ACKNOWLEDGEMENTS

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EXECUTIVE SUMMARY

INTRODUCTION

The South African Cities Network (SACN) commissioned a study to create a public transport investment assessment framework that encompasses broader built environment objectives. These objectives were taken from the South African policies, grant guidelines and the Integrated Urban Development Framework (IUDF) instituted by the government. International examples of assessment framework indicators were also assessed, and their outcomes analysed and compared with the South African policy direction. The City Support Programme (CSP) indicators were then compared with both internationally recognised indicators and the built environment objectives, and the relevant ones were brought into a Theory of Change assessment framework. Where no indicators from the CSP existed, new ones were created. The indicators were presented to municipal officials, who were asked whether the relevant data was collected and, if so, how often; if not, then what systems and resources would be required to collect this data. They were also asked whether they thought any area was missing from the proposed indicators.
POTENTIAL BENEFITS OF PUBLIC TRANSPORT

Public transport has many benefits. The most pertinent of these are summarised in Table 1.

Table 1: Potential benefits of public transport

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic</td>
<td>Public transport investments generally lower the cost of movement, thus increasing the accessibility of social, retail, educational and employment opportunities to those who may not previously have been able to afford transport to access them.</td>
</tr>
<tr>
<td></td>
<td>The investments may also reduce congestion, which can cost up to 3.5% of a developing country’s GDP.</td>
</tr>
<tr>
<td></td>
<td>Increased real estate value and economic concentration will improve an area's local economy.</td>
</tr>
<tr>
<td></td>
<td>Public transport investments may stimulate the green economy of an area.</td>
</tr>
<tr>
<td>Social</td>
<td>South Africa’s urban poor generally live on the periphery of the city, creating socio-spatial segregation. Correctly designed public transport investments could encourage socioeconomic integration rather than discrimination.</td>
</tr>
<tr>
<td>Environmental</td>
<td>An environment friendly, public transport investment will reduce the total amount of energy used in the area, and reduce carbon emissions from the transport sector.</td>
</tr>
<tr>
<td></td>
<td>It will also have micro climatic effects, as there will be less air pollution, and could thus improve the overall health and aesthetics of the area for the urban resident.</td>
</tr>
</tbody>
</table>

The ultimate objectives of public transport investment are to improve the quality of life of the user or potential user of the public transport system, and to improve the quality of the environment. These are the guiding outcomes of the investment assessment framework.

DEVELOPMENT OF A THEORY OF CHANGE FOR PUBLIC TRANSPORT

A range of assessment framework types were analysed, and a Theory of Change model is the most appropriate to inform the development of the public transport assessment framework, as it best encompasses the timescale of a public transport investment that may have effects over 20+ years. The Theory of Change explicitly states the external factors and assumptions that will need to be tested if public transport investment is to be as efficient as possible. The full Theory of Change is shown in Figure 1. This was critically examined to find which aspects were most appropriate to be measured, and the results of this examination are shown in Table 2. Utility theory was used to determine which modes are chosen by particular transport users. This theory states that their choice will be the one that will maximise their utility.
Table 2: Potential impacts of a public transport investment

<table>
<thead>
<tr>
<th>Mode prior to investments</th>
<th>Mode after investments</th>
<th>Impact on total utility/standard of living</th>
<th>Reason</th>
<th>Implications for measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private</td>
<td>No impact</td>
<td>Total utility not increased</td>
<td>No need to measure</td>
<td></td>
</tr>
<tr>
<td>Public</td>
<td>Private</td>
<td>Positive impact</td>
<td>Total utility of public transport now higher than that of private transport, due either to reduced cost or increased safety, reliability or convenience</td>
<td>Measure modal shift from private to public (non-motorised transport) through a longitudinal investigation of the modal split</td>
</tr>
<tr>
<td>Private</td>
<td>Negative impact</td>
<td>Investment has decreased total utility</td>
<td>Measure modal shift from public to private, through a longitudinal investigation of the modal split</td>
<td></td>
</tr>
<tr>
<td>Public</td>
<td>No or positive impact</td>
<td>Positive if user cost has decreased or if other utility has increased because of safety, reliability or convenience</td>
<td>Measure cost to the user, and perceived safety, reliability and convenience</td>
<td></td>
</tr>
</tbody>
</table>

The aspects of the Theory of Change that will measure the quality of life of the potential user are as follows:

- private transport trips as a percentage of total trips,
- public transport users’ costs per public transport trip,
- public transport users’ total travel time per trip,
- public transport users’ perceptions of safety, convenience or reliability of public transport.

The quality of the environment will be assessed by measuring:

- the tons of CO2 equivalents emitted by private and public transport vehicles (combined) per passenger kilometre,
- the proportion of public transport routes as a percentage of total route kilometres constructed in undeveloped areas.

ASSUMPTIONS AND EXTERNAL FACTORS

The Theory of Change shown in Figure 1 explicitly states the assumptions that underpin the causal linkages. These assumptions will require a qualitative assessment to explore whether they are still applicable. There are also external factors that should not deviate from predictable norms if the Theory of Change is to remain applicable and appropriate.

INSTITUTIONALISATION OF THE FRAMEWORK

Interviews were held with transport practitioners and spatial planning practitioners from the City of Cape Town, City of Johannesburg and eThekwini Metropolitan...
Municipality to discuss the proposed indicators, examine the ultimate objectives of the assessment framework, discuss the data collection methods and explore the institutional arrangements for collecting the data.

Generally, the practitioners found that data for the indicators could be collected and would add value when measuring the impact and assessing public transport investments, although financial, human capacity and additional technological systems may be required. The practitioners are preparing their systems to collect the CSP indicators and are therefore aware of the administrative burden this collection may involve.

Views were mixed about whether the data collection needs to be regulated through legislation. All the practitioners see the value of accurate and relevant data for long term strategic planning, but they are unsure whether politicians will take the same view, as politicians’ terms of office will not be long enough to see the full value of this investment. This provides an argument for legislating the collection process.

**Figure 1: Theory of Change for public transport investments**

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Activities</th>
<th>Outputs</th>
<th>Medium term outcomes</th>
<th>Long term outcomes</th>
<th>Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sufficient funds available</td>
<td>Inter– and intra–governmental relations work effectively</td>
<td>Public transport catalyses private sector investment in close proximity to nodes and corridors</td>
<td>Improved access to public transport facilities</td>
<td>Social inclusion and equal opportunity</td>
<td></td>
</tr>
<tr>
<td>Sufficient skilled staff available</td>
<td>Plans are prioritised and implemented as planned</td>
<td>Public transport nodes close to residential and economic areas</td>
<td>Improved public transport network services that are formal, scheduled and well managed</td>
<td>Economic growth</td>
<td></td>
</tr>
<tr>
<td>Human capacity</td>
<td>Public transport investment is located according to need</td>
<td>Increased development around public transport nodes</td>
<td>Increased use of public transport due to safety and convenience</td>
<td>Reduced poverty and equality</td>
<td></td>
</tr>
<tr>
<td>Spatial plans</td>
<td>Construction of public transport infrastructure</td>
<td>Community Facilities created close to public transport nodes</td>
<td>Increased private investment close to public transport nodes</td>
<td>Improved quality of the environment</td>
<td></td>
</tr>
<tr>
<td>Transport plans</td>
<td>Retrofitting of existing public transport infrastructure</td>
<td>Networks and services covering a greater part of the city</td>
<td>Environmentally sound public transport systems</td>
<td>Improved quality of life</td>
<td></td>
</tr>
<tr>
<td>Planning of Community Facilities</td>
<td>State housing provision</td>
<td>More vehicles on existing and new routes</td>
<td>The use of NMT becomes more prevalent, safer and integrated</td>
<td>Better standard of living for urban residents</td>
<td></td>
</tr>
<tr>
<td>Capital funding</td>
<td>Private sector development</td>
<td>NMT facilities that support network integration</td>
<td>Reduced total travel cost, particularly for low income households</td>
<td>Improved quality of the environment</td>
<td></td>
</tr>
<tr>
<td>Operating subsidies</td>
<td>Construction of Community Facilities</td>
<td>Safety increases with increasing economic and other activities</td>
<td>Reduced travel time</td>
<td>Lower greenhouse gas emissions</td>
<td></td>
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<tr>
<td>Policies</td>
<td>Vehicle purchase</td>
<td>Land use is effectively managed and regulated</td>
<td>Mixed use, integrated areas around transport nodes</td>
<td>Preservation of the natural environment</td>
<td></td>
</tr>
<tr>
<td>Incentivised private sector investment</td>
<td>Increased policing and community involvement</td>
<td></td>
<td>Increased density close to transport</td>
<td></td>
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Institutional arrangements for collecting and collating the data were discussed with municipal officials in the transport and planning departments of the three metros interviewed. These arrangements differ: Cape Town and eThekwini use an internal department under their respective departments, while the City of Johannesburg uses an entirely separate department.

**CONCLUSION**

The proposed public transport investment assessment framework uses utility theory to measure the ultimate objectives of the urban resident. It uses six indicators to measure two components of the quality of life: the standard of living and the quality of the environment. Several inherent assumptions and external factors need to be tested and assessed to ensure that the Theory of Change is still appropriate and valid.

Correctly instituting such a framework is crucial to achieving its objective of measuring the impact of public transport investment on the built environment. South African metropolitan municipalities are currently adjusting to dealing with increased public transport responsibilities and managing the systems that are resulting from the high levels of recent public transport investment. In addition, National Treasury is focusing on built environment performance and spatial efficiency through the CSP and its Urban Networks Strategy and Integrated City Development Grant. The required financial, human and technological resources will thus need to be efficiently aligned to the integrated and successful reporting on the CSP indicators.
# CONTENTS

## EXECUTIVE SUMMARY

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ii</td>
</tr>
</tbody>
</table>

## LIST OF FIGURES

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
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</table>

## LIST OF TABLES

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>xi</td>
</tr>
</tbody>
</table>

## 1 INTRODUCTION

<table>
<thead>
<tr>
<th></th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Background to the study</td>
<td>2</td>
</tr>
<tr>
<td>1.2 The link between land use and public transport</td>
<td>2</td>
</tr>
<tr>
<td>1.3 The process of assessing whether public transport investments contribute to built environment outcomes</td>
<td>3</td>
</tr>
</tbody>
</table>

## 2 POTENTIAL BENEFITS OF PUBLIC TRANSPORT AND ITS LINKS TO THE BUILT ENVIRONMENT

<table>
<thead>
<tr>
<th></th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Overview of links between public transport and the built environment</td>
<td>6</td>
</tr>
<tr>
<td>2.2 Economic</td>
<td>7</td>
</tr>
<tr>
<td>2.3 Social</td>
<td>8</td>
</tr>
<tr>
<td>2.4 Environmental</td>
<td>9</td>
</tr>
<tr>
<td>2.5 Lessons learnt from international case studies</td>
<td>9</td>
</tr>
<tr>
<td>2.6 Barriers to integration of land use and transport</td>
<td>11</td>
</tr>
<tr>
<td>2.7 South African policy direction on built environment</td>
<td>12</td>
</tr>
</tbody>
</table>
3  CHOOSING AN ASSESSMENT FRAMEWORK ................................................................. 21
   3.1 Some international public transport indicator sets ..................................................... 22
      3.1.1 OpenEI ........................................................................................................... 22
      3.1.2 Department of Environment, Tourism and Regions, UK ........................................... 25
      3.1.3 Social impact assessment .................................................................................. 25
      3.1.4 Sustainable public transport assessment (Renne, 2007) ........................................... 25
      3.1.5 Public transport investment assessment (Lake and Ferreira, 2002) ......................... 27
   3.2 South African public transport assessment ............................................................... 28
   3.3 Types of assessment frameworks ............................................................................ 32

4  THEORY OF CHANGE FOR PUBLIC TRANSPORT IMPACT IN THE BUILT ENVIRONMENT ................................................................. 35
   4.1 The Theory of Change .............................................................................................. 36
   4.2 Points of measurement and selection of indicators .................................................... 38
      4.2.1 Improvement in standard of living ...................................................................... 40
      4.2.2 Improvement in quality of the environment .......................................................... 45
      4.2.3 Summary of key indicators in the Theory of Change ............................................. 47

5  ASSUMPTIONS & EXTERNAL FACTORS .................................................................. 51
   5.1 Assumptions ........................................................................................................... 52
   5.2 External Factors ..................................................................................................... 56
5.2.1 Price of ................................................................. 56
5.2.2 Price of electricity .................................................. 56
5.2.3 Economic growth .................................................... 56
5.2.4 Population growth .................................................... 56
5.2.5 Environmental policy ............................................. 56

6 FEASIBILITY OF PROPOSED PUBLIC TRANSPORT INVESTMENT ASSESSMENT .... 57
   6.1 Assessment of feasibility of proposed indicators .................. 58
   6.2 Organisational and institutional considerations ..................... 60

7 CONCLUSION: TOWARDS A PUBLIC TRANSPORT INVESTMENT ASSESSMENT FRAMEWORK ................................................................. 63

REFERENCES ............................................................................ 68

APPENDICES .............................................................................. 72
   Appendix A: International examples of ‘good’ public transport and land use interventions and interactions ................................................................. 72
   Appendix B: Indicators proposed by Renne (2007) ....................... 80
   Appendix C: City of Cape Town sustainable transport indicators .......... 83
   Appendix D: Types of assessment frameworks ............................... 84
   Appendix E: Possible indicators associated with the potential Theory of Change .......... 87
LIST OF FIGURES

Figure 1: Theory of Change for public transport investments ................................................................. v

Figure 2: Simplified Theory of Change ........................................................................................................ 36

Figure 3: Proposed Theory of Change for public transport investment ....................................................... 37

Figure 4: Utility comparison for a private transport user ............................................................................... 41

Figure 5: Utility comparison for a public transport user ............................................................................. 41

Figure 6: How a public transport investment may improve utility for a private transport user through mode shifting ......................................................................................... 42

Figure 7: How a public transport investment may improve utility for a public transport user ............. 43

Figure 8: Mode shift in public transport due to increased benefits for private transport ............................. 43

Figure 9: Selected key indicators for the Theory of Change ........................................................................ 47

Figure 10: Additional measurements resulting from the six key indicators .............................................. 48
LIST OF TABLES

Table 1: Potential benefits of public transport ................................................................. iii

Table 2: Potential impacts of a public transport investment .............................................. iv

Table 3: Existing programmes and policies in the urban built environment ....................... 14

Table 4: DETER criteria for assessing public transport .................................................. 23

Table 5: Sub-criteria used to identify good practice .......................................................... 24

Table 6: Proposed outcomes of public transport investment .......................................... 27

Table 7: CSP indicators relating to public transport in the built environment ..................... 30

Table 8: Comparison of assessment frameworks ............................................................. 34

Table 9: Possible impacts of a public transport investment ............................................... 44

Table 10: Proposed six indicators, data needed to inform the indicator and the best method by which this data can be measured ................................................................. 49

Table 11: Correlation between proposed indicators and CSP indicators ............................ 50

Table 12: Assumptions made in the Theory of Change .................................................... 52

Table 13: Comparison of Curitiba, Bogotá, Tshwane, Cape Town and Johannesburg .............. 75
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>APTA</td>
<td>American Public Transport Association</td>
</tr>
<tr>
<td>CBA</td>
<td>Cost Benefit Analysis</td>
</tr>
<tr>
<td>CSP</td>
<td>City Support Programme</td>
</tr>
<tr>
<td>DCoG</td>
<td>Department of Cooperative Governance</td>
</tr>
<tr>
<td>DETR</td>
<td>UK Department of Environmental, Tourism &amp; Regions</td>
</tr>
<tr>
<td>DORB</td>
<td>Division of Revenue Bill</td>
</tr>
<tr>
<td>DoT</td>
<td>Department of Transport</td>
</tr>
<tr>
<td>EPMP</td>
<td>Electronic Performance Management Platform</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>IDP</td>
<td>Integrated Development Plan</td>
</tr>
<tr>
<td>ITP</td>
<td>Integrated Transport Plan</td>
</tr>
<tr>
<td>IUDF</td>
<td>Integrated Urban Development Framework</td>
</tr>
<tr>
<td>Km</td>
<td>Kilometre</td>
</tr>
<tr>
<td>MCA</td>
<td>Multi-Criteria Analysis</td>
</tr>
<tr>
<td>MTREF</td>
<td>Medium Term Revenue and Expenditure Framework</td>
</tr>
<tr>
<td>NDP</td>
<td>National Development Plan</td>
</tr>
<tr>
<td>NMT</td>
<td>Non-Motorised Transport</td>
</tr>
<tr>
<td>NSPG</td>
<td>National Strategic Plan Grant</td>
</tr>
<tr>
<td>OpenEI</td>
<td>Open Energy Initiative</td>
</tr>
<tr>
<td>PRASA</td>
<td>Passenger Rail Agency of South Africa</td>
</tr>
<tr>
<td>PTNOG</td>
<td>Public Transport Networks Operating Grant</td>
</tr>
<tr>
<td>SACN</td>
<td>South African Cities Network</td>
</tr>
<tr>
<td>SAPS</td>
<td>South African Police Service</td>
</tr>
<tr>
<td>SDBIP</td>
<td>Service Delivery and Budget Implementation Plan</td>
</tr>
<tr>
<td>SDF</td>
<td>Spatial Development Framework</td>
</tr>
<tr>
<td>SIA</td>
<td>Social Impact Assessment</td>
</tr>
<tr>
<td>SIPs</td>
<td>Strategic Integrated Projects</td>
</tr>
<tr>
<td>TOD</td>
<td>Transit Oriented Development</td>
</tr>
<tr>
<td>UITP</td>
<td>International Association of Public Transport</td>
</tr>
<tr>
<td>USA</td>
<td>United States of America</td>
</tr>
<tr>
<td>USDG</td>
<td>Urban Settlements Development Grant</td>
</tr>
<tr>
<td>VCI</td>
<td>Visual Condition Index</td>
</tr>
<tr>
<td>VKT</td>
<td>Vehicle Kilometres Travelled</td>
</tr>
</tbody>
</table>
INTRODUCTION
1.1 BACKGROUND TO THE STUDY

The South African Cities Network (SACN) commissioned this study to develop an assessment framework that goes beyond the current technical assessments of public transport operations to include an evaluation of the longer term impact of public transport investments on transport users and the built environment. The study is required to consider the effect an investment may have on the economy of the region and its ability to transform urban space and integrate the people of the area, irrespective of race and class. The institutional implications of such an assessment framework are also to be assessed.

