced cost. This collection includes physical design, planning and technological aspects. The physical design features of BRT include the use of dedicated bus lanes or bus ways[1], enabling higher speeds and priority in congested traffic (Shaw in Freeman & Jamet, 1998: 108; Wright & Fjellstrom, 2005: 2). Rapid boarding and alighting capacity of busses and bus-stops, through elevated boarding platforms and boarding bridges on busses, also plays a significant role in making BRT competitive with other modes of transport (Wright, 2005: 47). These features are closely related to BRT planning aspects such as, modal integration at interchanges, consolidation of transport into corridors and operation of short distance high demand routes to minimize dead mileage (Shaw in Freeman & Jamet, 1998: 108). Supportive management technologies are routinely incorporated into BRT systems and include off-vehicle ticket handling, real-time information displays and automatic vehicle location (Shaw in Freeman & Jamet, 1998: 108; Wright, 2005: 1; Wright & Fjellstrom, 2005: 2). It should also be noted that the busses employed in BRT systems can operate on a variety of alternative fuels which can dramatically reduce pollution emission. The most notable alternative fuel currently used in BRT systems is compressed natural gas, which is widely used in both Europe and South America (Wright, 2005: 1). BRT also appears to be a cost-effective and practical mass transit option, particularly for developing countries. In this regard Wright and Fjellstrom (2005: 21-26) argues that BRT holds several advantages over other mass transit systems, most notable in terms of ; cost, planning and construction time, capacity, flexibility and speed.

According to Hensher (2007: 99) and Zheng & Jiaqing (2007: 140), capital costs for rail-based mass transit approximates US$ 20 – 180 million per kilometre (Wright and Fjellstrom, 2005: 18), compared to the substantially lower US$ 1 – 10 million per

[1] Bus lanes are dedicated lanes on road surfaces used by other modes of transport. Such lanes might be opened to all modes of transport for periods of time. Bus ways are physically separated road-beds for exclusive bus traffic.

kilometre for BRT. The cost of transport technologies is also significantly lower for BRT as compared to rail-based alternatives, with for example, a Compressed Natural Gas bus retailing for US$ 150 000 – 350 000, compared to a Metro rail car costing US$ 1.7 – 2.4 million (Wright & Fjellstrom, 2005: 19). Due to the relatively simple design requirements of BRT, the planning and construction time proves to be much shorter than for rail-based alternatives. A case in point is Bangkok's Skytrain rail transport project, including 25 stations, which required four and a half years to be completed, from the time of signing the construction contract to its first operation. Bogotá's TransMilenio BRT system with 56 stations took less than 3 years from concept phase to full implementation (Wright & Fjellstrom, 2005: 20).

BRT displays passenger carrying capacities comparable to most Light Rail and Metro systems, with Brazilian and Colombian BRT's handling passenger flows of 20 000 to 35 000 per hour per direction. This appears to be on par with Metro lines in countries such as London, which accommodates 25 000 passengers per hour per direction (Wright & Fjellstrom, 2005: 23). In terms of flexibility, BRT offer clear advantages over rail-based alternatives. Adapting routes to demographic and planning changes is fairly easy with BRT systems, due to its flexibility to operate on and off its dedicated bus ways and bus lanes, as opposed to fixed rail options (Zheng & Jiaqing, 2007: 140). This capacity also reduces the impact of disabled busses on the BRT system, preventing major hold-ups due to vehicles blocking routes, as is the case in rail break-downs (Wright & Fjellstrom, 2005: 23). A common misconception is that urban bus systems cannot compete with the speed[1] of rail-based systems. Wright and Fjellstrom (2005: 24) corrects this, reporting that in a comparative study of BRT vs. Light rail

[1] Speed is regarded as a pivotal factor in determining the efficiency and competitiveness of any transport mode.

speeds, conducted in five cities, four of the five cities showed faster BRT speeds than Light rail. They do however indicate that BRT speeds comparable to light rail is generally associated with dedicated bus ways (Wright & Fjellstrom, 2005: 24). Finally, the urban spatial form of most cities in developing countries is disposed to transit based on corridor's, such as BRT, as development is generally concentrated along major arterials radiating from the CBD (Wright & Fjellstrom, 2005: 18).

4.2.15 Light Rail Transport & Ultra Light Rail

Light rail transport (LRT) is a comparatively new urban transport concept, but in principle it is based on the model of the old electric streetcar (Wright & Fjellstrom, 2005: 11). Unlike the old streetcar, LRT is more versatile and can travel at much higher speeds, making it a popular choice both as an integrated transit system which shares road space with other modes of traffic and travels at slower speeds, and as a high speed, mass transit system operating on physically segregated or elevated lines (Wright & Fjellstrom, 2005: 11). LRT also produces no local emissions[1] as it is electrically powered.

Knowels (2007: 82) however warn that LRT suffers the same fate as most other rail-based transit systems[2], namely; being very expensive to construct and relatively expensive to maintain. This is clearly reflected in the fact that, apart from in Eastern Europe and the Soviet Union, extensive LRT systems have only been implemented in wealthy developing cities such as Kuala Lumpur and Hong Kong (Wright & Fjellstrom, 2005: 11). But even wealthy developed cities such as Leeds and Liverpool

[1] Emissions produced at immediate area of application.
[2] These include metro and commuter rail systems. Metro systems are capable of carrying the greatest number of passengers (twice as much as commuter rail and four times the ridership of LRT) and, like commuter rail, require exclusive right of way and safety measures due to their relative high speeds. Metro and commuter rail also requires additional subsidies to be economically viable.

was forced to scrap some of its LRT strategies due to high construction and operational costs (Knowels, 2007: 86). Griffin (2001:1) reports on a smaller capacity LRT system called Ultra Light Rail (ULR), which is characterised by the use of tramway technology and energy storage as opposed to continues electrification. ULR systems convert vehicle kinetic energy into electricity and store this electricity for later use[1], giving it a cost advantage over conventional LRT which requires expensive continuous electrification (Griffin, 2001: 2). Griffin (2001: 2) further asserts that lightweight tramway lines are cheaper to install than heavier LRT lines and concludes that the total system cost for ULR is £ 1 – 2 million per kilometre, a cost comparable to that of BRT systems. ULR offers the additional advantages of greatly reducing emissions due to its energy conversion and storage capacity.

4.3 Fuel and vehicle technologies

4.3.1 Gasoline & diesel

A discussion on the technological advances and alternatives in vehicle fuel will not be complete without reference to gasoline (petrol) and diesel. Walsh & Kolke (2005: 3) indicates that reducing levels of lead in gasoline and sulphur in diesel produces significant reductions in pollutants. The most notable pollutants in gasoline are Carbon Monoxide (CO), Hydrocarbons (HC), Nitrogen dioxides (NOx) and lead (Walsh & Kolke, 2005:3). These can however be reduced through the use of three-way catalytic converters, fitted to 90% of new motor vehicles, which converts these gasses to harmless carbon dioxide, water vapour, oxygen and nitrogen (Walsh & Kolke, 2005: 4). However, the presence of lead in gasoline, apart from being a

[1] The Parry-Clayton PPM50 is a ULR system that employs a Liquid Petroleum Gas engine for main propulsion, while storing and using kinetic energy as back-up electricity. Accordingly it is not dependant on electrification of any sort.

dangerous pollutant, also poisons the catalytic converter, progressively reducing its performance until no pollutants are converted. It should also be noted that lead does not occur naturally in gasoline, but is added to gasoline to improve its performance (Welch & Kolke, 2005: 4). Hence, international emphasis should be placed on eliminating the addition of lead to gasoline. The combustion of diesel produces significant quantities of particulate matter (PM) and Nitrogen dioxides (NOx). Reducing the levels of PM is of particular importance, as it is a known carcinogen (Welch & Kolke, 2005: 6). The presence of sulphur in diesel has a dual negative impact in this regard. Sulphur not only increases the amount of PM in diesel fumes (see Table 6), but also precludes the use of technologies to reduce PM and NOx in vehicle exhaust gas (Welch & Kolke, 2005: 6). Catalytic converters in diesel engines are poisoned by sulphur in much the same way as lead poisons catalytic converters in petrol engines, leading Welch and Kolke (2005: 8) to state that: "*[T]he presence of sulphur in diesel fuel effectively bars the way to low emissions of conventional pollutants*."

Table 6: Summarised influence of fuel properties on diesel emissions

Fuel Modification	NOx	Particulates (PM)
Reduce sulphur	No effect	Large reduction
Increase cetane	Small reduction	No effect
Reduce total aromatics	Small reduction	No effect
Reduce density	Small reduction	Large reduction
Reduce polyaromatics	Small reduction	Large reduction
Reduce T90/ T 95	Very small reduction	No effect

Source: Adapted from Welch and Kolke (2005)

4.3.2 Natural gas and Natural Gas Vehicles (NGV's)

Natural gas or biogas is a fuel sources generally consisting of 60% - 85% methane gas and carbon dioxide (Swanepoel, 2007: 151). Natural gas is manufactured through the anaerobic digestion of organic-waste, most notably sewage in urban settings, which produces methane (Swanepoel, 2007: 151; Natural Gas Vehicles, 2005: 1). The use of natural gas[1] in vehicles, especially urban bus transport is increasing in popularity, with 25% of new busses in the United States of America and France being natural gas vehicles (NGV's) (Natural Gas Vehicles, 2005: 1) and displays encouraging pollution and energy reductive capacities. Welch & Kolke (2005: 11) reports volatile organic compound (VOC), NOx and CO emissions from natural gas combustion to be substantially lower than that of gasoline and diesel. Furthermore, the total greenhouse gas emission (GHG) of natural gas is 15% - 20% lower than gasoline, as the total carbon content per unit of energy of natural gas is less than that gasoline (Welch & Kolke, 2005: 11). The importance of natural gas, and other biomass-based energy, however lays in its 0% contribution to carbon dioxide to the atmosphere. Rather than producing new carbon dioxide, biomass-based fuels re-circulate the existing carbon dioxide in the atmosphere and utilizes stored solar energy as its primary energy source (Swanepoel, 2007: 148).

Most Natural Gas Vehicles are normal diesel or gasoline powered vehicles that have been retro-fitted with natural gas systems, even though a growing amount of originally build NGV's are emerging. In essence, retro-fitting involves the addition of a high-pressure fuel tank to store biogas (Natural Gas Vehicles, 2005: 1-2), which is

[1] Liquid Petroleum Gas (LPG) is also commonly used in vehicles. LPG consists of primarily propane or a propane/butane mixture, both fossil fuel derivatives, which adds to global CO2 emissions when burned. Apart from this, there is practically no difference between LPG & Natural gas in terms of use and emissions.

combined with either a bi-fuel engine system (for gasoline engines), enabling the engine to run on either gasoline or natural gas, or duel-fuel engine systems (for diesel engines), where the vehicles operates on a mixture of diesel and natural gas (Natural Gas Vehicles, 2005: 1). Welch and Kolke (2005: 11) cites the major obstacles to the wide-spread use of NGV's as the absence of a gas transportation and storage infrastructure and the high cost of natural gas, but also reduced vehicle range due to a 10% - 15% decrease in fuel efficiency in NGV's as compared to gasoline or diesel vehicles (Natural Gas Vehicles, 2005: 3).

4.3.4 Biodiesel

Biodiesel is a fuel obtained from plant oils that have been transformed in a process called *transestrification.* Plant oil is mixed with methanol and a potassium hydroxide catalyst (KOH), which results in a fatty-acid methyl ester (FAME), better known, as biodiesel, which can be used neat or blended with petroleum diesel in normal engines (Swanepoel, 2007: 152; Welch & Kolke, 2005: 16). Biodiesel is similar in physical character to petroleum diesel, except that it contains no sulphur, which makes it particularly suitable for use in conjunction with catalytic converters to reduce PM and NOx levels in diesel exhaust gas (Welch & Kolke, 2007: 17). The use of catalytic converters in conjunction with biodiesel is of particular importance as the NOx levels of biodiesel is shown to be higher than that of petroleum diesel (Welch 7 Kolke, 2005: 71). HC and CO emissions in biodiesel are however lower than that recorded in petroleum diesel, while information on PM emissions appear to be mixed, with some studies indicating reductions and others showing increases over petroleum diesel's PM emissions (Welch & Kolke, 205: 17).

The energy balance[1] of biodiesel is dependent on the feedstock used in its production, but is generally cited between 3 and 9, distinguishing it as one of the best available alternative fuels in terms of the amount of energy output versus energy input (Swanepoel, 2007: 152). Biodiesel's economic viability is however restricted by the cost of feedstock oils and, more severely, by competition for arable land between food crop production and fuel crop production (Swanepoel, 2007: 152; Monbiot, 2005: 158). Monbiot (2005: 152-153) illustrates this tension by indicating that the United Kingdom alone would require 25.9 million hectares of arable land to cultivate enough fuel crops to meet its petroleum energy demand. The United Kingdom however only has 5.7 million hectares of arable land. Monbiot (2005: 153) concludes that the impact on food prices and production will be; firstly, excessively high food prices, which would place it way beyond the reach of the poor, and secondly, "*much of the arable surface of the planet will be deployed to produce food for cars, not for people.*" (Monbiot, 2005: 153).

4.3.5 Ethanol

The fermentation of primarily starch or sugar produces a liquid fuel called ethanol which can be used as a substitute for gasoline. Standard gasoline engines need slight adjustment to operate on 100% ethanol; alternatively, 10% ethanol can be mixed into gasoline, producing a fuel known as "gasohol" and used in standard engines (Swanepoel, 2007: 153; Welch & Kolke 2005: 16). The combustion of "gasohol" results in reduced levels of VOC's and CO, but an increase in levels of NOx (Welch & Kolke, 2005: 16).

