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The development of a service delivery index for municipalities

by

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Abstract

Performance management has become legislative requirement for municipalities in South Africa. Unfortunately, not many tools exist to measure and monitor municipal service delivery effectively. Municipal managers and politicians require accurate information to ensure that their decisions are not based on emotions and assumptions but that the information with regards to municipal service delivery is accurate and relevant.

Descriptions and terminology used to describe engineering services are sometimes complex and confusing. To aggravate the situation, technical and non-technical people seem unable to communicate effectively about township engineering services. The development of the Service Delivery Index is a helpful tool in providing decision makers with accurate information. The index translate engineering services and service delivery aspects into numerical data that can also be represented graphically.

The Service Delivery Index for municipalities comprises four components of engineering services being delivered in residential areas. The components are infrastructure quality, delivery efficiency, access to services and affordability. Each component comprises specific elements that are measured on a regular basis such as payment levels, proportion of household income to service charges, service interruptions, response times to outages and service levels.

Not only can services be measured and represented graphically, they can also be compared and over time to establish trends. Desegregation of the index is easy. The index system allows municipalities to provide service delivery information to communities effectively and transparently and in an easily comprehensible manner.

Components of the index can also be linked to a GIS system to display different aspects of service delivery geographically. The index system in combination with services costs graphs can also be utilised to make instant and accurate assessments of upgrading costs for township services.

The data used for the compilation of the index is normally readily available form Census data, financial statements and departmental job evaluation reports. The index also effectively addresses the issue of communication between technical and non-technical people with the aid of graphical presentations.

Opsomming

Prestasie-bestuur in munisipaleteite het onlangs wetlik afdwingbaar geword. Daar bestaan egter onvoldoende metodes en toerusting om munisipale dienslewering effektief te kan meet. Akkurate inligting is 'n vereiste vir munisipale bestuurders en politici om te verseker dat besluite nie gebaseer word op emosies en aanames nie. Om dit te kan verseker moet inligting in terme van munisipale dienslewing akkuraat en toepaslik wees.

Terminologie en beskrywings wat normaalweg gebruik word om ingenieeursdienste te beskryf is somtyds kompleks en verwarrend. Die probleem word vererger aangesien tegniese en nie-tegniese mense klaarblyklik nie in staat is om effektief te kommunikeer oor ingenieersdienste nie. Die ontwikkelling van die Diensleweringsindeks is 'n bruikbare hulpmiddel om akkurate inligting aan besluinemers te kan verskaf. Die indeks vertolk ingenieersdienste en diensleweringsaspekte in numeriese getalle wat dan grafies voorgestel kan word.

Die Diensleweringsindex vir munisipaleteite bevat vier komponente van die verskillende ingenieersdienste wat in residensieële gebiede gelewer word. Die komponente is infrastruktuurkwaliteit, diensleweringseffektiwiteit, toegang tot dienste, en bekostigbaarheid. Elke komponent bevat spesifieke elemente wat op 'n gereelde grondslag gemeet word soos byvoorbeeld betalingsvlakke, verhouding van basiese huishoudelike inkomste benodig vir dienste kostes, aantal diensonderbrekings, reaksietyd op onderbrekings, en diensvlakke.

Nie alleen kan dienste gemeet en grafies voorgestel word nie, hulle kan ook oor 'n periode van tyd vergelyk word om neigings te bepaal. Die indekssisteem help munisipaleteite om inligting aangaande dieslewering in gemeenskappe op 'n deursigtige, effektiewe en maklik verstaanbare wyse te kan verskaf.

Die komponente van die indeks kan ook met 'n GIS-sisteem gekoppel word om verskillende aspekte van dienslewering geografies voor te stel. Vinnige en akkurate berekenings van opgraderingskostes van ingenieeursdienste in dorpsgebiede is ook moontlik deur die indeks te gebruik in samewerking met kostegrafieke.

Die inligting wat ingesamel moet word om die indeks saam te stel is normaalweg geredelik beskikbaar van uit nasionale sensus data, finansieële state en evalueeringsverslae van departemente. Die indeks speek ook die kommunikasie probleem tussen tegniese en nie-tegniese mense effektiewelik aan met behulp van die grafiese voorstellings.

Acknowledgements

To Professor Johannes Haarhoff whose insight and enthusiasm about urban engineering services kept me inspired. His clear perspective on complicated problems and situations assisted me to constantly maintain a high level of professionalism.

To Professor Leon Pretorius who provided me with the opportunity to continually evaluate myself in terms of my objectives.

To Danie Nel, whose inspiration and clear perspective of municipal service delivery motivated me to strive for the top. His constant search for improvement and professionalism is a commendable and contagious characteristic.

To the staff of the City of Johannesburg and its Utilities for their assistance in the gathering of the data.

Finally, my sincerest thanks for her love, assistance, patience, motivation, and support - to my wife, Sandra.

Dedication

To the nearly three billion people living on this planet without access to improved water sources or basic sanitation.

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List of Acronyms

Aids	Acquired Immunodeficiency Syndrome
ANC	African National Congress
BEE	Black Economic Empowerment
BWR	Basic Water Requirement
CDI	City Development Index
CoJ	City of Johannesburg
CPI	Consumer Price Index
CSIR	Council for Scientific and Industrial Research
DBSA	Development Bank of South Africa
DPLG	Department of Planning and Local Government
Du	Dwelling Unit
FAO	Food and Agricultural Organisation
GDP	Gross Domestic Product
GGP	Gross Geographic Product
HDI	Human Development Index
HIC	Highly Industrialized Countries
HIV	Human Immunodeficiency Virus
HPI-1	Human Poverty Index
IDP	Integrated Development Plan
IPCC	Intergovernmental Panel on Climate Change
KPA	Key Performance Area
KPI	Key Performance Indicator
LDC	Least Developed Countries
LDO	Land Development Objective
OECD	Organisation for Econom ic Cooperation and Development
OHS	October Household Survey
PPP	Parity Purchasing Power
SDI	Service Delivery Index
Stats SA	Statistics South Africa
SMME	Small Medium & Micro Enterprises
UNCHS	United Nations Centre for Human Settlements
UNDP	United nations Development program
UNEP	United Nations Environmental Program
UNFPA	United Nations Population Fund
WCMC	World Conservation Monitoring Centre
WHO	World Health Organisation
WWF	World Wildlife Fund

CHAPTER 1

1 Problem statement

1.1 Introduction

Municipalities throughout South Africa are facing the dilemmas of reduced local funding, increased demand for services and the obligation of additional service delivery functions not previously associated with municipalities. Both national and provincial governments have sought to reduce their cost by reducing funding to local governments and increasing the mandate for services.

In addition, provincial government is no longer obliged to assist municipalities experiencing financial problems as was found when the Leandra local council in Mpumalanga expected the provincial government to come to their rescue with their R16 million debt. In the judgment of the Appeals Court on 27 September 2001, Judge Louis Harms expressed serious concern about the appalling financial situation of several municipalities. (Beeld, 2001).

Observing the large number of local authorities suffering financially in South Africa at present, one has to question the reasons for their precarious financial situation and the consequential dramatic decline in service delivery standards since 1994. Although every municipality in South Africa differs uniquely from every other municipality, the fact remains that most municipalities experience financial difficulties to some degree. The financial problem of one of the largest municipalities in the country, Johannesburg, during 1997 received wide publicity and criticism. Various reasons for this financial decline were cited and the following list provides an overview of some of the problems that were experienced:

- An enormous restructuring process took place during 1995 where existing municipal boundaries were largely ignored to achieve integration at all cost. Logistical problems with services were consequently experienced.
- Nearly all available funds were redirected to previously disadvantaged communities for services expansions and in some cases, at the expense of existing infrastructure requiring urgent upgrading.
- A new political dispensation meant a new organisational structure. Senior officials in local authorities should naturally be acceptable to ruling party political expectations. In some instances staff with little or no local government experience were appointed in decision-making positions.

- The implementation of affirmative action caused an enormous brain drain of expertise from local authorities and consequently required the appointment of expensive consultants and contractors to supplement capacity.
- Inadequate revenue collection due to the culture of non-payment initiated during the days of the "struggle" resulting in huge cash deficits for numerous municipalities.
- The cycle of non-payment for services due to inadequate delivery, which in turn resulted in a lack of resources and a subsequent decline in standard of delivery, which in turn lead to non-payment.
- Corruption.
- Low staff morale.
- Appalling work ethics.
- The introduction of legislation during 1997 prohibiting municipalities to independently source international funding.
- Complete absence of integrated development planning processes in municipalities causing different departments to move in different directions, often in opposition to each other.
- The absence of financial and performance management procedures and systems in most municipal service delivery departments.

In Johannesburg, the opposition parties accused the ANC of gross mismanagement by bankrupting the city in just three years. The ANC blamed the apartheid government of handing over a bankrupt municipality.

What has become abundantly clear from the reasons, accusations and excuses listed was the absence of accountability and responsibility.

One of the biggest problems was that municipalities could not be measured or compared with one another due to the absence of standardised performance indicators, baselines, benchmarks or targets. Apart from their financial statements, no one was measuring their performance. By not measuring performance, it was impossible to determine or quantify to what extent services were being rendered.

It has therefore, become imperative for municipalities to know and understand what they should do, why they should do it, and if they have done it well. By knowing their mission, establishing goals and targets based on measurable outcomes they can focus on the ultimate purpose of their activities of public service and by measuring their progress, they will know if they are achieving success or failure.

This thesis addresses the development of appropriate methods to determine how a municipality is progressing in terms of its service delivery vision. It is about creating an understandable indicator to measure service delivery on a municipal level. An indicator that can clearly reflect how municipalities are faring in terms of their predetermined goals for delivering engineering services.

1.2 Background

1.2.1 Urban governance

Most people in most countries, including the wealthier industrial countries, rely on public service for health, education, justice and other services that maintain the social fabric. They will continue to do so, since profit-oriented services cannot guarantee access and equity.

The international consensus promotes the human rights of individuals at the same time as it works towards social cohesion and the solution of global problems such as rapid population growth.

Despite the challenges of impoverished rural areas and overburdened cities, poorer countries can provide an adequate level of public service - but they need systems of governance which allow significant expression of community interests, leaders who are willing to respond, commitment to improved public services as a development goal and an international economic system which favours, or at least does not militate against, social investment.

The term "governance" has become an integral part of the "aid vocabulary" used today. However, different practitioners interpret it differently. Urban governance differs from the broader governance agenda (which has tended to concentrate on macro-levels), in that it focuses on local-levels. It also differs from the urban management perspective of operations and maintenance of infrastructure and services, because urban governance acknowledges that one should not ignore the complex social and political environments in which these services are being managed. At the city level, good governance is not only concerned with good urban management but also with interactions between all stakeholders in the city. Therefore, political, contextual, constitutional and legal dimensions need to be considered.

In South Africa, the new constitution transformed local government into a sphere of government in its own right and is no longer a function of national or provincial government. Local government was also given a distinctive status and role in building democracy and promoting social development. The Constitution of the Republic of South Africa (1996) mandates local government to:

- Provide democratic and accountable government for local communities.
- Ensure the provision of services to communities in a sustainable manner.
- Promote social and economic development.

- Encourage the involvement of communities and community organisations in the matters of local government.

The White Paper on Local Government (1998) urged local government to focus on realising developmental outcomes, such as the provision of household infrastructure and services; the creation of liveable, integrated cities, towns and rural areas; and the promotion of local economic development and community empowerment. It also provided three approaches which could assist municipalities to become more developmental, namely integrated development planning and budgeting; performance management; and working together with local citizens and partners.

1.2.2 Globalisation

The pace of globalisation appears to be unstoppable. But for globalisation to be sustainable it is not sufficient to liberalise trade and economic activity- there must also be parallel efforts to ensure that social investment, including environmental protection, is available. International as well as national efforts for health, education and social services depend on the public sector. These cannot succeed without transfer from richer to poorer nations. Globalisation in the social as well as the economic sense is central to the success of local efforts to maintain and rescue environments.

Policy makers in favour of globalisation must also concern themselves with localisation-ensuring that economic activity benefits local communities, or at least to leave them no worse off. Most municipalities in South Africa have local economic development in some form or another in their mission statements but, very few actually regard this as a priority considering the effort and resources allocated towards it.

1.2.3 Developments in the South African public sector

Since 1994, South African local government has undergone extensive changes. The changes that were introduced had far reaching consequences through privatisation and the implementation of affirmative action. The birth of mega-cities and the establishment of "wall to wall" municipalities have also been evident.

Considering the mood, expectations and fears of the nation prior to the 1994 elections when the Tripartite alliance between the ANC, Cosatu and the South African Communist party threatened with nationalisation of banks and big businesses, it seemed ironic that quite the opposite actually happened. Completely contrary to expectations and despite the objections from labour and the communists, the ANC adopted a westernised, capitalistic approach to government and consequently privatised national, provincial and local government.

During this period, hundreds of new laws were enacted, including the Municipal Structures Act of1998 that introduced the demarcation of new municipal boundaries and the formation of mega-cities, district councils and local councils were formed and the Municipal Systems Act of 2000 that introduced Integrated Development Plans (IDPs), privatised municipal service delivery and legislated the implementation of performance management systems.

Additional regulations were also promulgated to assist provincial government in assessing the performance of municipalities.

Performance management, and in particular performance measurement was introduced at every conceivable level of local government, from the lowest general worker through all levels of management, departments, committees and also council. It was clearly the intention of national government to instill a culture of responsibility and accountability in local government through the legislation of performance management.

1.2.4 Integrated development planning

The compilation of the previous Land Development Objectives (LDOs) in terms of the Development Facilitation Act (1995) was considered ineffective and inappropriate for the new way of running local government. A much more business orientated and focused approach was required. Elaborate programmes or schemes without any substantial financial planning was simply no longer acceptable. The new approach required municipalities to implement a strategy that would accomplish the outcomes of their visions. The strategy, by nature also required detailed financial planning and multi-year budgeting. This Integrated Development Plan (IDP) is a plan of actions and strategies with specific targets and outcomes and measurable performance indicators. In terms of section 26 of the Municipal Systems Act 2000, the core components of an Integrated Development Plan include inter alia:

- An assessment of the existing level of development, specifically referring to communities without access to basic services.
- A vision, emphasizing the most critical development and internal transformation needs.
- Council's development strategies.
- Council's development priorities and objectives.
- A financial plan (3 year budget projection).
- The setting of performance indicators and targets.

Not only must the Premier approve the plan, it must also be monitored on a regular basis (quarterly progress reports to council) and annual reports to the Auditor General and the Premier. All committees, departments, units and employees should understand the vision and the strategy to direct their efforts in reaching the objectives.

1.2.5 Performance management

It is then no coincidence that performance management forms part of the IDP process. The setting of performance indicators and targets as part of the planning process compels municipalities to develop performance-monitoring systems. Municipalities need to determine appropriate performance indicators for every department and in particular, service delivery. The development of good performance indicators is problematic because municipalities generally lack strategic direction with a clear vision of the required outcomes. To achieve the objectives of the strategy, a monitoring system to measure performance and progress in terms of the key performance indicators (KPIs) must be implemented to guide and direct the process.

Chapter six of the Local Government Municipal Systems Act, 2000 pays particular attention to the development of a performance management system in municipalities. Current legislation requires municipalities, to develop (KPIs) in line with their vision as well as to set targets for achievement. They must also track progress over time and report quarterly to council as well as annually to the Premier on how they are faring with the achievement of their objectives. Naturally, these reports also require verification and auditing.

In order to ensure good governance, municipalities are obliged to interact with all stakeholders. The whole process of setting performance indicators, targets, priorities, monitoring systems and cycles for measurement should form part of a consultation process with the community. Municipalities are obliged to satisfy the Premier that the process was in fact extensive and inclusive of all stakeholders.

In addition to the performance monitoring, corrective measures must be applied. This could entail the redirection of resources, re-training of staff and even dismissals. This, by implication could mean that even new councillors could be elected if so required. It is clear that the legislation intends to convert local government from unproductive, bureaucratic and mostly bankrupt institutions into efficient, accountable and sustainable service providers. Time will tell.

1.3 Thesis rationale

1.3.1 Why a performance indicator for service delivery?

As was stated in the introduction, this thesis addresses the development of an understandable indicator to measure service delivery on a municipal level. The indicator should reflect how municipalities are faring in terms of its predetermined goals for delivering engineering services. The specific engineering services under discussion are: water and wastewater, roads and stormwater, solid waste removal and electricity. These services are also normally referred to as economic services.