1.2 THE LINK BETWEEN LAND USE AND PUBLIC TRANSPORT

Public transport involves the movement of people, as opposed to goods, between home, workplaces and other social land uses such as schools or community facilities. Land use and transport are thus intrinsically linked. Each land use will have a pull factor (such as a commercial area where people go to work) or a push
factor (such as a residential area which people leave to go to work). The efficiency of a public transport network is also determined by spatial form. For example, a dense, compact, mixed-use spatial arrangement shortens travel distances, reduces the need for private transport and, because of the higher residential densities, improves the business case for public transport. Similarly, public transport can affect spatial form, since property markets respond to the increased opportunities provided by public transport. These effects have been well documented and investigated (Carlson and King, 1998; Ewing, 1997; Thorsnes, 1994). Road, rail and other transportation links shape land development around them and affect travel patterns city-wide. Road-based transport, which prevails in South African cities, both responds to and creates a low density sprawled city, whereas a denser, more integrated city creates more opportunities for non-motorised transport (NMT) and other forms of public transport. One effect of apartheid-era spatial planning has been the creation of sprawling cities that rely on cars or other road-based public transport as the primary modes of travel (Williams, 2000).

Public transport is generally viewed as a public good (Low, 2013) as the benefits are more far reaching than the simple movement of people. Public transport is provided where mass transit (by train or large bus) is more efficient than private transport, or where many people cannot afford private transport. The direct benefits to commuters are lower cost, shorter travel time and increased mobility, but beyond this the broader social benefits may be a more productive economy, improved safety, less environmental impact and wider citizen access to the city.

While the benefits of public transport are widely acknowledged in the literature, the systems are often expensive to install (particularly if retrofitted into an existing urban fabric) and can be expensive to operate if sufficient ‘ridership' (i.e. number of passengers) is not realised. Decisions to invest in public transport therefore need to be well informed.

However, it is not a simple matter to assess the expected benefits of a public transport investment – for commuters and for the built environment – since these are generally qualitative and therefore difficult to measure.

This study examines and maps the causal relationships between public transport infrastructure investment and the direct/indirect benefits of this investment to commuters and the built environment in South African cities. The study then identifies ways in which these relationships can be leveraged in order to create or assess a public transport system that will bring maximum benefits to all who use or are affected by it.

1.3 THE PROCESS OF ASSESSING WHETHER PUBLIC TRANSPORT INVESTMENTS CONTRIBUTE TO BUILT ENVIRONMENT OUTCOMES

To assess whether a public transport investment contributes to built environment outcomes, these outcomes need to be agreed on and defined. Chapter 2 therefore looks at the benefits that public transport could create in the broader built environment, and draws on the international literature to distil public transport outcomes. It assesses South African policies, grants and
the Integrated Urban Development framework (IUDF) to identify priorities for built environment outcomes, and uses these priorities to define what the ultimate built environment in South African cities should look like. As the correct monitoring and evaluation tool is essential for assessing these outcomes, Chapter 3 investigates a range of theoretical assessment frameworks and practical frameworks in use internationally. This discussion then informs the selection and description of the theoretical framework that is developed in Chapter 4.

One of the primary benefits of the chosen assessment framework is the explicit stating of assumptions, which are critiqued in Chapter 5. Public transport will make an impact only in a certain environment which operates under certain external conditions. Chapter 5 discusses these external factors. Chapter 6 then examines the feasibility of the proposed public transport investment assessment approach through a telephonic survey of spatial planning and transport officials from the City of Johannesburg, the City of Cape Town and eThekwini Metropolitan Municipality (these being large metros with established public transport networks). The interviewees were asked the following questions:

- Are the proposed indicators adequate to measure the effects of the public transport investment in terms of the agreed outcomes?
- Is the data required currently measured, or measurable, and if so, how regularly and consistently can it be collected?
- What (financial, technical, human) resources are required to implement the assessment framework?
- How can this approach be institutionalised at the local government level?
- What structures and support are required from other spheres of government?

Chapter 6 concludes by considering measures to institutionalise the proposed public transport investment framework and how these differ from current practice. Overall conclusions are drawn in Chapter 7.
POTENTIAL BENEFITS OF PUBLIC TRANSPORT AND ITS LINKS TO THE BUILT ENVIRONMENT
2.1 OVERVIEW OF LINKS BETWEEN PUBLIC TRANSPORT AND THE BUILT ENVIRONMENT

To fully understand the effects that the public transport investment will have on the built environment, the links between transport and the built environment must be investigated. It is important to understand these links, as spatial transformation cannot be achieved by investment in public transport alone. In addition to a public transport system being in place, this transformation requires many other factors to be aligned. The public transport system will contribute to several aspects of spatial transformation, which are discussed.¹

Public transport can be a catalyst for spatial transformation and social integration, and can stimulate the economy. Jensen (1997) says ‘socio-spatial transformation’ consists of the economic, political, social and cultural changes in an area and their relation to the urban space. He notes the strong link between transport infrastructure investment and socio-spatial transformation under conditions regulated by regional policy instruments. Spatial transformation in South Africa has a particular meaning, as it involves correcting the anomalies created by apartheid spatial planning. This means bringing the poor and previously marginalised into the cities and bringing the poor and their work opportunities closer together. It is also about spatially integrating different race and income groups and equalising access to public amenities.

From a more techno-centric point of view, Lehmann (2010) states that a sustainable city is one which successfully manages to integrate and harness the three dimensions of urbanism:

- Energy and materials
- Water and biodiversity
- Urban planning and transport

¹. See Appendix A for case studies of international examples of good public transport interventions.
These three dimensions interact with one another and are essential to the holistic health of a city. The first dimension is broad in scope and reflects the need to have efficient cities, which means that the energy consumption should either be from sustainable resources or be used sparingly. The materials used in the city should also be environment friendly and come from sustainable sources. The second dimension relates primarily to the natural environment, on both a local and a global scale. Public transport should not harm the environment by excessive emissions or air and water pollution. Lehmann’s third dimension reflects the importance of addressing urban planning and transport simultaneously. The integration of land use and public transport design is essential to the creation of compact, efficient cities – an increasingly popular notion which has been termed ‘Transit Oriented Development’ (TOD) (Wilkinson, 2006). Underpinning these three dimensions are 29 sub-categories comprising indicators that measure and determine the extent to which these essentials of sustainability are being achieved.

It is important to note that creating dense, compact cities and other more efficient spatial forms is not an end in itself but a means to achieving economic, social and environmental benefits. The following three sections outline the economic, social and environmental outcomes towards which public transport investment can contribute.

### 2.2 ECONOMIC

Transport investments contribute to the general economy primarily through lower freight costs, higher output and increased consumption (Tikoudis et al., 2012). A study commissioned by the American Public Transportation Association (APTA) found that capital investment in a public transport scheme can have a 3:1 positive effect on the economy, so for every R10 million spent, a R30 million increase in business productivity could be expected (APTA, 2007). A similar ratio was found for expenditure that went specifically into the operating costs of the entire public transport network. In the USA, it has been estimated that congestion costs the GDP 0.7% and wastes almost 22 million litres of fuel annually. In developing cities such as Buenos Aires, Mexico City and Dakar, traffic congestion can cost up to 3.5% of the annual GDP (due to lost productivity), money which could go towards rectifying some of the inequalities present in all major cities (Peter and Swilling, 2012).

Public transport is also a major employment generator, not only for those directly responsible for the operation of the system, but also for those providing ancillary services, such as mechanics, security personnel and cleaners. In 2013, the total formal and informal employment in the transport industry, including ancillary services, was 961 000 people (Stats SA, 2014).

Public transport investments are also likely to increase the value of real estate in areas close to the stations or terminals, particularly around modal interchanges. Transport, in its entirety, is a fundamental part of a strong and prosperous economy. TOD will benefit the local economy by increasing the concentration of activity in an area (Cervero, 2004). Public transport nodes or interchanges concentrate people in mixed-use land zones, creating a market for commercial and retail activity.
It has also been suggested that public transport is an effective means to stimulate the 'green economy':

Of the various channels through which investment can flow into green transport, investment in infrastructure offers the greatest potential for economic growth, by encouraging government investment and stimulating new business opportunities. Investment in green transport technology is also likely to benefit the overall economy, particularly through its potential to stimulate government investment. (GER Transport, 2011)

Public transport is generally cheaper than private travel and so benefits individuals, by increasing their disposable income. It also improves accessibility for those who cannot afford private transport. It creates better ‘matching’ of the labour market. Tikoudis et al. (2012) show that matching skills to employment opportunities at the lowest cost can result in a 10% higher per capita output. Integrated public transport systems and more compact spatial patterns will also increase employee productivity, as businesses located near public transport routes often have higher employee reliability and less absenteeism (Tikoudis et al., 2012).

In South Africa, current spatial growth patterns, characterised by low density sprawl, could cost the low income user up to 14% more in transport costs than if a more compact growth trajectory was followed (PDG et al., 2011). This is because of the dependence on unsubsidised para-transit (minibus taxis) where mass transit systems are unavailable or unaffordable. A study for the Bloomberg Industry Leaderboard of commuters in 60 countries found that South Africans spend the highest proportion (4.6%) of their annual personal income on fuel (Randall, 2013). A study by the Department of Transport (DoT) in 2003 found that almost 50% of South Africans earning less than R500 per month spent more than 20% of their income on transport (Mtantato, 2012). Given that South African transport costs are already some of the highest in the world, to increase them by up to 14% would be untenable for the urban poor.

2.3 SOCIAL

South African cities’ passenger transport systems operate in a dualist manner, which is reinforced and sustained by the fragmented nature of our cities, arising from apartheid spatial planning (Lemon, 1991). The urban poor are confined almost exclusively to public transport and NMT, while the wealthy use private vehicles to commute, a division which generally corresponds to racial divides (Williams, 2000). This socio-spatial segregation has perpetuated many social problems, as the poorer people are trapped by the prices that public transport requires them to pay (Wilkinson, 2006). Therefore, public transport in South Africa carries an overlay of socio-economic stigma and a legacy of apartheid engineering. Public transport need not discriminate between different socio-economic classes, disabilities (if it has the facilities) and ages. Systems that are attractive to users from all income groups, while still being affordable to all, could overcome these problems and encourage social integration (Lucas et al., 2009).
2.4 ENVIRONMENTAL

Among the environmental impacts caused by public transport systems (poor aesthetics, noise, loss of biodiversity, loss of productive land, etc.), the greatest direct impact is fossil fuel combustion and the associated greenhouse gas emissions and damage to local air quality. The transport sector is the most rapidly growing source of greenhouse gas emissions in South Africa and the second most significant source of CO₂ emissions in the country (Gondwana and PDG, 2013). In this regard, public transport systems are less harmful than the use of private vehicles, as the carbon emissions per person-km are lower when vehicles run at capacity (APTA, 2007). In addition, a reduction in vehicle kilometres travelled (VKT) and a move toward a ‘green’ public transport system and non-motorised transport (NMT) will benefit the environment by further reducing greenhouse gas emissions. Globally, this will help South Africa’s commitment to reduce emissions by 34% by 2020 (Parliament of RSA, 2011), and locally a less polluted area will ultimately mean happier and healthier citizens (APTA, 2007).

2.5 LESSONS LEARNT FROM INTERNATIONAL CASE STUDIES

Cities such as Hong Kong and Tokyo demonstrate that the efficient integration of land use planning and transport planning can influence the shape of the city and capture value through property development. In Tokyo, the development of property has become so financially appealing that the private companies which built the railways purchased properties near to the stations, upgraded them according to the government’s requirements (mixed-use land zoning) and sold them to the public. This is an example of how public-private sector interaction can benefit the city by creating new market opportunities (Suzuki et al., 2013). Tokyo is an example of a city that has embraced the concepts of TOD and, through this, captured value through the properties which are benefiting from the creation of these public transport routes.
A cogent vision of the city's future is the single most important principle for successful transportation schemes and integrated land use (Pienaar et al., 2005; Suzuki et al., 2013; Urban Landmark, 2012). Suzuki et al. say that a land use vision shapes the city far more than transportation investments. However, Van de Walle and Steenberghen (2002) say that the relative priorities of land use policies and transport policies do not make a difference, as long as their guiding principles are the same.

Suzuki et al. (2013) draw the following seven lessons from case studies of how public transport can transform cities.

**The impacts of transport-related land use are greatest before an upswing in regional growth**
Investment timing strongly influences whether significant land use shifts will occur. For many rapidly developing cities, investing in transport during growth phases can translate into appreciable land use impacts, assuming the institutional capacity and funding to leverage land development opportunities are in place and readily accessible.

This point is relevant in South Africa's current post-recessional phase, suggesting that transport investments may not have their maximum impact on land use changes. However, current South African public transport investments are generally dealing with a backlog, rather than creating public transport in response to a predicted future demand.

**Transport systems generally reinforce and often accelerate decentralisation**
By improving accessibility to different parts of a region, extensive railway and BRT networks, like their highway counterparts, generally encourage decentralisation to some degree. Decentralisation could be used in an efficient way if it is the objective of the body which has instituted the project.

Supporting this conclusion, Metz (2008) notes that, since travel times began to be documented in the early 1970s, the average travel time per person per year has not fluctuated below 300 hours or above 400 hours per person per year, despite improvements to transport systems. This shows that people generally select their place of residence according to the travel time from work to home, regardless of the distance, indicating that travel time may be more of a factor in personal behaviour than location.

**Proactive planning is necessary if decentralised growth is to take the form of outlying business districts**
A proactive effort to leverage the benefits of mass transit services can lead to more concentrated forms of decentralised growth. This emphasises the need for planning to be efficient and cross-sectoral, integrating transport and spatial planning.

**Radial high-capacity transport systems such as bus rapid transport (BRT) and metros (under- and above-ground rail networks) help keep city centres economically viable**
These systems lead to increased employment growth in urban centres because such centres receive the largest relative gains in regional accessibility. However, the city centre's regional share of jobs and retailing often falls in the wake of new transport investments because of the decentralisation trends mentioned above. Increased employment in the city centre implies an improved standard of living for those accessing these jobs.
Under the right conditions, railways and high-capacity bus routes can catalyse central city redevelopment

When the government is willing to absorb some of the risks inherent in redeveloping depressed and economically stagnant areas, railways and high-capacity bus routes can help attract private capital and inject new funds into struggling areas. However, an unwavering public commitment is necessary to underwrite redevelopment costs and provide needed financial investments. This may often lead to the value capture that the government is searching for, but it may also lead to lost revenue if the private sector is not suitably engaged and has not bought into the new ideas proposed by the government.

Other pro-development measures must accompany railway and high-capacity BRT types of investment

In addition to financial incentives, other policies are needed to make land near to transport routes attractive to land developers. These policies include financial (such as density bonuses) and tax (such as tax deductions) incentives, as well as preferential land rights.

Network effects matter

If railway and BRT systems are to induce large-scale land use changes, they must provide the same geographic coverage and regional accessibility as their main competitors provide for the use of private vehicles (highways and arterial roads). The addition of these fixed path services can have spillover effects beyond the focus zone, benefiting not only the newly served corridors but existing ones as well.

The integration of transport investments and spatial development can produce meaningful outcomes, but it does require a clear forward looking strategy, an enabling institutional framework and a sustainable financial model in order to achieve the outcomes set out for it by the relevant authorities. The efficient integration of transport and spatial planning can create communities with compact, mixed land use, and become a useful tool for attracting outside investments, knowledge-based companies and businesses, which increasingly place a premium on liveability and quality of place, thus leading to a happier and more productive location. This creates a virtuous cycle in which these higher density, high quality areas generate higher profits and thus increased fiscal revenue through value capturing processes (Suzuki et al., 2013).

2.6 BARRIERS TO INTEGRATION OF LAND USE AND TRANSPORT

If public transport has all the benefits described above, then why is it not more widely adopted? Barriers that are specific to South Africa may be the vested interests of certain groups, such as taxi associations, in maintaining the status quo and the institutional fragmentation of responsibility for public transport modes and functions across the spheres of government (including parastatals). Numerous issues have been raised about the public sector’s capacity to manage and implement large, complex projects such as a BRT system (Van Ryneveld, 2010).

It is important to understand the barriers that make it difficult to implement public transport systems and integrate them with land use. Suzuki et al. (2013) identify eight barriers of this kind:
- Lack of regional coordination at the metropolitan level
- Sector silo behaviour and practices at the city level
- Inadequate policies and regulations for strategically creating ‘articulated densities’ (densities that are strategically distributed across parts of a metropolitan area)
- Restrictive national regulations and administrative constraints
- Inconsistencies in the planning instruments and deficiencies in their implementation
- Inadequate policies, regulations and supporting mechanisms for redeveloping built-up areas, particularly brownfields or distressed and blighted districts
- Neglected urban design at the neighbourhood and street level
- Financial constraints

Although this list is based on Suzuki’s international experiences, these barriers are all applicable in South Africa. This list will help to identify actions or inputs required to remove the barriers.

### 2.7 SOUTH AFRICAN POLICY DIRECTION ON BUILT ENVIRONMENT

This chapter has illustrated thus far the benefits that public transport could have for the built environment. The question now is whether South African policy makers have realised the extent of these potential benefits and integrated them into the objectives for the built environment policies and grants. Although public transport cannot by itself bring about spatial transformation, it does contribute to spatial transformation in its area of influence. Sections 2.5 and 2.6 above highlight a number of preconditions that need to be in place for the full benefit of integrated land use planning and transport to be realised. Whether these external factors are in place will need to be considered further in the development of the assessment framework. The generic list of desired outcomes of public transport investment will need to be further refined for the South African context by analysing the direction of existing built environment policy on built environment outcomes.

A plethora of government policy exists that affects the built environment. The purpose of assessing these policies here is twofold. Firstly, this assessment looks at where national priorities for public transport and the built environment lie and distils the most important outcomes for public transport investment in South Africa from the generic list developed. Secondly, the assessment will help in understanding the role that public transport is expected to play in urban development and its spatial transformation, and identify the links between public transport investments and their longer term outcomes.