[1] Energy balance refers to the ratio of net energy output to total energy input

Swanepoel (2007: 153) reports that ethanol extracted from sugar displays a superior energy balance to that of ethanol extracted from maize[1]. About 38% of sugar's original energy content can be converted into ethanol, giving it an energy balance of approximately 8. However, only 27% of the energy content of maize can be converted into ethanol giving it a best estimate energy balance of about 1.5 (Swanepoel, 2007: 153-154). Furthermore, Swanepoel (2007: 154) warns that the true energy balance of maize-based ethanol is disputed and argues that it may even have a negative energy balance, production more GHG and pollutants than using fossil fuels. As such, maize-based ethanol as a viable alternative fuel is regarded with suspicion and scepticism. This scepticism also results from ethanol's direct competition with food crop production, mentioned in the previous section, and its resultant high cost. According to Swanepoel (2005: 154), The United States of America produces 40% of the world's corn and is responsible for 70% of international exports. He argues that if the USA's planned ethanol plants for 2008 come on line, it would consume 50% of the countries total corn crop (Swanepoel, 2007: 154). Welch and Kolke (2005: 16) sustain this argument, indicating that ethanol's high price due to its competition with food crops is making it economically unviable. They report that the Brazilian "Prooalcool" ethanol fuel project, internationally recognized for its success, is dependant on heavy government subsidies, even though Brazil has access to abundant and inexpensive biomass resources (Welch & Kolke, 2005: 16)

[1] Ethanol can also be produced from cellulosic biomass. This is achieved if the cellulose fibre in biomass is hydrolysed by acids or enzymes to produce glucose which can subsequently be fermented to ethanol. This process involves advanced technical processes, most of which are still under development.

4.3.6 Hydrogen

Hydrogen is a highly flammable gas that can be stored and used as either a gas or a liquid, making its ideal for the automotive industry. The preparation of hydrogen can by achieved by a variety of means, but electrolyses appears to be the most practicable method of hydrogen extraction. Electrolyses imply passing an electric current through an aqueous solution to liberate gasses, such as hydrogen, from the electrolyte[1]. (Swanepoel, 2007: 160). The electricity used in this process is at present primarily generated from fossil fuels, but can in principle be generated using renewable energy sources. The intermittency of renewable energy sources and the current lack of energy storage technology however provides for practical limitations in executing large-scale hydrogen electrolyses (Swanepoel, 2007: 155). Hydrogen's value as an alternative fuel source is located in the possibility of using renewable energy in preparing hydrogen, thus creating a closed loop system requiring no fossil fuel energy inputs and producing only water as a by-product, when used in fuel cells (refer to next section), which can be re-used in electrolyses. Hydrogen prepared in this fashion can then be used as either a direct energy source or an energy storage medium, which is mobile and can be traded, giving rise to the concept of a Hydrogen Economy (Swanepoel, 2007: 155).

Hydrogen is however not a primary source of energy, but a secondary or energy storage source (Welch & Kolke, 2005: 17). As discussed earlier, it can only be generated by an existing source of energy; accordingly, hydrogen currently generated by fossil fuels offers no GHG or energy advantage over existing fuels. Swanepoel (2007: 156) also rapports that the storage of hydrogen can reduce its energy

[1] An electrolyte is a solution of chemical substances dissolved in water

efficiency, indicating that liquefying hydrogen consumes 30% of its energy content. The cost of preparing transporting and storing hydrogen is at present a major restriction to the large-scale use of hydrogen as an alternative fuel (Welch & Kolke, 2005: 18).

4.3.7 Fuel cells

The operation of a fuel cell is similar to that of a conventional battery. Chemical energy constitutes the power source of the fuel cell, but unlike in batteries, this energy is constantly supplied by means of hydrogen and oxygen gasses[1] (Swanepoel, 2007: 164). This process allows for hydrogen to be converted directly into electricity without combustion in oxygen, as required in electricity generation where hydrogen is "burned" to generate heat. This direct conversion to electricity produces only water as a by-product (Swanepoel, 2007: 164) which can be re-used in electrolyses for the preparation of hydrogen. Accordingly, fuel cells introduce the opportunity to install electric engines in motor vehicles, which promises to practically eliminate pollutants such as NOx and PM normally emitted by alternative fuels (Welch & Kolke, 2005: 20). The high cost of fuel cells appears to be the major barrier to its large-scale acceptance as an alternative fuel source (Welch & Kolke, 2005: 20; Swanepoel, 2007: 170).

4.4 Summary

A basic understanding of fundamental sustainable transport strategies is of particular importance to transportation planners, especially in the South African context where knowledge on such strategies is limited (Barbour & Kane, 2003: 34). This chapter

[1] Other energy sources such as methanol, ethanol and even petrol can be used in so-called novel fuel cells. Further research is however required to make these fuel cells cost effective.

provided a brief discussion of a selection of sustainable transport strategies; supplying a definition of each relevant strategy and its positive and negative attributes. For the purpose of clarity, the transport strategies are sub-divided into Transport Demand Management, pertaining mainly to planning, and Fuel Technologies; dealing exclusively with less environmentally degrading fuel sources.

CHAPTER 5

SYNTHESISING A SCORECARD FOR SUSTAINABLE TRANSPORT (SST)

5.1 Introduction

The previous three chapters each discussed a vital component of the proposed scorecard. Knowledge from these chapters will now be synthesised into a coherent Scorecard for Sustainable Transport (SST), capable of appraising the sustainability of transport programmes or plans (See Appendix B). Firstly, the theoretical perspective employed in compiling the SST will be clarified; and this is followed by an explanation of the SST's aims and objectives. The methodologies used in developing the SST are then discussed in depth and the chapter concludes with a detailed description of its structural design.

5.2 Theoretical perspective of the scorecard

The scorecard draws its theoretical base from the perspectives discussed in Chapter 2, section 2.3. Accordingly, the scorecard's structural approach to sustainability in transportation is informed by the flexible, multi-domain model of sustainable development by Allan and You (2002) and Muller (2007). In keeping with this model, the scorecard does not merely measure environmental, social and economic impacts of transportation, but also includes physical (built environment) and institutional impacts. Furthermore, the "steady-state" paradigm is used as the ethical underpinning of the scorecard; resulting in much emphasis being placed on the creation of performance targets, thresholds and absolute limits. The scorecard does not favour extreme strategies on the continuum between anthropocentric and ecocentric approaches to sustainable transport, but maintains a balanced position in keeping with a moderate position on the sustainable development matrix of Swilling (2006a).

5.3 Scorecard aims and objectives

The goal which this scorecard aims to achieve is to function as a policy and/or planning appraisal instrument which can be used to either, measure the sustainability status quo of existing transport systems, or to guide potential transport policy and/or planning towards a more sustainable product. It is important to note that the scorecard is primarily an awareness rising instrument, which can be used as a checklist, but also offers a simple quantitative measurement of sustainability in transport. The scorecard is not biased towards either developed or developing countries, or towards rich or poor segments of society, but rather aims to be a universally applicable instrument. The score, which is the end-product of the scorecard, is represented as an aggregated percentage, indicating the overall sustainability of the transport policy and/or plan, and, individual percentage scores assigned to each sub-category which the scorecard measures. Such individual scoring aims to help decision makers to identify specific areas requiring investment and ensures efficient use of time, money and skills. The scorecard further aims to provide decision makers with benchmark sustainable transport alternatives connected to each objective measured. Finally, the scorecard aims to be a low-cost appraisal tool which decision makers can use as an "early warning system" to identify sustainability flaws before policy and/or plan implementation. As a result, the scorecard does not provide in-depth measurement, but rather a broad overview.

As mentioned earlier, the objective of the scorecard is to appraise the sustainability of transport policy and planning. Accordingly, it is necessary to define what this scorecard holds as objectives of sustainability, or put differently, what objectives must be reached to ensure sustainability. These objectives are quite simply the sustainable transport principles identified and discussed in Chapter 2. For purposes of clarity, these principles will now briefly be restated as objectives.

Objective 1: Universal Access

Maintaining and encouraging the viability of diverse transportation options, while keeping destinations within easy reach of all transport users and promoting access rather than mere mobility.

Objective 2: Social Equity

Equitable access and distribution of transport benefits, with special emphasis being placed on the transportation needs of the poor, elderly, woman and children, while also mitigating biased distribution of traffic pollution and accidents.

Objective 3: Ecological Limits

Setting, maintaining and respecting maximum sustainable ecological limits pertinent to the transport sector.

Objective 4: Safety and Security

The absolute minimisation of traffic induced pollution and accidents, while personal safety of passengers utilizing public transport services and the safety and liveability of neighbourhoods must be achieved.

Objective 5: Public Participation

A process whereby transport planning is no longer the exclusive domain of "experts", but a method that empowers members of the public to participate in setting and planning their "own" transport agenda in order to ensure sustainability.

Objective 6: Affordability

Transport services and strategies must be affordable to the lowest income group, taking into account the full cost of transport, and, being progressive according to income and/or mode of transport utilised.

Objective 7: Institutional Capacity

The capacities to plan, influence, implement and maintain transport systems and strategies, both at the public, private and community level, which requires the necessary skills, integration and co-operation within and between these sectors.

5.4 Methodologies employed in developing the SST

The process involved in developing a sustainable transport scorecard necessitated the amalgamation of various measuring apparatus, namely; indicators, benchmarking and appraisal techniques. The combined use of these three measurement techniques were selected to enhance the practicality of the scorecard. When used in isolation, each of the techniques offers unique limitations. Indicators tends to be reactive, providing information on development only after it has been implemented, while benchmarking takes no account of local needs and conditions, but merely provides a means of identifying best practice in a given field. Finally, appraisal techniques do provide information on the performance of a given development, but do not provide viable alternatives in the case of poor performance. Accordingly, the amalgamation of these techniques offers the opportunity to make the scorecard more useful in practice.

5.4.1 Indicators

According to Mitchell (1996: 1), an "*indicator is a means devised to reduce a large quantity of data down to its simplest form, retaining essential meaning for the questions that are being asked of the data.*" Such simplification implies that some data will be lost, and, as such, one should accept that indicators are not perfect measurement tools, but nonetheless effective in portraying fast amounts of complex data in a user-friendly fashion (Mitchell, 1996: 1). Within the field of sustainable development, the prominence and demand for indicators are the result of the UN Conference on Environment and Development (the Rio Earth Summit of 1992) which stressed that sustainable development indicators are obligatory to provide much needed decision support and self-regulating capacity to integrated environmental and development systems and decision makers (Mitchell, 1996: 1-2; Satterthwaite, 1999: 352).

The limitations of indicators should however be noted. Brugmann (in Satterthwaite, 1999: 394) warns that indicators can create confusion if they are used to serve multiple, vague and/or contradictory objectives. Mitchell (1996: 8) reports that indicators lack flexibility and consistency over time, as old issues disappear and new issues rise to prominence. He also warns that indicators can be controversial due to the loss of vital information in the simplification process and the need for value judgements in weighting indicator components (Mitchell, 1996: 8). Being aware of these limitations and taking action to avoid these pitfalls can however ensure that indicators are strikingly effective. From a methodological perspective, the SST adopted the use of composite indicators; measuring a variety of variables, as opposed to aggregated single index indicators which reports on only one variable. According to Mitchell (1996: 3), aggregated single index indicators are not user friendly, not easily understood by the layperson and, while it may communicate changes *within* sustainable development at a national level, it is unlikely to identify changes required to *promote* sustainable development at a local scale. Flowing from the purpose of this study, composite indicators appeared to be the obvious choice, as this study intends to guide sustainable transport at local and/or regional levels.

Traditionally, indicator development methods consisted of extensive consultation with stakeholders in the particular phenomenon for which indicators are being developed. The famous "Sustainable Seattle"[1] programme generated sustainable development indicators through such a public consultation process lasting five years and incurring significant costs both in terms of time and money (Satterthwaite, 1999: 352-354). Such recourses were however not available for this study. In this eventuality, Mitchell (1996: 3) suggests the use of a more theoretical approach which draws on published work.

5.4.2 Benchmarking

Benchmarking is an ongoing process of identifying and analysing the most efficient and effective practices and knowledge in a given field, and sharing and applying such practices and knowledge to gain an operational and financial advantage (APQC, 2008). Adebanjo and Mann (2008) report that benchmarking can be further divided

[1] For more information on the Sustainable Seattle programme see: Atkinson, (1996).

into two distinct fields, namely; performance benchmarking and best practice benchmarking. Performance benchmarking concerns itself with comparing performance levels of organisations with relation to a specific activity or process, while best practice benchmarking aims to hone practices in order to reflect the best in a given field (Adebanjo &Mann, 2008). Best practice benchmarking is considered to be the most valuable type of benchmarking, but, also the most difficult and costly to establish (Adebanjo &Mann, 2008). This is attributed to the difficulty of identifying appropriate benchmarking partners that are willing to share sensitive information, and, the resource intensity and organisational support required by best practice benchmarking (APQC, 2008). A typical benchmarking methodology will include most or all of the following steps:

1. Identifying crisis areas
2. Identifying organisations utilizing similar processes and practices
3. Identifying organisations that are regarded as leaders in the required areas (as defined by step 1)
4. Survey organisations for best measures, processes and practices
5. Conduct site visits to "best practice" organisations to identify most excellent practices, and
6. Implementing new and/or improved practices

For the purposes of this study best practice benchmarking was selected as the type of benchmarking employed in constructing a sustainable transport scorecard, as a best practice approach is most relevant to the sustainable development field. The difficulty of establishing best practice benchmarking did not apply to this research due to the fact that sustainable transport is not considered a closely guarded business practice, but rather as a research and development topic intended for the common good of mankind. As a result, best practice within the field of sustainable transport is freely shared and widely available. The benchmarking methodology indicated above, was closely followed in the establishment of sustainable transport benchmarks, with the exception of step 5 which was not always practically possible to execute.

5.4.3 Appraisal techniques

Policy or project appraisal is often confused with policy evaluation. May (2005:32) resolves this confusion by indicating that appraisal is an ex ante process of deciding how to measure how well a possible policy or project will perform, whereas policy evaluation is an ex post[1] assessment of completed projects or reached objectives. From a methodological perspective, appraisal is most often conducted by means of cost-benefit analysis (CBA), multi-criteria analysis (MCA) or a combination of both (Bristow & Nellthorp, 2000: 53). CBA aims to attach a monetary value to alternative policy options in order to determine opportunity costs and actual costs for selecting or not selecting a given option (Weimer, 2008). Put differently, CBA is a comprehensive indicator of economic efficiency (Jonsson, 2008: 30). Bistrow and Nellthorp (2000: 52) summarize the characteristics of CBA as:

- seeking to include all significant impacts to all sections of society subject to certain technical constraints
- using monetary values to express measured impacts as a total money amount, based on consumers' preferences
- requiring only quantitative data, and
- seeking to avoid double counting of the benefits in different economic markets.