By developing and consistently measuring the service delivery indicator, municipalities will be able to track their own progress and compare themselves with other municipalities. Municipalities would also be able to judge if the time effort and resources spent to achieve their goals are in fact, effective or whether their efforts should be redirected to achieve their desired outcomes.

1.3.2 Methodology

The methodology adopted to develop a tool for effective comparisons of municipal service delivery was:

1) To understand the essence of the problem of municipal service delivery measurement:
   - by examining global, regional and local trends with respect to human behaviour;
   - by determining the influence and impact of these trends on human, social, environmental and economic development;
   - by determining measures to be taken to manage these impacts;
   - by examining international best practices applicable to the measures taken.
2) To develop indicators to compare and measure progress over time.
3) To determine acceptable international and local standards (benchmarks) for the indicators chosen.
4) To develop a single composite index from all the key performance indicators for easy comparisons.

1.3.3 Goals and objectives of the thesis

During the last few decades, several indicators have been developed to measure different aspects of social and economic development. Economic indicators such as the well known CPI and CPIX, that measure inflation, are widely used in South Africa. After the quarterly publication of the indices, decisions that affect everyone in the country are taken by the Reserve Bank, especially with regards to the adjustment of interest rates. The impact that these indicators have on daily lives is far reaching and it is difficult to imagine how else decisions would be taken without the availability of these statistics.

The delivery of municipal services or the lack thereof, also has dramatic effects on daily lives, yet the measurement of the quality or efficiency of municipal services is seriously lacking. It appears that good numerical information will be the only credible tool to effectively manage municipalities. It is therefore, the main aim of this thesis to develop a credible performance indicator to measure municipal service delivery.

The goal

The goal of the thesis is:

To develop a credible performance indicator that accurately reflects the quality, efficiency, affordability and accessibility of the services being rendered by the municipality to enable decision makers in public and private institutions to evaluate municipalities in terms of their service delivery mandates so that corrective actions can be taken where required. The aim is to ensure that decision makers have accurate information to prevent that decisions are made based on emotions and assumptions.

The objectives

The main objectives of this thesis is to develop an indicator:

5) That can be utilised continuously. The results of a quarterly analysis should yield enough evidence of municipal service delivery so that decisions can be taken to implement actions that will effectively control service delivery in municipalities. It should therefore, serve as an early warning indicator in a monitoring system.
6) That is simple enough to understand and to disaggregate into various usable components. The information required to compile the indicator must be therefore, be easily accessible and inexpensive to collect.
7) That is sensitive enough to reflect changes over short periods.

1.4 Scope and limitations of the study

1.4.1 The scope of the thesis

This thesis is a product of the field of Engineering Management and as such focused primarily on the engineering component of the research. The research undertaken for the development of the service delivery indicator emanates from an engineering perspective by virtue of the author's background. Its main focus is therefore, on the provision of engineering services (economic services). Municipalities in South Africa, however, are expected to provide much more than just the traditional engineering services. They should also provide healthcare, safety and security as well as educational and recreational services (social services).

1.4.2 Limitations of the study

Size of the sample

Very large volumes of data would naturally be required to assess the quality and efficiency of service delivery in a municipality, particularly in cities. In order to develop and demonstrate the usefulness of the indicator, only a limited area in the City of Johannesburg was chosen as a sample for reasons of access and familiarity with the area.

Populating data

Some of the data required for the population of the indicators is unavailable or too expensive for the author to collect. “Best estimates” were used insofar as data required for engineering services during the periods chosen prior to the establishment of the Unicity.

1.5 Organisation of the thesis

The seven chapters in the thesis are arranged to follow a logical developmental order and are shortly described as follows:

CHAPTER 1: Problem statement.

In this chapter, a brief overview is given of the challenges facing municipalities and the reasons for introducing performance management in local government. The need for a performance indicator that measures the service delivery component of a municipality’s agenda is explained. The methodology for research and development of the indicator is described and the goals and objectives of the thesis clarified.

CHAPTER 2: Trends of human behaviour.

The issues examined in this chapter are broader issues than what are required for the development of a municipal performance indicator. A literature review is done to examine global trends of population growth and urbanisation to determine the impacts of urbanisation on human, social, environmental and economic development. How to measure the impacts of these changes is examined in order to gain a better understanding of the needs, problems and challenges facing municipalities and to grasp the enormity and complexity of the environment in which they must operate to improve the lives of its inhabitants.

CHAPTER 3: Literature review.

Existing performance management methods are examined to enhance service delivery in this chapter by developing a better understanding of the methods employed to monitor performance of projects, programmes and resources. Existing literature is examined and evaluated in order to establish the extent of which the problem of measuring service delivery in municipalities has been addressed by the work of others.

CHAPTER 4: Development methodology.

With the understanding gained about performance measurement of municipal service delivery from the literature review, an attempt is made to solve the problem by systematically developing a measurement system.

CHAPTER 5: Data collection.

In order to give substance to the indicators developed in the previous chapter, appropriate data is collected through visits to different departments at the City of Johannesburg as well as consulting other sources such as the population Census and World Bank studies.

CHAPTER 6: Analysis.

The indicators that were developed to measure service delivery performance are analysed and its usefulness and versatility are examined. The concept of using graphs to illustrate the interrelationships between various performance measurements is demonstrated.

CHAPTER 7: Conclusions and Recommendations.

The last chapter of the thesis provides some discussions around the usefulness of the model and possible applications. Finally, some recommendations with regard to possible extensions and improvements to the model are made.

2 Trends of Human Behaviour

2.1 Introduction

In this chapter, an assessment is made of the global trends of population growth and urbanisation focusing on trends more specific in Africa and sub-Saharan Africa. The impacts of urbanisation on human, social, environmental and economic development are examined and the impacts of these changes are examined in order to gain a better understanding of how it should be measured and managed. This global overview and analysis form an integral part of the development of the service delivery index and is regarded as valuable background information required to develop a broader perspec tive of the needs, problems and challenges facing municipalities and to grasp the enormity and complexity of the environment in which they must operate to improve the lives of its inhabitants.

The content of this chapter actually form part of the Literature Review of **CHAPTER 3**, but as was explained in **CHAPTER 1**, the service delivery indicator should focus primarily on indicators or factors where the workings of municipalities have a direct influence on. For this reason, the content of this chapter was kept separately. It is clear that the development of a service delivery indicator required a narrower focus than this broad scope of global trends.

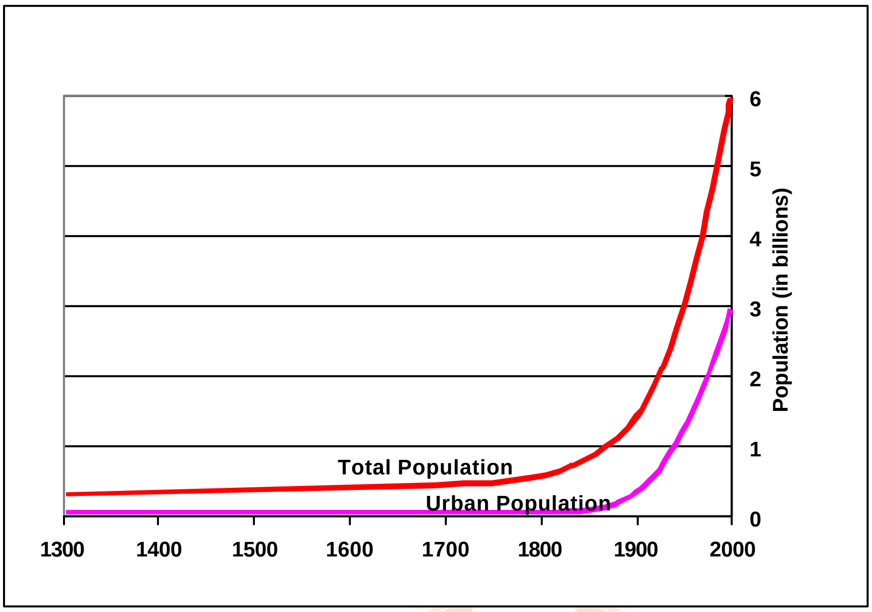
The inclusion of this chapter was necessary to develop a broader understanding of the spatial and social implications of the group-forming tendencies of humans. It also helped to develop an understanding of the dynamics necessary to ensure progress and provide order in a society where millions of people live in close proximity to one another and the consequential impact of sharing resources.

2.2 Population growth

Extraordinary population changes have taken place in the past 150 years - human numbers have increased from one billion to 6.0 billion today - **Figure 2.1**. If present trends continue, there will be at least 8.9 billion people on the planet in the year 2050 - **Figure 2.1a**. The Population Division of the United Nations Department of Economic and Social Affairs projects that world population will grow from 6 billion in 2000 to between 7.3 and 10,7 billion by 2050, with 8.9 billion considered most likely. The 3.4 billion difference between the high and the low projections, which reflect varying assumptions about future fertility rates, is as much as the total world population in 1966. The current growth rate is 1.33 per cent

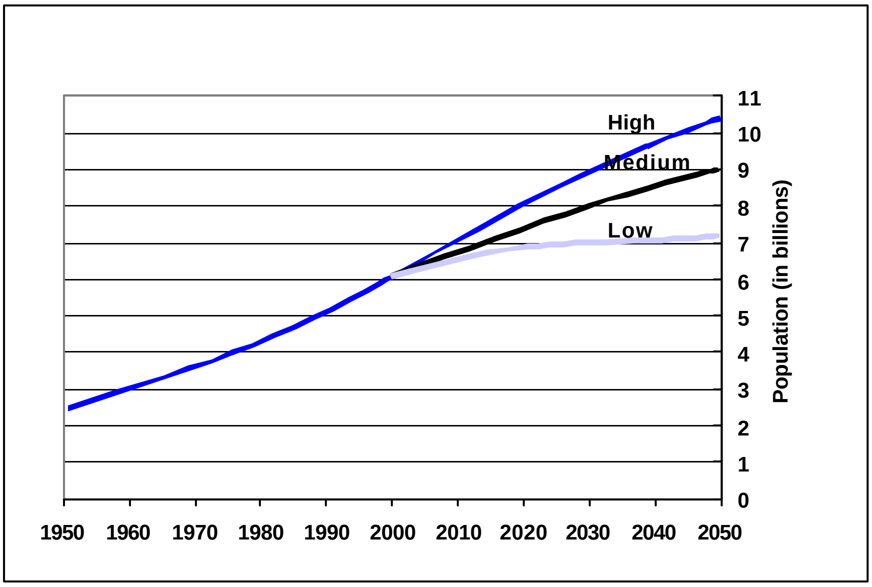
The world's population is increasing by three people every second, which is equivalent to a quarter of a million people every day. South Africa's population of 40,58 million (1996 Population Census) is growing at a rate of 2,6 percent each year, making it set to double within the next 25 years, which emphasizes the need for effective engineering management.

Figure 2.1: Population growth



UNCHS (2001a)

Figure 2.1a: World Population growth, annual & projected 1950-2050



UNFPA (1999)

2.2.1 Urbanisation

Urbanisation is the process in which the number of people living in cities increases compared with the number of people living in rural areas. A country is considered to be urbanised when over 50 percent of its population live in urban places.

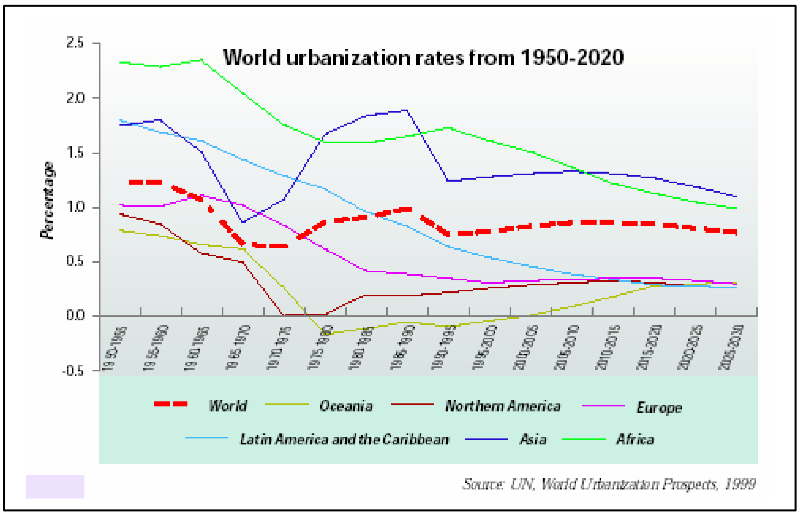
During the past two hundred years of global economic expansion, the collective population of the world's cities grew from less than 30 million to 3 billion – from one in thirty of the earth's inhabitants to every other person on earth. Now at the beginning of the new century and millennium, UNCHS (2001a) reported that the planet hosts 19 cities with 10 million or more people; 22 with 5 to 10 million people; 370 cities with 1 to 5 million people; and 433 cities with 0.5 to 1 million. Another 1.5 billion people live in urban areas of less than half a million people. At the present rate of urbanisation, 60 percent of all people will be urbanised by 2030.

Great Britain and some European countries were amongst the first countries to become urbanised. Their urbanisation was relatively slow, allowing governments time to plan and provide for the needs of increasing urban populations. The rise of the mega-city (cities with more than 10 million people) in developing countries over the past twenty years is of concern because of incapacity to increase the provision of housing and basic services at the same pace.

The current worldwide rate of urbanisation (that is, the percentage rate per year, that the urban share of the population is expanding) is about 0.8 percent (UNCHS, 2001a), varying between 1.6 percent for all African countries to about 0.3 percent for highly industrialised countries.

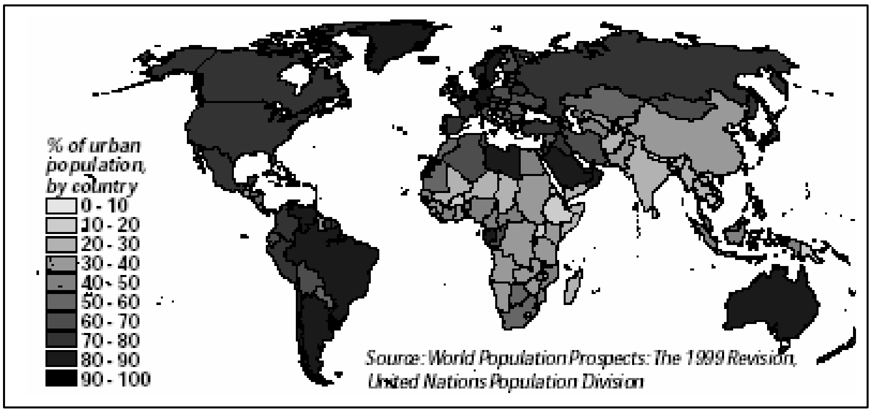
Figure 2.2 and **Figure 2.3** indicate urbanisation rates. Worldwide, nearly all cities continue to grow in absolute terms. The rate at which they are capturing a portion of the country's population, however, vary. Asian cities are still taking in national population at and *increasing* rate. In Africa, Europe and Latin America, urbanisation rates are slowing. With very few exceptions, however, rates of urbanisation are expected to drop in all regions after 2015. Slowing urbanisation rates mean that the combined rate of (1) domestic rural-to-urban migration, (2) immigration of foreigners directly to the cities and (3) the natural rate of population growth in cities is dropping off.