The South African Cabinet adopted the National Outcomes Approach Guideline in 2010 (The Presidency, 2010a), introducing the 12 National Outcomes on which the government would focus its efforts. These 12 outcomes have served to coalesce the multitude of government programmes into a defined policy agenda that spans all three spheres of government. Each of the 12 outcomes has a list of outputs, which are further
divided into the measurable sub-outputs and supporting activities required to achieve the outputs and, in turn, the outcomes. The outcomes relevant to public transport and the built environment are:

- Outcome 6: An effective, competitive and responsive economic infrastructure network

- Outcome 8: Sustainable human settlements and an improved quality of household life

- Outcome 9: A responsive, accountable, effective and efficient local government system

Other government policies and programmes contribute towards these outputs, mainly by contributing to the sub-outputs and supporting activities. Table 3 lists policies and instruments relevant to the built environment and public transport, and highlights the outcomes the government is trying to achieve and the activities designed to achieve these outcomes.
Table 3: Existing programmes and policies in the urban built environment

<table>
<thead>
<tr>
<th>Type of tool</th>
<th>Programme</th>
<th>Inputs</th>
<th>Objective</th>
<th>Activity</th>
<th>Output</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overarching policy</td>
<td>National Development Plan (NDP)</td>
<td>National Planning Committee (NPC) consulted widely in order to create a plan which will be accepted by a large proportion of the population. South Africa can realise these goals by drawing on the energies of its people, growing an inclusive economy, building capabilities, enhancing the capacity of the state, and promoting leadership and partnerships throughout society.</td>
<td>To eliminate poverty and reduce inequality by 2030</td>
<td>A strategy to address poverty and its impacts by broadening access to employment, strengthening the social wage, improving public transport and raising rural incomes. Public infrastructure investment at 10% of gross domestic product (GDP), financed through tariffs, public-private partnerships, taxes and loans and focused on transport, energy and water. New spatial norms and standards – densifying cities, improving transport, locating jobs where people live, upgrading informal settlements and filling housing market gaps.</td>
<td>A plan to reduce poverty and reduce inequality. A list of 645 infrastructure projects. 18 strategic integrated projects (SIPs) which form part of the National Infrastructure Plan (all commenced in 2012).</td>
<td>Reduced poverty and inequality. Increased urban densities to support public transport and reduce sprawl (transforming human settlements). More reliable and affordable public transport and better coordination between various modes of transport. Consolidate and selectively expand transport and logistics infrastructure.</td>
</tr>
<tr>
<td>Type of tool</td>
<td>Programme</td>
<td>Inputs</td>
<td>Objective</td>
<td>Activity</td>
<td>Output</td>
<td>Outcomes</td>
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<tr>
<td><strong>High-level instrument</strong></td>
<td><strong>City Support Programme (CSP)</strong></td>
<td>Coordinated city plans; targeted national grants</td>
<td>To give larger, more capable municipalities the opportunity to restructure existing components of the social wage (redistributive entitlements in housing, transport, land and infrastructure development and provision of free basic services) into a coordinated framework to help them navigate and improve the functioning of the land and housing markets, reduce current spatial and infrastructure inefficiencies, and simultaneously fulfil constitutional objectives</td>
<td>Core city governance implementation support and spatially and sectorally targeted funding of strategic built environment investments (in land, transport, human settlements, infrastructure, public spaces and climate change mitigation and adaptation measures)</td>
<td>Spatial transformation accelerated by influencing where and how public funds are invested in the urban environment</td>
<td>More functional, productive, inclusive and sustainable cities</td>
</tr>
</tbody>
</table>

*Continued...*
<table>
<thead>
<tr>
<th>Type of tool</th>
<th>Programme</th>
<th>Inputs</th>
<th>Objective</th>
<th>Activity</th>
<th>Output</th>
<th>Outcomes</th>
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</thead>
<tbody>
<tr>
<td>Instrument</td>
<td>Integrated Urban Development Framework</td>
<td>Not yet established, still in discussion</td>
<td>To integrate urban development within the context of realising the NDP’s objectives</td>
<td>Research and case studies</td>
<td>Framework for integrated urban development, fostering shared understanding across government and society about how to implement the urban futures vision, proposing ways to overcome entrenched apartheid spatial patterns, and unlocking citizens’ energies to contribute to developing their communities</td>
<td>Integrated urban development</td>
</tr>
<tr>
<td>Instrument</td>
<td>Neighbourhood Development Programme</td>
<td>Municipalities must align to Urban Networks Strategy (UNS) and Neighbourhood Partnership Development Grant (NDPG) criteria, for example densities, levels of economic activity, concentration of poverty and presence of public transport. Member of 18 urban municipalities are currently eligible.</td>
<td>To promote mixed-use development in township areas (urban hub / precinct development)</td>
<td>Funding for planning Capital funding for projects Creation of precinct toolkits</td>
<td>Urban hub precinct plans Project plans in urban hubs Total investment in urban hubs in public and private sector Firm size diversity Mixed-use urban hubs</td>
<td>Sustainable, mixed-use, TOD urban hub precincts Shift infrastructure investments towards creating efficient and effective urban centres that will increase economic growth, create employment and increase access to urban amenities, especially for the poor located in marginalised settlement areas such as townships</td>
</tr>
<tr>
<td>Type of tool</td>
<td>Programme</td>
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<td>Objective</td>
<td>Activity</td>
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<tr>
<td>Instrument</td>
<td><strong>Urban Settlements Development Grant</strong></td>
<td>The receiving municipality must submit Urban Settlements Development Grant (USDG) matrix, Integrated Development Plans (IDPs) and budget, and prioritise spending on the eradication of backlogs.</td>
<td>To supplement capital revenues of metropolitan municipalities in order to support the national human settlements development programme, focusing on poor households.</td>
<td>Supply of capital and operational funding to aid in the housing programmes</td>
<td>Land units (acquisition, establishment, servicing, transfer to poor)</td>
<td>Lower average real cost of urban land for integrated development. Increased supply of well-located land. Densities improved by providing access to amenities and services. Improved access to basic services. Improved security of tenure. Improved employment and skills levels. Increased private and non-state funding. Improved spatial integration of the urban poor. More sustainable livelihoods.</td>
</tr>
<tr>
<td>Type of tool</td>
<td>Programme</td>
<td>Inputs</td>
<td>Objective</td>
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<tr>
<td>Instrument</td>
<td><strong>Housing code</strong></td>
<td>Description of various housing programmes and associated subsidy instruments available to assist low income households to access adequate housing</td>
<td>To support delivery of housing opportunities to low income households in order to progressively realise the right to housing.</td>
<td>Provision of capital funding</td>
<td>Serviced stands and tenure provided in informal settlements and top structures completed (across typologies and tenure types)</td>
<td>Progressive realisation of the right to housing for all South Africans</td>
</tr>
<tr>
<td>Instrument</td>
<td><strong>Public Transport Infrastructure Grant</strong></td>
<td>Provision of integrated public transport network operational plans and related plans, including financial models</td>
<td>To provide for accelerated planning, construction and improvement of public and NMT infrastructure</td>
<td>Provision of capital funding</td>
<td>Public transport infrastructure including development, maintenance and upgrading of dedicated lanes, routes, stations, depots, control centres and related information technology, fare systems and vehicles And NMT infrastructure that supports network integration (e.g. sidewalks, cycle-ways and cycle storage at stations)</td>
<td>Improved public transport networks in cities, supporting formal, scheduled and well-managed services accessible to an increasing percentage of the urban population</td>
</tr>
<tr>
<td>Instrument</td>
<td><strong>Public Transport Operating Grant</strong></td>
<td>Provision of integrated public transport network operational plans and related plans, including financial models</td>
<td>To provide supplementary funding towards public transport services provided by provincial departments of transport</td>
<td>Operating funding</td>
<td>Public transport services in terms of contracts which are kilometre based and affordable to the users of the services</td>
<td>Formal, scheduled and well-managed services, accessible to an increasing percentage of the population of urban municipalities</td>
</tr>
<tr>
<td>Type of tool</td>
<td>Programme</td>
<td>Inputs</td>
<td>Objective</td>
<td>Activity</td>
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<td>Outcomes</td>
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<tr>
<td>Instrument</td>
<td>Integrated City Development Grant</td>
<td>Outcome indicators</td>
<td>To provide a financial incentive for metropolitan municipalities to integrate and focus their use of available infrastructure investment and regulatory instruments to achieve a more compact urban spatial form</td>
<td>Funding for integrated city infrastructure</td>
<td>Sub-metropolitan spatial transformation zones identified and formalised in participating municipalities</td>
<td>Improved spatial targeting and sequencing of public investments in the urban built environment to achieve a more compact urban spatial form</td>
</tr>
<tr>
<td>Instrument</td>
<td>Public Transport Network Operating Grant (PTNOG)</td>
<td>Provision of integrated public transport network operational plans and related plans, including financial models</td>
<td>To provide operational funding to support the planning, regulation, control and management of municipal public transport networks and services</td>
<td>Provision of operational funding to facilitate the administration of public transport networks and services</td>
<td>Increased number of average weekday passenger trips carried on PTNOG funded systems</td>
<td>Improved integrated public transport network services that are formal, scheduled and well managed, and accessible to an increasing percentage of the population of urban municipalities</td>
</tr>
</tbody>
</table>

Source: National Treasury (2013a) and authors’ input
In summary, South African policies, frameworks and grants are trying to achieve the following:

- Reduce poverty and inequality through the provision of services and service infrastructure
- Increase urban density to support public transport
- Make public transport more reliable, integrated and affordable
- Create sustainable, mixed-use TOD precincts
- Stimulate urban centres that will provide economic growth
- Increase private sector funding
- Improve spatial targeting of public investments to achieve a more compact spatial form

The analysis of the grants and funding (Table 1) raised the question of whether the instruments that have been put in place are in line with the direction in which, according to the policies, South Africa should be moving. Several disjunctures have been found between the policy and what is stated in the Division of Revenue Bill (DORB), which is what National Treasury bases its funding on. For example, the Public Transport Infrastructure Grant’s strategic goal is ‘To provide for accelerated planning, construction and improvement of public and non-motorised transport infrastructure’ (National Treasury, 2014). The DORB states that the project must ‘support an integrated network approach’ and include provision for NMT, but makes no mention of the integration of this public transport investment with any existing public transport investment. This is not in line with the integration listed as a strategic goal in the National Land Transport Act. This example demonstrates the misalignment between the policy and the instruments used to enact the policy.

Table 2 makes explicit the objectives towards which the policies, frameworks, grants and programmes are attempting to guide the built environment objectives. These various programmes are all working towards the same ultimate objective: to improve the quality of the built environment, which in turn will improve the urban residents' standard of living. The development of the assessment framework in Chapter 4 draws on these long-term impacts and outcomes.

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2. A standard of living is defined by Sen (1999) as not just a measure of opulence, but rather the combined utility derived from physiological, psychological, medical, climatic (environmental), social and economic factors.
This chapter investigates indicator sets from around the world, to get a perspective on international feeling about the relationship between public transport and the built environment and the methods proposed for measuring it. The chapter then investigates various assessment framework models and selects the most appropriate one.

3.1 SOME INTERNATIONAL PUBLIC TRANSPORT INDICATOR SETS

This section describes systems for assessing public transport investment that are currently in place around the world. The aim is to suggest outcomes and indicators and to provide guidance for structuring frameworks.

3.1.1 OpenEI

Open Energy Information (OpenEI) is a knowledge-sharing online community dedicated to connecting people with the latest energy information and data. OpenEI is helping to promote a culture of environmental awareness and responsible consumption. It has created an assessment framework for public transport investments.

- According to OpenEI, a sustainable public transport system is one which:
  - is affordable,
  - is convenient,
  - creates a healthy and safe local environment,
  - helps preserve the ecosystem and limits greenhouse gas emissions,
- supports economic development and growth,
- is equitable, and
- respects and preserves local cultural and natural landmarks.

The OpenEI description of an assessment framework is not complete, as it does not describe the indicators further or discuss whether they will be measured qualitatively or quantitatively. It also does not fully address the spatial implications of a public transport investment.

### Table 4: DETER criteria for assessing public transport

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Environment</th>
<th>Safety</th>
<th>Economy</th>
<th>Accessibility</th>
<th>Integration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Must ensure that all decisions are taken with the environment in mind</td>
<td>To improve safety for all road users</td>
<td>Supporting sustainable economic activity in appropriate locations and getting good value for money</td>
<td>Improving access to everyday facilities for those without a car and reducing community severance</td>
<td>Efficient coordination between sectors to achieve a common objective</td>
</tr>
<tr>
<td>Sub-criteria</td>
<td>Noise</td>
<td>Accidents</td>
<td>Journey times and vehicle operating costs</td>
<td>Option values</td>
<td>Interchange</td>
</tr>
<tr>
<td></td>
<td>Local air quality</td>
<td>Security</td>
<td>Financial flows</td>
<td>Severance/community impact</td>
<td>Land use policy</td>
</tr>
<tr>
<td></td>
<td>CO₂ impact</td>
<td></td>
<td>Journey time reliability</td>
<td>Social inclusiveness</td>
<td>Other governmental policy</td>
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<td></td>
<td>Landscape</td>
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<td></td>
<td>Biodiversity</td>
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<td>Built environment</td>
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<td>Water</td>
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<td></td>
<td>Other health impacts</td>
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<td></td>
<td>Quality of journey</td>
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</tbody>
</table>

Source: Jones and Lucas (1999)
The DETR also lists 150 further sub-criteria which are used to identify good practice. Those relevant to transport systems are shown in Table 4, roughly grouped according to topic.

Table 5: Sub-criteria used to identify good practice

<table>
<thead>
<tr>
<th>Traffic, vehicles and economy</th>
<th>Passengers</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic congestion</td>
<td>Passenger travel by mode</td>
<td>Depletion of fossil fuels</td>
</tr>
<tr>
<td>Road traffic</td>
<td>People finding access to services difficult</td>
<td>Local environmental quality (noise and pollution from traffic)</td>
</tr>
<tr>
<td>Distance travelled relative to income</td>
<td>Average journey length by purpose</td>
<td>Concentrations and emissions of selected air pollutants</td>
</tr>
<tr>
<td>Real changes in the cost of transport</td>
<td>Access to rural services</td>
<td>Sulphur dioxide and nitrogen oxide emissions</td>
</tr>
<tr>
<td>Average fuel consumption of new cars</td>
<td>Access to the countryside</td>
<td>Emissions of greenhouse gases</td>
</tr>
<tr>
<td>Heavy goods vehicle mileage intensity</td>
<td>How children get to school</td>
<td>International emissions of carbon dioxide per capita</td>
</tr>
<tr>
<td>Energy efficiency of road passenger travel</td>
<td>Leisure trips by mode of transport</td>
<td>Carbon dioxide emissions by end user</td>
</tr>
<tr>
<td>Freight transport by mode</td>
<td>Access for the disabled</td>
<td>Ozone depletion</td>
</tr>
<tr>
<td></td>
<td>Major factors leading to health inequalities</td>
<td>Acidification in the UK</td>
</tr>
</tbody>
</table>

Source: Jones and Lucas (1999)

These sub-criteria are interestingly holistic in scope but do not take into account what is currently being measured and how it can be integrated into the system in order to make it easier to collect the required data (Jones and Lucas, 1999). As with the OpenEI framework, there is no explicit measure which includes the spatial implications of a public transport system. There is a proxy measurement in the 'average journey length by purpose' but spatial transformation is not defined as an outcome of this framework.
3.1.3 Social impact assessment
The social impact assessment (SIA) is a framework for assessing the social impact of public transport projects in cities. It is frequently used in Asian cities during the planning phase of public transport infrastructure (Thynell et al., 2009).

The SIA takes into account more than just economic poverty – it looks also at ‘time poverty’ and how this can affect the public transport user. Public transport can bring social problems in its wake, however most of these problems are widely known and most systems address them. The designers of the SIA framework have kept them in mind and used them to identify specific outcomes for a public transport assessment, asking, for instance, whether the public transport scheme has helped to solve them or further entrenched them. As these problems are not specific to Asia, it is useful to take them into account in the South African context.

Thynell et al. (2009) introduce a seven-step process for the SIA approach: scoping, assessment, mitigation, reporting, decision making, monitoring and managing, and public consultation. This model could be used in the planning phase of a public transport project, and parts of it could be used to assess an existing public transport system. The methods the SIA model uses during the assessment phase are surveys (many different types, using many media), face-to-face interviews, focus group discussions, public hearings and open houses. These methods could be used to gather information about public transport systems in South Africa.

3.1.4 Sustainable public transport assessment (Renne, 2007)
Renne’s investigation into the creation of a sustainable framework to measure public transport investment highlights many of the difficulties involved in creating a framework that will be comprehensive and practical enough to achieve its intended objectives. Renne proposes 10 possible achievements for the public transport investment, and more specifically for the entire TOD precinct:

- Increased mobility choices
- Increased public safety
- Increased transit ridership
- Reduced rates of vehicle-km travelled (VKT)
- Increased household disposable income
- Reduced air pollution and energy consumption rates
- Preservation of farmland and open ‘green’ spaces
- Enhanced economic development
- Reduced infrastructure costs
- Contribution to more affordable housing

3. Time pollution refers to the excessive time people spend travelling resulting in less time to carry out other productive social and recreational activities.
Renne investigated the holistic success of a TOD area and developed nine high-level indicators, which would show whether the TOD in that area was achieving its objectives:

- Increased public transport ridership
- Increased population and housing density
- Improved streetscape design
- More mixed-use structures
- More pedestrian activity and better pedestrian safety
- Increase in property value/tax revenue (value capture)
- Improved public perceptions — measured by resident and merchant surveys
- Better quality intermodal connections at transit stations
- Better parking configuration for commuters and residents, and shared parking

Renne proposes putting these indicators into the following categories, to show which areas of the TOD are more and less successful:

- Travel behaviour
- The local economy
- The natural environment
- The built environment
- The social environment
- The policy context

Renne also lists sub-indicators for these categories. He conducted interviews with transport officials and tested whether data for the proposed indicators are feasible or easy to collect. Indicators rated as both 'very useful' and ‘easy to collect’ were given priority and included if they were applicable. It must be noted that ‘easy to collect’ is a relative term, as Renne conducted these investigations in Western Australia and the USA, where the cities' systems and institutional structure will differ from those in South Africa.

After his investigation, Renne broke down his findings into a series of three steps which should be performed in order:

**Step 1: Rank indicator importance**
This is essential to shorten the list of indicators and relieve the reporting burden on the municipality. However, if the data is collected through household surveys then there may be no need to reduce the number of indicators as this will not reduce the cost, which is mainly a fixed cost.

**Step 2: Establish a monitoring cycle**
The areas which need to be evaluated should be monitored cyclically. Every five years is usually the norm for longitudinal data collection. The cycle should ensure that all precincts are not evaluated at the same time. According to the municipal officials interviewed for the purposes of the proposed public transport investment assessment framework, they agree that five years is an appropriate timeframe for measuring the indicators, as spatial transformation may have occurred during this time. It also coincides with the end of the mayoral term, which is a good point at which to synthesise available data and re-evaluate a municipality's long-term strategy.
Step 3: Analyse data and public outreach
Making the data publically available creates the stewardship and buy-in which is often required in public participation situations such as this.

Renne’s system (2007) is comprehensive and can be adapted to different contexts by modifying selected indicators. It is also a progressive assessment framework as it includes the potential benefits of TOD in the city as a result of a public transport investment.

3.1.5 Public transport investment assessment (Lake and Ferreira, 2002)
In 2002, the University of Queensland commissioned a study to answer one question: 'What does the community get for every dollar spent on public transport infrastructure?' Lake and Ferreira (2002) attempted to answer this question by creating a method for assessing public transport investments. Their proposal of what the outcomes of public transport investment should be are indicated in Table 6.