[1] Post-implementation

Even though CBA is extensively and successfully used in transport studies, it nonetheless has definite shortcomings. Certain environmental, social and equity measurements are beyond the capability of CBA, as it is either difficult to quantify or due to values differing considerably according to circumstances and across individuals (Minken, Jonsson, Shepherd, Jarvi, May, Page, Pearman, Pfaffenbichler, Timms & Vold, 2003: 59). Mackie and Preston (1998: 4) cites the United Kingdom's Department of Transport's Cost-Benefit Analysis computer program (COBA) as an example of inadequate consideration given to unquantifiable factors as a result of CBA's shortcomings. These limitations can be overcome by applying MCA methods in policy appraisal (Mackie & Preston, 1998: 4; Minken et al, 2003: 59).

MCA enables measurement when various objectives must be met and progress towards such objectives cannot be adequately measured by a single indicator such as money (UNESCAP, 2008). MCA can be used to evaluate either quantitative or qualitative data, or a combination of the two; thus enabling decision makers to measure more than pure economic efficiency (Minken et al, 2003: 47). As the MCA process does not rely on monetary value as an indicator of efficiency or success, alternatives need to be formulated through a relevant research process which could serve as objectives to be reached. Thereafter a criteria or set of sub-objectives must be devised which could measure the progress made towards reaching the identified objectives. Policies or projects can be scored in terms of how well it reaches the main objectives and can be referenced against a "Business-as-usual" score; measuring progress towards the stated objectives if no intervention is taken. MCA also allows for objectives to be weighted or prioritised by either a specialist, decision maker or relevant stakeholders (Minken et al, 2003: 48). The weighting process is often done in a subjective fashion by making value judgements, as is the case with the United Kingdom's New Approach to Appraisal (NATA) (Sayers, Jessop & Hills, 2003: 95), or alternatively a mathematical process can be followed. One such mathematical process is the Linear Additive Model[1], which entails multiplying the value scores of each criterion by the weight of that criterion and then adding all such weighted scores together to arrive at a single score for each considered option (Minken et al, 2003: 47; Sayers et al, 2003: 96). Minken et al (2003: 47) assert that: "*Models of this type have a well-established record of providing robust and effective support to decision-makers working on a range of problems and in various environments. They have an adequate theoretical foundation and an ability to diminish the cognitive limitations of unaided decision makers*." Stewart (1992: 586) alludes to the practicality of the Linear Additive Model; indicating that the connection between the inputs of the decision maker and the outputs acquired are easily understood and not hidden behind "*a screen of complex mathematical manipulation*." However, a major shortcoming of the Linear Additive Model is the complexity of determining and assigning explicit weights to each criterion (Sayers et al, 2003: 97), especially when trade-offs between different criterions are difficult to quantify, or where a given criterion would have a different value depending on the specific needs of the area where it is applied. This complexity causes the NATA system to stoutly reject assigning weights to evaluation criterions, stating that: *"…it is for the decision-takers to make judgements about the relative value to be put on the individual criteria."* (Sayers et al, 2003: 97).

Both MCA and CBA can be subject to sources of error or bias when applied as an appraisal method. Mackie and Preston (1998: 1-7) identifies some of these

[1]For more information on the Linear Additive Model, see: Keeney and Raiffa, (1976).

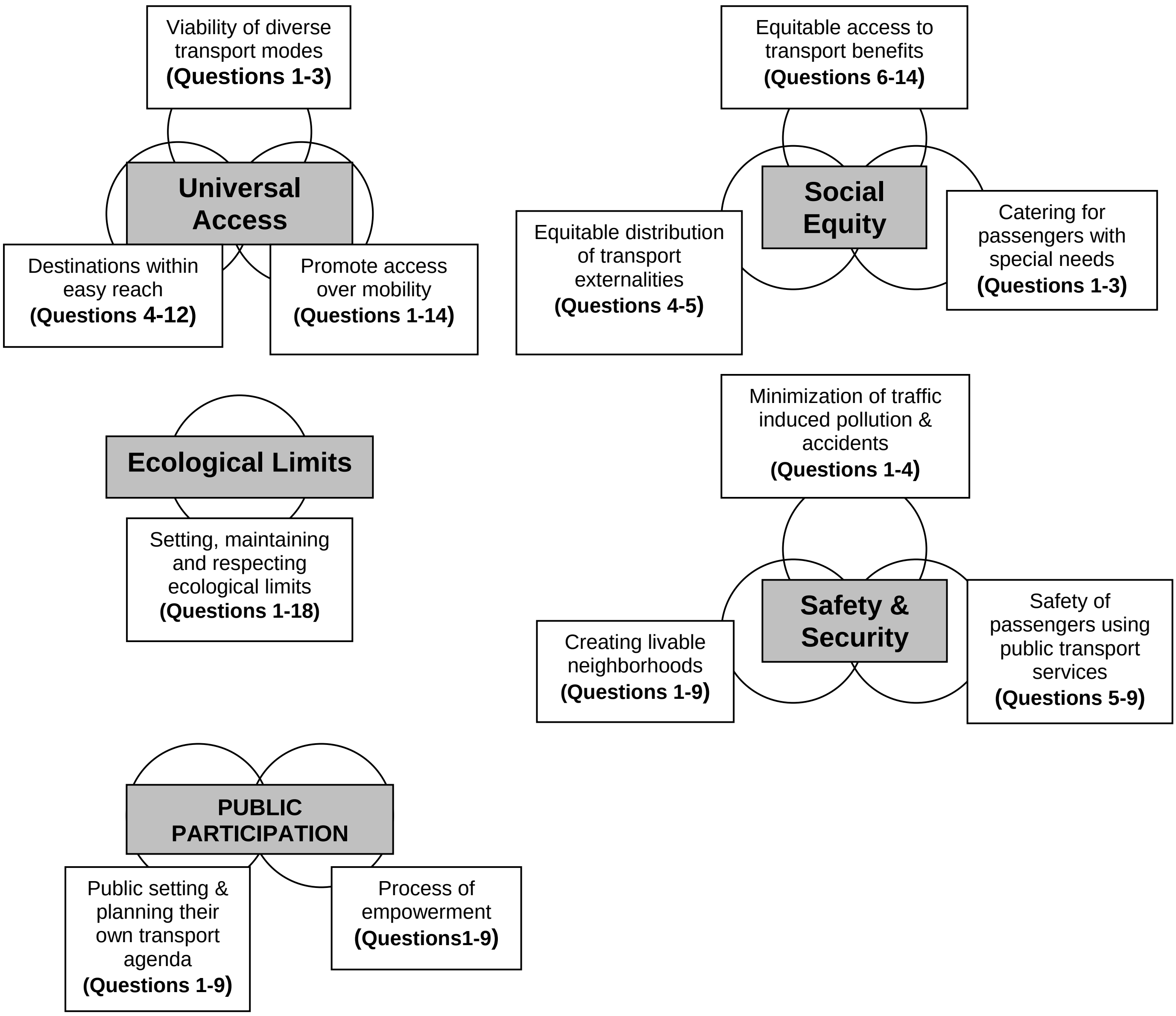
shortcomings; specifically in terms of transport appraisal and includes the following leading examples:

- *Unclear objectives:* Ideally, the appraisal's objectives should be clear and unambiguous and the appraisal criteria should follow directly from it.
- *Prior political commitment and political pressure:* Some policies or plans might be difficult to reject or adapt due to the amount of political commitment and/or prestige it has accumulated.
- *Current (Business-as-usual) situation not accurately known:* The starting point of any appraisal exercise is to collect accurate data on the current condition of whatever one aims to appraise. Lack of such data leads to an inaccurate appraisal.
- *Interactions not taken into account:* In terms of transport, investment in one mode or market may lead to a reaction from rival markets or alternative modes which are difficult to forecast.
- *Omitting quantifiable impacts:* It often happens that easily quantifiable impacts are excluded from the analysis, leading to suboptimal appraisal capacity.
- *Exclusion of qualitative impacts:* Qualitative impacts are often left out of the analysis due to difficulty in quantification or measurement.
- *Double counting:* Impacts may be counted more than once as result of the multiplier effect; being merely downstream manifestations of a primary impact which was already counted (Mackie & Preston, 1998: 1-7).

For the purposes of this study a MCA methodology has been selected. The multi-disciplinary nature of sustainable transport necessitates a measurement methodology that adequately caters for both quantitative and qualitative data. Due to vastly different developmental goals and transport realities encountered in various different countries, no criterion weighting methodology is employed in this study. This study agrees with the NATA system's approach to criterion weighting; accordingly allowance had to be made for the adoption of a weighting system which would be subject to the value judgement of local specialists as dictated by their local environments.

5.5 Structural layout of the SST

Structurally, the scorecard consists of five columns, which states; the sustainability objectives to be achieved, the indicator used to measure such achievement, a point score column and finally, a percentage score column (Refer to Appendix B). The sustainability objectives are located in the first column and have already been discussed in the previous section. It should however be noted that each objective is subdivided into sub-objectives in column two, and is stated as a range of questions. All questions have yes or no answers; this is done to avoid the obvious pitfall of setting maximum or minimum requirements which would reduce the scorecards' universality, and, to maintain the ex ante or proactive nature of the scorecard as opposed to a pure measurement instrument. Each sub-objective has ideal answers, which can be *either* yes or no and are indicated in column three. If the test case's answer corresponds with the ideal answer on the scorecard, one point is scored, if not, no points are awarded. Figure 10 illustrates which aspects of each sustainability objective are addressed and by what questions. It should be read with the objectives stated in section 5.1. Each sustainability objective will end up with a score which will be moderated to a percentage and displayed in column five. This percentage score will be presented numerically as well as in a spider-graph format to enable decision-makers to easily identify areas in need of attention (see Figure 11). Added to the scorecard is a table which links benchmark sustainable transport practices applicable to each measured objective of the scorecard; supplying decision makers with sustainable alternatives pertinent to the specific objective. For the complete SST with ideal answers and list of best practice sustainable transportation practices, see Appendix B.



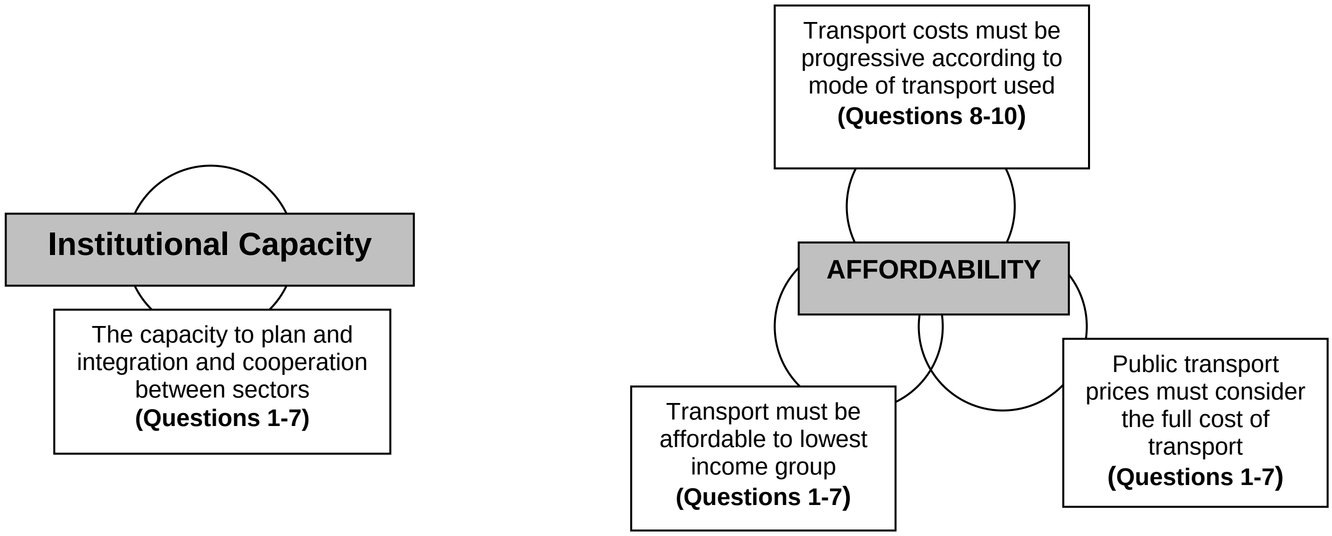


Figure 10: Venn diagrams illustrating which aspects of each objective are addressed and by what questions
Source: Drafted by author

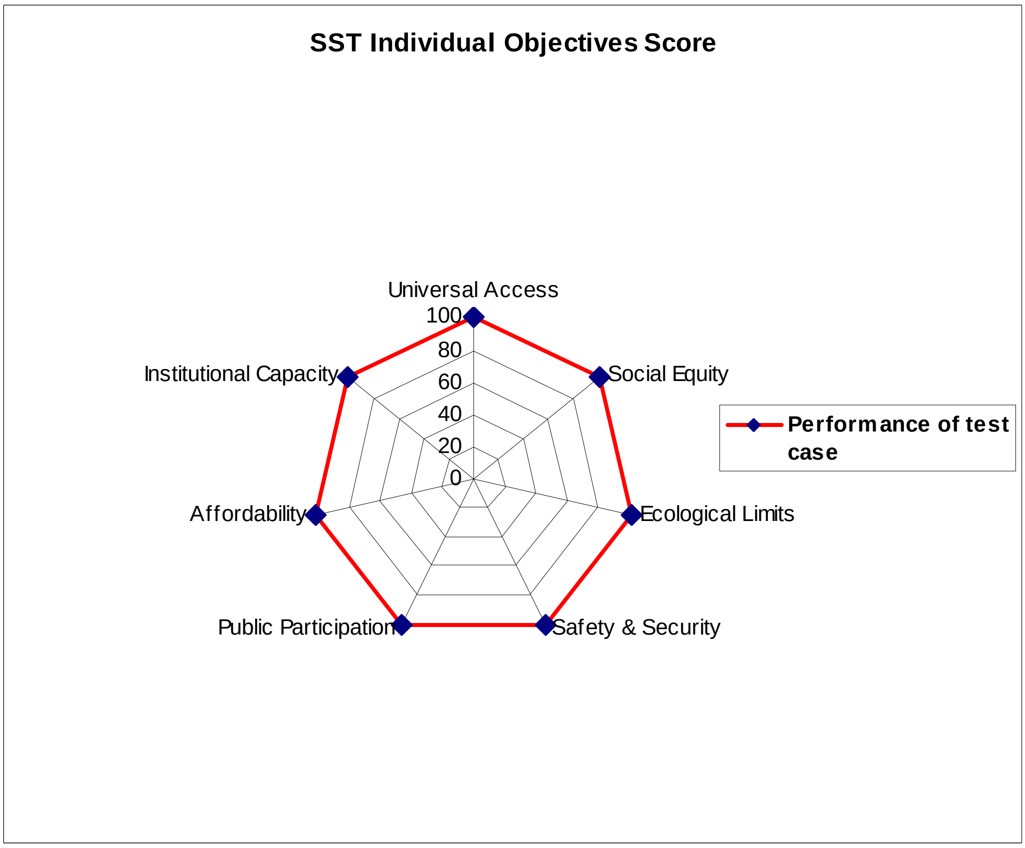


Figure 11: Example of spider-graph used in the scorecard with a 100% score on all objectives
Source: SST as contained in Appendix B

CHAPTER 6

CAPE TOWN'S TRANSPORTATION REALITY AND THE INTEGRATED TRANSPORT PLAN (ITP)

6.1 Introduction

The case study for testing the operability of the sustainable transport scorecard, as mentioned in the introduction, is the City of Cape Town's Draft Integrated Transport Plan (ITP) 2006-2011. This chapter will provide relevant background information on the socio-spatial and physical structure of Cape Town and how this influences transport and energy consumption within the city. A discussion of the city's latest attempt to address its transport legacy, the ITP, is also included to present a proper understanding of the background and objectives of the plan this study proposes to appraise.