Figure 2.2: Urbanisation rates



UNCHS (2001a)

Figure 2.3: Urbanisation rates, 2000



UNCHS (2001a)

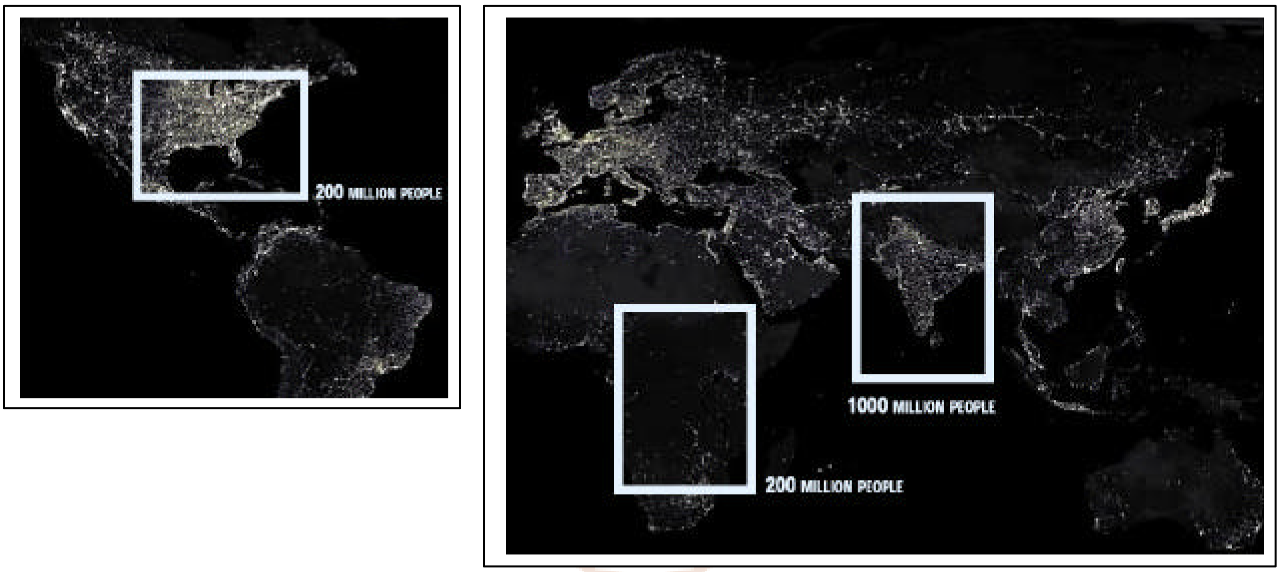
With just under half the world's population living in cities, the world is already urbanised. When measured in knowledge, attitude, aspirations, commercial sense, technology, travel and access to information, even the most rural societies on earth are to one extent or another, woven into a global network of cities. A Brazilian miner uses his cell phone to monitor gold prices in London through a broker in São Paolo. A Kazakh folk singer places her music on the Internet in Alma Alta for downloading by a scholar in Shanghai. A Canadian farmer flies his own plane to Vancouver to meet a friend from San Francisco. Rural people in small African villages produce masks and statues for purchase in Johannesburg by the owner in a European Africana shop.

Despite this contact that rural societies have with cities through technology, travel and information, a different picture emerges in the poverty stricken Sub -Saharan Africa where the

World Wide Web is still unaffordable for millions, partly because of the cost of computers that are the standard entry point to the web.

It is interesting to examine nighttime satellite photographs of countries. **Figure 2.4** displays chains and nets of intense light reflected into the nighttime skies. Most of the light is produced by the world's cities and is an indicator of their accumulated productive strength.

Figure 2.4: Nighttime global photographs



UNCHS (2000a)

In almost every country, the cities' share of national outputs is much higher than its share of the population. UNCHS (2001a) reported that Lima for example, has less than 30 percent of Peru's population but produces over 40 percent of its national output. Bangkok, in an even more dramatic example produces nearly 40 percent of Thailand's output with just over 12 percent of its population, nearly the same ratio of production to population as São Paolo, Brazil.

Taking a closer look at nighttime satellite images reveals black holes in the fabric of light covering the continents. Except for small specs of light emitted from major cities in South Africa, swaths of darkness, stretching across much of populated Africa, imply exclusion from the modern productive world. The darkness signals a parallel universe where individuals, families, communities, cities and whole countries may be disconnected, not part of the global economical grid.

By comparing also the brightest metropolitan clusters of eastern North America with the relatively low levels of light emitted by five times as many people in India. Which is more sustainable? Are the energy-rich cities of highly industrialised countries (HIC) now what others could become? To answer these questions, one must examine many cities, over time from all angles and all levels- from the global satellite view to the gritty footpath of the shantytown.

The enormous rate of urbanisation since the beginning of the industrial revolution brought about the modern era of electrical power, motorized vehicles, air transport, the space age and the computer age. Accompanied with it, however, this modern age also brought with it enormous levels of destruction and poverty.

2.2.2 Poverty

Heads of state at the United States Assembly recognised their collective responsibility to uphold the principles of human dignity, equality and equity at the global level and adopted the United Nations Millennium Declaration. Among the many objectives set out by the delegation are specific, quantified and monitorable goals for development and poverty eradication by 2015. **Table 2.1** reflects these ten ambitious goals taken from UN (2000).

Table 2.1: Millennium Declaration goals for 2015

Goals
❑ Halve the proportion of people living in extreme poverty
❑ Halve the proportion of people suffering from hunger
❑ Halve the proportion of people without access to safe water
❑ Enroll all children in primary school. Achieve universal completion of primary schooling
❑ Empower women to eliminate gender disparities in primary and secondary education
❑ Reduce maternal mortality ratios by three quarters
❑ Reduce infant mortality rates by two thirds
❑ Halt and begin to reverse the spread of HIV/AIDS
❑ Provide access to all who want reproductive health services
❑ Implement national strategies for sustainable development by 2005 to reverse loss of environmental resources by 2015

Despite the enormous inroads made on development over the last thirty years, human development challenges remain large, especially in developing countries. The World Bank (2000) reported that nearly a billion people still lack access to improved water sources; around 36 million people are living with HIV/AIDS; around 120 million couples who want to use contraception do not have access to it; the developing world still has 828 million undernourished people; in 21 countries the reported maternal mortality ratio exceeds 500 per 100,000 live births and nearly a billion people are living in extreme poverty in the developing world.

War and Poverty

In the last decade, more than 90 armed conflicts took place in different parts of the world; more than half of these conflicts arose in Africa and many of them had been underway for more than 15 years. While death and disablement are common features of wars and contemporary complex political emergencies, there has been a disturbing shift in the scale of suffering in that 90 percent of casualties are civilians.

Table 2.2 highlights some of the negative aspects in the world at present in terms of health, education and poverty. The table is taken from UNDP (2001, p.9)

Table 2.2: Serious deprivations on a global scale

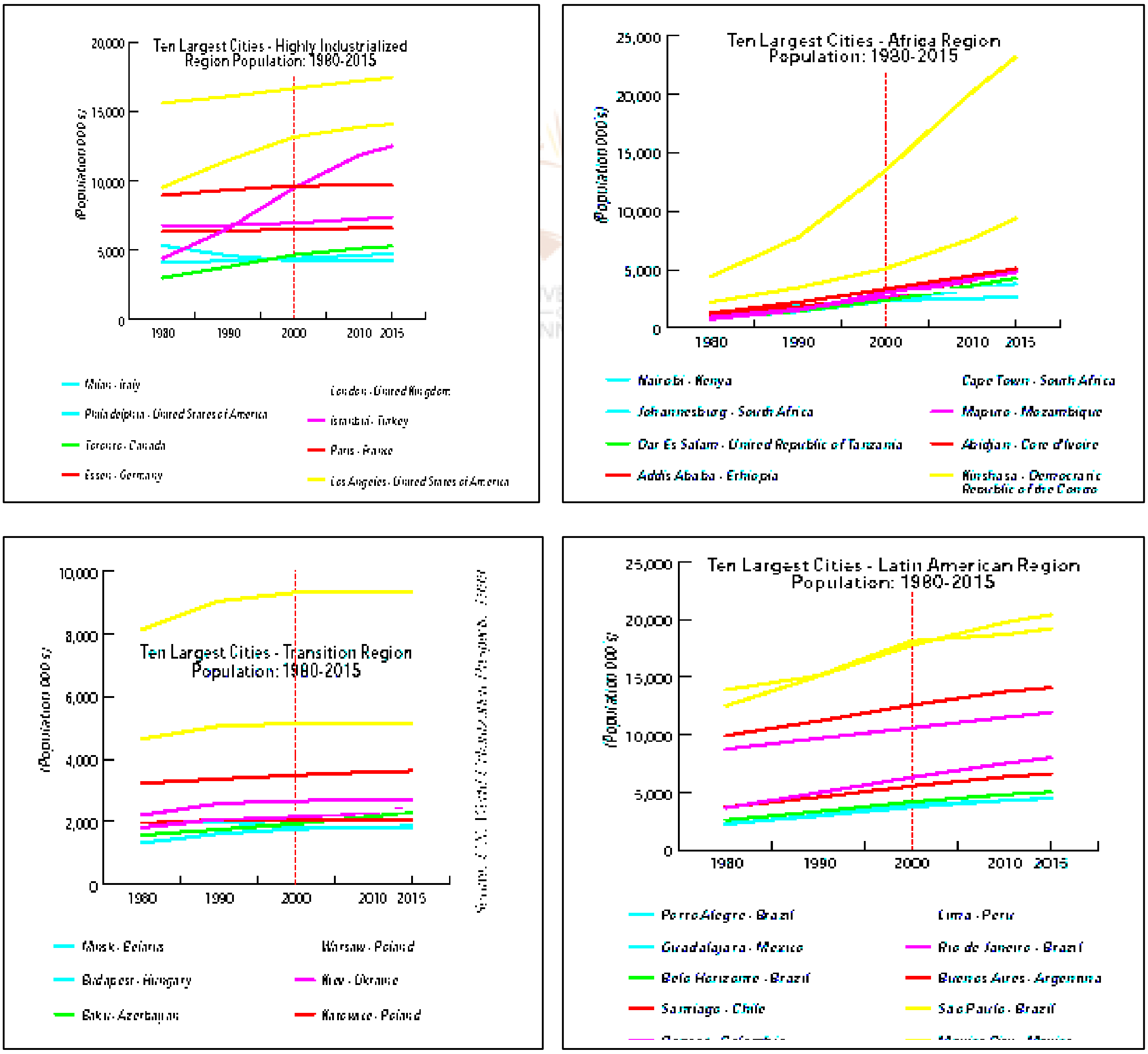
Developing countries
Health:
986 million people without access to improved water sources (1998)
2.4 billion people without access to basic sanitation (1998)
34 million people living with HIV/Aids (end of 2000)
2.2 million people dying annually from indoor air pollution (1996)
Education:
854 million illiterate adults, 543 million of them women (2000)
325 million children out of school at the primary and secondary levels, 183 million of them girls (2000)
Income poverty:
1.2 billion people living on less than $1 a day (1993) PPP US$), 2,8 billion on less than $2 a day (1998)
Children:
163 million underweight children under age five (1998)
11 million children under age five dying annually from preventable causes (1998)
OECD countries
15 % of adults lacking functional literacy skills (1994-1998)
130 million people in income poverty (with less than 50% of median income) (1999)
8 million undernourished people (1996-98)
1.5 million people living with HIV/AIDS

2.2.3 Urbanisation and growth

The rapid growth of population and its concentration in cities around the world are affecting the long-term outlook for humanity. Despite four millennia as centres of civilisation and economic activity, cities never attracted more than a few percent of the population until the last century. Now, at the beginning of the 21st century, systems of cities have become a dominant factor in the world's social economical, cultural and political matrix. Burdened with all the problems associated with growth, cities are increasingly subject to dramatic crisis, especially in developing countries. Unemployment, environmental degradation, lack of urban services, deterioration of existing infrastructure and lack of access to land, finance and adequate shelter are among the main areas of concern. For better or for worse, the development of contemporary societies will depend largely on understanding and managing the growth of cities. The city will increasingly become the test bed for the adequacy of political institutions, for the performance of government agencies, and for the effectiveness of programmes to combat social exclusion, to protect and repair the environment and to promote human development.

The four graphs displayed in **Figure 2.5** were taken from UNCHS (2001a) and reflects the growth of the ten largest cities in: Highly Industrialized Regions; Africa Region; Transition Region and Latin American Region.

Figure 2.5: Population growth of cities in regions

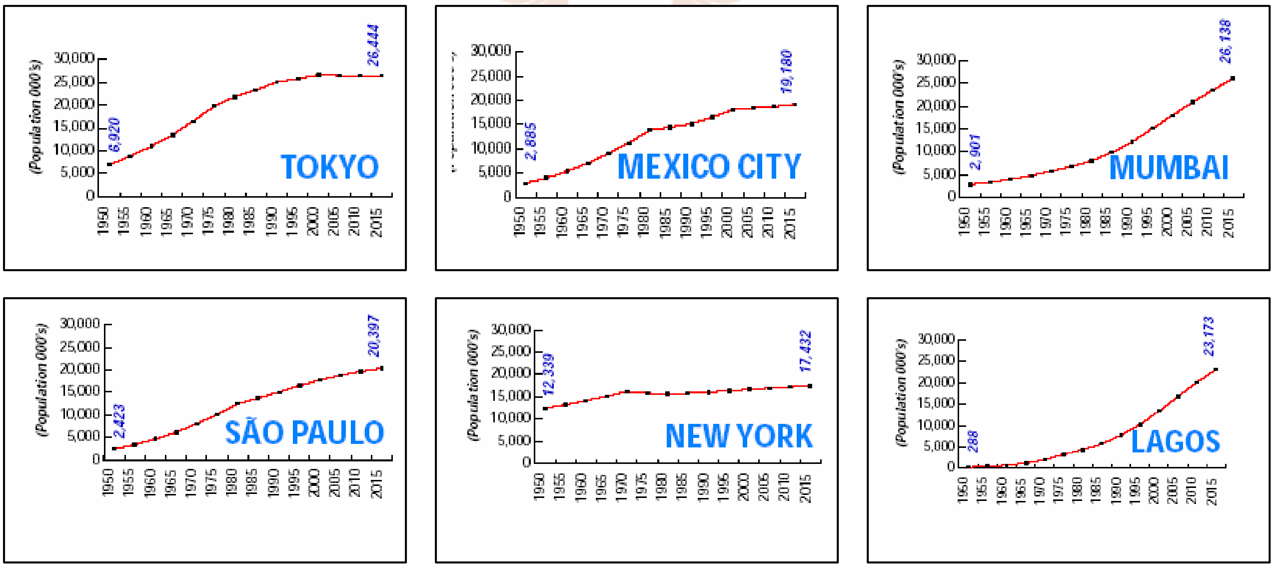


It is now widely recognised that cities play a vital role in social and economic development in all countries. Urbanisation builds diversified and dynamic economies, which raise productivity, create jobs and wealth, provide essential services, absorb population growth, and become the key engines of economic and social advancement. Thus, efficient and productive cities and towns are essential for national economic growth and welfare (UNCHS, 2000a); equally, at the local level, strong urban economies generate the resources needed for public and private investment in infrastructure, education, health and improved living conditions.

2.2.4 Mega-cities

Some of the world's largest cities occur in Third World countries, where urbanisation is most rapid. UNCHS (2001a) reported that Lagos, Nigeria, presently the world's fifth largest city, has a population of more than 13.4 million and is estimated to grow to over 20.2 million people by the year 2010 to become the worlds third largest city. Dhaka, Bangladesh has grown from 6,6 million people in 1990 to 12.3 million people in 2000 and is expected to expand to 18.5 million people by the year 2010. Tokyo has, however, over the last 30 years, remained the world's largest urban agglomeration totaling 26.4 million inhabitants.

Figure 2.6: The six world's largest cities



The six graphs reflected in **Figure 2.6** were taken from UNCHS (2001a) and illustrate interesting trends with regards to the population growth rates of different cities. Mega-cities are still growing, but in the developed world they are part of a general slowdown of urban growth rates to a global rate of 0.3 percent per year. The overall urbanisation rate in Asia in contrast is four times that and is reflected in the growth of its mega-cities.

2.2.5 Urbanisation and the environment

A remarkable chain of coincidences preserved the trail of footprints left in the sand over three and a half million years ago, by two of modern humanity's ancestors near Laetoli in the United Republic of Tanzania. Their people probably numbered in the hundreds or thousands. Today the footprints of humanity are impossible to miss. Human activity has affected every ecosystem on the planet, no matter how remote, from the simplest to the most complex. Our choices and interventions have transformed the natural world, posing great possibilities and extreme dangers for the quality and sustainability of civilizations and for the intricate balances of nature.

Today every part of the natural and human world is linked to every other. Local decisions have a global impact. Global policy, or the lack of it, affects local communities and the conditions in which they live.

Population and the environment are closely related, but the links between them are complex and varied, and depend on specific circumstances. Generalisations about the negative effects of population growth on the environment are often misleading. Population scientists long ago abandoned such an approach, yet policy in some cases still proceeds as if it were a reality.

As human populations increase and globalisation proceeds, key policy questions are: how to use available resources of land and water to produce food for all; how to promote economic development and to end poverty so that all can afford to eat; and in doing so how to address the human and environmental consequences of industrialisation and concerns like global warming, climate change and the loss of biological diversity.

Environmental devastation is not simply a waste of resources; it is a threat to the complex structures that support human development.