Table 6: Proposed outcomes of public transport investment

<table>
<thead>
<tr>
<th>Ultimate outcome</th>
<th>Specific outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Improve air quality and reduce emissions</td>
</tr>
<tr>
<td></td>
<td>• Reduce traffic noise and impact</td>
</tr>
<tr>
<td>Environmental and urban amenity</td>
<td>• Improve safety and reduce accidents, injuries and deaths.</td>
</tr>
<tr>
<td></td>
<td>• Reduce transport energy consumption and CO2 emissions</td>
</tr>
<tr>
<td></td>
<td>• Improve visual, aesthetic and other aspects of urban amenity</td>
</tr>
<tr>
<td>Accessibility (social)</td>
<td>• Improve accessibility to work and other activities (car and non-car trips)</td>
</tr>
<tr>
<td>Economic efficiency</td>
<td>Reduce costs for urban freight and commercial traffic, including cost of congestion, and reduce cost to health</td>
</tr>
<tr>
<td></td>
<td>• Reduce travel times and costs for all trips</td>
</tr>
<tr>
<td></td>
<td>• Reduce capital and other subsidies for providing transport except where these form part of a wider pricing policy</td>
</tr>
<tr>
<td></td>
<td>• Increase opportunities for economic interaction</td>
</tr>
</tbody>
</table>

Source: Lake and Ferreira (2002)
Lake and Ferreira looked at numerous public transport evaluation frameworks from around the world that are used in the respective countries or geographic areas.

Externalities are costs which are not explicitly taken on by the user of that mode of transport. Examples of these are environmental impacts (air, water and land pollution, noise, visual intrusion and the effect on flora and fauna), congestion costs, accident costs and energy impacts (the cost incurred when buying fuel does not represent the depletion of natural resources). These externalities can be evaluated in one of the following four ways:

- **Resource approach**: the value of the externality is defined by the corresponding resource price of the private market, which in most cases relates to prices for damage or repair.

- **Avoidance approach**: the value of the externality is defined by the possibility of substituting the resource, the technology or the good in question for a resource, technology or good without the external properties.

- **Risk approach**: the value of the externality is defined by the discounted expected monetary value based on an evaluation of risk.

- **Utility approach**: the value of the externality is defined by the willingness to pay in order to reduce negative effects.

Another aspect which must be considered is the scale of the externality, for example, short-term air pollution may be unhealthy and unsightly, but climate change is the long-term effect, so both of these must be taken into account when making valuations (Lake and Ferreira, 2002).

The assessment indicators and frameworks discussed in Sections 3.1.1 to 3.1.5 show that it is a complex process to encapsulate the possible effects of public transport on the built environment and the public transport user. Unless transport users are unable to choose their mode of preference (because, for example, it is inaccessible, unsafe or too costly), they will choose the mode which brings them the most satisfaction. This is known as the utility of their decision (see Section 4.2.1).

### 3.2 SOUTH AFRICAN PUBLIC TRANSPORT ASSESSMENT

The South African National Outcomes Approach introduced in Section 2.7 is designed to ensure that government focuses on ‘achieving the expected real improvements in the life of all South Africans’. It clarifies ‘what we expected to achieve, how to achieve it and how we will know whether we are achieving it’ (The Presidency, 2010b:9–10). In line with this approach, the desired public transport outcomes need to be measured.

Most metropolitan municipalities (metros) collect data using an ‘extensive’ set of existing indicators, primarily as part of their internal performance management and monitoring systems. A provision for this is set out in the Municipal Systems Act (32 of 2000). These systems are largely legislated and include Integrated Development Plans (IDPs), Medium Term Revenue and Expenditure Frameworks (MTREFs), and Service Delivery and Budget Implementation Plans (SDBIPs). The City of Johannesburg has an indicator planning framework which falls within its monitoring and evaluation framework. This is still in the internal consultative
phase (City of Johannesburg, 2012). Cape Town has a set of public transport investment assessment indicators (City of Cape Town, 2006). These have not yet been fully integrated into Cape Town’s monitoring and evaluation and data collection processes.

The SDBIPs for the cities often have very specific indicators, which are revised every year and do not fully encompass the broader built environment objectives as they are focused on the short and short to medium term only. For example, one of the City of Johannesburg’s indicators is ‘completion of design phase of Rea Vaya stage 1C by Q3 2013/14’ which is obviously short term. Most of the SDBIP indicators are quantitative comparisons of what is expected. An example of this would be the ridership indicators for MyCiti in the Cape Town SDBIP or the expenditure on certain projects in the City of Johannesburg. eThekwini also has very specific objectives in its SDBIP, such as ‘50% completion of annual review submitted to council by the end of Q2 2013/14’. An attempt has been made to mitigate this narrow approach by allocating each of these indicators to a national key performance area, such as ‘to develop and implement a sustainable and integrated spatial planning system’. Measurements of this type would fit best into either an MCA (multi-criteria analysis, see Section 3.3) or a cost:benefit analysis.

The cities are using various techniques to collect the data. Cape Town, for example, uses an up-to-date transport model calibrated with existing primary data, and Johannesburg has recently completed a household survey which will address issues such as the modal split and travel time of the user. However, South Africa lacks a comprehensive public transport investment assessment framework which would integrate public transport and spatial transformation over the longer term.

To address this issue, the City Support Programme (CSP) is introducing a set of long-term, outcome-based indicators to monitor city (particularly metro) efficiency, as the cities’ own indicators do not capture the broader objectives of creating sustainable human settlements or the implications for housing diversity, density, associated amenities (such as public transport) and access to economic opportunities (National Treasury, 2013b). Public transport is a core component of the CSP and is therefore mentioned as part of the programme’s outcomes for sustainable, liveable cities. For such cities to be achieved, indicators of performance have been created for measurement. Those relating to public transport are shown in Table 7.

5. See Appendix C for details.
Table 7: CSP indicators relating to public transport in the built environment

<table>
<thead>
<tr>
<th>Theme</th>
<th>Result</th>
<th>Element</th>
<th>Indicator area</th>
<th>Indicator subset</th>
<th>Intermediate outcome indicator</th>
<th>Desired outcome</th>
<th>Input/ Process/ Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inclusive city</td>
<td>Mobility</td>
<td>Public transport access</td>
<td>Access to public transport service</td>
<td>Closer proximity to home</td>
<td>(BO2.1)* Annual percentage change in proportion of dwellings within 500m of access points to integrated public transport system within integration zones</td>
<td>An increasing proportion of dwellings within 500m of access points to integrated public transport system within integration zones</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(BO2.2) Percentage change in share of household income spent on transport costs for passengers city-wide, measured over a decade</td>
<td>Progressively decreasing share of household income spent on transport costs for passengers city-wide</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Reduced average cost/km to passengers</td>
<td>Reduced travelling time</td>
<td>(BI2.3) Percentage change in average weekday peak hour commuting time of passengers, until an optimal commuting time is reached</td>
<td>Progressive decrease in average weekday peak hour commuting time of passengers, until an optimal commuting time is reached</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Improved access to social facilities and services</td>
<td>Decreased walking distance</td>
<td>(BI2.4) The number of Early Childhood Development facilities provided city-wide</td>
<td>The number required by the norms and standards for the provision of Early Childhood Development facilities</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(BI2.5) The number of libraries provided city-wide</td>
<td>The number required by the norms and standards for the provision of libraries</td>
<td></td>
</tr>
</tbody>
</table>

Continued...
<table>
<thead>
<tr>
<th>Theme</th>
<th>Result</th>
<th>Element</th>
<th>Indicator area</th>
<th>Indicator subset</th>
<th>Intermediate outcome indicator</th>
<th>Desired outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inclusive city</td>
<td>Mobility</td>
<td>Public transport systems</td>
<td>Changing modal (private/public) split</td>
<td>(Bo2.6) Percentage change of commuters (city-wide) using private motorised transport</td>
<td>Decrease in percentage of commuters (city-wide) using private motorised transport</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Increased public transport integration</td>
<td>Greater operational integration</td>
<td>(Bo2.7) Annual percentage change of all trips that use the same ticketing system</td>
<td>Annual percentage increase of all passenger trips that use the same ticketing system</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Progressively integrated infrastructure</td>
<td>Progressive annual percentage increase in capital expenditure on transport infrastructure spent on integrated public transport networks city-wide, until an optimal level is reached</td>
<td>(B029.8) Annual capital expenditure on integrated public transport networks city-wide as a percentage of overall transport capital budget</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(B02.9) Percentage change in total km of dedicated walkways and cycle paths in relation to the length of roads within integration zones</td>
<td>Progressive annual percentage increase in capital expenditure on transport infrastructure spent on integrated public transport networks city-wide, until an optimal level is reached</td>
<td></td>
</tr>
<tr>
<td>Productive city</td>
<td>Integrated, efficient and economically stronger city</td>
<td>Increased economies of agglomeration</td>
<td>More efficient urban structure</td>
<td>Higher occupancy rates</td>
<td>(C01.3) Annual percentage of available passenger spaces weekday scheduled public transport trips that are occupied</td>
<td>Progressively greater percentage of available passenger spaces occupied on transport trips until an optimal level is reached</td>
</tr>
</tbody>
</table>

* Codes B02, C01 etc. relate to indicators which already exist and could measure an outcome (O) or indicator (I) or a certain component of it.

Source: National Treasury (2013c)
The indicators shown in Table 7 attempt to measure the full effect of public transport on the built environment. However, several of the indicators are insufficiently nuanced and may skew the data. For example, ‘progressively decreasing share of household income spent on transport costs for passengers city-wide’ (the desired outcome for BO2.2) is an important indicator only for low-income groups, as the percentage of income spent decreases dramatically as income increases, so that above a certain income level the indicator looks good, but in fact represents the wealthy, who make expensive (yet cheap relative to their own income) private vehicle trips instead of public transport ones. The absolute user cost of a trip is more important than the percentage it represents of the users’ income. Another insufficiently nuanced indicator is the percentage of city capital expenditure spent on integrated public transport networks (‘progressively integrated infrastructure’ – an indicator subset). This indicator encourages increasing spending on public transport infrastructure but does not specify what kind of infrastructure is intended, apart from being ‘integrated’.

Another problem is that the indicators do not mention the environment. They do not say that public transport vehicles should be efficient and have low carbon emissions. A further problem is that they do not say what method will be used to collect the indicators. This is an important point: if many different methods will be required, the end result may be an increase rather than a decrease in the municipal reporting burden. The indicators do, however, provide a fairly good basis for public transport investment assessment, and they do show some strong correlations with the indicators proposed by several international case studies (see Section 3.1).

In their entirety, the above sets of public transport indicators encompass much of what the South African policy direction is trying to achieve; however, instituting all of these indicators would add to the municipal burden and be unnecessary. The indicators need to be organised in a concise, intuitive manner that will adequately reflect the situation on the ground and be simple to report on.

### 3.3 TYPES OF ASSESSMENT FRAMEWORKS

Sections 3.1 and 3.2 have shown that public transport investments can have a wide range of benefits for the built environment, but how can these investments be measured to show that the right investment is being made to achieve the intended outcomes? As the need to prove the efficacy of public spending becomes more pressing, it is vital to select the correct assessment tool to ensure that the correct public investment decisions are made (Silverman et al., 2011). Narrow measurement of performance can have negative side effects, if decisions are not based on a holistic set of data that encapsulates all aspects of the intended outcomes. An assessment framework that encompasses all these types of data and measures the options against one another is therefore a crucial tool (Renne, 2007).

A full assessment of a public transport scheme should encompass the economic, social, environmental and policy outcomes described in Chapter 2. According to the International Association of Public Transport (UITP, 2009), until recent years, appraisals of transport schemes have looked only at the economic sustainability of a scheme and may have disregarded environmental
effects or failed to be socially inclusive. An assessment of a public transport scheme should (UITP, 2009):

- help to develop and prioritise transport strategies and policy packages,
- help to monitor the outcomes of the scheme not only from the perspective of the efficiency of the transport but also from more holistic perspectives, and
- increase public participation and acceptance of the scheme by ensuring the decision-making process is transparent.

Several types of assessment frameworks are used internationally, the most common being cost:benefit analysis, multi-criteria analysis (MCA), the Logic Model and the Theory of Change. Table 8 summarises the advantages and disadvantages of the different assessment frameworks.

In their study, Lake and Ferreira (2002) show that most international public transport investment assessment frameworks use a cost:benefit analysis or MCA, and tend to focus on the economic impacts of the scheme, and the weightings reflect this. Some will use a Logic Model to depict the causal pathways through which any actions will have an effect, although these pathways are assessed by other methods. The fact that these frameworks are quantitative presents a challenge, as the set-up of the model is often at the discretion of the creator, thus possibly introducing subjective bias. Often the social implications are not included in the analysis. Most of these frameworks are presented in a Microsoft Excel spreadsheet, which is user friendly and intuitive to use.

The summary of assessment frameworks in Table 8 suggests that the Theory of Change model is the most applicable for assessing a public transport system, since it is flexible and easy to test. This model can be applied to any existing public transport system, whereas the cost:benefit analysis and MCA are more applicable to the decision-making process.

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6. See Appendix D for a full investigation of these four assessment frameworks
<table>
<thead>
<tr>
<th>Assessment framework</th>
<th>Description</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cost: benefit analysis</strong></td>
<td>A simple assessment framework in which the indicators are ascribed monetary values, and the option with the lowest total sum is the chosen scenario.</td>
<td>The outcome of the analysis is a decision which is represented quantitatively.</td>
<td>A potentially subjective tool as the decision criteria are based on monetary values which vary, such as the value of life. For a public transport investment, this is particularly relevant as the value of congestion is often highly contested (Argyrous, 2010).</td>
</tr>
<tr>
<td><strong>Multi-criteria analysis (MCA)</strong></td>
<td>Similar to the cost:benefit analysis, but the different options and their indicators are weighted according to the priorities of the creator of the framework.</td>
<td>Mixes qualitative and quantitative indicators. The weightings are generally made explicit, allowing for some transparency in the decision-making process, in particular if a public participatory process is followed in the creation of the weightings.</td>
<td>The weighting of the criteria allows for subjectivity by the makers of the framework. This can be confusing if every project requires a new set of indicators and set of weightings.</td>
</tr>
<tr>
<td><strong>Logic Model</strong></td>
<td>Consists of inputs, activities, outputs and outcomes, where the links between the different stages are made explicit and can be tested.</td>
<td>The causal sequencing of events creates a critical path that can be tested, and the process can be seen along this pathway.</td>
<td>Can become very complex, as multiple critical pathways may be created. Large amounts of quantitative data are often required to measure the indicators along the pathways.</td>
</tr>
<tr>
<td><strong>Theory of Change</strong></td>
<td>Similar to the Logic Model, but has the assumptions and external factors explicitly stated along the framework.</td>
<td>In addition to the advantages of the Logic Model, this framework allows for the testing of external factors and assumptions to see if the environment is still conducive to the intended change.</td>
<td>Theory of Change can require a large amount of both quantitative and qualitative data.</td>
</tr>
</tbody>
</table>
THEORY OF CHANGE FOR PUBLIC TRANSPORT IMPACT IN THE BUILT ENVIRONMENT
As mentioned in Chapter 1, the Theory of Change was selected as the assessment framework for this report, as it was considered the best model for measuring the impact of a public transport investment. This chapter describes and develops the Theory of Change in detail.

4.1 THE THEORY OF CHANGE

The structure of a Theory of Change is simply defined in Figure 2 as an ideal causal chain from inputs through activities and outputs to outcomes (short and medium term) and longer term impacts. This causal chain assumes a number of pre-conditions are in place and that processes occur in a particular way. External factors outside the direct causal chain determine whether the theory holds or breaks down.

For the Theory of Change to be fully understood, the guiding outcomes and long-term impacts must first be identified and defined. The outcomes that should be included in a South African public transport investment assessment framework were distilled from the explicit and implicit outcomes referred to in the multiple sources.
documented in Chapter 2. These were then analysed to identify overlaps and to eliminate any that were not relevant to South Africa or to public transport investment. The result was a consolidated list of seven outcomes and six longer term impacts. Once the outcomes had been defined, the same sources were again used to identify the inputs, activities and outputs and the causal relationships between them to develop the Theory of Change for public transport investment as shown in Figure 3.

The Theory of Change illustrates the range of impacts, activities and outputs that feed into the broad set of desired outcomes. However, the medium-term outcomes lead to a smaller set of long-term outcomes, which in turn are intended to affect two aspects of quality of life: better standards of living and improved environmental quality. This is important when considering what needs to be measured and how this is to be done.

Figure 3: Proposed Theory of Change for public transport investment

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Activities</th>
<th>Outputs</th>
<th>Medium term outcomes</th>
<th>Long term outcomes</th>
<th>Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sufficient funds available</td>
<td>Inter- and intra-governmental relations work effectively</td>
<td>Public transport catalyses private sector investment in close proximity to nodes and corridors</td>
<td>Improved access to public transport facilities</td>
<td></td>
<td>Social inclusion and equal opportunity</td>
</tr>
<tr>
<td>Sufficient skilled staff available</td>
<td>Plans are prioritised and implemented as planned</td>
<td>Public transport nodes close to residential and economic areas</td>
<td>Improved public transport network services that are formal, scheduled and well managed</td>
<td></td>
<td>Economic growth</td>
</tr>
<tr>
<td>Human capacity</td>
<td>Public transport investment is located according to need</td>
<td>Increased development around public transport nodes</td>
<td>Increased use of public transport due to safety and convenience</td>
<td></td>
<td>Reduced poverty and equality</td>
</tr>
<tr>
<td>Spatial plans</td>
<td>Construction of public transport Infrastructure</td>
<td>Community Facilities created close to public transport nodes</td>
<td>Increased private investment close to public transport nodes</td>
<td></td>
<td>Improved quality of life</td>
</tr>
<tr>
<td>Transport plans</td>
<td>Retrofitting of existing public transport infrastructure</td>
<td>Networks and services covering a greater part of the city</td>
<td>Environmentally sound public transport systems</td>
<td></td>
<td>Improved quality of the environment</td>
</tr>
<tr>
<td>Planning of Community Facilities</td>
<td>State housing provision</td>
<td>More vehicles on existing and new routes</td>
<td>The use of NMT becomes more prevalent, safer and integrated</td>
<td></td>
<td>Lower greenhouse gas emissions</td>
</tr>
<tr>
<td>Capital funding</td>
<td>Private sector development</td>
<td>NMT facilities that support network integration</td>
<td>Reduced total travel cost, particularly for low income households</td>
<td></td>
<td>Preservation of the natural environment</td>
</tr>
<tr>
<td>Operating subsidies</td>
<td>Construction of Community Facilities</td>
<td>Safety increases with increasing economic and other activities</td>
<td>Reduced travel time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Policies</td>
<td>Vehicle purchase</td>
<td></td>
<td>Mixed use, integrated areas around transport nodes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incentivised private sector investment</td>
<td>Increased policing and community involvement</td>
<td></td>
<td>Increased density close to transport</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intergovernmental relationships and structures</td>
<td>Land use is effectively managed and regulated</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transport plans and sector departments are aligned to the SDF and there is a single version of the city future</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Political will exists to support public transport interventions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public supports the public transport investment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Casual Path: Assumptions
4.2 POINTS OF MEASUREMENT AND SELECTION OF INDICATORS

One of the benefits of using the Theory of Change as the assessment framework is that measurement can be done at any point along the chain, depending on what is to be measured. For example, outputs or impacts are measured to assess the overall performance or success of the investment, while inputs or activities are measured to assess whether implementation is taking place as intended. The assumptions can also be evaluated to assess whether the Theory of Change itself is valid, or whether the preconditions for a successful investment have been met. Measurement is done using indicators which are selected and defined to relate as directly as possible to the element of the Theory of Change being measured. Schiavo-Campo (1999) suggests that the indicators have the following characteristics, which can be memorised as ‘CREAM’:

- **Clear** (precise and unambiguous)
- **Relevant** (appropriate to the subject at hand)
- **Economic** (available at reasonable cost)
- **Adequate** (able to provide sufficient basis to assess performance)
- **Monitorable** (amenable to independent validation)

National Treasury (2013b) guidelines for the selection of indicators are as follows:

- To limit the administrative burden, the emphasis should be on fewer indicators clearly linked to the objectives, rather than many indicators that measure performance across a wide range of specific sectors.
- The emphasis should be outcome indicators, rather than input and output objectives.