6.2 Socio-spatial and physical city structure

Cape Town's socio-spatial landscape appears to be dominated by at least three major characteristics, namely; fragmentation, separation and low-density sprawl (Dewar *et al*, 1990; Dewar & Uytenbogaardt, 1991; Behrens & Watson, 1992). Contrary to expectations, the scrapping of segregation laws since 1994 achieved little in altering the segregated *apartheid* city landscape of South Africa in general and Cape Town in particular (Watson in Harrison *et al*, 2003: 140; Christopher, 2005, 1).

Dewar (1990; 1991) and Behrens (1995) ascribe Cape Town's fragmented and separated nature primarily to South African layout planning approaches, based on the "garden city" and "neighbourhood unit" concepts. The "garden city" concept was proposed by Ebenezer Howard in 1902, in response to rapid metropolitan growth and aimed to balance and integrate the best attributes of the human habitat, namely; urban, rural and primeval (Dewar, 1990; Behrens, 1995). Accordingly, “garden cities” were intended to be self-contained, offering a full range of services and activities which are spatially separated by green and open spaces while maintaining low densities. Clarence Perry’s (1939) “neighbourhood unit” perfectly complemented the “garden city” concept on various accounts. Feelings of neighbourliness and community were promoted by the “neighbourhood unit” in the creation of self-contained and inwardly focussed residential areas. This feeling of cohesion was further strengthened by the ideal to separate residential locations from the perceived negative impacts of commercial and industrial activities. Such separation was achieved by spatial buffers, such as belts of open space, wide roads and freeways. The “neighbourhood unit” also provided for ease of access to green or open space, which encourages single dwellings on large plots of land and abundant recreational space in residential developments (Dewar, 1990; Behrens, 1995).

Historically, the “garden city” and “neighbourhood unit” well suited the segregatory purposes of apartheid planning, consequently gaining rapid acceptance and entrenching itself as a dominant South African planning concept (Dewar, 1990; Behrens, 1995). The political flavour added to these planning concepts ensured not only that white, coloured and black communities were segregated, but also that coloured and black communities were settled on the urban periphery. The persistent legacy of these planning concepts is still apparent in Cape Town’s land use patterns (Dewar, 1990; Dewar & Uytenbogaardt, 1991; Behrens, 1992; Watson in Harrison *et al*, 2003).

Relatively homogeneous clusters of various services and activities are spread out over the city and connected with limited access high-speed transport routes, with historically coloured and black communities, such as Mitchell's Plain and Khayelitsha, being relegated to the urban edge (Dewar, 1990; Dewar & Uytenbogaardt, 1991; Van der Merwe, 1993). This causes the grain of the overall city to be coarse, fragmenting the urban fabric between residential, commercial and industrial, and physically separating income groups and concurrent racial groups between expensive housing stock close to developed "spines" in the city and cheap housing stock on the urban periphery (Dewar, 1990; Todes in Harrison *et al*, 2003). These spines, or mature metropolitan corridors, contain the bulk of Cape Town's commercial, industrial and community facilities, as well as middle and upper income residential areas (Dewar, 1990; MSDF Technical Report, 1996). As a result, the urban fabric within these spines is fine-grained and relatively dense and contains the most integrated and concentrated public transport systems (Dewar, 1990). Cape Town exhibits three spines; the north-westerly spine, including Voortrekker Road, Parow, Bellville and Kuilsrivier; the southern spine which consists of Main Road and adjacent areas through to Wynberg, Muizenberg and Simonstown, and finally, a short western spine running from Greenpoint through Seapoint to Camp's Bay (Dewar, 1990; MSDF Technical Report, 1996). The schematic illustration of the racial spatial distribution (see Figure 12 and Figure 13) representing discrepancy between work and residence clearly depicts the spatial inequality and segregated nature of Cape Town.

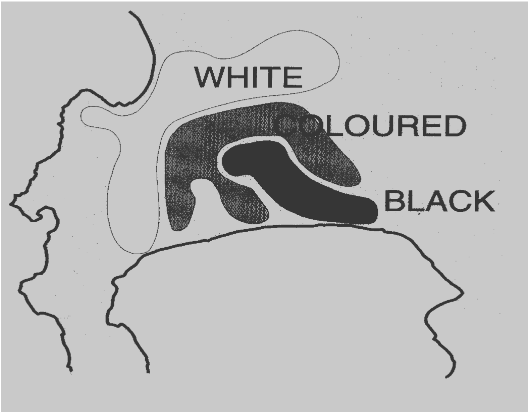


Figure 10: Racial spatial distribution in Cape Town
Source: MSDF Technical Report (1996)

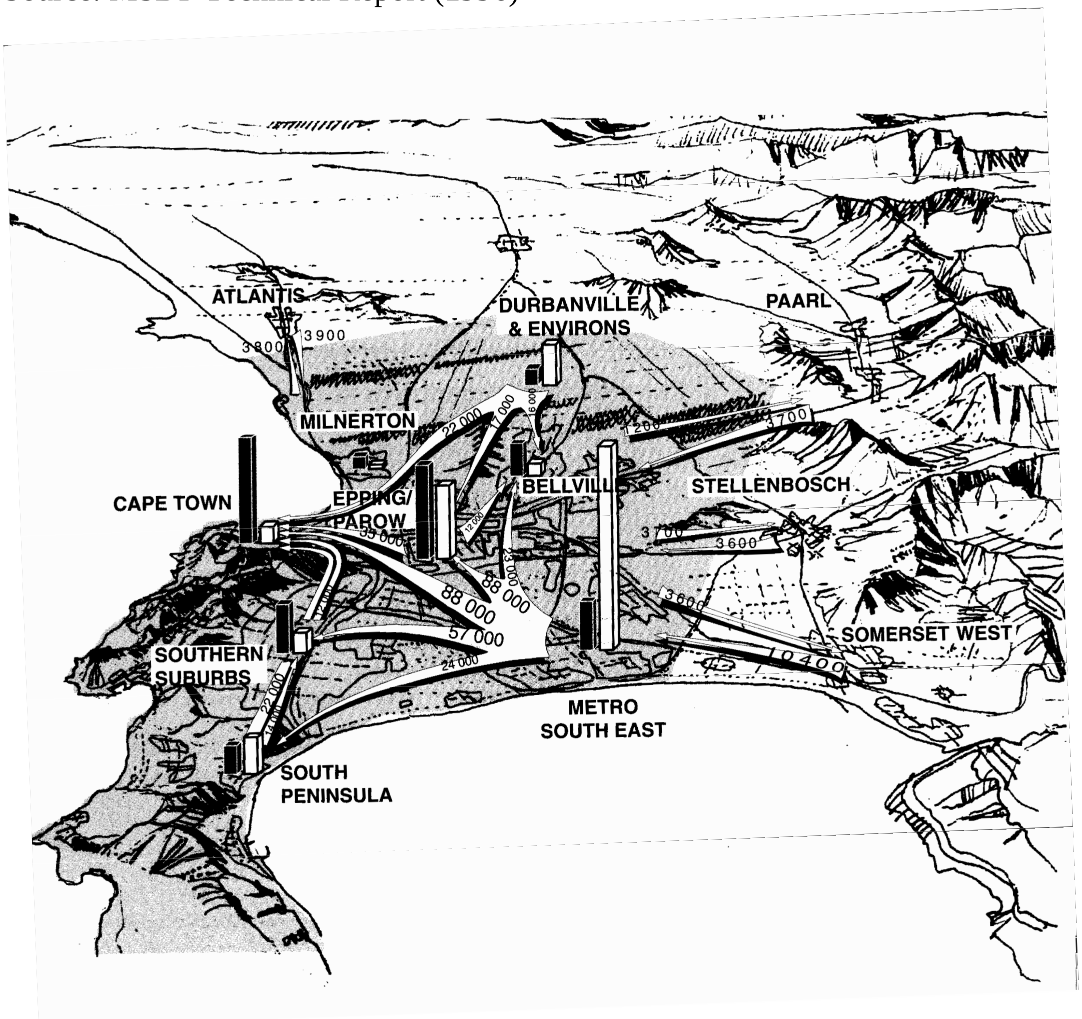


Figure 11: Discrepancy between work and residence in Cape Town
Source: MSDF Technical Report (1996)

An obvious corollary of such a spatial arrangement is low-density sprawl. High-and middle-income groups continually seek residential property that offers privatised amenities, such as natural beauty and open space, in keep with the entrenched values of the "neighbourhood unit" (Dewar, 1990). Such amenities are most commonly found on greenfield areas, causing what Dewar (1990) refers to as speculative sprawl. The historical relegation of poor communities to the urban periphery, combined with Cape Town's growing housing backlog (Dewar, 1990; Intergovernmental Integrated Development Task Team for Cape Town Functional Region, 2006: 10) exacerbates urban sprawl in at least two ways.

The urban poor represent a significant and growing number of the urban population. However, poor communities remain captive to low-income-and informal-housing stock on the urban edge, while their numbers continues to grow, forcing new arrivals to locate on vacant land. Secondly, in an attempt to address the housing back-log, new low-income housing developments in Cape Town is often located on affordable and available land on the urban periphery or even beyond existing informal settlements that currently exist on the urban edge (Dewar, 1990; Dewar & Uytenbogaardt 1991; Todes in Harrison *et al*, 2003; Behrens & Wilkinson in Harrison *et al*, 2003).

6.3 Transport and energy consumption impacts

Cape Town's urban form results in a particular transport pattern with resultant energy consumption characteristics, and can be summarised into three main impacts, namely; private automobile dependence, high time and financial costs and exorbitant energy demand and pollution generation. According to Dewar (1990), Cape Town's urban structure generates high volumes of traffic movement, but such movement is dominated by the private car, as distances between citizens, services and activities are too great for non-motorised transport and low-density sprawl prevents the creation of a critical mass of population density, required to make public transport viable. Behrens and Wilkinson (in Harrison et al, 2003) illustrates the long trip distances the urban poor is faced with by referring to the start time of work trips in Cape Town. Black and coloured communities, due to their peripheral location, on average start their working trips considerably earlier than white communities (See Figure 14). Figure 14 indicates that when white commuters start their work trips at 05h15, approximately 2 to 3 % of coloured and black commuters are already busy commuting to work.

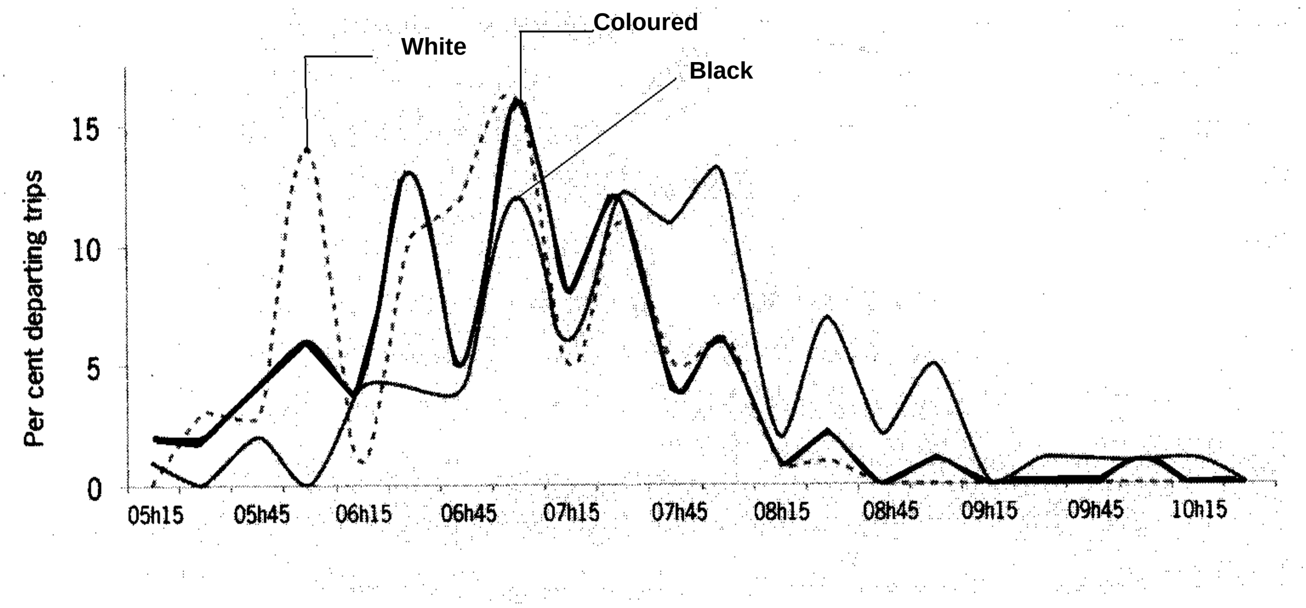


Figure 12: Work trip departure time by race in metropolitan Cape Town
Source: Behrens & Wilkinson in Harrison *et al* (2003)

Behrens and Wilkinson (In Harrison et al, 2003) attributes these earlier starts to slower modes of transport accessible to the poor, and trip distances of up to 50% longer than more centrally located communities, which results in trip distances of 15.5 km versus 12.6 km for high-income communities (see Table 7). The urban poor qualifying for the maximum housing subsidy must earn no more than R 1500 per month. Behrens and Wilkinson (in Harrison et al, 2003) indicates that 90% to 95% of such households do not have access to a motor car, and, seeing that most low-income housing in Cape Town is located on the urban periphery, poor communities are left at the mercy of unviable public transport systems and taxi's which consumes up to 10% of their disposable income, the maximum internationally accepted limit. (Behrens & Wilkinson in Harrison et al, 2003). Transport accounts for 54% of Cape Town's energy consumption and produces 22% of the city's total greenhouse gas emissions. Private automobile use accounts for 51.4% of the total passenger kilometres travelled in the city and research indicates that this might be escalating (Energy Research Centre, 2005 & Sustainable Energy Africa, 2003). Private automobile use accounts for 55% of all transport in the Central Business District (CBD) of Cape Town, as opposed to other international cities which displays a much higher percentage of public transport use in its CBD's (Sustainable Energy Africa, 2003). Private automobile ownership also increased by 45% from 1990-2000 which translates into an increase in inbound traffic (over a 12 hour period) from 123 985 vehicles in 1994, to 157 452 in 2001 (Sustainable Energy Africa, 2003).