UNFPA (2001) stated that the development potential of cities is increasingly threatened by environmental deterioration. Aside from it's obvious effects on human health and well-being, environmental degradation directly impedes socio-economic development. Water, air and soil pollution, for example, impose extra cost on business and industry, and on households as well as public services. Inefficient use and depletion of natural resources raise input prices and operating costs throughout the economy, and also deters new investment. Heightened risk of environmental hazards has the same effect.

In terms of impact, it is usually the poor who suffer most cruelly and directly from environmental degradation, although the lives of all urban residents are also affected. Failing to deal with the problem today, moreover, leads to much greater problems (and cost) in the future. For development achievements to be truly sustainable, cities must find better ways of balancing the needs of urban growth and change with the opportunities and constraints of the environment.

Are there environmental limits to growth?

Thankfully, the apocalyptic predictions that human population growth would eventually outstrip the capacity of land to produce food have not come true. Human ingenuity and continued improvements in agricultural technology have thus far ensured that global food supplies have grown at least as fast as population. Scientists are still pondering the question: are there environmental limits to the number of people and the quality of life that the earth can support?

Scientists seem to be in agreement that there are natural limits, but the predicted limits fall within a broad range: 4 -16 billion people (UNFPA, 2001). What will happen when these limits are reached will depend on human choices about lifestyles, environmental protection and equity.

We have learned how to extract resources for our use but not how to deal with the resulting waste. The UNFPA (2001, p. 19) report stated that emissions of carbon dioxide for example grew 12 times between 1900 and 2000. In the process we are changing the world's climate. The great questions of the 21st century are whether the activities of the 20th century have set us on a collision course with the environment, and if so, what can we do about it? Human ingenuity has brought us this far. How can we apply it to the future so as to ensure the well being of human populations, and still protect the natural world?

2.2.6 The impact of human activity

A formula was developed in the early 1970's as part of a debate over the contribution of population to air pollution in the United States. It reached explicit mathematical formulation in *Erlich & Holdren's* (PIP, 2000) now famous equation: I=PAT, meaning that people's impact on the environment (I) is a product of population size (P), affluence (A, representing output per capita or the level of consumption) and technology (T, representing the per unit output or efficiency in production).

This equation has been often used but also often criticised or elaborated. The main factors in the relationship are not independent, but are related in complex ways. Nonetheless, the approach has been useful in demonstrating that population dynamics are central to environmental change. For example, since 1970 global carbon dioxide emissions per capita have been relatively constant, while GDP per capita has increased in both more developed and less developed regions. This means that improvements in technology have offset the effects of increased consumption. Whether carbon dioxide emissions continue to increase in step with population size will depend on economic and social trends, the institutional response to environmental problems and the pace of technological change.

Pollution and health

Pollution has a direct effect in reproductive health, especially among the poor. Unplanned urban development and the opening of marginal, rural lands increase the number of people without access to reproductive health services, increasing the risk of maternal mortality and unwanted pregnancy. Lack of clean water at health facilities undermines service quality. Densely populated and rapidly growing mega cities subject their populations to air pollution levels far in excess of the allowable recommended by the World Health Organisation.

Since 1900, industrialisation has introduced almost 100 000 (UNFPA, 2001) previously unknown chemicals into the environment. Most of these chemicals have not been studied, either individual or in combination, for their health effects. Some of them, banned in industrialised countries because of their harmful effects, continue to be widely used in developing countries. Many chemicals have found their way into the air, water, soil and food, and human beings. Exposure begins in the womb. Some agricultural and industrial chemicals are associated with pregnancy failures and with infant and childhood developmental difficulties, illness and mortality. Exposure to nuclear radiation and some heavy metals has generic impacts.

UNFPA (2001) also reported that indoor air pollution- soot from the burning of wood, dung, crop residues and coal for cooking and heating- affects about 2.5 billion people, mostly women and girls, and is estimated to kill more than 2.2 million each year, over 98 percent of them in developing countries.

2.2.7 Poverty and the environment

Despite soaring global wealth, now estimated at $24 trillion annually, some 1.2 billion people across the world live on less than $1 a day- a condition classified as extreme poverty and characterized by hunger, illiteracy, vulnerability, sickness and premature death. Half the world lives on $2 a day or less.

UNFPA (2001, p. 28) reported that:

- more than a billion people cannot fulfill their basic needs for food, water, sanitation, health care, housing and education;

- Nearly 60 percent of the 4.4 billion people living in developing countries lack basic sanitation;
- almost one third do not have access to clean water supplies;
- one-quarter lack adequate housing;
- 20 percent do not have access to modern health services and 20 percent of children do not attend school through grade five;
- worldwide 1.1 billion people are malnourished, unable to meet minimum standards for dietary energy; and protein and micronutrient deficiencies are widespread and
- nearly 2 billion people in developing countries are anaemic.

Ending poverty has been an international aim since 1960. After significant advances between 1970 and 1990, the rate of poverty reduction in the 1990's fell to only one third of the pace required to meet the United Nation's commitment to halve poverty levels by 2015. Although affluence consumes energy and produces waste at far higher rates, the effects of poverty also destroy the environment. For example UNFPA (2001) reported that slash-and-burn agriculture and logging are expanding in and around Mexico's Calakmul Biosphere Reserve on the Yucatan Peninsula, because of rapid migration and high fertility. The report also stated that subsistence farmers have under unrelenting population pressure, stripped forest cover from the Garo Hills in northeast India.

Growing poverty in coastal communities and rapid population growth in large towns along the coast of West Africa are similarly driving destruction of the mangrove swamps for firewood and dynamite fishing in nursery waters.

In these and many other examples, the poor are the most visible agents of destruction in degraded environments. Poor people depend heavily on natural resources for direct income and their poverty offers them few choices. They stand at the end of a long chain of cause and effect. UNFPA (2001) stated that poor people "are the messengers of unsustainability rather than its agents."

There is increasing consensus that only an integrated approach to the problems of poverty and the environmental degradation can result in sustainable development. UNFPA (2001, p.30) argues that the building blocks of a sustainable development strategy include:

- **Increasing the resource base of the poor**, through measures such as land ownership reform, participatory management of common resources, public investment in land conservation and the creation of employment opportunities.
- **Investing in alternative energy services and infrastructure,** such as sanitation, clean water, education, health care and other services.
- **Support to "green" technologies.**

- **Pricing policies** that do not encourage profligate use of resources such as electricity water and fertilizer.

2.2.8 Climate change

In the 20th century, the human population quadrupled- from 1.6 billion to 6.1 billion, and the carbon dioxide emissions, which trap heat in the atmosphere, grew 12-fold- from 534 million metric tons in 1900 to 6.59 billion metric tons in 1997.

Climate change will have a serious impact, including increased storms, flooding and soil erosion, accelerated extinction of plants and animals, shifting agricultural zones, a threat to public health due to increased water stress and tropical disease. The condition could increase environmental refugees and international economic migration.

The Intergovernmental Panel on Climate Change (IPCC) cited in UNFPA (2001) estimated that the earth's atmosphere will warm by as much as 5.8 degrees Celsius over the coming century, a rate unmatched over the past 10 000 years. The panel's "best estimate" scenario projects a sea-level rise of about half a meter by 2100.

UNFPA (2001) reported that the United States with only 4.6 percent of the world's population produces a quarter of the global greenhouse gas emissions. Per capita emissions for Industrial countries are about 3 metric tons per person. Although per capita emissions of developing countries are still far lower than developed regions, the gap is closing.

Equalizing the benefits and cost of climate change for the good of all will require responsible leadership, concrete steps by the wealthier countries to curb their emissions, coupled with financing, technology transfer and capacity building to help poorer regions respond to the significant challenges ahead.

2.2.9 Wasteful consumption

Consumption is a critical factor in the relationship between population and environmental stress. Almost all human activities put demands on natural resources: food, housing, clothing and transportation use resources like arable land, water, oil gas and wood. Most human activities also produce wastes that are released back into air, water and soil, often with little or no treatment to mitigate their environmental impact.

While population growth puts increased demands on resources, the environmental impact of a given population depends on a combination of human numbers, levels of consumption and the extractive regenerative technologies available.

In the 20th century, consumption of goods and services rose to unprecedented levels- powering the expansion of the global economy and changing the realities of billions of people's lives. But vast numbers of people have been left out of the consumption boom.

A huge "consumption gap" exists between industrialised and developing countries. UNFPA (2001) reported that the world's richest countries, with 20 percent of the global population, account for 86 percent of total private consumption, whereas the poorest 20 percent of the world's people account for just 1.3 percent. The report also argued that a child born today in an industrialised country will add more to consumption and pollution over his or her lifetime that 30 to 50 children born in developing countries.

The ecological "footprint" of the more affluent is far deeper than that in the poor, and in many cases, exceeds the regenerative capacity of the earth.

As individuals and countries grow more affluent, their demands move beyond basic needs- magnifying the impact of population growth even in poor regions. With globalisation of western culture, demands for a range of products, including cars, computers and air conditioners will only increase- adding pressure on natural resources and ecosystems' capacity to absorb waste.

The value of generic diversity

Dependence on only a few crops is dangerous because disease can spread rapidly through monocultures, as it did through the Irish potato harvest in the 1840's, starving to death a fifth of the country's population. Despite nearly 10 000 years of settled agriculture and the discovery of some 50 000 varieties of edible plants, very few varieties of food crops feed the inhabitants of this planet. According to UNFPA (2001), just 15 food crops provide 90 percent of the world's food energy intake. Three of them- rice, wheat and maize- are the staple foods of 4 billion people.

The Food and Agriculture Organisation of the United Nations (FAO) cited in UNFPA (2001) estimated that since 1900 about three quarters of the generic diversity of domestic agriculture crops has been lost. Without constant infusion of new genes from the wild, geneticists cannot continue to improve plant crops. Cultivars (cultivated plants) need to be reinvigorated every 5 to 15 years in order to give them greater resistance against diseases and insects, as well as to introduce new yield enhancing traits, such as increased tolerance to drought or saline soils. The most effective way to do this is to interbreed domestic varieties with wild ones.

Plant breeders are alarmed at the continued genetic erosion of the earth's wild strains of cereals and other cultivars. Tropical deforestation, rapid urbanisation, the destruction of vital wetlands and the over-cultivation of dry lands has destroyed countless habitats for wild progenitors of domestic crops. According to the International Centre for Agriculture Research in Dry Areas cited in UNFPA (2001) as many as 60 000 plant species - roughly one quarter of the world's total- could be lost by 2025 unless the rate of plant genetic loss is halted or slowed substantially.

The International Food Policy Research Institute (IFPRI) cited in the UNFPA (2001) projected that meat demand in the developing world will double by 2020 to 190 million metric tons. Demand for meat in the developing world is expected to grow much faster than for cereals - by close to 3 percent per year for cereals. In per capita terms, demand for meat will increase 40 percent by 2020.

What this means is that demand for cereals to feed livestock will double in developing countries over the next generation. It takes 4 – 5 kilograms of feed to produce 1 kilogram of meat. UNFPA (2001) projected that by 2020 feed grain demand is projected to reach just under 450 million metric tons and that given this trend, well under way in much of Asia, demand for maize will increase much faster than other cereal, growing by 2.35 percent per year over the next 20 years. Nearly two thirds of this increased demand will go towards feeding livestock.

In China, rising incomes and changing diets have already resulted in a tremendous demand for meat, particularly poultry and pigs. UNFPA (2001) predicts that over the next two decades total demand for meat will double, increasing pressure on grain producers.

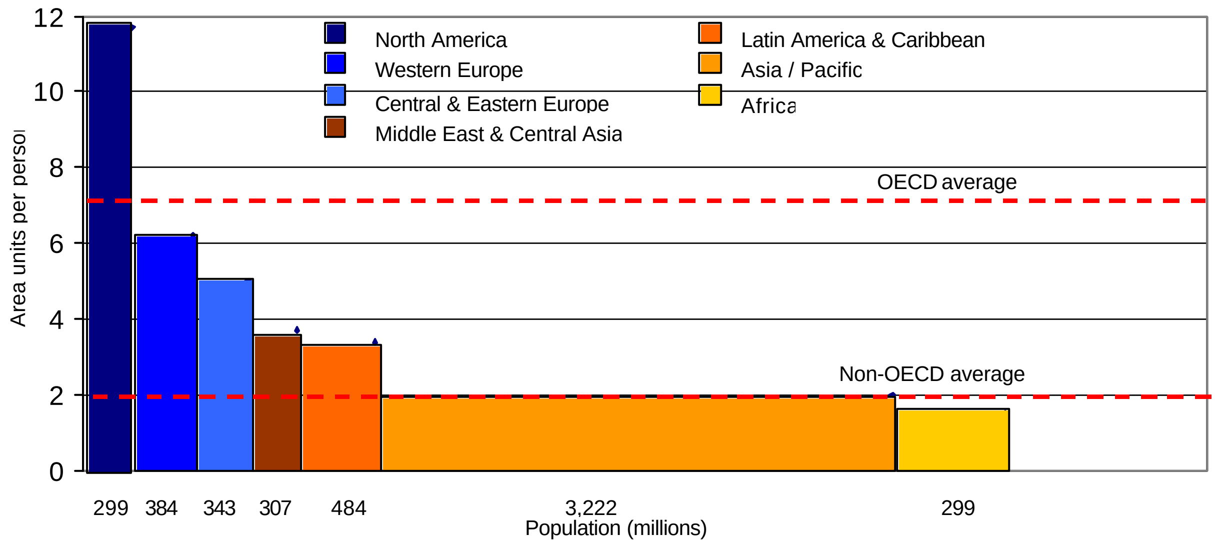
2.2.10 Ecological footprint

To measure people's impact on the environment, some scientists have devised an ecological footprint indicator. It shows which regions are the heaviest consumers of specific resources, on a per capita basis as well as in absolute terms.

Figure 2.7 was taken from UNFPA (2001, p. 36) and reflects ecological footprints by region.

The construction and the technical details of the ecological footprint and the so-called "living planet index" is described in **Chapter 3**.

Figure 2.7: Ecological footprint by region, 1996



The footprint estimates a population's consumption of food, materials and energy in terms of the area of biologically productive land and sea required to produce those natural resources or, in the case of energy, to absorb the corresponding carbon dioxide emissions. Measurement is in "area units". One area unit is equivalent to one hectare of world average productivity.

Each region is represented by a rectangle in which the width is proportional to the population, the height represents the per capita resource consumption, and the area represents the region's total consumption. Thus, Asia, which has a population over ten times the size of North America's but a per capita resource consumption level only one sixth as large, has a footprint only slightly bigger than North America.

Such an analysis captures the two most important dimensions of the challenge of *sustainability - per capita resource consumption* and *population growth*.

This indicator also identifies areas of high and low natural biological capacity and regions responsible for "ecological deficits", where resource consumption exceeds sustainable use levels. WWF (2000) reported that global consumption in 1996 stood at 2.85 area units per person, 30 percent more than biological availability (2.18 units).

The wealthy countries in the Organisation for Economic Cooperation and Development (OECD) had a total ecological footprint of 7.22 area units per person in 1996, more than twice the biological capacity of 3.32 units. Non-OECD countries had a total ecological footprint of 1.81 area units per person, slightly less than the biological capacity of 1.82 units.

North America had the world's highest ecological deficit (WWF, 2000) of 5.64 are units per person in 1996, despite having the second highest biological capacity of 6.13 units. The United States registered an ecological deficit of 6.66 units per person.

Africa had an ecological surplus in 1996 of 0.40 area (WWF, 2000) units per person (a footprint of 1.33 units and available biological capacity of 1.73 area units). Many African countries enjoyed large ecological surpluses and very few countries had deficits in excess of 1 area unit per person. However, these surpluses result from extensive poverty rather than beneficial management.