- Each indicator should not require undue original effort to collect the relevant data, and it should be possible to repeat the exercise over time.
- Indicators should be reasonably simple, understandable and meaningful.
- Indicators should be replicable (they should have an unambiguous definition and be capable of objective measurement).
- Indicators should be timely (i.e. record performance within a reasonable time frame) and be capable of showing a trend over time.
- They should be sensitive to a change in performance.
- Indicators should evoke action, thereby pointing to how decisions might be improved to achieve better outcomes.
- They should be specific enough to point towards policy actions that can address the problem.
- Indicators should not replicate other indicators for similar objectives, as this would duplicate effort.

(National Treasury has established a data collection working group to look at information sources at the local level.)

- If possible, existing indicators should be used if they add value to the programme.

While almost any point along the causal path can be measured, gathering data and reporting are expensive and can be burdensome to those who are responsible for its collection. Municipalities carry a large burden of reporting, as National Treasury is aware, and the creation of additional indicators will increase this burden. In addition, the data required to populate the indicators may be impossible or too time consuming or expensive to collect. There is thus a strong motivation to focus only
on the critical points that require measurement and reduce the number of indicators to a minimum. To this end, the Theory of Change was re-evaluated to identify the critical points that would:

- clearly indicate whether the desired outcomes are being achieved, and
- be able to attribute the change directly to public transport investment.

The first step in this process was to identify the range of indicators that could be associated with all the elements of the Theory of Change. These indicators were developed by reviewing existing indicators being used locally and internationally to assess public transport investments.\(^7\)

The second step was to critically examine the Theory of Change to determine where measurement is most appropriate. It is clear that most existing indicators relate to inputs, activities and outputs, and to a lesser extent to the medium-term outcomes or ultimate objectives of public transport. The inputs, activities and outputs are tangible, well understood and generally easy to measure. These elements are already measured through the existing framework for inter-governmental planning and coordination, and are integral to the oversight of local government that is exercised by the other spheres of government. Most, if not all, are considered critical to the Theory of Change and therefore there is no single element that is more or less important than another.

In contrast, the outcomes and impacts are often intangible, poorly understood and difficult to measure. For this reason, the assessment framework should focus more on finding ways to measure outcomes and impacts, rather than the inputs, activities and outputs which are largely covered by existing monitoring and evaluation practice. However, it is apparent that the implicit assumptions may be more important than the elements that make up the inputs, activities and outputs. This is because in many cases these underlying assumptions (for example, that there is sufficient skilled staff to plan and implement projects) are unwarranted. These assumptions are discussed in Chapter 5 and evaluated to show how they would fit into a public transport investment assessment framework. The critical assessment of the outcomes and impacts was undertaken, ensuring that they clearly indicated the desired outcome being achieved and that the change be directly attributable to the public transport investment.

While the two quality of life impacts listed in the last column of Figure 3 are the ultimate objectives and should be measured, they are informed by a wide range of factors. Changes in quality of life are not directly attributable to public transport investments alone, and therefore a measurement of quality of life (if this could be done) would not serve the purpose of assessing the impact of public transport.

- The contribution that a public transport investment makes to these two impacts is better assessed by measuring some of the medium-term and long-term outcomes.

- It is desirable to use single indicators that measure the entire public transport system (i.e. all modes and all users) than indicators that measure only one aspect (i.e. one mode or one user group).

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\(^7\) The results of this process are provided in Appendix E.
4.2.1 Improvement in standard of living

A range of physiological, psychological, medical, environmental, social and economic factors contribute to an improvement in the standard of living. The relationship between public transport and standard of living is complex, incorporating user choice at relative income levels and causality in both directions. People’s standard of living is relative to the happiness they derive from the choices they make in their daily life. They will make a choice based on what they perceive will maximise their happiness, which is also known as the utility of their decision (Hensher, 1994). This theory is known as utility theory, and is the basis and justification for the selection of the ultimate outcomes in the Theory of Change.

A user who has a high total utility is one who has a high standard of living, as these are proxies for one another. The utility is not relative to the income of the user, but relies on the assumption that the user will make rational decisions in order to maximise their happiness. This is particularly relevant when the user selects a mode of travel, as it will be done in order to maximise the user’s utility.

The explanation assumes that ‘standard of living’ and the economics concept of ‘utility’ are equivalent. It then assumes that a user's total utility is made up of the sum of cost utility (the benefit gained from spending money, which is higher for a product at a low price than for the same product at a higher price) and other utility, which may comprise any number of components, but in the context of public transport is argued to be dominated by the safety, reliability and convenience of the service (Thynell et al., 2009).

It is necessary to consider behaviour change over time in a longitudinal assessment to determine how a public transport investment may affect the two groups of commuters – public and private. The various ways in
which a public transport investment may affect the user are described. The terms used here, ‘private transport user’ and ‘public transport user’, assume that all other factors, such as overall income profile and taste, are equal.

Figure 4 shows why a user would choose private transport over public transport: even though the cost of public transport may be lower, other factors contribute to a higher private transport’s utility.

Figure 5 shows that a person chooses to take public transport because private transport is too expensive (or totally unaffordable, in which case the cost utility is zero) and thus public transport maximises total utility, but at a lower level than for a private car user, indicating a lower standard of living.

How a public transport investment improves total utility (or standard of living) is different for private and public transport users. Private transport users will continue to use private transport if the public transport investment does not result in higher total utility, and the investment will have no, or very little, direct impact on that user. If, however, the investment does increase total utility, either by reducing cost or improving other factors (e.g. safety, reliability and convenience), then the private transport user will shift to public transport.

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8. However, the other utility may still be so low that even if the public transport service were free, the user would not change modes.
It is possible that a public transport investment (or even no investment at all) could decrease the private car user’s total utility. For example, the failure to build additional roads may increase congestion and hence travel times, thus reducing the 'other utility' component of private transport. In this way the private transport utility could be pushed lower than the public transport utility and the private transport user may then be motivated to shift modes. Thus a shift in modes still represents an increase in total utility for that user (in comparison with continuing to use a private car), even though this may be at a lower level than the private transport user may previously have enjoyed (see Figure 6).

Figure 6: How a public transport investment may improve utility for a private transport user through mode shifting

Figure 7 shows that for public transport users the investment will improve utility if it reduces cost or improves other utility. However, if the investment has a negative effect on the public transport, this may cause a shift to private transport.
Figure 7: How a public transport investment may improve utility for a public transport user

Figure 8 shows the possible shift from private transport to public transport based on a public transport investment which decreases the utility of the private transport user and induces a modal shift.sight

Figure 8: Mode shift in public transport due to decreased benefits for private transport
Table 9 summarises the scenarios described above and provides some insight into the indicators that can be used to assess whether an increase in total utility has been achieved after a public transport investment.

Table 9: Possible impacts of a public transport investment

<table>
<thead>
<tr>
<th>Mode prior to investment</th>
<th>Mode after investment</th>
<th>Impact in total utility / standard of living</th>
<th>Reason</th>
<th>Implications for measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private</td>
<td>Private</td>
<td>No impact</td>
<td>Total utility not increased</td>
<td>No need to measure</td>
</tr>
<tr>
<td>Private</td>
<td>Public</td>
<td>Positive impact</td>
<td>Total utility of public transport now higher than that of private transport either because of reduced cost or increased safety, reliability or convenience</td>
<td>Measure modal shift from private to public (or NMT) through a longitudinal investigation of the modal split</td>
</tr>
<tr>
<td>Public</td>
<td>Private</td>
<td>Negative impact</td>
<td>Investment has decreased total utility</td>
<td>Measure modal shift from public to private, through a longitudinal investigation of the modal split</td>
</tr>
<tr>
<td>Public</td>
<td>Public</td>
<td>No or positive impact*</td>
<td>Positive if user cost has decreased or if other utility has increased because of safety, reliability or convenience</td>
<td>Measure cost to the user, as well as measures of perceived safety, reliability and convenience</td>
</tr>
</tbody>
</table>

* For simplicity, possible negative impacts on existing public transport users (such as a price increase with an inability to shift modes) are not considered here – it is assumed that the investments are designed to improve public transport.

The implications for measurement column of Table 9 implies that only the following four indicators may be required to measure improved standard of living as a result of transport investments:

1. **Private transport trips as a percentage of total trips.** No change, or an increase, in the proportion of private transport use after the investment means there has been zero or negative impact, while the increased use of public transport may indicate a positive impact. To capture modal shifts from private or public transport to NMT that result from increased utility, total trips (including NMT trips) are used instead of public transport trips. Trips are used instead of passengers because the investment may result in greater accessibility, enabling more public transport trips.
2. **Public transport user costs per public transport trip.** If the user cost per trip is reduced, then utility is increased and the financial burden of transport is reduced. User costs are selected to deliberately exclude subsidies. Subsidies indicate the level of state assistance that relates to the benefit of public transport as a public good. Although this does return to users as a cost (through taxes), it does not get paid by all users and therefore represents an element of cross subsidy. The ‘public good’ element and the cross subsidy are included because they are not directly linked to the objective of improving the standard of living. The number of trips is used instead of trip kilometres in order to factor in an accessibility measure, and a measure of total cost burden. If the public transport network makes destinations more accessible within close proximity of trip origins, then trips will be shorter, may be more frequent, and total costs will be reduced. Costs per trip will therefore be reduced. If cost per trip-kilometre were used, then extending the public transport networks to allow for more dispersed settlement would mean greater total cost to the user, but the cost per trip-kilometre could remain constant, or even decrease, making this an ineffective indicator.

3. **Public transport user’s total travel time per trip.** A reduction in travel time increases ‘other utility’ for public transport users. Only the travel time is considered here, because this will be the measure that dictates the user’s utility. This measure will be the public transport user’s total travel time, from the moment of leaving home to arriving at the destination. Once a public transport system is optimised, the only way the total trip time can be reduced is through a reduction in the ‘first mile’ and ‘last mile’ on either side of the public transport trip. Reductions in the time for these trips could indicate spatial transformation and therefore should be included in the indicator.

4. **Public transport users’ perceptions of safety, convenience or reliability of public transport.** Clarkson et al. (2010) found that self-regulation is governed by perceptions rather than by the real situation. An improvement in users’ perceptions of these factors, whether the users shifted modes as a result of the investment or not, indicates an increase in utility and therefore an improvement in the standard of living. Perceptions are more important than actual measures of these factors (e.g. incidences of crime, records of punctuality, etc.) because perceptions change behaviour and increase utility. The perceptions of private transport users are not relevant as the investment has no or little impact unless that perception results in a modal shift.

Details of the data that would be required for these indicators are shown in Table 10 and Table 11.

### 4.2.2 Improvement in quality of the environment

The Theory of Change indicates that there are three ways in which a public transport system could contribute directly to long-term environmental improvements:
Lower resource consumption: The level of ridership of a public transport system determines the level of resource consumption per user trip on the system. The depletion of natural resources is detrimental to the environment, but some resources are scarcer (and so more valuable) than others. This means that scarcity value must be allocated to the energy sources and then summed to obtain a total ‘cost’ of resource consumption.

Lower greenhouse gas emissions: Vehicle emissions contribute significantly to global greenhouse gas levels. More efficient modes of transport use less fuel and therefore contribute less to greenhouse gas emissions and climate change.

Preservation of the natural environment: As cities grow, so natural areas are developed. This can threaten biodiversity, ecosystems and food security, and reduce the amenity value of the environment. If these areas are developed, the assumption is that, per passenger kilometre, public transport routes (which consist of a single rail line or a dedicated public transport lane) take up less space than the equivalent general road space (measured in lane or carriageway kilometres) to transport the same number of passengers. Therefore, the most spatially efficient method (and the least harmful to the surrounding land use) is if the new transport routes developed in previously undeveloped areas are all public transport routes.

The first of these three desired outcomes, lower resource consumption, is difficult to measure, and can be accommodated to a certain degree in the measurement of the second outcome if the type of fuel is factored in. Therefore the following two indicators are sufficient for assessing the effect on the environment:

1. Tons of CO2 equivalent emitted by private and public transport vehicles (combined) per passenger kilometre. As private vehicles are less efficient than public transport vehicles (particularly at low car occupancy), this indicator will decrease with the increased use of public transport. Tons of CO2 equivalent account for a range of greenhouse gases and the normalisation by passenger kilometre accounts for the greater efficiencies achieved by mass transit modes.

2. Proportion of public transport routes as a percentage of total route kilometres constructed in undeveloped areas. This indicator assumes that transport routes (road-based or dedicated public transport routes) developed on brownfield sites do not have an impact on the natural environment. However, this indicator measures the relative impact on previously undeveloped areas (however defined). It assumes that the total length (measured in route kilometres) is made up either of general road space or dedicated public transport routes, with the latter being more efficient. This indicator would vary between zero and one, with zero being the largest impact of new infrastructure and one being the smallest impact.

The international case studies discussed in Chapter 2 support the concept of having fewer, more holistic indicators that measure a number of possible public transport infrastructure impacts, but to date no single refined set of indicators like this has been developed.
4.2.3 Summary of key indicators in the Theory of Change

Sections 4.2.1 and 4.2.2 propose six key indicators that may be adequate to measure the impacts of a public transport investment. These are shown in Figure 9.

Figure 9: Selected key indicators for the Theory of Change
This does not mean that other elements are not measured. It is expected that they will be measured either through their causal relationship to the proposed set of six indicators, or as part of an alternative monitoring and evaluation process at city level.

Figure 10 shows other elements of the Theory of Change that will be measured along with the six key indicators. These include proxy measurements of a number of spatial outcomes resulting from the reduced travel time. Note that there is a feedback loop between the 'improved public transport network services that are formal, scheduled and well managed' and the perceptions, as the more efficient services will improve perceptions, and thus increase the use of the public transport facilities.

Figure 10: Additionall measurements resulting from the six key indicators
Table 10 provides additional information on the six key indicators. This information will feed into the indicators and also into the method of collecting them. This table was shown to the municipal officials who were interviewed (see Chapter 1).

Table 10: Proposed six indicators, data needed to inform the indicator and the best method by which this data can be measured

<table>
<thead>
<tr>
<th>Proposed indicator</th>
<th>Data needed for this indicator</th>
<th>How this should be measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private transport trips as a percentage of total trips</td>
<td>Number of trips per day Modal split</td>
<td>Travel survey or Transport model</td>
</tr>
<tr>
<td>Public transport user costs per public transport trip</td>
<td>Modal split Average trip length per mode Average operating cost per kilometre per mode</td>
<td>Travel survey OR Transport model AND Fare survey/information</td>
</tr>
<tr>
<td>Public transport travel time per trip</td>
<td>Modal split Trip Length Average speed</td>
<td>Travel survey or Transport model</td>
</tr>
<tr>
<td>Public transport users’ perceptions of safety, convenience or reliability of public transport</td>
<td>Responses by users to questions on safety, convenience and reliability of public transport</td>
<td>Travel survey</td>
</tr>
<tr>
<td>Tons of CO2 equivalents emitted by private and public transport vehicles per passenger kilometre</td>
<td>Modal split Trip length Vehicle occupancy rates Average speed Fuel source per mode Fuel efficiency CO2 equivalent per fuel source</td>
<td>Transport model</td>
</tr>
<tr>
<td>Proportion of public transport routes as a percentage of total route kilometres constructed in undeveloped areas</td>
<td>Spatial mapping of new transport infrastructure Length of: Road Lanes Dedicated bus lanes Commuter rail lines Land use overlay</td>
<td>GIS data Land use Transport plans</td>
</tr>
</tbody>
</table>
The six proposed indicators shown in Table 10 have several links with the CSP indicators, as shown in Table 11.

**Table 11: Correlation between proposed indicators and CSP indicators**

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Correlation with CSP indicator set</th>
<th>Additional data or systems required?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private transport trips as a percentage of total trips</td>
<td>CSP has the same indicator, which measures the modal split.</td>
<td>No</td>
</tr>
<tr>
<td>Public transport user costs per public transport trip</td>
<td>CSP has an indicator that measures the percentage of household income spent on public transport, but as mentioned previously, an absolute measure of user cost is more accurate than a percentage household cost due to the percentage decreasing as the users’ income increases.</td>
<td>No</td>
</tr>
<tr>
<td>Public transport travel time per trip</td>
<td>CSP has an indicator identical to this.</td>
<td>No</td>
</tr>
<tr>
<td>Public transport users’ perceptions of safety, convenience or reliability of public transport</td>
<td>CSP has no indicator that considers user perspective.</td>
<td>Yes – travel survey data</td>
</tr>
<tr>
<td>Tons of CO$_2$ equivalents emitted by private and public transport vehicles per passenger kilometre</td>
<td>No CSP indicators investigate carbon emissions from public transport. (There is one that looks at reducing carbon emissions from municipal buildings.)</td>
<td>Yes – transport model outputs (trip numbers and distance by mode)</td>
</tr>
<tr>
<td>Proportion of public transport routes as a percentage of total route kilometres constructed in undeveloped areas</td>
<td>No CSP indicator looks at undeveloped land used as transport routes, either mixed use or dedicated.</td>
<td>Yes – spatial data</td>
</tr>
</tbody>
</table>

Three of the six proposed indicators are contained in the current list of CSP indicators, while the remaining three would require additional data. This modest level of overlap shows that the CSP is moving towards assessing the full effect of public transport on the built environment and urban resident, but does not adequately measure all the impacts contained in the public transport Theory of Change. A public transport investment assessment framework could be an independent framework focused on the impact of public transport alone, but it is likely to be more feasible, and more likely to be accepted by municipalities, if included in the CSP indicator process. This is discussed further in Chapter 7. If it is included, the public transport investment assessment indicators could still be ring-fenced as a subset of the CSP set of indicators and reported on as such.
### 5.1 ASSUMPTIONS

One of the main benefits of the Theory of Change is that it explicitly states the assumptions that are made in order for the process to proceed. These assumptions are examined in Table 12.