Table 7: Distances and average time spent in commuting in major South African cities

	Distance between black township(s) & CBD (kms)	Average time spent in transport (minutes per journey)
Johannesburg (bus/trai	20.0	77
Johannesburg (taxi/cars	20.0	44
Pretoria	52.0	75
Durban	20.0	n. a.
Bloemfontein	58.4	86
Port Elizabeth	16.1	n. a.
East London	21.4	n. a.
Cape Town	18.8	65
Average	28.3	69

Source: De Saint-Laurent in Freeman & Jamet (1998)

The transport sector in Cape Town consumes 1.7 million litres of imported oil annually, contributing to 17.2% of the total sulphur dioxide emissions, 72.4% of the total nitrogen oxide emissions and 70.3% of the total Volatile Organic Compounds (VOC's). Of these greenhouse gasses the most striking transport emission contribution is however from CO2, which accounted to 4.3 million kg's in 2001 (Sustainable Energy Africa, 2003).

6.4 Cape Town's Integrated Transport Plan (ITP)

6.4.1 Background and motivation

It is with the aim of addressing the abovementioned imbalances that the City of Cape Town drafted its Draft[1] Integrated Transport Plan (ITP) in June 2006. The ITP aims to be a comprehensive transportation plan which will guide the management and development of the Cape Town Metropolitan transport system (ITP, 2006: xiii), and was prepared in terms of section 27 (1) of the National Land Transportation Transition Act no. 20 of 2000. Currently, the ITP is still in draft format and will be submitted for adoption to the Provincial MEC of Transport and Public Works as well as to the National Minister of Transport, once the public review process is completed and all necessary corrections are made. The ITP operates over a five year period (July 2006 to June 2011) and will be reviewed annually to ensure that it complies with international best-practice (ITP, 2006: xiii).

The ITP was called into life to address Cape Town's growing transport challenges. Congestion in the city is growing, with peak-hour traffic extending over a three hour

[1] Available at:
www.capetown.gov.za/en/IDP/Documents/Statutory%20compliance%20plans/M.Integrated%20Transport%20Plan.pdf

period (ITP, 2006: 31), while commuter travel distances are steadily increasing; indicating urban sprawl. Travel distances are increasing in the absence of neither a high quality public transport system, nor any noteworthy non-motorised transport developments; exacerbating congestion further (ITP, 2006: 31). Many perceived and real safety issues also plague the city's transport system; with a significant accident rate of 77 514 accidents per year (2003), and a public perception that public transport services are not safe (ITP, 2006: 31). Finally, private car usage is rapidly increasing, causing transport to account for more than 50% of air pollution in Cape Town (ITP, 2006: 31).

6.4.2 Aims and objectives

The ITP sets itself the aim of providing sustainable transport to the Cape Town Metropolitan area by sifting all modes of transport through a set of social, economic and environmental objectives (ITP, 2006: xiii). Sustainable transport is defined by the ITP as: *"the ability to move people and goods effectively, efficiently, safely and most affordably without jeopardising the economy, social matters and the environment, today and in the future."* (ITP, 2006: xiii). According to the ITP, the social, economic and environmental objectives utilized to "sift" through transport modes, must conform to the following sustainability principles:

- *"Meeting the basic access needs of individuals and societies in a safe and secure way, in a manner consistent with human and ecosystem health, and with equity within and between generations,*
- *Affordability - operates efficiently, offers choice of transport mode, and supports a vibrant economy, and*

- *Limits emissions and waste within the planet's ability to absorb them, minimizes consumption of non-renewable resources, limits consumption of renewable resources to the sustainable yield level, reuses and recycles its components, and minimizes the use of land."* (ITP, 2006: 21-22).

As a practical manifestation of these principles, a rather long list of objectives is proposed by the ITP, and is summarised in Table 8. However, measuring success in reaching this comprehensive list of objectives appears to be problematic. The ITP admits that it is still investigating actual targets to finalise its list of measurement indicators (ITP, 2006: 26) and that it will strive to reach the "purposes" of these sustainability indicators in the interim. Unfortunately, no date or timeline appears to have been set for its completion, though mention is made that it will be included in the document's next review (ITP, 2006: 36). When this review will take place is however unclear. One exception to this rule is a set of targets for the share of modal split which the ITP envisage for its lifespan and beyond. The ITP intends to move the private versus public transport modal split from the current (2006) 52 % and 48% respectively, to a 50/50% split by 2010 and a 43/57% split by 2020 (ITP, 2006: 37).

Table 8: List of objectives of the ITP

- To strive towards a complete transport system (non-motorised, taxi, bus, light rail and heavy rail)
- To promote travel demand management measures to encourage less car usage, to improve the environment, and to improve road safety. This will be promoted in CBD's, major public transport routes and cycle routes
- To align transport and land use planning to bring about a land-use pattern where the necessity to travel, especially by car, is minimised, and where there is a feasible choice of mode of transport
- To promote sustainable travel patterns by encouraging walking, cycling and the use of public transport
- To improve safety and security at interchanges, station car parks, and en-route to interchanges and stations. To provide better maintenance of facilities
- To provide non-motorised transport facilities and include their requirements in Traffic Impact Studies
- To protect the environment from pollution through vehicle emissions

- To manage the road network so that the current road space is optimised, and to only invest in new roads where it provides accessibility and support to public transport
- To promote and incorporate the principles of Universal Access in design and construction of transport infrastructure
- To support the use of rail for freight use and to manage road based freight vehicles
- To provide safe and convenient cycle and motor-cycle parking at stations, leisure facilities, public buildings and within employment areas (CBD's)
- To apply reduced parking standards for developments in CBD's and that are on major public transport routes
- To make better use of existing parking facilities – municipal and privately owned car parks should be made available for variable land use developments to increase their utilisation and return to the city
- To provide safe and affordable Park and Ride facilities at stations and other key sites
- To provide safe access to new developments
- To incorporate self enforcing traffic calming measures in the design of new residential areas, and to apply the traffic claming policy for existing areas

Source: ITP (2006)

6.4.3 Strategies for achieving sustainability in transport

The ITP proposes to meet its objectives through a variety of strategies; each targeting a specific sub-section of the urban transport system. These strategies, when taking into account its relevance to this study, can be broadly categorised in the following categories:

Strategies targeted at;

- Integration of land-use planning
- Streamlining institutional arrangements with relation to transport
- Improving public transport
- Universal access
- Non-motorised transport
- Travel Demand Management (TDM)
- Transport network operations; and
- Safety in transport (ITP, 2006)

A complete list of priority projects within each of these strategies is contained in the ITP and will not be discussed in this chapter, as it falls beyond the scope of this study.

6.5 Summary

Apartheid-style planning and fixation with the "garden city" model of town planning, resulted in Cape Town's urban character of separation, fragmentation and low-density sprawl. As a result of this character, Cape Town generates high levels of mobility, via high-speed, limited access roads which connects its mono-functional units, but at the expense of the poor. Historically, apartheids legislation forced the poor (black and coloured people) to settle on the urban fringes, and more recently, land values are preventing them from obtaining more centrally located property. Accordingly, the poor devotes a higher percentage of income and time on travel. Cape Town's most recent attempt to rectify these transport imbalances is the Draft Integrated Transport Plan (ITP) (2006), which aims to be a comprehensive and sustainable management and development policy for transport in the whole Cape Town Metropolitan area. Now that a clearer picture of the test case has been drawn, the next step, of testing the scorecards operability, can be entered into. The following chapter will apply the SST to the Draft ITP to firstly, analyse the ITP's sustainability, and secondly, test the scorecard's operability.

CHAPTER 7

DISCUSSION OF FINDINGS

7.1 Introduction

This chapter provides a discussion of the findings of this study, of which the aim was to design an appraisal mechanism for sustainable transport planning and then to measure how operable the appraisal mechanism is, by applying it to a test case. To this end, the results of the SST as applied to the ITP test case will be discussed (a complete copy of the SST test case is contained in Appendix C). The results are discussed under each of the seven measured objectives contained in the SST, namely: universal access; social equity; ecological limits; safety and security; public participation; affordability and finally, institutional capacity. This discussion is followed by an interpretation of the results, which attempts to place the results in context and draw possible conclusions. Finally, the chapter concludes with a discussion of the findings of the research question.

7.2 Results of the SST test case

7.2.1 Universal access

The ITP performed very well in terms of universal access, with a score of 78.5 %. Universal access is extensively integrated into the ITP (ITP, 2006: 15; 16; 22; 25) and it appears as if the City of Cape Town Municipality is duly aware of the importance and application of universal access in transportation planning. No targets are however set to measure the ITP's performance towards attaining an improved state of accessibility. Access to places of cultural importance and social interaction also seems to have been neglected in the ITP.

7.2.2 Social equity

Social equity, with a score of 71.4 %, is well addressed in the ITP. The ITP caters well for the needs of marginalised passengers and recognises the importance of providing equity in accessing transportation benefits. Two important issues are however not clearly addressed. Firstly, inequitable distribution of transport externalities appears to be only implicitly acknowledged and corrective action seems to be limited to reducing the amount of road accident injuries and deaths. Secondly, transportation's impact on landownership rights and livelihoods also appears to have been largely neglected.

7.2.3 Ecological Limits

The ITP scored relatively poor in terms of ecological limits (38.8%). Even though the ITP incorporates other sectoral strategies, such as the Air Quality Management Plan for the City of Cape Town and the City of Cape Town Biodiversity Study (ITP, 2006: 79-86), it fails to connect the plans contained in these strategies with the city's transportation reality, specifically in terms of environmental impacts. Conspicuously absent in the ITP, is any mention of noise pollution and/or assessment. Neither are any targets set to protect ecological limits, with the exception of air quality targets contained in the Air Quality Management Plan for the City of Cape Town, and no mile stones are set to measure the ITP's progressive realisation of ecological protection. Again it appears as if ecological limits are implicitly acknowledged by the ITP, but not explicitly addressed. The ITP does however suggest an urban edge or boundary, while also aiming to reduce energy consumption in the transport sector by actively reducing the use of single occupancy vehicles.

7.2.4 Safety and security

The ITP scored well (63.6 %) in terms of safety and security. Accident prevention in general (involving only motorised vehicles) and accidents involving NMT is extensively incorporated into the ITP. Furthermore, definite cognisance is taken of the transportation needs of NMT users and the general and specific issues required to improve the security of public transport infrastructure. The only criticism, in terms of safety and security, is directed towards the lack of performance targets and the apparent lack of catering for the security needs of vulnerable transportation users.

7.2.5 Public participation

In terms of public participation, the ITP achieved a poor score of 11. 1 %. The ITP does not illustrate the importance of public participation in transportation planning, nor does it provide guidance on how public input should be gained and what influence such input should have on planning decisions.

7.2.6 Affordability

The ITP scored a relatively low 33.3 % in terms of the affordability objective. The peripheral location of housing was considered for transportation affordability purposes and a transportation affordability analysis was conducted by the ITP. Low-income groups will however be spending more than 10 % of their income on transportation services by 2014 (ITP, 2006: 276), which is higher than the national strategic objective (ITP, 2006: xxi). Even though efforts are made to increase the affordability of transportation services in general, little appears to have been done on the longer term to target transportation affordability for marginalised transport users such as children, women travelling with children and the elderly.

7.2.7 Institutional capacity

Institutional capacity is well addressed in the ITP (71.4 %) with a substantial amount of inter-and-intra-governmental cooperation with regards to transportation planning. A large amount of research was conducted before the drafting of the ITP, providing it with enough reliable data for informed decision-making. A continual ex post evaluation system and a list of benchmark indicators are also prepared to ensure that the ITP stays adaptive and effective.

7.3 Interpretation of results

The ITP achieved an overall sustainability score of 52.6 %. Considering the present poor state of sustainability in transportation planning in South Africa (Barbour & Kane, 2003: 34), this score can probably be considered as indicative of a reasonable scale for a first effort at a sustainable transportation plan in a very unsustainable South African city. The top-scoring objectives were universal access (78.5 %); institutional capacity (71.4 %); safety and security (63.6 %) and social equity (57.1 %) (See Table 9). High scores in these objectives may be the result of Cape Town’s local transportation needs demanding more attention in these specific areas.

Table 9: Individual objective arranged from highest to lowest score attained

Individual Objective	Score
Universal access	78.5 %
Institutional capacity	71.4 %
Safety & security	63.3 %
Social equity	57.1 %
Ecological limits	38.8 %
Affordability	33.3 %
Public participation	11.1 %

Source: Drafted by author

When Cape Town's transportation reality (Chapter 6) is considered, it becomes clear that universal access, social equity, as well as safety and security is in high demand, while a high score in institutional capacity might be attributed to the City of Cape Town Municipality's greater awareness of sustainability issues, compared to other local governments in South Africa. It is also important to note that the SST does not assign weights to the objectives it measures, but leaves such weighting up to the judgement of local specialists who understand local transportation needs and challenges.

The three lowest scored objectives, namely: ecological limits (38.8 %), affordability (33.3 %) and public participation (11.1 %) provide some reason for concern. Ecological limits' poor performance is partially due to the fact that the SST's theoretical grounding is based on the steady-state theory which demands the setting of limits, especially in terms of natural resources. Very few limits are set by the ITP in general, but this lack is most keenly displayed in terms of ecological factors.