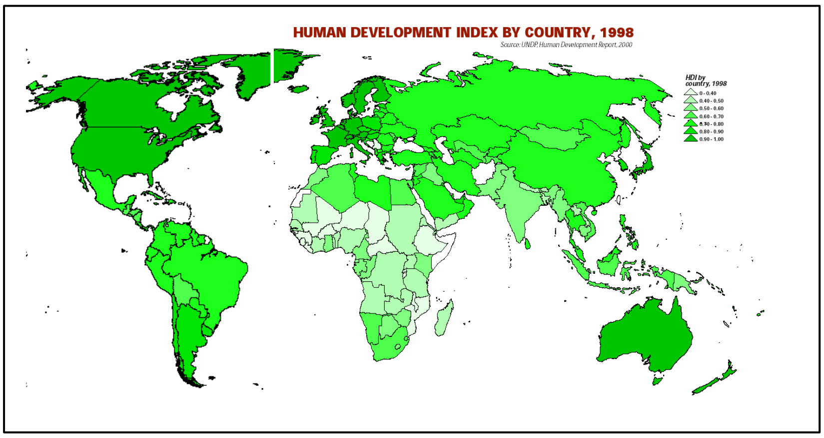
2.2.11 Urbanisation and human development

Cities are the generators of national development, which inevitably starts with migration. Opportunity is the attractor, the rural poor the attracted. In an urbansing world, cities, with all their demands and promise, harvest the countryside of people who can no longer tolerate the limitations of rural life or who simply see urban life as presenting more options for livelihood. Rural to urban migration is naturally greater where the benefits (that is, decent wages, adequate shelter, longer life) have not been well distributed over the natural landscape.

Urbanisation offers a series of risks and opportunities to women. Pregnancy and childbirth are generally safer in urban areas, where healthcare is more likely to be accessible. City life also offers women a broader range of choices for education, employment and marriage but it also carries heightened risk of sexual violence, abuse and exploitation.

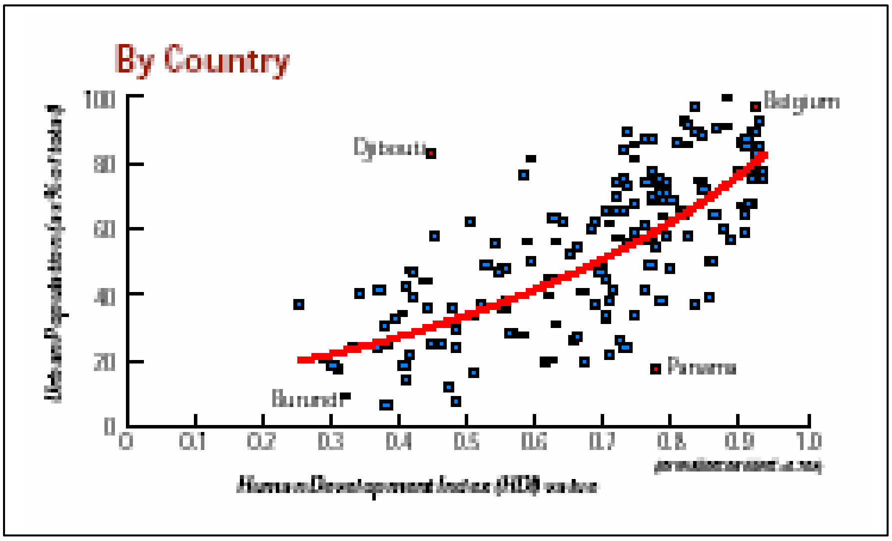
The graphs in **Figure 2.8** and **Figure 2.9** of human development versus urbanisation was taken from UNDP (2001a) and is interesting in that it clearly reflects that the Human Development Index is high in countries where urbanisation is high. This is in line with the reasons or motivations for humans to concentrate or cluster into cities. There is therefore a strong, positive link between national urbanisation and national levels of human development. Urban population, as a share of total national population in both highly industrialized countries (HIC) and those countries with a high Human Development Index (HDI), is above 70 percent. Urbanisation falls to less than 30 percent in countries that are classified as Least Developed Countries (LDC) or have a low HDI. All HICs score high in their provision of urban services and infrastructure to all citizens and low in incidence of absolute poverty. Development and urbanisation, therefore, proceed hand-in-glove. Without substantial investment in infrastructure and services to support both, neither can occur.

Figure 2.8: Human Development Index by country, 1998



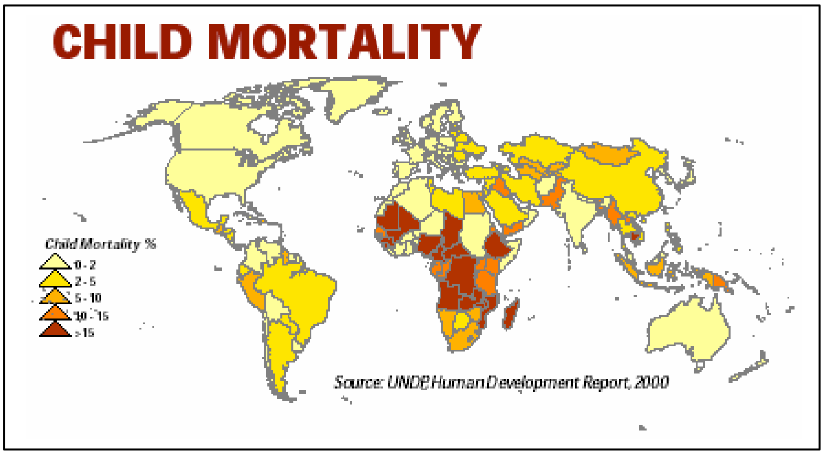
UNCHS (2000a)

Figure 2.9: Human development versus urbanisation, 1998



UNCHS (2000a)

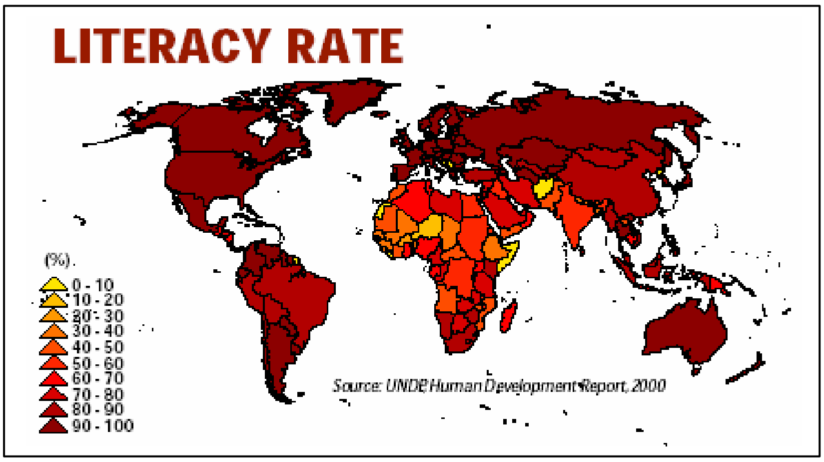
Figure 2.10: Child mortality rates



UNCHS (2000a)

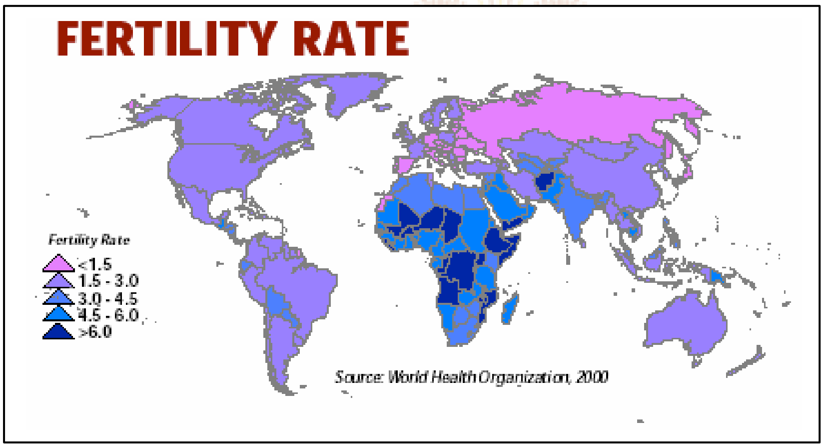
Figures 2.10 to **Figures 2.12** were taken from UNDP (2001a) and reflect worldwide child mortality rates, literacy rates and fertility rates.

Figure 2.11: Literacy rates



UNCHS (2000a)

Figure 2.12: Fertility rates



UNCHS (2000a)

2.3 Urbanisation and services

According to the UNCHS (2001a) report, the world population will grow by 50 percent, from 6.1 billion in 2001 to 9.3 billion by 2050. The 49 least developed countries will nearly triple in size, from 668 million to 1.86 billion people, according to the United Nations Population Division. Their latest estimates and projections indicate that the world population is now growing at 1.3 percent, or 77 million people per year. Six countries account for half of this growth: India (with 21 percent of the total increase), China, Pakistan, Nigeria, Bangladesh and Indonesia.

They also predict that all of the projected growth will take place in today's developing countries, which by 2050 will account for over 85 percent of the world's population. The total population in developed countries will remain at around 1.2 billion. Population will decline in 39 low-fertility countries, most sharply in Eastern Europe. Population in both developed and developing countries will be older in 2050 than today. As many people will be added in the next 50 years as were added in the last 400 years and these will be concentrated in the world's poorest countries, which are already straining to provide basic social services to their people.

2.3.1 Water and sanitation

"Access to safe water is a fundamental human need and, therefore, a basic human right". Said Secretary-General to the United Nations, Kofi Annan on World Water Day, 12 March 2001.

Without water, human development or even human existence is not possible. It may be the resource that defines the limits of sustainable development. It has no substitute.

Water availability

UNFPA (2001) stated that the supply of fresh water is essentially fixed and the balance between humanity's demands and available quantity is already precarious. Only about 2.5 percent (UNFPA, 2001, p.11) of all water on the planet is fresh water- essential for most human purposes- and only about 0.5 percent is accessible groundwater or surface water. Rainfall quantities vary greatly around the world. Portions of Northern Africa and Western Asia receive very small amounts of rain.

The UNFPA (2001, pp. 11-13) report stated that experts have outlined a basic daily water requirement (BWR)- 50 litres per capita per day for the purposes of drinking, sanitation, bathing, cooking and kitchen needs- and urged its recognition as a standard against which to measure the right to safe water. This minimal standard does not take into account other necessary uses of water- for agriculture, ecosystem protection and industry. A consumption standard of 100 litres per person per day would reflect these additional needs; in 2000 there were 3.75 billion people in 80 countries below this level. The population of these countries will increase to 6.4 billion by 2050.

Countries use different methods for collecting data on domestic water use and uniform standards for assessing quality have not been set. Available country estimates indicate that 61 countries, with combined populations of 2.1 billion people in 2000, were using less water than the BWR. By 2050, 4.2 billion people (over 45 percent of the global total) will be living in countries below the BWR standard.

Income is related to availability of water between and within nations. The more developed regions have on average substantially higher rainfall than those less and least developed. Additionally, richer countries can better afford the investment needed to develop reservoirs, dams and other technologies to capture fresh water run-off and available groundwater.

Not all countries are affected equally. The more-developed regions have, on average, substantially higher rainfall than less developed regions and have developed technology to use water more efficiently.

UNFPA (2001, pp11-13) stated that while global population has tripled over the last 70 years, water use has grown six-fold. Worldwide, 54 percent of the annual available fresh water is being used, two thirds of it for agriculture. By 2050 it could be 70 percent because of population growth alone or-if per capita consumption everywhere reached the level of more developed countries - 90 percent.

Total water consumption, therefore, is growing at about the same pace as population. Satisfying the water needs of 77 million additional people each year has been estimated, as requiring and amount roughly equal to the flow of the Rhine. But the amount of available water has not changed.

In the year 2000, 508 million people (UNFPA, 2001) lived in 31 water-scarce countries. By 2025, 3 billion people will be living in 48 such countries. By 2050, 4.2 billion people (over 45 percent of the global total) will be living in countries that cannot meet the requirements of 50 liters of water per person each day to meet basic human needs.

Many countries use unsustainable means to meet their water needs, by depleting local aquifers. The water table under some cities in China, Latin America and South Asia are declining over one metre per year. Water from seas and rivers is also being diverted to meet the growing needs of agriculture and industry, with sometimes-disastrous effects. The Aral Sea has been destroyed by diverting its feeder waters for irrigation. In 1997, the Yellow River in China (UNFPA, 2001) ran dry for a record 226 days. The Rio Grande River on the US-Mexico border developed a sandbar at its mouth recently due to a reduction in flow. The World Health Organisation (WHO) estimates that about 1.1 billion people do not have access to clean water. For the first time, official statistics reflect a decline in water coverage compared to previous estimates.

While the Middle East and North Africa are the regions most affected by water scarcity today, sub-Saharan Africa will be increasingly affected over the next half century, as its population doubles or even triples. In several countries, water supply is already inadequate to meet the demands of the growing industrial sector. The UNFPA (2001) predicts that within the next 10 years, Kenya, Morocco, Rwanda, Somalia and South Africa are projected to join the ranks of the water scarce.

The construction of large dams has slowed, particularly in more developed countries, as their disadvantages are appreciated: environmental disruption, displacement of long-settled populations, loss of agricultural land, silting and denial of water to downstream areas, sometimes in other countries. Large dam projects continue inter alia in Turkey, China and India.

Countries are characterised as water-stressed or water-scarce depending on the amount of renewable water available. Water stressed countries have fewer than 1700 cubic metres of water available per person per year. In these circumstances, water is often temporarily unavailable at particular locations and difficult choices must be made among uses of water for personal consumption agriculture or industry. Water scarce countries have fewer than 1000 cubic metres of water available per person per year. At this level, there may not be enough water to provide adequate food, economic development is hampered and severe environmental difficulties may develop.

The UNFPA (2001) reported that in the year 2000, 508 million people lived in water stressed or -scarce countries and predict that by 2025, 3 billion people will be living in 48 such countries.

Women in many parts of the world have the primary responsibility for collecting water for their families and spend up to five times as much time on this as men do. The more distant the water source the greater the burden on women.

Both distance and the source affect the amount of water used by the individual households. For example, when the source is a public standpipe more than a kilometre away from the home, use is typically less than 10 litres per day; water consumption may be twice as high when the standpipe is closer and considerably higher in households with running water connections.

Water quality

Quantitative estimates of water availability or consumption do not capture the full challenge of water needs. The quality of the available water is far from adequate. The WHO (2001) reports about 1.1 billion people do not have access to clean water (whatever its quantity). Fully 2.4 - 3.0 billion people lack access to sanitation. These shortcomings are more pronounced in rural areas where 29 percent of residents lack access to clean water and 62 percent to sanitation systems.

Rapid and unplanned population growth in and around urban areas is overwhelming their capacity to meet water needs. For the first time, official statistics reflect a decline in coverage compared to previous estimates: current estimates are that clean water is not available to at least 6 percent of urban dwellers and 14 percent lack sanitation, but this clearly understates the problem.

Water quality is closely related to availability and to decisions about land use, industrial and agricultural production, and waste disposal. The UNFPA (2001) reported that in developing countries, 90-95 percent of sewerage and 70 percent of industrial waste are dumped untreated into surface water where they pollute the water supply. In many industrial countries, chemical run-off from fertilizers and pesticides, and acid rain from air pollution require expensive and energy-intensive filtration and treatment to restore acceptable water quantity.

Challenges

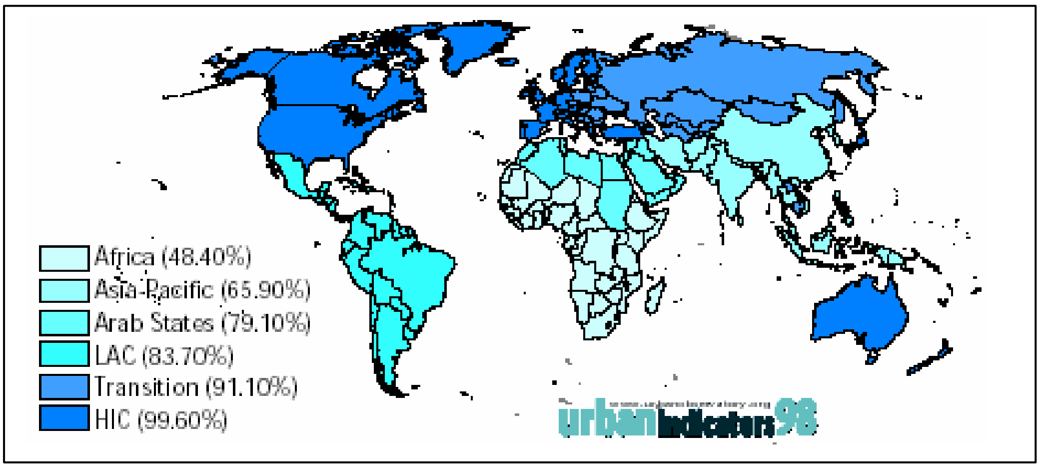
Purely technological solutions to water scarcity are likely to have limited effect. Desalinised seawater is expensive and now accounts for less than 1 percent of the water people consume. The UNFPA (2001) stated that protecting water supplies from pollutants, restoring natural flow patterns to river systems, managing irrigation and chemical use, and curbing industrial air pollution are vital steps to improving water quality and availability.