<table>
<thead>
<tr>
<th>Assumption location in the Theory of Change</th>
<th>Assumption</th>
<th>How does the assumption affect the Theory of Change?</th>
<th>How is the assumption tested?</th>
<th>Appropriate mechanism for the testing of the assumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inputs</td>
<td>Sufficient capital and operational funding are available</td>
<td>Without capital funding infrastructure will not be constructed. Without operating funding, systems will not function or will be too expensive for users</td>
<td>Assessment of trends in annual funding allocations to public transport at all spheres of government, and comparison against system cost estimates</td>
<td>Can be included in standard National Treasury reporting and expenditure reviews</td>
</tr>
<tr>
<td></td>
<td>There are sufficient and sufficiently skilled staff</td>
<td>Without sufficient staff, projects will not be implemented timeously and efficiently and operations will be negatively affected</td>
<td>Capacity audits</td>
<td>Internal organisational staff reviews and Municipal Demarcation Board Municipal Capacity Assessments</td>
</tr>
<tr>
<td></td>
<td>Transport and sector departments’ plans are aligned to the spatial development framework</td>
<td>Spatial alignment of transport investments to other development is crucial to integrated development, spatial transformation and spatial efficiency</td>
<td>Qualitative assessment of the alignment between sector plans</td>
<td>National, provincial and municipal reviews of planning alignment undertaken by sector departments, in particular the Department of Transport (DoT), as well as the Department of Cooperative Governance (DCoG)</td>
</tr>
<tr>
<td></td>
<td>Political will exists to support public transport investments</td>
<td>This ensures implementation of policy and sufficient allocation of funding to public transport</td>
<td>Qualitative assessment of political statements on public transport. Analysis of policy versus funding allocation</td>
<td>Independent external review</td>
</tr>
<tr>
<td></td>
<td>There is a single, cogent vision of the city’s future</td>
<td>The city’s different departments must agree on what the future of the city looks like in order to align their plans and resources</td>
<td>This assumption is difficult to test, as it requires an assessment of both the plans and the actual project implementation from the different departments</td>
<td>Qualitative assessment of the plans of the different city departments</td>
</tr>
<tr>
<td>Assumption location in the Theory of Change</td>
<td>Assumption</td>
<td>How does the assumption affect the Theory of Change?</td>
<td>How is the assumption tested?</td>
<td>Appropriate mechanism for the testing of the assumption</td>
</tr>
<tr>
<td>---------------------------------------------</td>
<td>------------</td>
<td>------------------------------------------------------</td>
<td>-------------------------------</td>
<td>---------------------------------------------------</td>
</tr>
<tr>
<td>Inter- and intra-governmental relations work effectively</td>
<td>Integrated development requires coordination between sector departments and intergovernmental coordination, to ensure funding and physical investments are aligned in time and space</td>
<td>Qualitative assessment of intergovernmental relations framework and its effectiveness. Assessment of the integrated development plan (IDP) and other planning documents to indicate effective internal relationships at local government level</td>
<td>Inter- and intra-governmental relations assessments undertaken by DCoG</td>
<td></td>
</tr>
<tr>
<td>City prioritises and implements plans</td>
<td>Plans need to be implemented as proposed to realise the outputs and outcomes</td>
<td>The actual implementation of a plan</td>
<td>Assessment of performance reporting in terms of grant conditions by National Treasury and review of Annual Reports (provincial and local) by DCoG</td>
<td></td>
</tr>
<tr>
<td>Adequate policing and community involvement</td>
<td>Adequate policing in conjunction with community involvement is needed, to produce a ‘critical mass’ to reduce crime and degradation in order to make the public transport services safe and attractive to use. However, this is beyond the scope of the Theory of Change of the public transport investment itself</td>
<td>The level of crime in a precinct can be measured quantitatively, as can the number of police officers per area or transport route. Community involvement is difficult to measure but can be assessed through attendance levels at ward meetings and other community forums</td>
<td>Reporting on transport-related crimes undertaken by SAPS and public transport service providers</td>
<td></td>
</tr>
<tr>
<td>Land use effectively managed and regulated</td>
<td>The lack of effective and regulated land use could affect the Theory of Change by not achieving the appropriate land uses adjacent to public transport nodes, not attracting private sector investment, or not resulting in sufficient density to make mass transit viable</td>
<td>Adherence or deviation from the zoning scheme and building regulations is indicative of the land use management and regulation. The uptake of land use rights is also indicative of a land use management programme that is matched to market needs</td>
<td>Independent comparison of existing land uses and densities against the land uses and desired densities in proximity of public transport nodes and corridors contained in the zoning scheme and any associated densification policy</td>
<td></td>
</tr>
</tbody>
</table>

continued...
### Assumptions in the Theory of Change

The assumptions in the Theory of Change relate to inputs, activities and outputs. They can therefore be measured more often than the six indicators relating to longer term outcomes, and in most cases annual measurement would be appropriate. However, some assumptions do not need to be assessed every time, but rather at the right time (when the political will exists, for example). Some assumed requirements (such as capacity) are realised slowly and there is no defined threshold for satisfying them. It is therefore not necessary, or possible, to measure all these assumptions all the time, just as it is not possible to monitor the entire Theory of Change all the time. It is therefore necessary to identify those indicators that tell us the most, in the most resource-efficient way. The purpose of Table 12 is to highlight the assumptions that need to be tested in an assessment, not to set out a timetable for regular monitoring.

<table>
<thead>
<tr>
<th>Assumption location in the Theory of Change</th>
<th>Assumption</th>
<th>How does the assumption affect the Theory of Change?</th>
<th>How is the assumption tested?</th>
<th>Appropriate mechanism for the testing of the assumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activities</td>
<td>Public transport catalyses private sector investment in close proximity.</td>
<td>The private sector is important in the creation of commercial, retail and residential buildings that increase the value and appeal of an area. The proximity of these land uses determines how far and how long commuters need to travel to get to them.</td>
<td>Qualitative assessment of the amount of private sector development; average price of land; number of construction sites in the precinct over a period</td>
<td>Independent property market analysis around public transport nodes and along corridors</td>
</tr>
<tr>
<td>Outputs</td>
<td>New community facilities are located within 1km of a public transport system.</td>
<td>The creation of community facilities within 1km of a public transport system increases the accessibility of these destinations, since they are within walking distance of a public transport drop-off point, and reduces travel time and distance.</td>
<td>The number of community facilities within 1km of the public transport system</td>
<td>Proximity measure can be included in internal project implementation reporting</td>
</tr>
<tr>
<td></td>
<td>Safety increases along with increasing economic activities.</td>
<td>The safety of an area is important, as it helps to attract private sector development in that precinct.</td>
<td>The number of crimes in an area can be measured in correlation with the qualitative assessment of economic activity in the area.</td>
<td>Reporting on transport-related crimes undertaken by SAPS and public transport service providers correlated with economic activity measurement</td>
</tr>
</tbody>
</table>
Table 12 also indicates that this measurement need not be specific to a public transport investment assessment, as the assessment mechanisms described in the last column are those that are either already undertaken by various authorities or should be undertaken as a broader assessment of the effectiveness of government activities. The only three assumptions in this table that may require specific inclusion in a public transport investment assessment framework are:

- Assessment of the level of political commitment to public transport investments.
- Independent comparison of existing land uses and densities against the land uses and desired densities in proximity to public transport nodes and corridors contained in the zoning scheme and any associated densification policy.
- Independent property market analysis around public transport nodes and along corridors.

As the assumptions are critical to the achievement of the desired outcomes and impacts of public transport investment, it is important that they be valid. If they are not, then additional investments are required in order to support and complement public transport investment, which would otherwise not be effective. The validity of the assumptions can be tested at the outset by developing baseline data on the full set of six indicators described above.
5.2 EXTERNAL FACTORS

Besides the assumptions that must be taken into account when assessing the impact of public transport, external factors that could affect the Theory of Change also need to be considered. Gomez-Ibanez (1996) even found in both Boston and Chicago that external factors (such as regional development, level of sub-urbanisation, amount of parking available and employment levels) can affect the Theory of Change more than some internal factors (such as fares). The following external factors are relevant for the public transport Theory of Change.

5.2.1 Price of oil
The rising price of oil can have a large effect on the price of travel as it increases the price of fossil fuel based transport systems. As public transport is generally less fuel intensive per user (based on a public transport system running at capacity), it becomes more attractive for private transport users. The price of oil will predominantly affect the modal split.

5.2.2 Price of electricity
The electricity price has far reaching impacts throughout the entire city. Increases in the cost of electricity will affect commuter rail prices the most, if electricity is used as the source of energy.

5.2.3 Economic growth
Economic growth increases levels of employment and consequently demand for transport. It may not affect the modal split, but it will increase the number of people using all of the systems. The reverse is also true, as a downturn in the economy is likely to reduce the demand for transport, and reduce the viability of mass transit.

5.2.4 Population growth
An increase in a city's population, including rural-urban migration, increases the demand for public transport. It also increases the demand for all other urban services, including land and housing. In a high-growth scenario the planning for transport and land use is particularly important.

5.2.5 Environmental policy
Environmental legislation, both local and international, can affect the modal split through the regulation of certain technologies. Instruments such as carbon taxes and mandatory pollution control measures for vehicles will increase the cost of fossil fuel based transport modes to account for the environmental externality and may stimulate a shift in technology (to electric cars, for example) or a modal shift to cheaper systems.

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9. An externality refers to a cost or benefit that affects a party who did not choose to incur that cost or benefit
FEASIBILITY OF PROPOSED PUBLIC TRANSPORT INVESTMENT ASSESSMENT
The feasibility of collecting the data for the indicators must be examined to see whether this collection can realistically be expected of the relevant authority. If it is not feasible for the data to be collected, then creating an assessment framework is a futile exercise.

6.1 ASSESSMENT OF FEASIBILITY OF PROPOSED INDICATORS

Interviews were held with transport practitioners and spatial planning practitioners from the City of Cape Town, City of Johannesburg and eThekwini to discuss the proposed indicators, examine the ultimate objectives of the assessment framework, discuss the data collection methods and explore the institutional arrangements for collecting the data.

Metropolitan municipalities are currently preparing for the CSP indicators to be confirmed, so they are aware of the systems they have in place and know what additional resources (human, financial and technical) will be required in order to collect this data adequately.

All the municipal officials interviewed felt that currently there is no adequate assessment framework which fully encompasses the intricacies of a public transport investment and its relationship with the built environment. It was generally agreed that utility theory was a good way to investigate the modal choice that the user would make. However, one transport practitioner felt that, while utility theory is well known, it does not fully take into account the social integration that public transport is trying to achieve.

Most of the data for the six proposed indicators would require an additional effort to collect. This data may exist but is not collected on a consistent and regular basis. Concern was expressed that the metro-wide software models for transport are still too crude to provide the
FEASIBILITY OF PROPOSED PUBLIC TRANSPORT INVESTMENT ASSESSMENT

level of detail and accuracy required. The City of Cape Town transport official believed that their model is almost there, and is currently being calibrated with actual data, which is being collected through manual vehicle counts.

The City of Johannesburg is currently revising its model; the transport official felt that no accurate data can be produced from it at present, although useful data was recently obtained from a household travel survey. The official believed that this type of survey is feasible and necessary, and should be conducted every five years (coinciding with the mayoral term in order to feed into the long-term strategy). Household travel surveys will provide much of the data required for the proposed set of indicators, including the modal shift, perceptions of crime, convenience and reliability and travel time. He also believed that an accurate model could produce the correct figures for carbon emissions.

Officials from eThekwini said that they use a model called ME4, which is a high-level macroscopic model that may provide some of the data required to measure these indicators. The data underpinning the ME4 is from a 2008/9 household travel survey and a 2004 study called CPTR (current public transport record), which contains an analysis of all the public transport routes, modes and destinations. This data is currently being updated, although service provider issues mean that its completion date is uncertain. An eThekwini official felt that the 2004 data was accurate enough on which to base high-level decisions, but the data currently being produced would be better. This model is also calibrated occasionally with data received from ‘screen counters’, which are sensors measuring traffic into and out of major routes in the city.

Two of the municipal spatial planners initially felt that this assessment framework was not targeted at them, as it is specific to public transport. This hesitation to engage with public transport indicators seems to illustrate the perceived separation between public transport and spatial planning outcomes. However, they were more willing to participate once it was explained that this assessment framework was attempting to bridge the perceived divide between public transport and spatial planning and transformation.

In addition to the spatial indicator relating to land taken by transport infrastructure, the major focus was on the proxy measurements derived from the reduced travel time, as these have the highest association with spatial transformation. All the spatial transformation practitioners felt that these proxy measures were good as a crude, high-level indicator of spatial transformation, although they felt that other measurements, such as density and floor area ratios, were missing. When it was argued that floor area ratios and density do not affect the quality of life of the urban resident, as is the ultimate objective of many built environment functions, there was marginally more acceptance of the proposed indicators.

On the whole, the spatial planners felt that the GIS information for analysing the use of undeveloped land for transport infrastructure is currently available. They felt less certain that the current transport system was mapped on GIS, and this may need to be done in retrospect. The point was also raised in eThekwini that much of the future public transport needs will still be served by minibus taxis, which will therefore require general road space. The area taken up by mass transit routes (dedicated public transport lanes and rail lines)
will therefore be significantly less than that taken up by roads, even in a well-designed public transport system. This point suggests that the proposed indicator for impact on the natural environment may not be of value if the current modal split is maintained. This could be improved by changing the indicator so that it will compare land take by mass transit routes with land take by arterial and distributor roads (Class 2 and Class 3), excluding collector and access roads (Class 4 and Class 5).

Some municipal officials felt that the indicator data could be collected without introducing new systems or allocating additional resources. However, the accuracy of modelling would need to be improved, and the need for additional staff and operating budget would depend on the frequency of data collection and reporting, as quality control is very important when collecting information upon which high-level decisions are made.

The City of Cape Town is already aware that it will need additional funding and human capacity. It will also probably be at least two years before any teething problems are rectified and the full set of CSP indicators correctly and accurately measured. The much smaller set of indicators proposed for the public transport investment assessment framework described in this report is believed to be less onerous than the current CSP proposal. However, if the indicators are contained in (or introduced alongside) the CSP indicator set, then relatively few additional resources will be required.

eThekwini municipality has conducted a preliminary investigation into the feasibility of the CSP indicators, given its current data and capacity. The results of this investigation show that some of the information is readily available, but most of the public transport indicators require a form of smart ticketing, which will only be implemented in 2018 along with the Go!Durban system. The officials were unsure whether the current smart ticketing systems could provide all the information required. The City of Johannesburg officials stated that if they are made aware early enough of the proposed assessment frameworks and the data collection required, then budget will be made available. External consultants are also used by eThekwini Municipality for big data collection exercises, although the quality of these is often a concern.

6.2 ORGANISATIONAL AND INSTITUTIONAL CONSIDERATIONS

If an integrated assessment framework such as this is going to be created and used efficiently, a clear understanding of which department within the city is responsible for the collection and collation of data is important.

Organisational responsibility for data collection and reporting

The City of Johannesburg’s Group Strategy, Policies and Relations Unit is a centralised department that deals with the metro’s long-term strategies. The unit collects data, creates indicators, and is responsible for drafting the IDP. The Johannesburg Roads Agency (JRA) contributes to the Integrated Transport Plan (ITP) and provides data on the condition of roads via a visual condition index (VCI) test. This data is provided to the Group Strategy department when necessary. The official interviewed was unaware of the capacity and resources at the disposal of this department and was therefore unable to say what additional resources would be required to institutionalise the proposed assessment framework.
The City of Cape Town’s transport department used to have its own internal data collection unit, but this has been closed down. The current transport authority, Transport for Cape Town, now employs consultants to collect data on their behalf, but the official interviewed believes that this had resulted in a generally lower quality of data. There was a feeling that this should again become the internal responsibility of the metro but would require greater in-house capacity. This was described as ‘time capacity’, as opposed to ‘people capacity’, meaning that the staff were capable of collecting the data but were too busy doing other things. This, however, would suggest that the department would either need more staff, or their tasks would have to be streamlined to make time to collect the necessary data.

In the City of Cape Town, the transport official noted that the Passenger Rail Agency of South Africa (PRASA) is responsible for the rail network, which may cause additional problems with collecting data and collating it into a manageable form. The transport planning powers that have been devolved to local government imply that they should be able to prescribe what data is collected and provided on the rail network, but this has evidently not been realised in practice.

**Software systems for data collection and reporting**

eThekwini has instituted an electronic reporting system, the electronic performance management platform (EPMP), to track all performance indicators contained in the IDP, SDBIP and Performance Scorecards on a quarterly basis. Each department is responsible for inserting its own data into the system. It is anticipated that this system will be able to incorporate the CSP indicators once they are approved. It is not known whether the other metros have a similar system. The eThekwini official made the point that introducing similar and compatible systems in all the metros (and smaller municipalities) would make the national collation and analysis of the data easier. The City of Cape Town and the City of Johannesburg do not have established systems that could be used by all departments to record indicator data, thus making it easier to streamline the collation of data. Besides making the national collection of data easier, a streamlined, interdepartmental electronic system could make collection and collation of detail easier within a metro.

**Regulation of the public transport indicators**

Views were mixed about whether data collection needs to be regulated through legislation. All the transport and
planning practitioners saw the value of collecting accurate and relevant data for long-term strategic planning. However, they were concerned whether politicians would take the same view, as politicians’ terms of office would not be long enough to see the full value of this investment. This provides an argument to support the legislation of these processes.

However, the counter-argument is that once an indicator becomes a statutory requirement, the data collection and reporting becomes a compliance exercise and the results can be used for the wrong purposes (such as motivating for funding allocation or other investments). In this regard, it is important to note that the indicators proposed here are not the same as the performance indicators used to assess municipal expenditure and efficiency on a quarterly or annual basis. Instead, they are measures to assess whether the public transport investment and spatial transformation have had the intended long-term impact. The purpose of the assessment framework is to inform the municipality’s overall strategy, to enable it to invest more effectively, rather than to measure short-term municipal performance.

The data collection period should also be prescribed. Not all the information is proposed to be collected on a yearly basis. Quarterly reporting is seen by officials as a burden but is required by some national departments, and is closely audited. The period for each indicator should be appropriate for its intended purpose. The implication for the public transport investment assessment framework, which measures long-term outcomes, is that the indicators should only be reported on over longer periods, with annual reporting being the shortest time scale. There was strong motivation for the data to be collected every five years, coinciding with the new mayoral term and therefore feeding into the new strategies for that metro.

If the public transport infrastructure investment framework and its associated indicators were regulated, the purpose of this regulation should be to ensure consistency in application, rather than compliance. This understanding implies that there is less need for auditing. Therefore, a critical component of the regulation should be the technical indicator description, including the required methods for collecting the data.