The ITP's poor performance in terms of affordability and public participation can however not be explained by the lack of limits. This seems to indicate that the ITP either provides too little information on these objectives, or that these two aspects of sustainability in transportation planning have been neglected. The spider-graph below (see Figure 15) clearly indicates a fair balance in all the objectives measured, except for affordability and public participation.

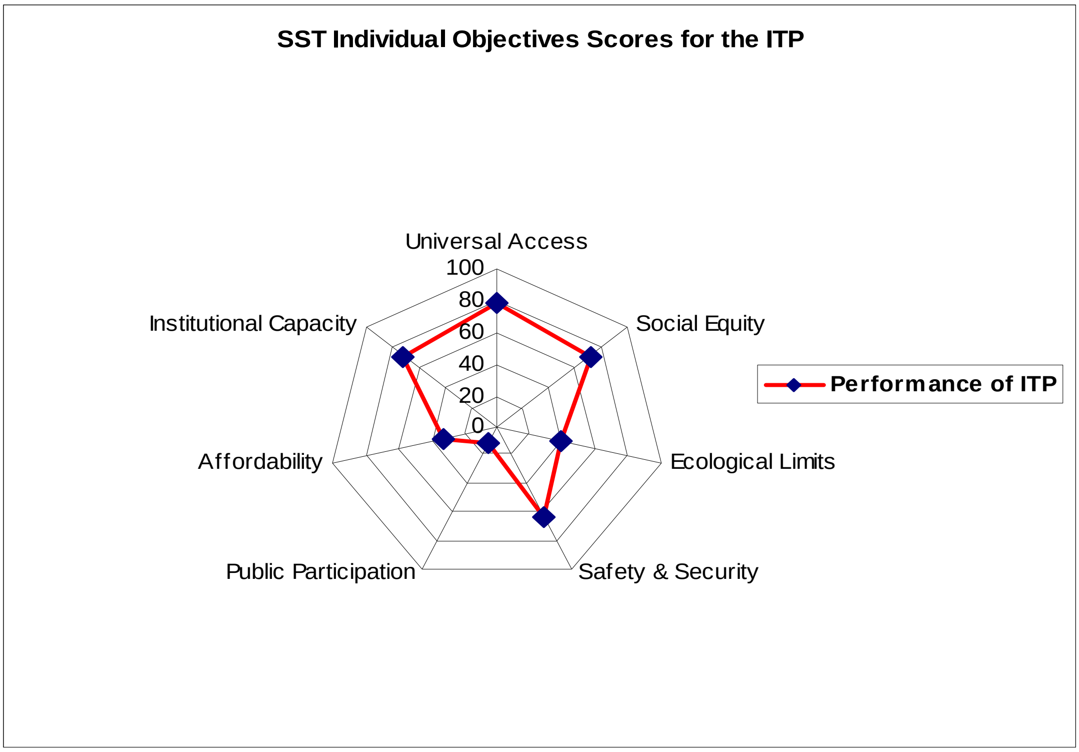


Figure 13: Spider-graph indicating individual objective scores for the ITP
Source: SST test case (Appendix C)

7.4 Discussion of findings of the research question

It appears as if the SST *is* practically operable in the field of transportation planning. The SST was relatively easy to apply to the test case, with the majority of information required by the SST being easy to locate. Such information could be interpreted objectively, due to the yes/no nature of the questions asked by SST, as well as the quantitative value assigned to each of the measured objectives. Furthermore, these quantitative values made the identification of deficiencies in the test case easy to identify. One of the major deficiencies identified by the SST was transportation affordability. The assertion made in the ITP itself, that transportation costs are expected to exceed the national strategic objective even with the intervention of the ITP (ITP, 2006: 276), appears to prove that the SST was correct in identifying transportation affordability as a major deficiency in the ITP. Finally, no specialist knowledge was required in completing and interpreting the SST, indicating that the scorecard is user-friendly and usable by a variety of decision-makers.

7.5 Summary

The results of the application of the SST to the ITP test case were discussed in this chapter with the aim of interpreting these results and finally answering the research question. Results were discussed according to the seven objectives identified in the SST, namely: universal access, social equity, ecological limits, safety and security, public participation, affordability and finally, institutional capacity. Finally, this study found that the SST is practically applicable in the field of transportation planning. The SST is however not free of deficiencies, these deficiencies, as well as possible recommendations are discussed in the following chapter.

CHAPTER 8

RECOMMENDATIONS AND CONCLUSION

8.1 Introduction

The design and testing of the SST provided an ideal opportunity to identify limitations in the study, as well as identifying areas requiring further research. These limitations and areas of potential further research are examined in this chapter. Finally, the chapter draws to an end with a conclusion of this study.

8.2 Limitations of the study

Several limitations presented itself during the course of this study. Firstly, considerable overlap exists between the various objectives measured by the SST. Two objectives which proved to be especially difficult to separate are universal access and social equity; many factors which would improve accessibility in transport would also positively influence social equity. Another example is ecological limits and safety and security; where improvements in ecological protection might also positively affect the safety of neighbourhoods. Accordingly, a measure of double counting due to up-stream or down-stream benefits is possible within these objectives.

Secondly, public transport was cumbersome to include in the SST, as it touches on almost all the objectives of the SST. Measuring the sustainability of public transport systems also required a large volume of information which would have made the list of questions in the SST too long and less user-friendly. As a result, public transport is probably poorly addressed in the SST.

Thirdly, macro-level transportation policies often do not contain sufficient detailed information to complete the SST and can therefore not be accurately interpreted by the scorecard.

Fourthly, in many instances the SST might measure perception rather than fact. Decision-makers might for example *think* that enough information was provided to the public to make informed decisions, but in reality, they might be wrong. This also raises the question of the influence of power in applying and interpreting the SST. The scorecard cannot effectively compensate for such differences in perception, as it relies on the judgement of decision-makers.

Fifthly, Cape Town's ITP was not the best test case to apply the SST to. Cape Town is more advanced in terms sustainability planning, especially in the field of transportation planning, than most other South African cities. Accordingly, the SST was only tested on a reasonably well designed transportation plan; how it would perform when applied to a poorly designed transpiration plan with limited data is uncertain.

Finally, the research question aimed to determine the operability of the SST, but the actual value it adds to the planning process was not determined and remains unclear.

8.3 Opportunities for further research

The following areas for further research are suggested:

- Firstly, the SST was developed to measure the sustainability of land-based passenger transportation. Accordingly, research is required to incorporate freight and tourism, as well as air and water-based transportation into the SST.

- Secondly, the SST was designed to focus exclusively on urban transportation. Further research is required to develop a rural transportation sustainability appraisal and to incorporate peri-urban or transitional areas into such an appraisal.

- Thirdly, and flowing from the previous point, the SST should be applied to small and/or medium sized towns, such as Stellenbosch, to test whether it can in fact be applied to smaller settlements and to refine the SST itself.

8.4 Conclusion

The purpose of this study was to develop a pragmatic, user-friendly appraisal scorecard, for measuring the sustainability of transportation policies, programmes and plans; called the Scorecard for Sustainable Transport (SST). It was necessary to test the scorecard on a real-life test case to determine whether it was practically operable in the field of transportation planning. In order to answer the research question, the scorecard was applied to Cape Town’s Draft Integrated Transport Plan (ITP) 2006-2011, with the aim of measuring the sustainability of the ITP. The SST was relatively easy to apply to the test case, attesting to a measure of user-friendliness. Furthermore, the information inputted into the SST could be interpreted in an uncomplicated and objective manner, due to the yes/no nature of its questions and the quantitative results provided by the SST. This seems to suggest a measure of practicality.

Accordingly, the study found that the SST *is* practically operable in the field of transportation planning, but suggests that further research is required to refine the scorecard and subsequently increase its value to the transportation planning profession. A pronounced need for a more extensive transdisciplinary process is also evident. The SST managed to integrate various disciplines, pertinent to planning, at a conceptual level, but true transdisciplinarity requires a practical participatory process involving community stakeholders and transportation decision makers to synthesise new knowledge. A final area requiring attention is Cape Town's lack of a functional spatial development framework. Even though this deficiency is not central to the research question, it does relate to the test case employed in this study, and as such, deserves to be mentioned.

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Appendix A:

Executive Summery: Integrated and Sustainable Development? A Checklist for Urban Transport Planning in South Africa

Urban Transport Research Group
Faculty of Engineering & the Built Environment

Executive Summary

Integrated and Sustainable Development? A Checklist for Urban Transport Planning in South Africa

December 2003

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Responsibility for any errors remains that of the authors.

EXECUTIVE SUMMARY

This Executive Summary provides documentation of a research study which, at its outset, aimed to:

- Develop a practical framework for the assessment of policies, programmes and projects in the Southern African transport sector and which would address the environmental and integrated planning requirements of policy and legislation;
- Work with local and national government role players in the development of such a framework in order to ensure its ultimate relevance, acceptance and implementation, and;
- Use the findings of the study in the under-graduate and post-graduate teaching programmes at University of Cape Town (UCT) in order to inform current and future transportation and environmental planners of the importance of integrated planning and environmental assessments

The project lasted for the seven months from March to September 2003, and was undertaken by a collaboration between the Urban Transport Research Group (UTRG) and the Environmental Evaluation Unit (EEU) at the University of Cape Town. The project was funded by the Environmental Protection Agency (EPA) of the US and the project process was directed by a US based consultancy company – ICF Consulting.

The main constraint on the project was time. Originally intended as a twelve month project, the final time permitted for the contract was seven months. The main change to the proposal was a smaller than intended assessment of the framework via case study review. Instead of assessing a well-developed framework, it was only possible to assess the principles behind the intended framework. These principles were in turn used to develop a checklist as opposed to a framework. It is hoped that future work will include a more detailed case-study review using the checklist developed and that this will in turn lead to the development of a framework.

Literature review work took place throughout the project duration, and interviews took place twice during the project. In terms of the original proposal submitted by the UTRG to ICF/EPA the approach to the project was broken down into three phases, discussed below:

Phase 1: 'Status Quo' review of local and international transport planning and environmental practice

The aim of the 'Status Quo' Review (later called the Current Practice Review) was to test the knowledge and assumptions within the study team regarding urban transport planning assessment and decision-making both locally and nationally. This phase comprised literature reviews of local and international assessment practice and interviews.

A questionnaire was designed, informed by the literature review and was administered by a series of one-on-one and telephonic interviews. A total of 23 interviews were undertaken in the three largest metropolitan areas in South Africa (SA). This provided the study with a representative geographical spread of transport and environmental planners. The findings of the current practice questionnaire review are summarised in a separate report, State of Current Practice in Transport Planning, Decision Making and Assessment in South Africa (UTRG, September 2003). This report and the findings of the literature review provided the study with the necessary baseline information for the development of the Draft Integrated Sustainable Transport Framework (ISTF), later called 'Checklist' (ISTC) in Phase 2.

The Current Practice Review interviews found that:

- Integrated transport planning is not being undertaken in the manner intended by legislation;
- There exists a lack of communication and integration between the departments of transportation and environment affairs;
- Strategic assessments for policies, programmes and plans are not required by law, and, as such, are seldom undertaken.
- Environmental assessment skills are not well developed in SA, particularly within the government sector; and
- Environmental concerns are frequently seen to add to the cost (time and money) of development initiatives and, as such, do not receive a high priority in the early stages of the planning and decision-making process.

Further more, the interviews highlighted the following:

- An expressed need for guidelines for integrated sustainable transport planning on the part of practitioners;
- A more politicised decision-making framework since 1994, which has changed the role of officials, and implies the need for a fresh approach to assessment;
- (Where assessment takes place) a shift from the consideration of mainly technical and/or financial criteria to a broader assessment framework;
- A lack of identification of alternatives, especially at the outset of the transport planning process;
- The need to promote integrated planning.

One important aim of the interviews was to verify or disprove the assertions made in the proposal at the outset of the study, and hence to provide a justification (or not) for the development of the ISTC/ISTF. The only proposal assertion that was not supported through this study was the expectation that "environmental assessments for transport projects are not always undertaken, even for those projects with the potential for significant environmental impacts". This hypothesis was found to be false, with all respondents indicating that, for "major projects", environmental assessment was considered an essential part of the transport planning process. In the main, though, the rationale for the project was upheld through the Current Practice Review

Phase 2: Development of Draft 'Integrated Sustainable Transport Framework' (ISTF), later renamed the Integrated Sustainable Transport Checklist (ISTC))

The development of the Draft ISTC was informed by the information collected in the Phase 1, a review of additional literature, specifically literature on transport planning in a developing world context, and numerous discussions and debates between the members of the UTRG and EEU project team and ICF. A number of concepts were explored, and these are written up fully in the report, and briefly here.

From the reviews of existing transport planning, other planning, development and environmental legislation, several legal principles were derived, and these were used to structure the framework, together with a review of the 'sustainable livelihoods framework', developed by the Department for International Development in the UK. The sustainable livelihoods framework has been used because it is purposefully directed towards understanding the resources and livelihood strategies employed by the poor. While the focus of the sustainable livelihoods framework is on the rural poor, it does provide the ISTC with a set of guiding principles that the project team believe can inform the process and approach to transport planning. In this regard the sustainable livelihoods framework can help transport planners to understand how the transport plans and interventions will impact on the range of resources/assets utilized by the poor, and to what extent these interventions will enhance or detract/impact on the livelihood strategies pursued by the poor. This is turn will influence the approach to transport planning and the identification of alternatives at both a strategic and project level.

The literature reviews gave rise to the following principles:

Principles regarding the transport **planning process**
- open and transparent decision-making;
- co-operative governance;
- integrated planning; and
- public participation.

Principles regarding the specific project **intervention**
- sustainable development, considered both generally and in terms of :
  - natural resources;
  - social resources;
  - human resources;
  - financial resources;
  - physical resources; and
  - time resources.