2.3.2 Infrastructure investment vs economic growth

Past experience has indicated that investment in infrastructure can stimulate economic growth. Several examples of increased economic activity can be cited after major engineering infrastructure was constructed such as roads, electric power stations and water supply schemes. The improvement of the American road transport sector during the middle of the twentieth century is a prime example of economic growth following infrastructure investment.

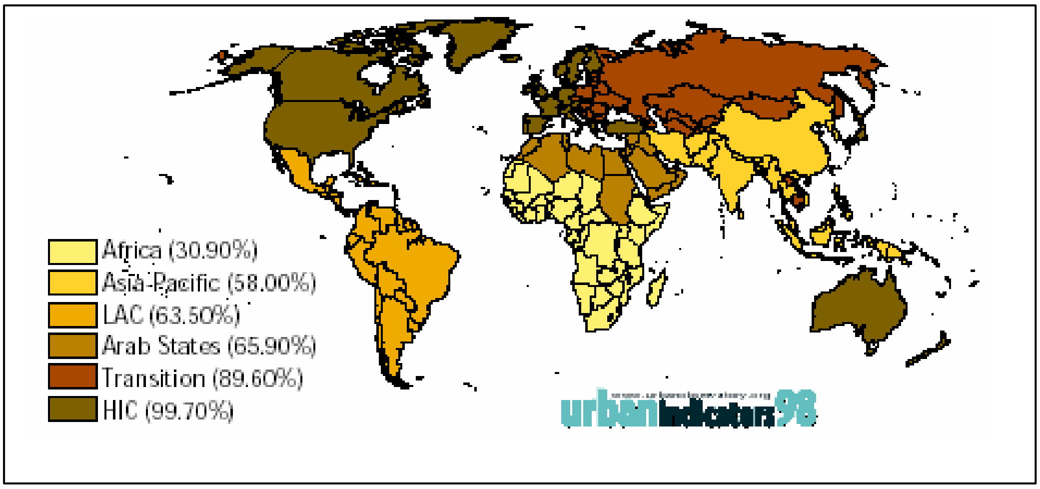
Examples of new investment in infrastructure following an upturn in the economy are more frequent. New housing schemes for example, are normally undertaken where industrial or commercial growth is evident. Very often these activities become indicators themselves to depict economic growth. The number or value of building plans approved in a municipality is often used as an indicator of economic activity in that region.

Figure 2.13: Household access to services-WATER



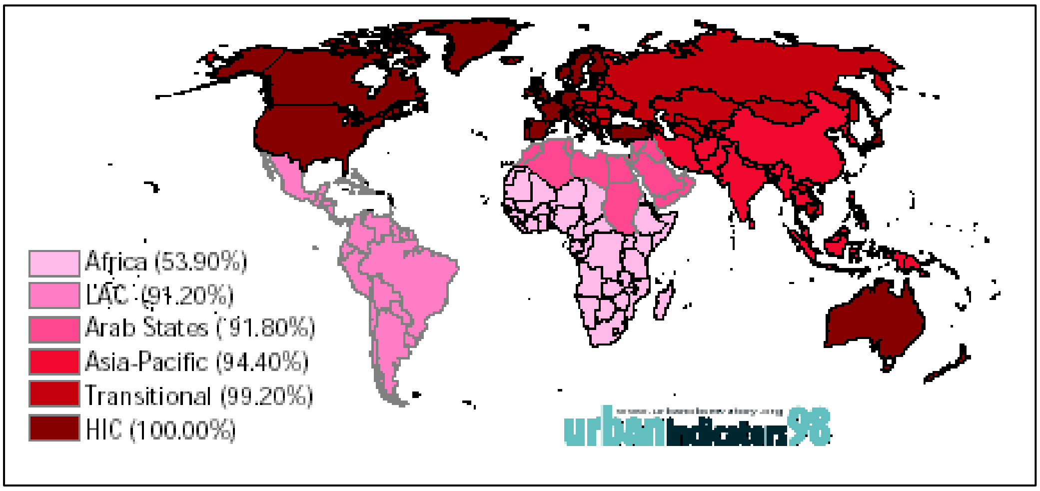
UNCHS (2000a)

Figure 2.14: Household access to services-SEWERAGE



UNCHS (2000a)

Figure 2.15: Household access to services-ELECTRICITY



UNCHS (2000a)

There is a definite relationship between infrastructure investment and economic growth. Whether infrastructure investment precedes economic growth, or whether it is the other way around, is uncertain at this stage considering that insufficient research on the topic has been undertaken as enough evidence exists to substantiate both. **Figures 2.13** to **2.15** were taken from UNCHS (200a) and reflect a worldwide distribution of access to water sewerage and electricity services. The low rate of access in South Africa should be noted.

2.3.3 Transformation

Municipalities have transformed over the last few years from the traditional service delivery role of to a much broader responsibility of ensuring economic growth and community development. Cities around the world now recognize that they need to excel in all four areas of sustainability as classified by the World Bank (2000b) namely:

- *Competitiveness*- reliability of services, knowledge of infrastructure, knowledge of business and service expectations. Providing a supportive framework for productive firms, to promote buoyant, broad-based growth of employment, incomes and investment
- *Livability*- compliance with standards, water and air quality, operations and maintenance practices. Committed to ensuring that the poor achieve a healthful and dignified living standard; that provide systems for adequate housing, secure land tenure, credit, transportation, healthcare, education and other services for households; and that address environmental degradation, public safety and cultural heritage preservation for the benefit of all residents.
- *Good governance*- with representation and inclusion of all groups in the urban society; with accountability, integrity and transparency of government actions in pursuit of shared goals; and with strong capacity of local government to fulfill public responsibilities based on knowledge, skills, resources and procedures that draw on partnerships.
- *Bankability*- Financially sound and creditworthy, asset management planning, acceptable financial accounting, disclosure policies, service cost recovery policy, asset accounting/costing/valuation, review and audit practices.

2.4 Economic development

World Bank (2000) and CoJ (2002) reported that whilst economic development is normally a matter for national government, cities recognise that they can and should play a role beyond the very limited role they have played to date. Monitor Group (2001) stated that National government is appropriately focused on the macro-economic issues, and whilst Trade and Industry departments focuses their efforts on sector-level programmes, cities are best positioned to facilitate alignment of effort and specific actions to support the economic imperatives for the local economy.

Cities can and should therefore, in alignment with and in support of national and provincial economic policy and strategy, assume a role in local economic development that can be focused on:

2.4.1 Building a basic competitiveness platform

Monitor Group (2001) argues that cities can focus on ensuring that the providers of basic infrastructure and services consciously focus on providing, maintaining and charging for infrastructure and services in a fashion which seeks to maximize the competitiveness of locally based firms, particularly on the service reliability and adequate rates of investment to upgrade sub-standard services, as well as ensuring that tariff and pricing policies are informed by customer needs and macro-economic requirements.

2.4.2 Supporting attractive economic sectors

Monitor Group (2001) suggests that cities can engage in processes of working with those clusters which are the most attractive to it as measured by their ability to deliver high returns against the vision – particularly on econom ic growth and job creation.

2.4.3 Build entrepreneurship and small business

Empowerment of previously disadvantaged people can systematically be done through appropriate policy formulation. Monitor Group (2001) suggested that cities can consciously work with appropriate institutions to adjust the skills and resources barriers to real growth and formal market entry by informal enterprises;

Stimulate through preferential procurement and innovative community-based service-delivery programmes the further emergence of the SMME sector; and

Implement programmes of providing the basic economic platform in a fashion that creates the basic linkages and delivers services in an SMME-friendly way.

2.4.4 Stimulate the creation of entry-level employment

The City of Johannesburg have identified a mismatch of skills in the city as one of the major stumbling blocks to becoming a world-class city. CoJ (2002) reported that despite the city having the highest skilled workforce in the country, 30 percent of the firms identified a lack of managerial, professional and technical skills as the major constraint to growth having more that 20 percent vacancy rates in these particular areas. Addressing the skills mismatch has become one of the city's highest priorities.

Interaction with the private sector through service delivery extensions is a useful option for work generation. Monitor Group (2001) suggests that:

- Cities can work with the private sector to determine a set of effective incentives to stimulate the large-scale creation of entry-level jobs by business;
- Leverage the opportunities created by service-delivery extension and infrastructure investment, to stimulate such employment;
- Explore the possibilities and pilot projects on community-based service delivery options where communities from within themselves organize to leverage council resources to provide basic services such as waste removal, road and infrastructure maintenance through the allocation of some form of work right.

2.5 Human development

Monitor Group (2001) argued that the City of Johannesburg could ensure human development through the facilitation of empowerment opportunities. It could also ensure that the people of the city have the means to participate in the growth of the economy to become engines of that growth through entrepreneurship. The city is also positioned to respond to the demand for skills from the growing economy by:

2.5.1 Supporting the education and skills development sector

Monitor Group (20001) argued that cities should actively seek to support the education and skills development sector through deploying its available and under-utilized services such as libraries, community centres and other appropriate infrastructure as facilities to be used by schools and public or private institutions. Support can range from working with schools and the Provincial Education Department to extend library access, equipping of libraries with appropriate reading materials and equipment, through to freeing up vacant buildings and facilities for extra-mural activities or for the use of emerging private training institutions which align their programmes with the development objectives of the city.

2.5.2 Investing in a "skills for employment" programme

Cities can invest significant resources to fund programmes through appropriate providers for unemployed youth, linked to a short-term work-experience programme located within the service-delivery extension programme of the city. Youth who graduate from the basic skills course could be taken up by contractors or through community-based service-delivery mechanisms set up to extend basic service access.

2.5.3 Development of entrepreneurialism

World Bank (2000) suggestions, similar to those of Monitor Group (2001) stated that cities can actively engage in the provision of business skills development and support for informal and SMME businesses focused in line with the economic strategic agenda. Cities can work together with the private sector in developing beyond the traditional short training course and basic business advice, moving instead into more sustained programmes of business-mentorship with a particular view of adjusting the barriers to formal market entry for firms and enterprises currently found in the informal economy.

2.6 Service delivery

2.6.1 Provision of access to basic services

Monitor Group (2000) suggested that the City of Johannesburg should strive to alleviate poverty through ensuring universal access over the long run to basic household-level infrastructure and services by:

- Facilitating the delivery of housing opportunities to the homeless.
- Provide basic access to water, sanitation, electricity and waste removal to the households served at below-minimum levels.
- Alleviate poverty through the provision free basic allowances for services in water, sanitation and electricity.
- Ensure the upgrading and extension of affordable basic access to community-level infrastructure and services such as surfaced roads public transport, primary health-care and community facilities such as libraries and community centres.

2.6.2 Maintenance and upgrading of infrastructure and services

In addition to the extension of basic access, cities can ensure that the decline in infrastructure quality is arrested through investment and upgrading programmes for the city's asset base are embedded into the operations of the various utilities ensuring long-term sustainability, improving reliability and appropriate upgrading in services.

2.6.3 Investing for excellence and competitiveness

Cities can also work with business and particularly the telecommunications and logistics sectors to ensure that rapid advances are made in the provision of world-class, value-added and high-technology infrastructure and service offerings in order to support the development of knowledge-based industries in the city. CoJ (2002) suggested that despite the non-existent role of the Council in the telecommunications field at present, if it is to engage in a meaningful way in developing the city's economy and bettering the lives of its citizens, it is crucial that the

City of Johannesburg carve out a niche for itself in this sector in order to become a world-class city.

2.7 Public services

Urban governance differs from the broader governance agenda in that it acknowledges that one should not ignore the complex social and political environments in which services are being managed. It includes interactions between all stakeholders in the city. Therefore, political, contextual, constitutional and legal dimensions need to be considered.

Urban governance is the sum of the many ways individuals and institutions, public and private, plan and manage the common affairs of the city. It is a continuing process through which conflict or diverse interests may be accommodated and cooperative action can be taken. It includes formal institutions as well as informal arrangements and the social capital of citizens.

Based on international legal instruments, commitments at major UN Conferences and operational experience in cities, good urban governance is characterised by the following seven interdependent and mutually reinforcing norms:

- **Sustainability** in all dimensions of urban development.
- **Subsidiary** of authority of resources at the closest appropriate level.
- **Equity** of access to decision-making processes and the basic necessities of urban life.
- **Efficiency** in the delivery of public services and in promoting local economic development.
- **Transparency and accountability** of decision-makers and all stakeholders.
- **Civic engagement and citizenship.**
- **Security** of individuals and their living environment.

2.7.1 Elements of good governance

UNDP (2001b) describe good governance as a process that includes the following elements:

- **Participation**: all men and women should have a voice in decision–making, either directly or through legitimate intermediate institutions that represent their interest. Local democracy and decentralization are prerequisite for participation.
- **Strategic vision**: leaders and the public should have a broad and long-term perspective on good governance, human development and the development of their city along with a sense of what is needed for such development.
- **Rule of law**: legal frameworks should be fair and enforced impartially, particularly on law on human rights.

- **Transparency**: processes, institutions and information are directly accessible to all stakeholders, and enough information is provided to understand and monitor governance processes.
- **Responsiveness**: institutions and processes try to serve all stakeholders.
- **Consensus orientation**: different interests are mediated in order to reach a broad consensus on what is the best interest of the group and where possible on policies and procedures.
- **Equity building**: all men and women have opportunities to improve or maintain their well-being.
- **Effectiveness and efficiency**: processes and institutions produce results that meet needs while making the best use of resource.
- **Accountability**: decision-makers in government, the private sector and civil society organisations are accountable to the public, as well as to institutional stakeholders.

A future challenge is to translate each component into practical tools and have benchmarks for each component. For instance the quality of civic engagement in the decision-making process, the responsiveness of local government towards its citizens and the respect for basic human rights are some of the benchmarks for good governance of cities.

2.8 Cities at risk

The events of September 11, 2002 have changed the way people think about cities forever. Cities, as the most complex of human creations, are at great risk from a wide range of hazards and from their own multiple vulnerabilities. Points of urban vulnerability are everywhere: infrastructure systems, factories and office buildings, telecommunications and transport, community structures, government agencies, schools, food supplies, energy and resource supply lines and others. Moor (2001) provided the following formula for cities at risk:

Hazard x Vulnerability = Risk

Where,
Hazard = that which may cause damage or loss.
Vulnerability = being susceptible to damage or loss
Risk = probable degree of damage or loss over time.

Moor (2001) states that although we presently pay more attention to predictable and manageable disasters such as earthquakes, hurricanes, fires, landslides and floods, and increasingly to "slow-motion" threats from pollution and crime, strategically and symbolically, cities have always been objects of war. The challenges now faced by globalists in a more knowledgeable world is to determine what changes will be needed to reduce both the vulnerability of the global economy and the threat it poses to many people.

2.9 Evaluation

Today the developing world's largest metropolitan areas shelter large and increasingly vulnerable low-income populations. If the peripheral settlements outside the formal boundaries of these cities are taken into account, populations living at or below the poverty line often exceed half of the total urban population. For these populations, urban services are either absent or erratically provided. In medium and smaller cities of the Third World, the quality and terms of urban services tend to be worse.

There is ample evidence that the cost of delivering adequate services to seriously degraded urban settlements is more expensive than delivering them to well-off neighbourhoods. The risk of contamination and/or breakdowns are higher in the former as are the costs of maintenance due to the fragile environment and social conditions. Private providers will have little incentive to assume these extra costs, nor will increasingly cash-strapped public authorities have the resources or political will to subsidise services to low-income areas.

An understanding of the dynamics necessary to ensure progress and provide order in a society where millions of people live in close proximity to one another is necessary to assist in the process of formulating measures and priorities in the sharing of resources.

3 Literature review

3.1 Introduction

In **CHAPTER 2** an understanding was developed of the spatial and social implications of the group-forming tendencies of humans as well as grasping the dynamics necessary to ensure progress, and to provide order, in a society where millions of people live in close proximity to one another and the consequential impact of sharing resources.

In this chapter existing literature relating to performance management and indicator development is examined in order to find solutions to the problems of measuring municipal service delivery. The best way to start with this exploratory exercise is to question why anyone would want to measure service delivery. The answer is, of course, derived out of a performance measurement perspective. No one would even attempt to develop such an indicator unless they were involved with an exercise in performance management or in particular, performance measurement. Therefore, existing literature is first examined to understand the broader concepts of performance management.