The role of external stakeholders in the assessment framework

Stakeholders external to the municipalities would need to be involved in the public transport investment assessment framework. Their buy-in is crucial as they may, knowingly or unknowingly, affect the city’s spatial arrangements. Their proposed roles are as follows:

**Metrorail/PRASA:** Collection and provision of data related to passenger rail usage and new infrastructure provision

**Provincial transport departments:** Oversight and support of the process; assessment of the use of the framework to inform the ITPs; incorporation of the assessment results into the Provincial Land Transport Frameworks

**National DoT:** Overall responsibility for the public transport investment assessment framework, including indicator definition; oversight and monitoring of the process of data collection and reporting to ensure consistency; and undertaking national level evaluations

**National Treasury:** Incorporation of the proposed public transport indicators in the CSP; oversight and monitoring of the implementation of the CSP and public transport grants
Theoretical basis for the framework: understanding the Theory of Change

The Theory of Change is the theoretical framework selected for the public transport investment assessment. This framework was selected because of the multiple processes that are involved to link public transport investment to spatial transformation of the built environment over extended time frames. The benefit of the Theory of Change is that it makes the causal linkages explicit, to explain how what is done in the present (public transport investment) is expected to cause the desirable future outcomes. In developing this Theory of Change, the proposed two ultimate long-term impacts are: improved standard of living for urban residents and improved quality of the environment. This has been linked back to the inputs and activities involved in public transport investment in a simple and coherent manner in the framework. In addition, the assumptions that are made in order for the Theory of Change to work as intended are made explicit to focus attention on ensuring that these critical success factors are in place.

Proposed assessment indicators

In determining points of measurement in the Theory of Change, the intention was to have as few indicators as possible that would clearly indicate whether the desired outcomes are being achieved, and would be able to attribute the change directly to public transport investment.
investments. This resulted in the proposal of six indicators for inclusion in a public transport investment assessment framework. These indicators measure multiple outcomes and outputs in the Theory of Change through direct and indirect linkages.

To take these indicators further, they would need to be properly defined with technical descriptions, and a protocol for the collection of the data developed. When creating indicators, one of the important steps is to rank them in order of preference (Renne, 2007). For the purposes of this study, this has not been done because it is a highly political process and can only be done in consultation with the relevant stakeholders. The proposed indicators should therefore be discussed further with the relevant stakeholders, particularly all the metros, the CSP at National Treasury and the DoT. The purpose of this discussion would be to debate and refine the indicators, and to confirm the most appropriate method for their institutionalisation.

Other factors to track the Theory of Change
In addition to the six indicators, 12 assumptions have been identified and need to be tested. Only three of these are specific to public transport, but all would need to be investigated as part of the process of setting up the public transport investment assessment framework.

The indicators that have been proposed are not intended to measure inputs and activities. It has been argued that multiple processes already exist to measure these elements. These processes are those included in the oversight of municipal planning, governance and financial management and therefore do not need to be included in a public transport investment assessment framework.

Institutionalising the assessment framework
The municipalities are in the process of adjusting to increased public transport responsibilities and management of the systems resulting from the high levels of recent public transport investment. National Treasury is focusing on built environment performance and spatial efficiency through the CSP and its Urban Networks Strategy and Integrated City Development Grant. Cities are engaging with the proposed CSP indicators that are intended to measure built environment performance. It is therefore logical that the public transport indicators be incorporated as a subset of the CSP performance indicators (where there is not overlap already). This is not to suggest that the public transport investment assessment framework is part of the CSP evaluation process, but rather that the indicators are institutionalised in that process. The public transport investment assessment framework should still be a distinct entity used for evaluating the impact of public transport investments separately from other investments in the built environment.

Once the cities have accepted the framework and indicators, the capacity to collect the data will need to be developed. This report’s brief survey suggests that, while cities may currently have the capacity and systems to collect the data required for the public transport indicators, this collection is not being done. The current inaccuracy of the metro transport models has been identified as an issue that will need to be addressed if the required data is to be collected. In addition, household travel surveys will have to be designed and implemented on a more regular basis where these are not being done. This report has also suggested that all metros develop compatible electronic systems for collecting and reporting data, where these do not exist.
Metros have identified that the institutionalising of the full suite of CSP indicators will require many more resources to populate the six indicators in the proposed public transport investment assessment framework. Therefore, the funding of additional staff, capacity building and introduction of new information systems should be dealt with as part of the CSP debate, and not specifically with regard to the public transport investment assessment framework.

Once the capacity and systems issues have been dealt with, baseline data will need to be collected as soon as possible. Silverman et al. (2011) propose that a phasing process be used to prepare cities to collect the data for evidence based evaluative processes such as this one. This view was supported by a municipal official who believed it was prudent to start by collecting good information using robust systems for a few indicators, rather than trying to collect too much information using untested systems. Another municipal official said it would take at least two years to get the software systems running efficiently. This suggests that indicators could be introduced one at a time, depending on which systems are in place, or easiest to put in place, to collect consistent and credible data.

This data collection may require a cross-sectoral effort, and thus a centralised authority and data collection centre may be required to facilitate this. However, much of the data is likely to be collected by the transport departments, with some input from the spatial planning departments, but the variation in organisational structures suggests that this will vary from one municipality to another.

Using the framework for monitoring and evaluation

The final step in institutionalising the framework is to set up the system of monitoring and evaluation, i.e. when the data will be collected and when overall evaluation will be done. Responses from municipal officials and information in the literature suggest that a five year cycle may be appropriate, but this may be resource dependent and subject to negotiation with the cities. It may be useful to monitor some indicators annually, while others may require a longer time frame to detect any meaningful changes.

It must be noted that the data provided through the indicators is not sufficient proof that the outcomes are being achieved. The indicators are only one source that would be used to indicate progress towards achieving the desired impacts. A formal evaluation that combines indicator data with external data and other qualitative assessments will be needed to judge whether the desired outcomes have been achieved. The overall evaluation will need to be properly designed, taking into account multiple forms of data that may exist to inform the evaluation, and what budget is available for the evaluation.

Use of the evaluation results

The results from an evaluation using the public transport investment framework will produce valuable insight into how public transport may transform the built environment for the benefit of its residents and the environment. It has been noted that this data is not specifically a reflection of municipal performance, but has more important strategic uses.
The results from such an evaluation should be used to assess whether the public transport investment is achieving broader built environment objectives, and to use the lessons learnt to improve the impact of such investments in the future. The results therefore have implications not only for all spheres of government but also for all stakeholders involved in the urban environment: from urban professionals, academics, and community-based organisations to the general public.

This report strongly recommends that the type of public transport and built environment related data that would result from the public transport investment assessment framework be popularised in the public domain to promote accountability and elevate the importance of public transport investments.

Public transport investment is crucial in South Africa, where reliance on this mode of travel is high. The inequalities of apartheid have given the South African city a spatial form in which lower income people live predominantly on the peripheries of cities and rely on public transport for mobility. Their level of mobility will ultimately affect their quality of life. The municipalities need to realise the potential impact of public transport for the urban resident, as it could catalyse social, environmental and economic transformation. An assessment framework such as this could provide guidance on whether this change is happening.
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APPENDIX A: INTERNATIONAL EXAMPLES OF ‘GOOD’ PUBLIC TRANSPORT AND LAND USE INTERVENTIONS AND INTERACTIONS

CURITIBA, BRAZIL

Curitiba is the capital of the Panama state in Brazil. It is located in the southern part of the country. Curitiba is a multi-functional centre in Brazil, surrounded by agriculture, mining, industry and manufacturing. The city had approximately 1.6 million inhabitants in 2003 and had an above-average car ownership rate of 410 vehicles per 1000 people. This high level of car ownership had led to a city which sprawled along major vehicular transport routes (Pienaar et al., 2005). Jamie Lerner, an urban planner and architect, was the three-time mayor during the initial conceptual and implementation phase of the public transport system. The entire process took over 30 years to complete. Lerner led the team which created the system and demonstrated that strong leadership is crucial to the success of such a project (United Nations, 2011).

The public transport system consists of a high capacity, dedicated right-of-way bus service along the activity corridors, which is, in turn, combined with circular routes that link the radial routes to one another.

Lerner instigated a special land use and transportation planning unit, Urbanização Curitiba SA (URBS). It has a total staff of 1730 people. Lerner knew that the problem of sprawl needed to be managed, and used a land use master plan to confine development to high density ‘activity corridors’ (Pienaar et al., 2005). Each of the activity corridors is 8–12 km long, radiating from the city centre. The average cost of these dedicated lanes (the last of which was completed in 1994) was $1.5 million per kilometre. The circular bus lanes are not dedicated lanes, and tend to be used by smaller vehicles to move passengers to the major arterial routes. The network uses buses that range from a small 30-person bus to a large double-articulated, 24.6m long, 270-person bus, which at the time was the only one in the world. The entire system is closed, with a single fare to access the system regardless of the distance travelled. As a result, people using the shorter routes cross-subsidise people using the longer routes. In many contexts, the poorer people, who live on the margins of the city, are being subsidised by the more affluent people who live closer to the city centre; the sharing of the bus also promoting social cohesion. The operational part of the Curitiba public transport system is financially independent, which is particularly interesting when one looks at the financial sustainability of BRT systems in South Africa (Pienaar et al., 2005).

The operational management of the system is taken on by URBS, which is owned by the city of Curitiba. A strategic body advises the city which measures should be taken to improve efficiency in the medium to long term.

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The operators, of which there are 28 privately owned companies, are compensated on the distances travelled, not on the number of passengers that use their vehicles. URBS sets the operational standards (for example, emissions limits, safety, service quality and efficiency) to which the bus operators must adhere. Seventy percent of all daily commuting in Curitiba is done by public transport (Pienaar et al., 2005).

Pienaar et al. (2005) state that one of the main reasons for the success of the Curitiba system is the governance of URBS. URBS is responsible for day-to-day operations, including managing service providers and revenue collection. In South Africa, the South African National Land Transport Act (NLTA) allows for transport authorities to be created which are responsible for public transport in their jurisdiction. The efficiency of URBS raises the question of whether the administration and governance of the transport authority responsible for public transport should be included as an indicator in the Public Transport Investment Assessment Framework.

A public transport system such as the one in Curitiba should ensure that it stays up to date with any developments within the city, in particular changing spatial demands and growth patterns. In the last four years the Curitiba system has experienced decreased ridership, attributable to changing usage patterns, evolving demographics and increased fares (Halais, 2012). This highlights the importance of having a dynamic and modern system with efficient monitoring systems in place.

BOGOTÁ, COLOMBIA

Bogotá is the capital of Colombia in South America. It is one of the highest capital cities in the world and is located at approximately 2600m above sea level. Colombia has experienced dramatic economic growth over the past 25 years, averaging an increase of approximately 4.5% per year, with some sectors registering an increase of 5% per year. This is above the average for that region and has resulted in large urbanisation. These figures exceed those of South Africa, with its economic growth rate consistently below 3% and its urbanisation peaking at around 65% currently (CIA, 2013).

The population of Bogotá is significantly larger than that of Curitiba at approximately seven million people (CIA, 2013), 80% of which rely on public transport for mobility. In South Africa, a similar proportion (70%) of the metropolitan population rely on public transport (van Ryneveld, 2008).

Historically, public transport has always operated in Bogotá but was ineffective in the 1990s, and the city suffered severe road congestion, poor road conditions, long travel times, frequent accidents and high pollution levels. These are indicators of a poor performing system. The economy was being negatively affected by the transportation issues, to the extent that in 1998 the decision was taken to reconstruct the pavements and sidewalks, construct cycle paths and develop a new, formalised public transport system. This system was implemented in the form of a bus rapid transit (BRT)

system to achieve two objectives. Firstly, to improve the quality of life of the citizens of Bogotá, and secondly, to improve the productivity of the city. The six basic outcomes which the system is striving towards were adopted at the initiation phase (Miranda, 2005):

- Respect for life (improvement of road safety)
- Respect for the time of users of public transport (reduced travel time)
- Respect for human diversity (the system should cater for all demographics from all parts of the city)
- Quality
- Consistency
- Affordability

In addition to this, the system had to be economically sustainable, and thus not further burden the taxpayer. Strong leadership also played a part in the transformation of Bogotá. Antanas Mockus was the mayor of Bogotá in 1995, and his primary focus was to change the lives of the people and their sense of morality. During his tenure as mayor, the homicide rate fell by more than 50% as did traffic fatalities, and the water consumption dropped by over 40%. He achieved this by showing the people that he was concerned about social equity and quality of life. Without Mockus it is unlikely that Bogotá would be the city that it is today (United Nations, 2011). The system in Bogotá is similar to the one that was implemented in Curitiba, particularly with regard to the dedicated bus lanes, pre-sale of tickets and level boarding platforms. The system has been dubbed Transmilenio (Pienaar et al., 2005).

The Transmilenio is not the only public transport system running in Bogotá, and strong parallels can be drawn between that city’s less formalised networks and the minibus taxi system in South Africa. When the Transmilenio was being planned, there was a huge drive towards including the existing operators and drawing them into the new plan. This was met with enthusiasm on the most part, although the operators with fleets that did not meet environmental or safety standards were not allowed to participate any further until their fleets were refurbished or they bought new buses. Owing to these requirements, many operators chose not to buy into the new Transmilenio system and to continue operating on their own routes, resulting in only 16% of public transport trips using the Transmilenio system. This, however, still totals approximately 1 600 000 trips during weekdays. The rest are split between 66 private companies and thousands of buses which operate on chaotic networks to unpredictable and often non-existent schedules.³ This is similar to the system which currently operating in South Africa, with many private taxi companies using erratic routes on unpredictable schedules to facilitate transport, either to a destination or to a larger trunk route. The low usage rate (16%) of the Transmilenio system does make one question the success of the system, in particular in comparison with the equivalent which operates in South Africa.

The Transmilenio Company is responsible for the strategic decisions behind the Transmilenio system, in collaboration with the relevant government body. As with the system in Curitiba, operators are reimbursed for every kilometre driven and not for the number of passengers (Miranda, 2005).

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There have been numerous reports of overcrowding and a lack of safety on the Transmilenio service, but the capital expenditure required to expand the service is in the region of $5.1 million per kilometre (Kash, 2011). Currently, planners are urging the Transmilenio Company to speed up Phase III, but no measures have been put in place yet.

Transmilenio is less effective than the system in place in Curitiba, and has a relatively low usage rate, so one must question its representation as one of the world’s premier BRT systems. In 2012 there were numerous riots, which were fuelled by the crowded buses and high fares. Five Transmilenio stations were destroyed.

Table 13 uses 1995 data to compare the different cities. Data from 1995 was selected because this was when Bogotá instigated its BRT system. The table shows that the cities’ transport statistics are not dissimilar, although an important parameter to note is the density of the cities

<table>
<thead>
<tr>
<th>Transport indicator</th>
<th>Curitiba</th>
<th>Bogota</th>
<th>Taiwan</th>
<th>Cape Town</th>
<th>Johannesburg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population (million)</td>
<td>1,6</td>
<td>6,4</td>
<td>2,3</td>
<td>2,9</td>
<td>2,8</td>
</tr>
<tr>
<td>Peak public transport person trips (am 2hr peak)</td>
<td>428 000 taken as 20% of daily figure</td>
<td>870 000</td>
<td>510 000</td>
<td>400 000</td>
<td>487 700</td>
</tr>
<tr>
<td>Public transport vehicle fleet</td>
<td>2 100</td>
<td>2 1000</td>
<td>17 500</td>
<td>10 770</td>
<td>13 450</td>
</tr>
<tr>
<td>Average public transport trips per inhabitant (am 2hr peak)</td>
<td>0,27</td>
<td>0,14</td>
<td>0,22</td>
<td>0,14</td>
<td>0,17</td>
</tr>
</tbody>
</table>

Source: Pienaar et al., 2005

COPENHAGEN

Copenhagen’s rail investments have been described as ‘a textbook example of long range planning’. The plan is called the ‘finger plan’, as early in its development the planners identified corridors into which to channel overspill growth from the major urban centre. Rail infrastructure was built, often in excess of demand, along these corridors to focus growth there. Green zones were retained as expansion occurred to maintain the bike and pedestrian friendly nature of the area (Suzuki et al., 2013).

Small towns outside Copenhagen (with populations in the region of 10,000 to 30,000) have remained socially intact owing to the prevalence and ease of public transport, whereas if there had been no effective public transport system, the people may have had to migrate into the city to be able to access their places of employment. Four out of five people living in these communities either walk, cycle or take a bus to their community’s railway station (Suzuki et al., 2013). These communities lie on one of the ‘fingers’ and can therefore use one of the arterial rail networks to get to work in the city. There are also ‘cross finger’ connections to allow movement between and not only along a ‘finger’.

Copenhagen also boasts one of the first and longest car-free streets in Europe, named Strøget, which during summer can often host up to 55,000 pedestrians. Copenhagen has introduced stationary activities to public spaces to encourage people to spend time in the pedestrian friendly zone as opposed to just passing through. Benches, tables and parks have been introduced in the mixed-use zones to support this behaviour. The reason for this is that Danish researchers have found that acceptable walking and cycling distances can be stretched considerably by creating these attractive, visually stimulating and safe travel corridors. Bicycles are very common, and the Danish transport authorities are aiming for a modal split of 50% use to work and school by 2015 (Suzuki et al., 2013).

One of the critical factors for the success of Copenhagen’s transport scheme is the implementation of national policies which aim to moderate car ownership and usage. The country’s government has issued policy statements every four years since World War II that are aimed at shaping the land-constrained country’s physical development. National infrastructure funds are tied to compliance with these directives. Another interesting political dynamic is that the nation’s Ministry of Environment has veto power over any proposed local development projects. This veto has been used sparingly, as most localities have embraced the notions of sustainable development and design. In addition, the government has placed levies on vehicles that can almost treble the price of some vehicles (Suzuki et al., 2013). The government’s use of policies and veto powers has drastically changed the spatial dynamics of both Copenhagen and Denmark as a whole, and demonstrated the effectiveness of these methods.

SINGAPORE

Singapore is internationally known as one of the most successful cities with regard to integrating the transport
and regional development aspects of its development (Suzuki et al., 2013). It is an entirely urbanised island with a population of 5.1 million people.

Singapore's transport and spatial land use inspiration came from the Scandinavian countries' planning model of radial transport corridors, interspersed with green belts and joined by orbital heavy and light rail networks to promote the use of public transport. Spatially, Singapore's planning authority adopted the notion that the building of new towns was not the creation of independent areas, but rather the creation of nodes with specialised functions that interact and depend on one another. For example, some of these nodes are industrial areas with very low residential components, while others are dormitory nodes with very low work opportunities. This means that travel is an integral part of the interrelation of these nodes, in particular as about three-quarters of the citizens do not live in the same node as they work in. There are, however, areas which have mixed use, and in these travel is less of an imperative, although it is still important.

Like Copenhagen, Singapore instituted progressive policies to complement its transport-orientated spatial design. It used market forces to drive down the demand for private vehicles through the following three tiers (Suzuki et al., 2013):

- The first tier of charges are high subscription fees for owning a car, consisting mainly of high registration fees, import duties and a licensing surcharge.
- The second tier of charges are use related, and come in the form of fuel taxes and parking fees.
- The third tier is a congestion charge for using the vehicle during peak hours.

These fees have reduced the growth rate of vehicles from 6% in 1997 to less than 3% in 2010, which is remarkable considering that the increase in the average per capita income has been one of the highest in the world over the same period (Suzuki et al., 2013).