These principles subsequently formed the main headings of the checklist. In summary the Phase 2 part of the project concluded that the ISTC will need to:

- recognise a fundamental shift in transport policy and planning, to one where issues of the environment and sustainability have some importance.
- use accepted good practice and legal principles as the starting point for a series of questions related to the sustainability of the *planning process* and the *intervention*.
- reflect the need for transport planning to move into arenas more inclusive of human and social concerns.
- use 'sustainable livelihoods assets' concepts as a starting point for a consideration of the sustainability of transport planning interventions with particular reference to the poor and vulnerable.
- introduce integration and sustainability concerns at the outset of the transport planning process.
- focus on the notion of accessibility, and including those who have been excluded from mainstream planning efforts.
- attempt to create a new checklist tool for transport planners, which will inform the planning process in terms of a set of sustainability criteria. In the case of South Africa these criteria are also entrenched in the legislation and as such are legally binding.
- use yes/no responses in preference to a fuller answer set.
- be clear, readily understood and efficient in terms of time.
- make best use of available data, and use appropriate data to assist as necessary.
- inform the transport planning process at a strategic level.

Phase 3: Evaluation of case studies and finalisation of Integrated Sustainable Transport Checklist

After some discussion regarding possible case studies for use in the project, three case studies were selected, namely:

- Stock Road Railway Terminal Station;
- Klipfontein Road Transportation Corridor Project;
- ‘Penway’ R 300 Toll Ring Road.

The case studies provided the study with a range of transport projects to review. Due to the reduced timeframe all three case studies were all located in the Cape Town Metropolitan Region. The selection of case studies was informed by:

- Availability and ease of access to information and key stakeholders;
- Familiarity of the UTRG and EEU project team with the case studies and the key stakeholders involved; but at the same time maintaining sufficient distance from the case studies in terms of previous advocacy work to ensure that access to stakeholders and information was not compromised; and
- The need to select as diverse a range of transport related projects as possible.

In terms of the original proposal the interviews were intended to review a well-developed ISTF/ISTC. However, due to time constraints only a review of the guiding principles from Phase 2 was possible. Interview held with key stakeholders involved in the case studies were guided by a short questionnaire developed by the project team. The focus of the questionnaire was informed by the conceptual principles that underpinned the development of the ISTC.

The development of the final ISTC, was the result of several rounds of discussion and review, and also other informants, principally:

- experience of the project team in assessment and decision-making in transport planning in South Africa;
- experience of the project team in social and environmental assessment methods;
- work underway by Booz-Allen Hamilton on developing environmental management guidelines for use in Tshwane and Gauteng municipalities (these particularly assisted in the development of Part 1);
- the extensive work being done by DfID, UK on the inclusion of social benefits in transport planning in developing countries.

This knowledge informed the development process, but the final ISTC is a piece of original work which has not been produced elsewhere.

The objective of the final ‘Integrated Sustainable Transport Checklist (ISTC)’ is to provide a clear and practical checklist for ensuring that transport planning adheres to accepted good practice principles for sustainable development. In addition, given the South African context of the study, a set of relevant legal requirements affecting transport planning in South Africa have also been identified. The intention is that the checklist will be used in the early conceptual and planning stage of the transport planning process in order to check that issues relating to sustainable development have been considered. As such the aim of the checklist is to inform the transport planning process while at the same time raise the awareness of transport planners on the need to address issue pertaining to sustainable development. The checklist does not replace the need for a decision-making framework, nor does it replace the need for project specific Environmental Impact Assessments. It should, however, assist decision-makers in reaching a decision which is consistent with principles of sustainable development, and, in so doing, may alert transport planners to social and environmental issues earlier in the decision-making process than would otherwise be the case.

The ISTC consists of a set of tables which ask a series of questions about both *the planning process* being undertaken and *the specific project intervention* being planned. These questions are based on good practice principles, South Africa legal principles, as extracted from planning-, environment- and development-related law current in September 2003, and selected concepts from the 'sustainable livelihoods framework'. The final Integrated Sustainable Transport Checklist (ISTC) is divided into four components.

- Part 1 provides a checklist of the *issues* that should be considered when identifying and defining the needs and applicability of the proposed transport intervention.
- Part 2 provides a legal checklist for the *transport planning process*. The checklist is divided into five components, namely the open and transparent decision-making process, co-operative governance, integrated planning, public participation and a summary of the constitutional rights relating to sustainable development.
- Part 3 provides a checklist for identifying and assessing the resources which may be impacted by the *intervention*, defined using sustainable livelihoods categories of natural, physical, human, social, financial resources/capital. An additional element, time, has been added.
- Part 4 summarises the whole checklist.

To use the ISTC Checklist, the practitioner can independently use the tables to inform the design of the transport planning process (the starting point for a decision-making process) or as a check for an existing plan, programme or project that is ongoing or proposed; or as a tool for the discussion of a project within professional teams. In all cases it is intended to raise awareness regarding sustainable development.

In conclusion, the work proposed, and the justifications for the work were found to be upheld in the main during the study. However, the original intention, to develop a full framework for ensuring sustainability concerns are integrated into the transport planning process was replaced by a checklist which could raise awareness of the good practice principles, existing South African legal prerogatives, and of sustainable development criteria. The checklist is thus essentially pragmatic, and is aimed at a transport planning/engineering audience who may appreciate the need to change practice but who do not necessarily have guidance on how or what to change. Its main role is an awareness raising tool aimed at raising the awareness of transport planners to the issues that underpin sustainable development and the need to address these issues at a strategic level during the early planning stages. However the checklist also addresses the need for open and transparent decision-making in its systematic approach to the 'softer' transport issues. With further development it could form the first stage of a decision-making framework, but this would require more work.

Appendix B:

Scorecard for Sustainable Transport (SST) with ideal answers and selection of benchmark practices

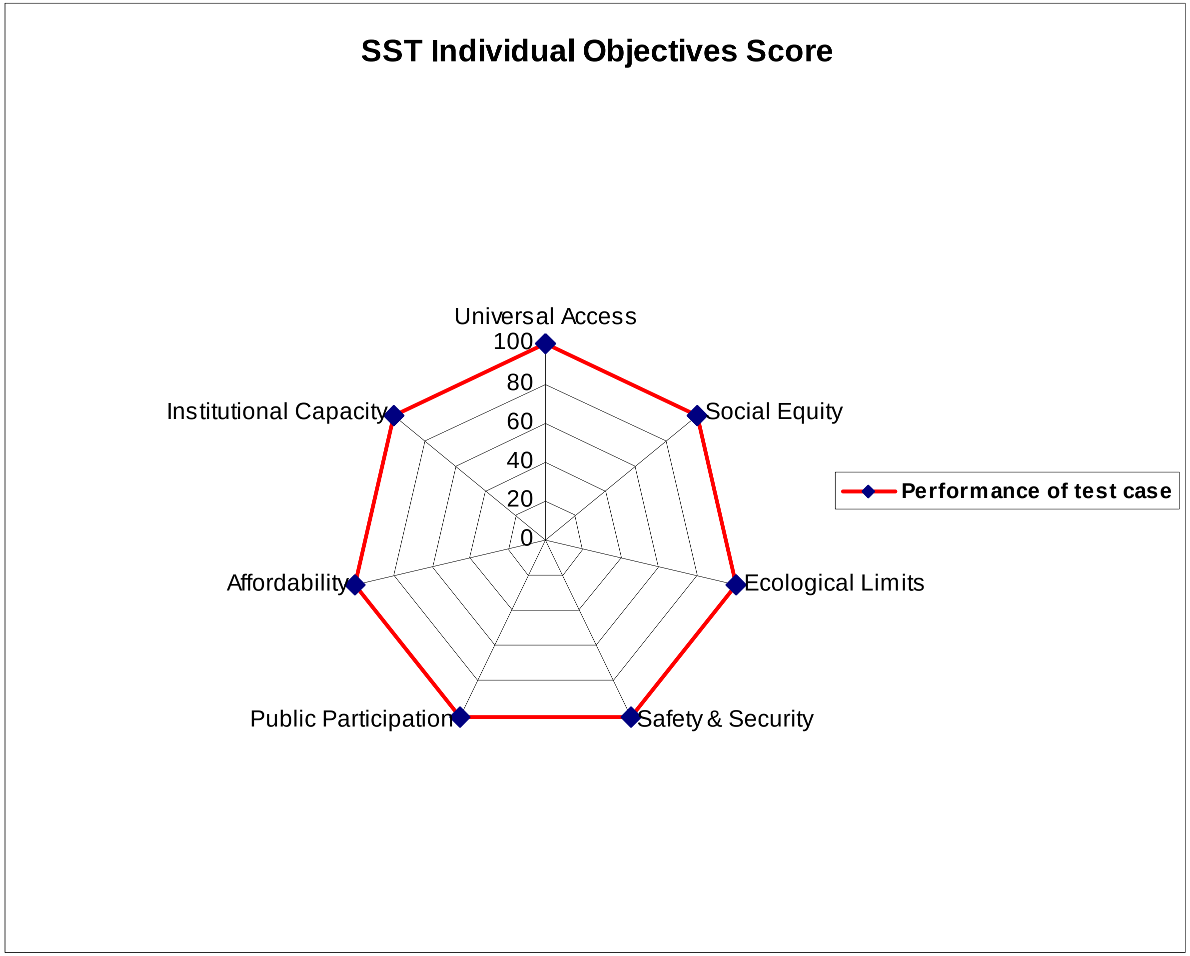
Scorecard for Sustainable Transport (SST)

Objective	Sub-objective	Yes	No	Score	%
Universal Access	1. Are non-motorised transport modes incorporated into the transport plan?	1			
	2. Is a target set for NMT share of modal split?	1			
	3. Are multiple transport modes integrated in the transport plan?	1			
	4. Is land-use planning used to enhance access?	1			
	5. Does such land-use planning enable high-density development?	1			
	6. Does such land-use planning enable multi-purpose trips?	1			
	7. Does the policy/plan reduce social interaction via community severance?		1		
	8. Does the policy/plan reduce access to educational centres (e.g. libraries and schools)?		1		
	9. Does the policy/plan reduce access to health centres (e.g. clinics, hospitals and green spaces)?		1		
	10. Does the policy/plan reduce access to public transport and/or non-motorised transport modes?		1		
	11. Are areas of current cultural value mapped and are such areas protected by the policy/plan?	1			
	12. Are areas with historic value identifies and protected by the policy/plan?	1			
	13. Is accessibility defined as ease of access?	1			
	14. Will the transport plan reduce overall travel times?	1		14	100
Social Equity	1. Are the travel needs of woman addressed?	1			
	2. Are the travel needs of the disabled addressed?	1			
	3. Are the travel needs of the elderly and children addressed?	1			
	4. Does the policy/plan take cognisance of inequitable distribution of transport externalities?	1			
	5. Is inequitable distribution of transport externalities corrected?	1			
	6. Is equitable access to transportation services addressed?	1			
	7. Will the policy/plan negatively impact on current land ownership and use?		1		
	8. Will the policy/plan adversely impact the livelihoods of threatened groups in society?		1		
	9. Will the health status of people be negatively affected by the policy/plan?		1		
	10. Does public spending favour car-oriented strategies?		1		
	11. Does the policy/plan impact negatively on social capital?		1		
	12. Does the policy/plan reduce accessibility of employment opportunities?		1		
	13. Does the policy/plan increase children's dependence on parents/caretakers?		1		
	14. Is "liveable communities/streets" considered as a transport strategy?	1			
				14	100

Individual Objectives Score	
Universal Access :	100
Social Equity:	100
Ecological Limits:	100
Safety & Security:	100
Public Participation:	100
Affordability:	100
Institutional Capacity:	100

Ecological limits					
	1. Are maximum levels for environmental pollution set (noise, soil, water, air & flora)?	1			
	2. Are maximum levels for biodiversity loss set in the policy/plan?	1			
	3. Are there performance targets in place to measure performance towards these targets?	1			
	4. Are maximum levels for traditional transport infrastructure development set (road surface)?	1			
	5. Is a definite urban boundary set?	1			
	6. Are international agreements on ecosystem protection incorporated into the transport policy (Such as the Climate Convention, Montreal Protocol and Kyoto Protocol)?	1			
	7. Will the policy/plan reduce noise pollution levels?	1			
	8. Will the policy/plan reduce barriers and disruptions of natural migration paths of animals?	1			
	9. Is important and/or sensitive ecosystems negatively impacted?		1		
	10. Will the policy/plan negatively impact natural biological diversity by threatening plant and animal species?		1		
	11. Will the policy/plan reduce levels of air pollution?	1			
	12. Will the policy/plan reduce surface and ground water pollution?	1			
	13. Will the policy/plan reduce soil pollution and land degradation?	1			
	14. Was the potential for increased soil erosion estimated and mitigated?	1			
	15. Is the precautionary principle applied?	1			
	16. Does the policy/plan induce mode shift to public transport & non-motorised transport modes?	1			
	17. Will the policy/plan cause a reduction in fossil fuel consumption?	1			
	18. Does the policy/plan actively control and/or reduce private car usage?	1			
				18	100
Safety & Security					
	1. Is general accident prevention addressed (accidents involving only motor vehicles)?	1			
	2. Is a performance target in place?	1			
	3. Is accident prevention in place to address motor vehicle and NMT accidents?	1			
	4. Is a performance target in place?	1			
	5. Are the safety and security needs of the pedestrian and cyclist considered?	1			
	5. Is security in and on public transport infrastructure improved?	1			
	6. Is a performance target in place?	1			
	7. Are the specific safety and security needs of vulnerable groups considered and catered for?	1			
	8. Is the general neglect of building stock and public environments addressed?	1			
	9. Is adequate lighting provided in and around transport interchanges?	1			
	10. Are access roads to public transport interchanges considered as part of the interchange and are steps taken to make these areas secure?	1			
				11	100

Public Participation					
	1. Is a public participation process conducted before decisions are made?	1			
	2. Is public participation seen as an end in itself (as opposed to a means to an end)?	1			
	3. Do the public define how they participate in the decision-making process?	1			
	4. Is the public provided with enough detailed information to participate meaningfully?	1			
	5. Is the public assured that their contribution will influence decisions?	1			
	6. Is the public informed how their inputs affect decisions?	1			
	7. Are vulnerable groups included in the participation process?	1			
	8. Does the policy/plan reflect the interests of the affected public?	1			
	9. Does the policy/plan take into account al forms of knowledge (both indigenous and ordinary)?	1			
				9	100
Affordability	1. Do public transport costs consider the impact of peripheral location?	1			
	2. Is public transport affordable to the lowest income groups?	1			
	3. Does the policy/plan do an affordability analysis of public transport fares?	1			
	4. Does such an analysis consider both the cost of housing and transport costs?	1			
	5. Is a specially reduced fare available for children?	1			
	6. Is a specially reduced fare available for disabled people?	1			
	7. Is a specially reduced fare available for the elderly/pensioners?	1			
	8. Is cost recovery on infrastructure improvements bourn by non-target groups? (e.g. are improvements benefiting car users being financed by a general tax also paid by non-car users?)		1		
	9. Will households spend more than 10% of their income on public transport?		1	9	100
Institutional Capacity					
	1. Do all relevant government departments cooperate in policy/plan design?	1			
	2. Is cross-departmental transport working groups established?	1			
	3. Are sufficient funds available to execute the policy/plan as envisaged?	1			
	4. Are policy/planning decisions based on objective and transparent evaluation tools and systems?	1			
	5. Is enough reliable and detailed data available for informed decision making?	1			
	6. Is an ex post evaluation of the proposed policy/plan in place?	1			
	7. Is a best-practice benchmarking system in place to measure performance against?	1			
				7	100
				Sub-Total:	
				700	
				Total Percentage Score:	
				100%	