3.1.1 Why measure performance?

During 2000, The *Department of Provincial and Local Government* appointed *Palmer Development Group et al* to conduct research and provide a set of *National Key Performance Indicators for Local Government.* Parts of their extensive and well-documented research is summarised especially to clarify terminology used in the performance management arena. The results of their research will be used inter alia, to describe the basis of performance management for municipalities. Gaebler, O (1992), cited in DPLG, (2001a) stated:

> What gets measured gets done
>
> If you don't measure results,
> you can't tell success from failure
>
> If you can't see success,
> you can't reward it
>
> If you can't reward success,
> you are probably rewarding failure
>
> If you can't see success,
> you can't learn from it
>
> If you can't recognise failure,
> you can't correct it
>
> If you can demonstrate results,
> you can win public support.

The above statement explains the reasons for measuring performance. It is the only way in which we can demonstrate that we are achieving what we have set out to achieve. It is the only way to distinguish between success and failure and it is the fundamental nature of performance management. In order to be able to monitor, evaluate and apply corrective actions, results must be measured.

What must be measured?

The essence of performance management is performance measurement. This is clear from the fact that unless performance is measured it cannot be managed. In order to measure performance, specific indicators for measurement should be determined. These indicators are aptly termed performance indicators. Results are therefore, measured by measuring performance indicators.

The various types of indicators are explained later on. Most important to note at this point is that some indicators are more relevant to the determination of success than others, hence the term “key” performance indicators (KPIs).

What are indicators?

Indicators are essential pieces of information that reveal conditions, and over time, trends. Indicators can be used to make policy and planning decisions, to identify whether policy goals and targets are being met, and sometimes to predict change. Indicators can also be used to compare conditions of different locales or progress towards policy targets.

Characteristics of good performance indicators

DPLG (2001a) & DPLG (2001b) provided characteristics of good performance indicators:

Measurable

- Key performance indicators should be easy to calculate from data that can be generated speedily, easily and at reasonable cost given the municipality’s financial and administrative capacity.

Simple

- Should be able to measure one dimension of performance (quantity, quality, efficiency, effectiveness and impact) at one given time.
- Avoid combining too much in one indicator.
- Separate different performance dimensions and set indicators for each separately.

Precise

- Should measure only those dimensions that an organisation or municipality intend to measure.

Relevant

- They should measure only those dimensions that enable organisations to measure progress on its objectives.
- They should measure performance on areas that fall within the powers and functions of a municipality.
- They should measure the performance of the year in question.

Adequate

- They should measure quantity, quality, efficiency, effectiveness and impact.
- Separate indicators should be set for each priority and objective.

Objective

- They should state clearly what is being measured without ambiguity.

3.2 Definitions and terminology

Although the principle of performance measurement is well understood and researched internationally, different people in different parts of the world still use different terminology to describe different types of indicators. There are a number of different types of indicators that measure different aspects of performance, such as input indicators, process indicators, output indicators and outcome indicators. In order to avoid the confusion and debates on definitions and in the absence of standardised terminology of the types of indicators, the following definitions and types of indicators will apply in this thesis and will in no way attempt to be prescriptive. The purpose of this chapter is not to investigate the different terminologies but to rather adopt the most common and sensible terms and descriptions in order to proceed with the more complex process of index development.

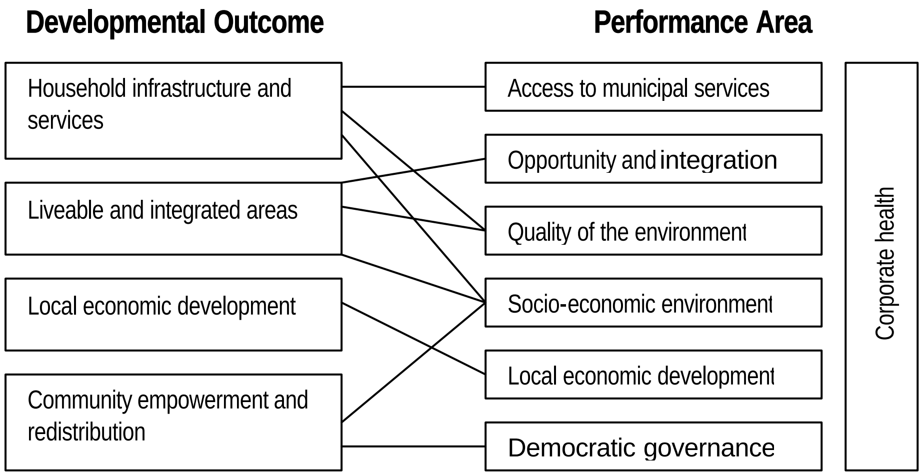
For this particular reason, the terminology used in the DPLG (2001a and 2001b) will be adopted where possible**. Paragraph 3.2** of this chapter summarises the definitions adopted.

3.2.1 Performance areas

Performance areas refer to outcomes and should be based on the developmental outcomes of local government as set out in the White Paper on Local Government, March 1998:

- Provision of household infrastructure and services.
- Creation of livable, integrated cities, towns and rural areas.
- Local economic development.
- Community empowerment and redistribution.

Figure 3.1: Developmental outcomes and performance areas



DPLG (2001b)

Developmental outcomes for local authorities have been interpreted by DPLG to comprise performance in the following six performance areas reflected in **Figure 3.1**, namely:

- Access to municipal services
- Opportunity and integration
- Quality of the environment
- Socio-economic environment
- Local economic development
- Democratic governance.

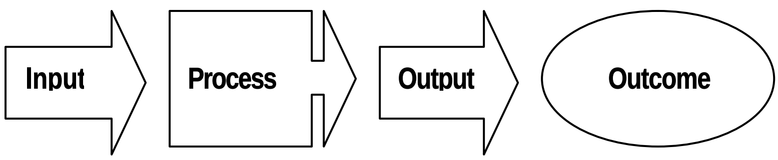
White Paper on Local Government, (1998a), places a strong emphasis on access to services.

3.2.2 Types of indicators

Performance indicators can be divided into three categories in terms of **what** aspects of performance (the performance areas) are being measured, **how** it is measured (the types of indicators) and **when** it is measured.

The four types of indicators are identified and illustrated in **Figure 3.2** namely, input, process, output and outcome indicators.

Figure 3.2: Types of indicators



DPLG (2001b)

Input indicators

Input indicators are also relevant to the day-to-day operations of a municipality and are typically cost related. These indicators refer to resources required to enable programmes, functions or processes to be performed, for example labour cost. Input indicators are typically used to measure resources. Inputs are what go into the process. Costs are the financial expenditure required to undertake the project.

These are indicators that measure economy and efficiency. That is they measure what it costs the municipality to purchase the essentials for producing the desired outputs (economy). The economy indicators are usually expressed in unit cost terms. For example, the unit cost for delivering water to a single household. Efficiency indicators may be the amount of time, money or number of people it took to a municipality to deliver the water to a single household.

Process indicators

Process indicators describe how well a municipality uses its resources to convert inputs to outputs in the provision of services. This type of indicator also measures compliance with regard to existing standards and requirements of national departments such as environmental legislation and water quality standards. Process is the set of activities involved in producing something.

Output indicators

Outputs are the products or services generated. Output indicators describe the products produced after processing the inputs and refer to the end point of an activity. Output indicators are used to measure the activities or the process. Examples of output indicators are:

- number of electrical connections made
- number of houses constructed
- kilometers of roads constructed

This type of indicator measures how well for example a municipality is performing in terms of its service mandate. These are the indicators that measure whether a set of activities or processes yields the desired products. They are essentially effectiveness indicators. They are usually expressed in quantitative terms (number of, or % of). An example would be the number of households connected to electricity as a result of the municipality's electrification programme.

Outcome indicators

Outcome indicators measure the extent to which goals and objectives are being met. They assist in checking whether the development strategies and policies are working or not. They also help to identify gaps and improve strategies and policies.

Outcomes are usually the result of a combination of different variables acting together for example the increase health of economic activity as a result of improved water supply. These variables can only be produced after the outputs have been completed. These indicators are normally influenced by factors outside the control of the municipality. The causative relationship between variables needs to be specified in order to understand their implications on the outcome indicator. A consumer satisfaction index and the HDI are examples of outcome indicators. Outcome indicators measure impact.

Outcome is the impact or the effect of the output being produced and the process undertaken. The Municipal Systems Act (2000) requires local government to measure its performance on outputs and outcomes.

These are the indicators that measure the quality as well as the impact of the products in terms of the achievement of the overall objectives. In terms of quality, they measure whether the products meet the set of standards in terms of the perceptions of the beneficiaries of the service rendered. Examples of quality indicators include an assessment of whether services provided to households complies with the acceptable standards or percentage of complaints by the community. In terms of impact they measure the nett effect of the products or services on the overall objective. An example would be the percentage reduction in the number of houses burnt due to other sources of energy, as a result of the electrification programme. Outcome indicators relate to programme objectives.

Baselines

Baseline measurements are indicators that show the status quo or current situation such as the level of services, poverty etc. These indicators are usually utilised in the planning phase to indicate the challenges the organisation is faced with. They are important because organisations use them to assess whether programmes are indeed changing the situation.

Targets

Targets are identified to be time related indicator types. Targets are simply goals or milestones that an indicator should measure at various timeframes.

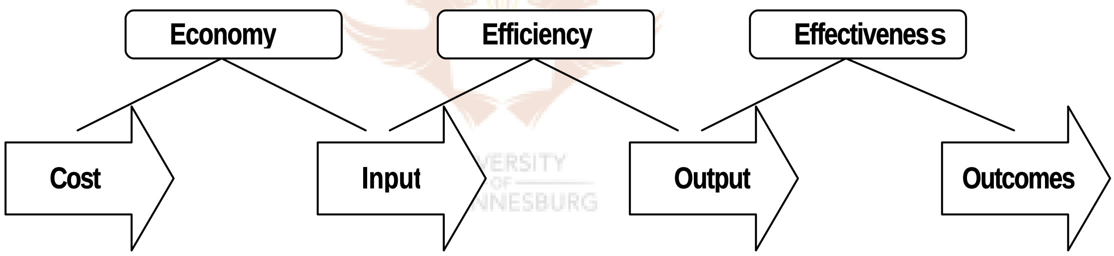
3.2.3 Economy, efficiency and effectiveness

Economy is used to describe the amount of money or cost of the resources required in terms a certain input to a process. A fast worker will cost an organisation less to produce a certain article or to provide a certain service than a slower worker. He is therefore a more "economical" worker (assuming they are paid similar wages). If he also does the work right first time ie without having to redo work previously done, he would also be an "efficient" worker. Efficiency therefore, refers to the inputs in terms of the required outputs.

Effectiveness is used to describe the outputs in terms of the outcomes. If our objective was to reduce the number of reported cholera infections (outcome) by providing clean piped water to houses in informal settlements (output) and the number of infections subsequently decreased, the plan can be described as "effective".

Figure 3.3 illustrates the British Audit Commission's "Three Es" model of economy, efficiency and effectiveness.

Figure 3.3: Economy, Efficiency and effectiveness



DPLG (2001b)

- Economy is defined as the ratio of input to cost.
- Efficiency is defined as the ratio of output to input.
- Effectiveness is defined as the ratio of outcome to output

In terms of how things are being measured, simple indicators (where only a single variable applies) are being distinguished from composite indicators. Composite indicators refer to situations where several indicators are used together to indicate overall performance Composite indicators are useful in simplifying a long list of indicators and the complex relationship between them into one index, such as the HDI.

3.2.4 Vision, strategy and indicators

Considering the literature examined on terms and definitions so far, now would be a good time to create an example to demonstrate how this all fits together. In order to put expression and meaning to the terms and definitions, **Table 3.1** can be complied. It is also an opportunity to become accustomed with the municipal environment and its jargon.

The terms and concepts can be explained through the schematic expression of **Table 3.1**. Firstly, the vision for the city is the ultimate end-state imagined and expected. The way the city should look, feel and perform after the corrective actions have been implemented. These goals are referred to as the outcomes for example, a safer environment or an improved economy.

Outcome indicators will therefore, become the tools by which the extent of the success will be measured in achieving the vision. Examples of such indicators are: a reduction in crime or an increase in Gross Geographic Product (GGP).

Secondly, the strategy will indicate the areas that the city should focus on to achieve its desired goals. These areas of intervention are referred to as performance areas or key performance areas (KPAs) for example a reduction in the crime rate or a reduction of pollution levels. The successes of the strategy's implementation in these performance areas are measured by means of output indicators where only the most important indicators are chosen to become key performance indicators (KPIs) such as the number of incidences of violent crimes or a decrease in the CO_2 levels.

Thirdly, action plans are the necessary vehicles to achieve the desired objectives for example increased law-enforcement visibility in the city center, or the intensification of the vehicle emission control programme. The successes of the action plans are measured with performance indicators (PIs). These indicators are also referred to as input indicators such as the increased number of traffic police shifts in the inner city or the increase in number of vehicles tested for emission control. **Table 3.1** was designed by the author to demonstrate the terminologies defined and is useful to gain an understanding of the different levels of indicators and how to apply them in terms of outcomes, outputs and inputs. It also assists in understanding the links between the vision, strategy and the action plans or programmes. The examples used are of a social nature, merely to demonstrate its applicability and similar processes are required for the provision of engineering services.

Table 3.1: Example of a performance measurement framework

Descriptions	Expected Products	Performance Measurement Indicators
Visions	*Outcomes*	*Composite Indicators or Indices*
Safe environment for residents to live, work and play	Evening recreation and entertainment activities for adults and children	Safety index
A clean and pleasant looking environment	Numerous outdoor recreation and entertainment activities	Clean index
Strategy	*Outputs/ Programmes*	*Key Performance Indicators (KPI)*
To reduce crime	Initiate Early Childhood Development programmes	Number of new Early Childhood Development programmes
	Increase police visibility	Number of violent crimes committed
To reduce pollution	Establish an Authority to set and control emission standards	CO_2 pollution levels Reduction of vehicles not complying with emission standards
	Establish a department to control and regulate waste recycling	Volume of waste recycled
Action plans / Programmes	*Inputs / Projects*	*Performance Indicators (PIs)*
Increase police visibility at public gatherings	Increased number of police shifts at public gatherings	Number of shits during weekends and after hours
Establish ECD centres	Provide facilities for ECD	Number of children in ECD centres
Reduce number of vehicles failing emission standards	Increased number of vehicles tested for emission levels	Number of vehicles tested for emission control
Establish waste recycling stations	Initiate waste recycling projects for the jobless and poor.	Volume of paper, metal and organic materials recycled

Transforming strategy and policy into practice requires a model (plan or framework) that can be implemented in the organisation. Models represent graphically how strategy should be translated into focus areas and activities. They indicate the interrelationship between the focus areas linking lies or arrows. Some models also allocate weightings (value of importance) to the focus areas, which are normally expressed as percentages. The focus areas and activities are normally represented as blocks in the diagrams, while the interrelationships between them are graphically represented by lines or arrows.