Another factor in the integration of spatial and transport planning has been that the government is completely centralised, even though these activities are undertaken by different authorities. This close institutional arrangement has led to a more successful and coordinated collaborative effort. The revenue gathered from congestion charges is put into the general national treasury pot, which then reallocates it to authorities that need it. In particular, some of this money from the national treasury is allocated to the built environment, and used to create sidewalks, civic squares and bus staging areas (Suzuki et al., 2013).

The manner in which Singapore has approached simultaneous transport and spatial design is novel in that not many areas in the world have been able to have a near 'greenfield' developmental opportunity, and most are rather retrofitting their current designs and infrastructure. There are still lessons to be learnt from Singapore though, in particular the way that market forces have been used to change the driving patterns in the city, as well as the close institutional arrangement between the two authorities, which has led to a more effective city being created.

Singapore is very different from cities in South Africa: the population density is much higher at 7540 people per square kilometre, which is approximately six times
higher than the more populous cities in South Africa. It also has one of the highest GDP per capita in the world—fifth according to the CIA (2013) – whereas, at 85th, South Africa is far behind. This shows that the people in Singapore have, on average, more money to spend on public transport and can therefore afford the expensive systems which are in place. This is not the case in South Africa, and so lessons learnt from Singapore may not apply in the South African context.

**TOKYO**

Tokyo has the world’s longest intra-city rail network. It is currently owned and operated by a mix of public, private and state-owned entities. The majority of the network was built by private companies that received government concessions, similar to the Build-Own-Operate concessions given by the South African government. Tokyo’s railway companies have historically leveraged real estate development to both pay for the infrastructure and produce profits for shareholders. These real estate developments have included convenience stores and shopping malls within and adjacent to stations (Suzuki et al., 2013). This is an example of the value capture which public transport investment can result in. Value capture does occur in South Africa, notably in various precincts around the country associated with public transport infrastructure investment, such as the Sandton Gautrain station as well as Century City in Cape Town (Urban Landmark, 2012).

In Japan, this value capture has such financial potential that the railway companies opened stations on previously unoccupied islands to the west of Tokyo. The railway companies vertically integrated themselves across the value chain, and now have branches in real estate, retailing, bus operations and electric power generation. The creation of shopping malls, apartments and entertainment complexes near stations made good economic sense. In the peak period of railway/new-town co-development in the 1980s, the returns on investment were as high as 50%–70%, which far outstripped the profit margins that could have been made from transport services alone, as is shown in Figure 14.

The Japanese government has actively promoted the railway companies’ involvement in the real estate market. In 1987 a former public company, which had been redesignated a private company, received large, developable property around the proposed stations. The land was ultimately converted into a mixed use area comprising a high-rise office building, retail centre and hotel. This development has yielded over 40% returns in 20 years (Suzuki et al., 2013).

This value capture has extended beyond these direct developments. Property along the largest loop, the Yamanote Loop, is generally double the value of that 15-20km from the city centre (Suzuki et al., 2013). The only region in Tokyo where property has not devalued since 2000 has been around the terminals on the Yamanote Loop. This illustrates the effectiveness of the transport intervention on the price of land and the extent of the slowdown of the Japanese economy.

A recent development in the city centre was a collaborative effort between the metropolitan government, national
government, the privatised Central Japan Railway Company and private real estate developers to create office towers and shopping malls, as well as high quality public green plazas and well-designed pedestrian circulation systems. This was done to attract both firms and workers to a place that puts a premium on liveability and to draw them to urban amenities (Suzuki et al., 2013). This model of value capture is one that has not been readily used internationally, although it is gaining traction as a financing tool. It is most commonly administered through a fiscal method such as tax incentives, land value taxation or development agreements. A ‘betterment tax’ could be most applicable, as this would add no additional cost to the public transport investment but would be directed towards the beneficiaries of the increased accessibility, reduced congestion and pollution, and lower transport costs. This tax is perceived as the most equitable and efficient of the possible financial levies, as it recovers the added value on private land because of the transport investment (Medda and Modelewska, 2011).

These tools to capture land value could be used in the South African context, as the authorities responsible for developing the transport infrastructure or spatial development may have the capacity or legal power to implement these value capture tools. The difficulty may come from perceptions, as the people may feel that the public transport investment is there to benefit them as opposed to creating a further burden through an additional tax (Urban Landmark, 2012).
### APPENDIX B: INDICATORS PROPOSED BY RENNE (2007)

<table>
<thead>
<tr>
<th>Categories of indicators</th>
<th>Indicators</th>
<th>Sub indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel behaviour</td>
<td>Vehicles kilometres travelled (VKT)</td>
<td>I feel safe walking around my neighbourhood at night</td>
</tr>
<tr>
<td></td>
<td>Mode split</td>
<td>My neighbourhood is well served with public transport</td>
</tr>
<tr>
<td></td>
<td>Frequency of public transit usage</td>
<td>Traffic is not a major issue in the area</td>
</tr>
<tr>
<td></td>
<td>Resident commuting time</td>
<td>The neighbourhood is easy to walk around</td>
</tr>
<tr>
<td></td>
<td>Quality of transit service</td>
<td>Footpaths are in good condition</td>
</tr>
<tr>
<td></td>
<td>Vehicle ownership</td>
<td>It is easy to cross the street</td>
</tr>
<tr>
<td></td>
<td>Transport-related perceptions of residents:</td>
<td>I feel safe from traffic while walking</td>
</tr>
<tr>
<td></td>
<td>I feel safe walking around my neighbourhood at night</td>
<td>Drivers give way to pedestrians crossing the road</td>
</tr>
<tr>
<td></td>
<td>My neighbourhood is well served with public transport</td>
<td>I can easily walk to the train station from my house</td>
</tr>
<tr>
<td></td>
<td>Traffic is not a major issue in the area</td>
<td>Hills along the route are a barrier to walking to the train station</td>
</tr>
<tr>
<td></td>
<td>The neighbourhood is easy to walk around</td>
<td>One of the main reasons I live here is to be close to the train station</td>
</tr>
</tbody>
</table>

*continued...*
<table>
<thead>
<tr>
<th>Categories of indicators</th>
<th>Indicators</th>
<th>Sub indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local economy</td>
<td>Number of jobs by type</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vacancy rate</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Home ownership vs rental</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Weekly housing expenses</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Property value</td>
<td></td>
</tr>
<tr>
<td>Natural environment</td>
<td>Transport energy consumption (computed)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CO2 emissions (computed)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Park space</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Percent of land cover as green space</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Percent of land cover as trees</td>
<td></td>
</tr>
<tr>
<td>Built environment</td>
<td>Population and housing density</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Street quality</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Amount and quality of public space</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Land cover/land use distribution</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pedestrian accessibility</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Parking inventory</td>
<td></td>
</tr>
</tbody>
</table>

Continued…
<table>
<thead>
<tr>
<th>Categories of indicators</th>
<th>Indicators</th>
<th>Sub indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social environment</td>
<td>Education</td>
<td>My neighbourhood is a good place to live</td>
</tr>
<tr>
<td></td>
<td>Income</td>
<td>My neighbourhood is a better place to live than other parts of Perth</td>
</tr>
<tr>
<td></td>
<td>Quality of life (resident perceptions):</td>
<td>My neighbourhood is clean and well maintained</td>
</tr>
<tr>
<td></td>
<td></td>
<td>My neighbourhood is a low crime area, compared to other parts of Perth</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The neighbourhood centre is an attractive place that is nice to be in</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I can do all my weekly/day-to-day shopping in the neighbourhood centre</td>
</tr>
<tr>
<td></td>
<td></td>
<td>There is a strong community feeling in my neighbourhood</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The area is quiet and free of traffic and other noise pollution</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The neighbourhood is well provided with community facilities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>There are many opportunities for recreation in my neighbourhood</td>
</tr>
<tr>
<td>Policy context</td>
<td>TOD future potential (TOD Assessment Tool)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Existing zoning</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Resident support for more retail development</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Resident support for more office space development</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Resident support for more residential development.</td>
<td></td>
</tr>
</tbody>
</table>
# Appendix C: City of Cape Town Sustainable Transport Indicators

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energy use for transport</strong></td>
<td><strong>Consumption of non-renewable resources</strong></td>
</tr>
<tr>
<td>Greenhouse gas emissions</td>
<td>Total GHG emissions (megatonnes of CO₂ equiv.)</td>
</tr>
<tr>
<td>Per capita expenditure on roads, and parking supply services</td>
<td>Rands per inhabitant of Cape Town</td>
</tr>
<tr>
<td>Commuters using NMT as main mode</td>
<td>Percentage</td>
</tr>
<tr>
<td>Population living within 500m of nearest public transport facility and service</td>
<td>Percentage</td>
</tr>
<tr>
<td>Public right of way (+ public parking) per capita</td>
<td>m²/capita</td>
</tr>
<tr>
<td><strong>Economic</strong></td>
<td></td>
</tr>
<tr>
<td>Average total journey time</td>
<td>Time unit</td>
</tr>
<tr>
<td>Number of job opportunities, commercial services and educational facilities within 5km of residence</td>
<td>Number</td>
</tr>
<tr>
<td>Modal split</td>
<td>NMT: mass transit: private transport</td>
</tr>
<tr>
<td>Ratio of number of daily passenger trips by public transport: public transport standee + seating capacity</td>
<td>Utilisation: capacity</td>
</tr>
<tr>
<td>Generalised cost of movement of goods and services</td>
<td>Percentage of total cost of goods and services to the customer</td>
</tr>
<tr>
<td>Condition of transport infrastructure</td>
<td>Visual Condition Index of 70+</td>
</tr>
<tr>
<td><strong>Social</strong></td>
<td></td>
</tr>
<tr>
<td>Portion of household income devoted to transport</td>
<td>Percentage</td>
</tr>
<tr>
<td>Per capita accident cost for fatal and serious accidents only</td>
<td>Rands/persons involved in accidents</td>
</tr>
<tr>
<td>Accessibility of infrastructure by mobility disadvantaged, children, elderly</td>
<td>Survey. During typical weekday trip on a typical journey, count and average the number of inaccessible locations</td>
</tr>
<tr>
<td>Car and bicycle ownership per 1000 population</td>
<td>Number of cars and bicycles per 1000 population</td>
</tr>
<tr>
<td>Transport impacts on the liveability of community</td>
<td>Survey: Converted to a scoring unit</td>
</tr>
</tbody>
</table>

Source: City of Cape Town, 2006
APPENDIX D: TYPES OF ASSESSMENT FRAMEWORKS

COST: BENEFIT ANALYSIS

A Cost:Benefit Analysis (CBA) is a conceptual framework for the evaluation of projects, often in the public sector, which attempts to consider all potential and actual gains and losses from the project. It takes a long and wide view of the project and includes the interests from any relevant stakeholders. It generally attempts to reconcile the different indicators into monetary units, which are then compared to one another and then a decision is made based on this (Argyrous, 2010).

The advantages of a CBA are that the output is a decision, which can include the ‘do nothing’ scenario, that is to maintain the status quo. This is often included as one of the scenarios. It ascribes a monetary value to all decisions, and therefore often prompts action from stakeholders who can familiarise themselves with the expenses which could be incurred if action is not taken. The disadvantages of a CBA are that it could potentially be a subjective tool, as the qualitative aspects have to be given a monetary value. This can often be manipulated or disagreed upon. For example, the value of life in the USA varies from department to department, with the Food and Drug Administration valuing a life at $7.9 million and the Environmental Protection Agency valuing a life at $9.1 million (2009 values). Discrepancies such as this may yield different results when the model is applied. Different values have even been found in the same geographic area when the models are generated by different people. Another major problem with ascribing monetary value is the discount rate used, as future values are brought back into current values. This could make one option seem viable even though it is based on a series of projections of a subjective discount rate.

These disadvantages are particularly relevant in the context of a public transport investment assessment framework as a comprehensive assessment requires a lot of interpretation to transform qualitative aspects (value of life, health, history, social integration, environmental sustainability, safety, access to work and education among others) into quantitative monetary value. This results in an assessment model which can easily be disputed and decreases its effectiveness as a tool (Argyrous, 2010).

MULTI-CRITERIA ANALYSIS FRAMEWORK

The Multi-Criteria Analysis (MCA) is a framework which is used to compare different options using a range of criteria, often a mixture of quantitative and qualitative indicators. It can compare many different alternatives and indicators, although it may become clumsy if there are too many indicators across too many projects. It is particularly appropriate in public participatory scenarios when there is a lot of stakeholder input and decisions need to be made in a democratic manner (Joubert et al., 1997). In MCA, criteria and sub-criteria are structured into a ‘decision tree’, and all criteria and sub-criteria are weighted. Each of the alternatives being assessed is scored on each criterion relative to the other alternatives, and the scores are multiplied by the weightings and summed up the decision tree. The outcome of an MCA is a single quantitative score for each alternative, which
identifies the most preferred option, but also the relative position of each of the other alternatives.

The advantages of an MCA are that it is open and explicit, and can incorporate a diverse range of information in a user friendly and understandable format in a flexible manner. The disadvantages of an MCA include the subjectivity of the weighting criteria, which can be a cause of contention, as well as reduced involvement of the public and stakeholders in the decision-making criteria and selection of the weightings (Argyrous, 2010).

Similar to Cost:Benefit Analysis, MCA is most suitable for assessing competing alternatives in order to make a decision. It is not well suited to impact assessment.

**LOGIC MODEL**

The Logic Model is an assessment tool which consists of four components:
- Inputs
- Activities
- Outputs
- Outcomes

These components create a robust system for programme management and evaluation. It is based on the causal ‘if this occurs, then this occurs’ approach to a relationship, so that any input can be measured across the Logic Model and the outcome can be predicted.

The advantages of a Logic Model is that it is very effective during the evaluation phase of a project, as the progress objectives are made explicit during the creation of the Logic Model. A Logic Model can also change over time as new stakeholders come on board and have new ideas for inputs and activities. The disadvantages of the model are that the outcomes (particularly in development applications) are long term and often cannot be measured in the short term, so the success of the programme is often unknown in the short to medium term. Any qualitative data required to measure the indicators of success are often difficult to measure. Logic Models also quickly become complex as the level of interaction increases between the different stages, and are particularly focused in the graphics which accompany them and often not on the content of the graphics. Logic Models should be kept as simple as possible (Morell, 2010).

The Logic Model could successfully be applied to the public transport investment assessment, as it is a long-term project which needs evaluation. This is the primary application of the Logic Model in the developmental field.

**THEORY OF CHANGE FRAMEWORK**

According to the Harvard Graduate School of Education, the Theory of Change is an evaluation methodology which is used in change design and management, and states what is expected to happen within a particular context and in relation to a particular intervention. It lays out the actors required to achieve and sustain a vision of success, and identifies the major links between them. It is particularly useful in mapping out social change in relation to interventions put in place by the public sector (Harvard Family Research Project, 2005). The Theory of Change is a difficult framework to describe, as Vogel (2012) states: ‘There is no single definition of what Theory
The Theory of Change defines all the building blocks which are required to bring about change in the form of an explicit, long-term goal. Every outcome is tied to an intervention and a series of assumptions which have been explicitly stated. Through a Theory of Change framework, in-depth evaluations of the progress of the initiatives underway can be made. It is also a widely used framework, and so can be read easily between role players in the change process (Centre for Theory of Change, 2013). The Theory of Change allows the creator the possible advantage of tying objectives to effects through the explicit statement of these assumptions, which is an important step in the monitoring and evaluation of change (Talen, 1997). The disadvantage of the Theory of Change is that it can be unwieldy if it is not created in an easily understood manner that is easy to read and interpret.

The Theory of Change is similar to the Logic Model but is more flexible and incorporates a wider set of actors and assumptions, and can also be used to monitor progress at the initial stages of the causal change. It also allows for greater complexity where the causal relationships are not as direct as is required in the Logic Model. The Theory of Change is therefore proposed as the most suitable evaluation framework for the Public Transport Investment Assessment Framework being proposed. The Theory of Change has also been implemented previously in the assessment of public transport (STPP, 2003).
APPENDIX E: POSSIBLE INDICATORS ASSOCIATED WITH THE POTENTIAL THEORY OF CHANGE

Inputs

- Length of time served in position
- Registered transport practitioners per 10,000 population
- Human Capacity
- Spatial Plans
- Transport Plans
- Planning Community Facilities
- Capital Funding
- Operating subsidies
- Policies
- Incentivised private sector investment
- Registered town planners per 10,000 population
- Qualitative analysis around alignment of spatial plans to transport plans
- Funding allocations for capital and operational functions
- Qualitative analysis of whether policy enables integrated transport and spatial development

Casual Path
Indicators
Total capital spending on public transport

Construction of public transport infrastructure

Retrofitting of existing public transport infrastructure

State housing provision

Private sector development

Construction of Community Facilities

Location of public transport investment in relation to other fixed investment

Number and type of vehicles purchased

Vehicle purchase

Casual Path

Indicators
Outputs

- Public Transport nodes close to residential and economic areas
- Increased development around public transport nodes
- Community facilities created close to public transport nodes
- New networks and services covering a greater part of the city
- More vehicles on existing and new routes
- NMT facilities that support network integration
- Residential density within 1km of public transport node
- Number of jobs within 5km of public transport node
- Number of community facilities within 1km of public transport node
- Developed area within 1km of public transport network
- Kilometres of dedicated walkways and cycle paths in relation to the length of roads within integration Zones

Number of vehicles per route
Medium term outcomes

- Improved access to public transport facilities
- Improved public transport network services that are formal, scheduled and well managed
- Increased private investment close to public transport nodes
- Increased use of public transport due to safety and convenience
- Environmentally sound public transport systems
- The use of NMT becomes more prevalent, safer and integrated
- Reduced total travel cost, particularly for low income households
- Reduced travel time
- Mixed use, integrated areas around transport nodes
- Increased density close to transport

- Proximity to home (dwellings within 500m of transport node)
- Frequency, reliability and occupancy of systems
- Passenger trips that use the same ticketing system
- Number, type and value of new developments within 5km of transport nodes
- Number of personal crimes per person kilometer
- Modal split analysis
- Passenger perceptions
- Percentage of household revenue spent on transport by mode
- Land use around transport nodes
- Density relative to status quo (city and precinct wide)
Medium term outcomes

- Precinct scale economic survey
- Income profile of residents in precinct
- Land use analysis
- Social inclusion and equal opportunity
- Economic growth
- Reduced poverty and inequality
- Modal shift from private to public transport
- Lower resource consumption
- Lower greenhouse gas emissions
- Preservation of the natural environment
- Quality of life (resident perceptions)
- Vehicle Kilometres Travelled (VKT)
- Passenger kilometres travelled
- Material flow analysis
- Modal Split analysis
- Ratio of green space to city space

Casual Path  Indicators
Impacts

Improved quality of life

- Better standard of living for urban residents
- Improved quality of the environment

Travel time

Total cost per passenger

Casual Path  Indicators