SST Individual Objectives Score
Universal Access
Social Equity
Ecological Limits
Safety & Security
Public Participation
Affordability
Institutional Capacity
100
80
60
40
20
0
Performance of test case

Selection of Benchmark Practices

Universal Access	• Smart City planning • Mixed-use areas • Improve access over mobility • Corridors and activity corridors • Optimising residential location in relation to public transport interchanges • Integration of multiple transportation modes • High density developments • Pedestrian precincts • Dedicated cycle and pedestrian lanes • Catering for special needs passengers and travellers; including: women, children, the elderly, the illiterate and people with disabilities • Promoting Non-motorised Transport (NMT) • Locating housing developments close to transportation corridors
Social Equity	• Catering for special needs passengers and travellers; including: women, children, the elderly, the illiterate and people with disabilities • Measuring and mitigating inequitable distribution of transport externalities • Optimising residential location in relation to public transport interchanges • Pedestrian precincts • Dedicated cycle and pedestrian lanes • Separation of men and women in public transport interchanges and on public transport services where culturally appropriate • Special fares for mothers, children, the elderly and/or disabled • Ensure that public spending is not skewed towards promotion of motorised traffic • Taking corrective action
Ecological Limits	• Actively controlling single occupancy vehicle use • Setting an urban edge or boundary • Setting minimum vehicle operation standards and enforcing such standards through vehicle testing centres • Reducing the use of fossil fuels by using: Natural gas vehicles; using bio-diesel and bio-ethanol; switching to hydrogen as a fuel source and/or the use of various fuel cell technologies • Increasing energy efficiency through: driver training; BRT; LRT; URT and HOV's • Encouraging telecommuting • Social marketing • Road and fuel taxes • Control and/or reduce the number of parking bays available • Reduced provision of road space

Safety & Security	• Speed reduction and control • Traffic Calming (e.g. raised intersections, speed bumps, rumble strips, partial street closure, mini circles and islands) • Dedicated cycle and pedestrian lanes and grade separation • Creation of liveable neighbourhoods (e.g. reduced noise levels, reduced traffic flow, creation of green spaces) • Closed circuit security camera's • Security personnel in public transport interchanges and onboard public transport services • Proper maintenance of building stock • Provide proper street lighting • Ensure the creation of defensible space and public policing in the design of public transport interchanges • Separation of men and women in public transport interchanges and on public transport services where culturally appropriate • Social marketing
Public Participation	• Social marketing techniques • Conduct a public participatory process before decisions are made • Public participation should be seen as an end in itself and not a means to an end • Allow the public to define hoe they participate in the decision-making process • Provide the public with enough detailed information to participate meaningfully • Assure the public that their opinions will influence decisions • Inform the public how their inputs will influence decisions • Ensure that vulnerable groups are included in the participatory process • Transportation policies should reflect the wishes of the affected public as far as possible • Ensure that the participatory process takes into account all forms of knowledge, both ordinary and indigenous
Affordability	• Special fares for mothers, children, the elderly and/or disabled • Optimising residential location in relation to public transport interchanges • Mixed-use areas • Ensure that fares reflect total transport costs (residential location and transport costs) • Ensure that transportation is available at the time and place the target users would require it • Road and fuel taxes for private vehicles to subsidise public transport • Try to maintain public transportation costs of below 10% of household income, especially for poorer socio-economic groups
Institution Capacity	• Establish cross-departmental working groups • Ensure adequate funding to execute transportation plan • Use objective appraisal tools to determine policy/ planning decisions • Ensure transparency in decision making • Implement ex post and ex ante evaluation plans • Creation of transportation information database • Adopt benchmarking system to evaluate performance

Appendix C:

Scorecard for Sustainable Transport (SST): Cape Town ITP test case application

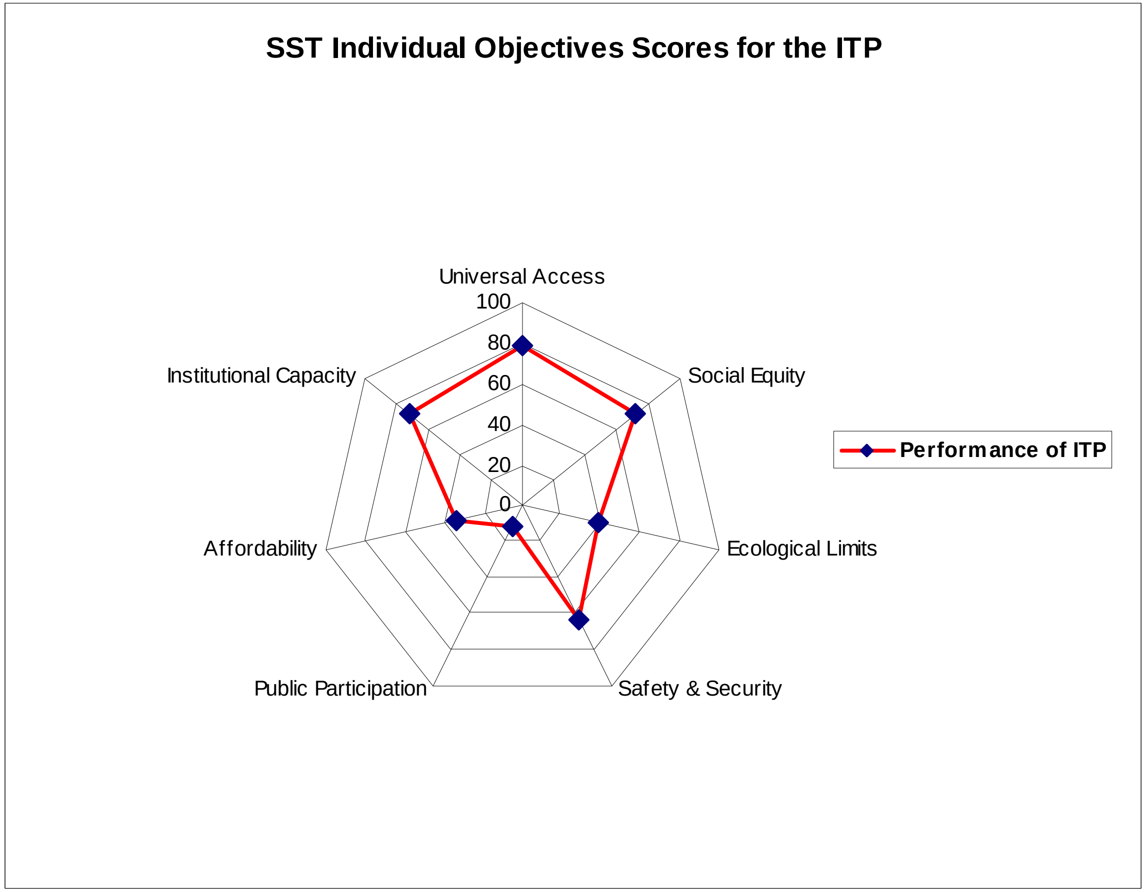
SST: Cape Town ITP Test Case Application

Objective	Sub-objective	Yes	No	Score	%
Universal Access	1. Are non-motorised transport modes incorporated into the transport plan?	1			
	2. Is a target set for NMT share of modal split?		1		
	3. Are multiple transport modes integrated in the transport plan?	1			
	4. Is land-use planning used to enhance access?	1			
	5. Does such land-use planning enable high-density development?	1			
	6. Does such land-use planning enable multi-purpose trips?	1			
	7. Does the policy/plan reduce social interaction via community severance?		1		
	8. Does the policy/plan reduce access to educational centres (e.g. libraries and schools)?		1		
	9. Does the policy/plan reduce access to health centres (e.g. clinics, hospitals and green spaces)?		1		
	10. Does the policy/plan reduce access to public transport and/or non-motorised transport modes?		1		
	11. Are areas of current cultural value mapped and are such areas protected by the policy/plan?		1		
	12. Are areas with historic value identifies and protected by the policy/plan?		1		
	13. Is accessibility defined as ease of access?	1			
	14. Will the transport plan reduce overall travel times?	1		11	78.57
Social Equity	1. Are the travel needs of woman addressed?	1			
	2. Are the travel needs of the disabled addressed?	1			
	3. Are the travel needs of the elderly and children addressed?	1			
	4. Does the policy/plan take cognisance of inequitable distribution of transport externalities?		1		
	5. Is inequitable distribution of transport externalities corrected?		1		
	6. Is equitable access to transportation services addressed?	1			
	7. Will the policy/plan negatively impact on current land ownership and use?		?		
	8. Will the policy/plan adversely impact the livelihoods of threatened groups in society?		?		
	9. Will the health status of people be negatively affected by the policy/plan?		1		
	10. Does public spending favour car-oriented strategies?		1		
	11. Does the policy/plan impact negatively on social capital?		?		
	12. Does the policy/plan reduce accessibility of employment opportunities?		1		
	13. Does the policy/plan increase children's dependence on parents/caretakers?		?		
	14. Is "liveable communities/streets" considered as a transport strategy?	1			
				8	57.14

Individual Objectives Score	
Universal Access:	78. 5%
Social Equity:	57.1%
Ecological Limits:	38.8%
Safety & Security:	63.6%
Public Participation:	11.1%
Affordability:	33.3%
Institutional Capacity:	71.4%

Ecological limits					
	1. Are maximum levels for environmental pollution set (noise, soil, water, air & flora)?		1		
	2. Are maximum levels for biodiversity loss set in the policy/plan?		1		
	3. Are there performance targets in place to measure performance towards these targets?		1		
	4. Are maximum levels for traditional transport infrastructure development set (road surface)?	1			
	5. Is a definite urban boundary set?	1			
	6. Are international agreements on ecosystem protection incorporated into the transport policy (Such as the Climate Convention, Montreal Protocol and Kyoto Protocol)?	1			
	7. Will the policy/plan reduce noise pollution levels?		1		
	8. Will the policy/plan reduce barriers and disruptions of natural migration paths of animals?		1		
	9. Is important and/or sensitive ecosystems negatively impacted?	1			
	10. Will the policy/plan negatively impact natural biological diversity by threatening plant and animal species?	1			
	11. Will the policy/plan reduce levels of air pollution?	1			
	12. Will the policy/plan reduce surface and ground water pollution?		1		
	13. Will the policy/plan reduce soil pollution and land degradation?		1		
	14. Was the potential for increased soil erosion estimated and mitigated?		1		
	15. Is the precautionary principle applied?		1		
	16. Does the policy/plan induce mode shift to public transport & non-motorised transport modes?	1			
	17. Will the policy/plan cause a reduction in fossil fuel consumption?	1			
	18. Does the policy/plan actively control and/or reduce private car usage?	1			
				7	38.88
Safety & Security					
	1. Is general accident prevention addressed (accidents involving only motor vehicles)?	1			
	2. Is a performance target in place?		1		
	3. Is accident prevention in place to address motor vehicle and NMT accidents?	1			
	4. Is a performance target in place?		1		
	5. Are the safety and security needs of the pedestrian and cyclist considered?	1			
	5. Is security in and on public transport infrastructure improved?	1			
	6. Is a performance target in place?		1		
	7. Are the specific safety and security needs of vulnerable groups considered and catered for?		1		
	7. Is the general neglect of building stock and public environments addressed?	1			
	8. Is adequate lighting provided in and around transport interchanges?	1			
	9. Are access roads to public transport interchanges considered as part of the interchange and are steps taken to make these areas secure?	1			
				7	63.63

Public Participation					
	1. Is a public participation process conducted before decisions are made?	1			
	2. Is public participation seen as an end in itself (as opposed to a means to an end)?				
	3. Do the public define how they participate in the decision-making process?				
	4. Is the public provided with enough detailed information to participate meaningfully?				
	5. Is the public assured that their contribution will influence decisions?				
	6. Is the public informed how their inputs affect decisions?				
	7. Are vulnerable groups included in the participation process?				
	8. Does the policy/plan reflect the interests of the affected public?				
	9. Does the policy/plan take into account al forms of knowledge (both indigenous and ordinary)?				
				1	11.11
Affordability	1. Do public transport costs consider the impact of peripheral location?	1			
	2. Is public transport affordable to the lowest income groups?	1			
	3. Does the policy/plan do an affordability analysis of public transport fares?	1			
	4. Does such an analysis consider both the cost of housing and transport costs?		1		
	5. Is a specially reduced fare available for children?		1		
	6. Is a specially reduced fare available for disabled people?		1		
	7. Is a specially reduced fare available for the elderly/pensioners?		1		
	8. Is cost recovery on infrastructure improvements bourn by non-target groups? (e.g. are improvements benefiting car users being financed by a general tax also paid by non-car users?)		1		
	9. Will households spend more than 10% of their income on public transport?		1	3	33.33
Institutional Capacity					
	1. Do all relevant government departments cooperate in policy/plan design?	1			
	2. Is cross-departmental transport working groups established?	1			
	3. Are sufficient funds available to execute the policy/plan as envisaged?				
	4. Are policy/planning decisions based on objective and transparent evaluation tools and systems?				
	5. Is enough reliable and detailed data available for informed decision making?	1			
	6. Is an ex post evaluation of the proposed policy/plan in place?	1			
	7. Is a best-practice benchmarking system in place to measure performance against?	1			
				5	71.42
				Sub-Total:	
				368.3983	
				Total Percentage Score:	
				52.62832%	



SST Individual Objectives Scores for the ITP
Universal Access
100
80
60
40
20
0
Social Equity
Ecological Limits
Safety & Security
Public Participation
Affordability
Institutional Capacity
Performance of ITP