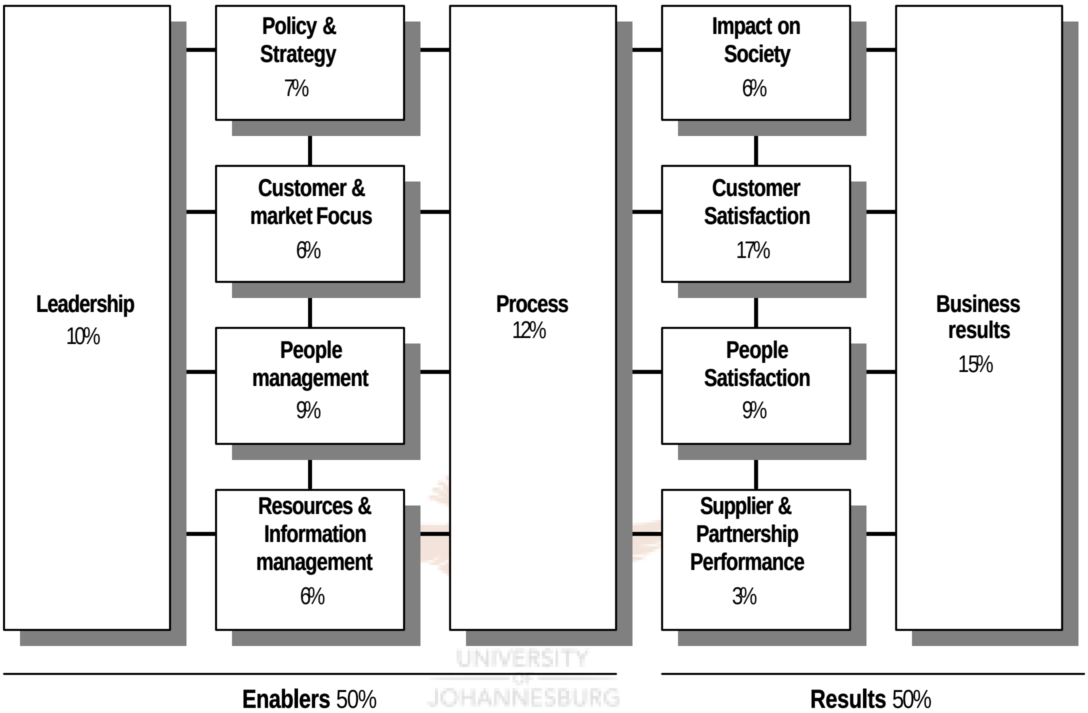
In order to undertake performance measurement municipalities should develop a framework for performance measurement. A typical model for undertaking performance measurement is the "South African Excellence Model" illustrated in **Figure 3.4**. Another very popular model adopted by numerous South African municipalities and private companies, is Kaplan and Norton's "Balanced Scorecard Method", **Figure 3.5**.

These models address different aspects of organisational performance and allocate scores. They focus on assessing whether:

- The policy and strategy are correct.
- Resources are spent appropriately.
- Processes yield results, and
- The impact of the results on society.

Both models rely on customer surveys as a tool to measure performance.

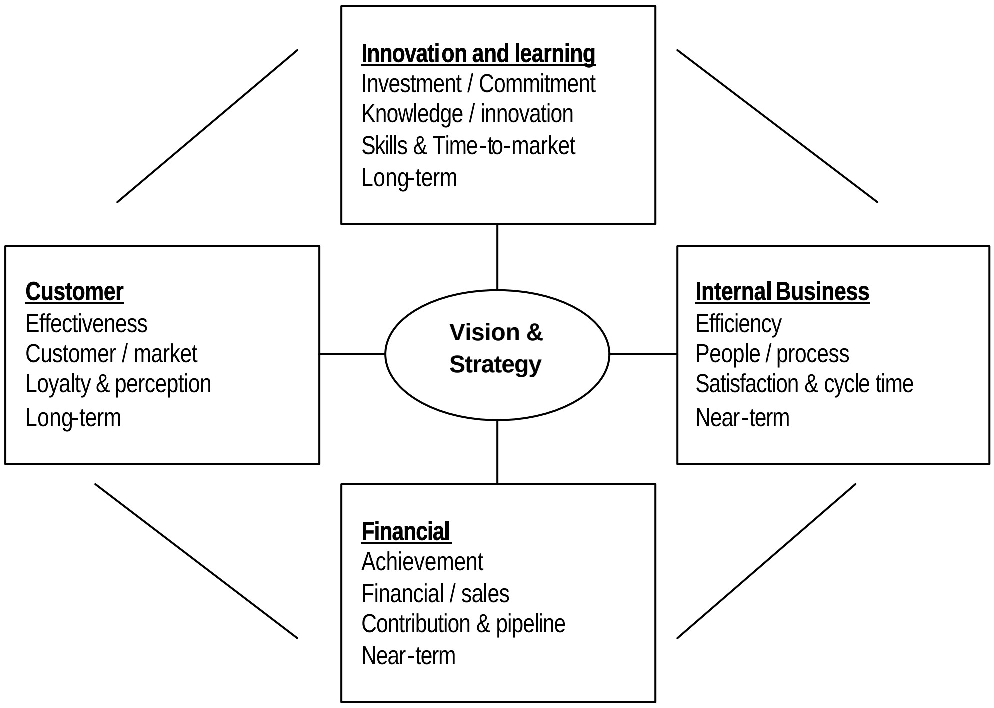
Figure 3.4: South African Excellence Model



DPLG (2001b)

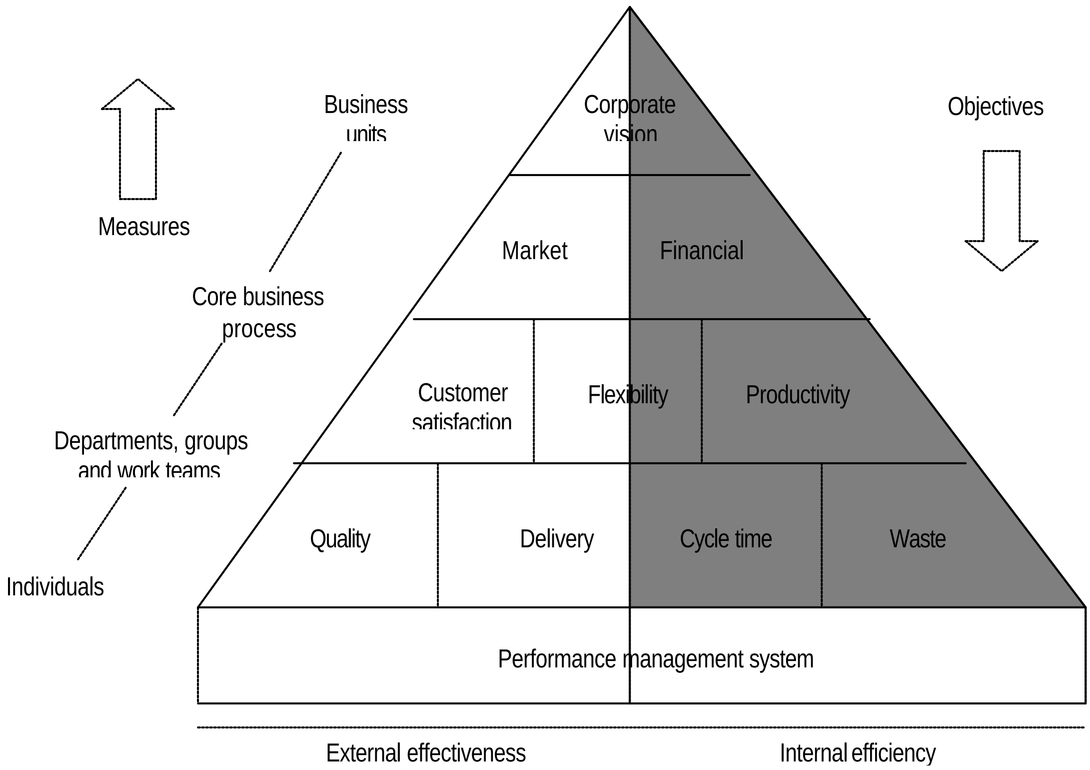
The performance areas in the South African Excellence Model are divided into two parts namely enablers and results. Both account for fifty percent of the total weighting. What is interesting to note is the high emphasis on customer satisfaction (17 percent) and business results (15 percent).

Figure 3.5: Kaplan and Norton's Balanced Scorecard



Pollard, D & Buckle, R. (2001) gave very good communication tool for showing how the key elements of business success are linked and who in the organisation is responsible for each element is the Performance Pyramid. **Figure 3.6** illustrates the performance pyramid.

Figure 3.6: Pollard & Buckle's Performance Pyramid



Pollard, D & Buckle, R. (2001)

3.3 Composite Indicators

DPLG (2001b) stated:

> Outcome indicators can be developed for each local government function. Each function can have a variety of outcomes that need to be measured. The danger of this is that a municipality can end up with a long list of indicators that become difficult to manage and communicate. One possible response to this problem is to use composite indicators for each sector (transport, water, sanitation, electricity, public housing, etc.) or across sectors. Composite indices combine one set of different indicators into one index by developing a mathematical relationship between them.

DPLG (2001a) stated:

> Composite indices are useful in simplifying long lists of indicators and the complex relationships between them into one index. However they do have their disadvantages. It is very difficult to ensure public involvement in monitoring of composite indices, as they appear unrelated to everyday life. Secondly, certain specific problem areas can become hidden and often overlooked when aggregated into a single composite index. Thirdly, composite indices rely on mathematical relationships between individual indicators based on assumptions as to how they relate to each other. Often these assumptions are untrue, misunderstood or merely simplistic. It is unwise to use composite indicators to aggregate a set of indicators where the mathematical relationship between them is not fully understood, tested or valid.

By knowing their usefulness and their disadvantages, it is up to the councils to decide whether or not composite indicators are appropriate.

It is also suggested that South African municipalities to start a performance management system at the very basic level by identifying only a few priorities and setting as few as possible indicators for those priority areas and that composite indicators be introduced in later years when the list of indicators gets longer and the capacity of citizens to participate is developed.

3.4 Human Development Index (HDI)

The United Nations for Human Development (UNDP) developed a composite indicator to determine and track human development over time. This human development index (HDI), comprises three dimensions namely, life expectancy, education, and gross domestic product.

The HDI is widely used to measure the progress of different countries and regions. For example, UNDP (2001a) ranks 162 countries in terms of the HDI. Top of the list is Norway, followed by Australia, Canada, Sweden and Belgium fifth. At present, the richest country in the world, United States, ranks only sixth in terms of human development, falling from third in

1997. South Africa is 94th on the list, being beaten even by the Philippines (70th), China (87th), and Kyrgyzstan (92nd). The lowest 28 countries are all in Africa.

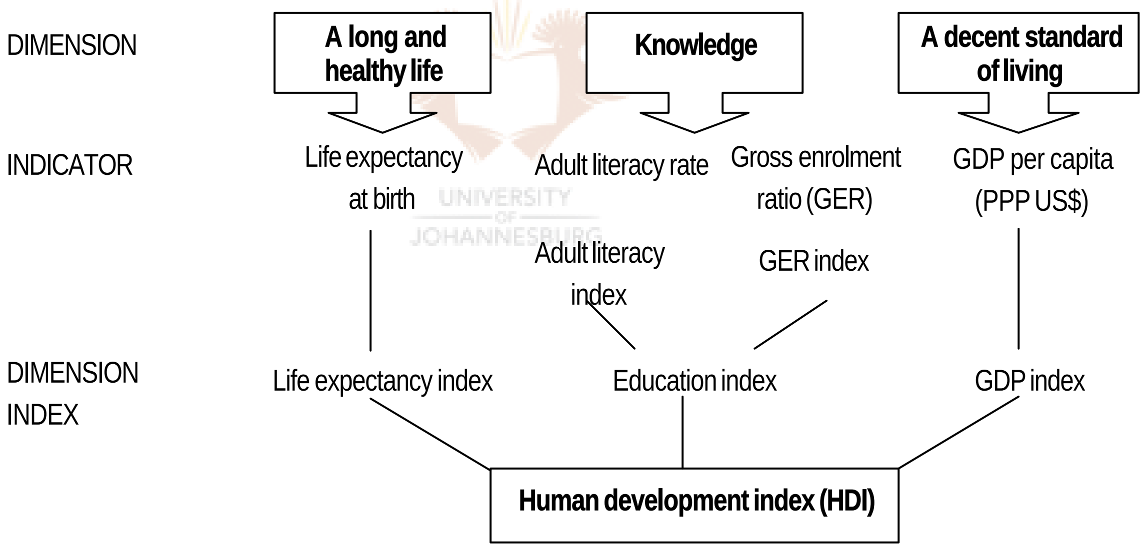
The HDI measures the average achievements in a country in three basic dimensions of human development:

- A long and healthy life, as measured by life expectancy at birth.
- Knowledge, as measured by the adult literacy rate (with two-thirds weight).
- A decent standard of living, as measured by GDP per capita.

The HDI is schematically described in **Figure 3.7**

Before the HDI itself is calculated, an index was created for each of the three dimensions. To calculate these indices (the life expectancy, education and GDP indices) minimum and maximum values (goal posts) are chosen for each underlying indicator. Performance in each dimension is expressed as a value between 0 and 1 by applying the general equation (3.1)

Figure 3.7: Construction of the HDI



UNDP (2001a)

$$\text{Dimension index} = \frac{\text{actual value - minimum value}}{\text{maximum value - minimum value}} \qquad (3.1)$$

The HDI is then calculated as an average of the dimension indices.

Table 3.2: Goalposts for calculating the HDI

Indicator	Maximum Value	Minimum Value
Life expectancy at birth (years)	85	25
Adult literacy rate (%)	100	0
Combined gross enrolment ratio (%)	100	0
GDP per capita (PPP US$)	40,000	100

UNDP (2001a)

Indices are calculated for each of the three dimensions, life expectancy index, education index and the GDP index.

The ***life expectancy index*** measures the relative achievement of a country in life expectancy at birth.

The ***education index*** measures a country's relative achievement in both adult literacy and combined primary, secondary and tertiary gross enrolment. First, an index for adult literacy and one for combined gross enrolment are calculated. Then these two indices are combined to create the education index with two-thirds weight given to adult literacy and one third to combined gross enrolment.

The ***GDP index*** is calculated using adjusted GDP per capita (PPP US$). In the HDI income serves as a surrogate for all the dimensions of human development in a long and healthy life and in knowledge. Income is adjusted because achieving a respectable level of human development does not require unlimited income. Accordingly the logarithm of income is used.

The ***HDI index*** is then a simple average of the three dimension indices.

$$HDI = \frac{1}{3}(\text{life expectency index}) + \frac{1}{3}(\text{education index}) + \frac{1}{3}(\text{GDP index}) \quad (3.2)$$

The index is calculated on a regular basis to determine the human development direction of regions, countries and cities.

Despite numerous criticisms of the HDI, it is widely used in almost every social development report, dissertation and thesis and has become the benchmark (CoJ, 2002) of indicators for human development.

3.4.1 The human poverty index for developing countries (HPI-1)

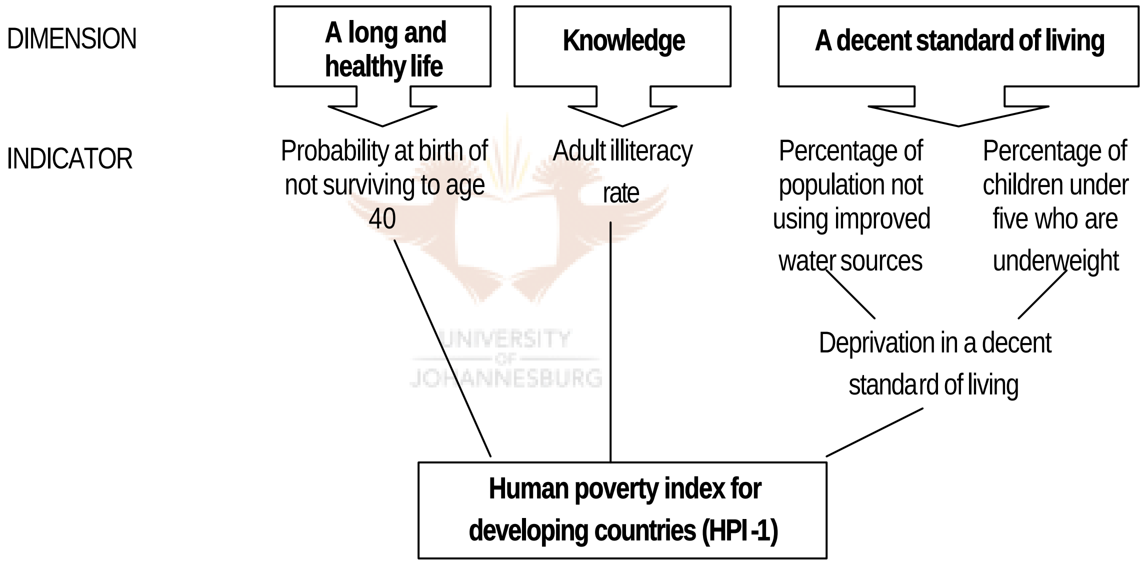
A human poverty index for developing countries (HPI-1) was also developed. While the HDI measures average achievement, the HPI-1 measures *deprivation* in the three basic dimensions of human development captured in the HDI:

- A long and healthy life- vulnerability to death at a relatively early age, measured by the probability at birth of not surviving to age 40.
- Knowledge- exclusion from the world of reading and communications, as measured by the adult illiteracy rate.
- A decent standard of living- lack of access to overall economic provisioning, as measured by the percentage of the population not using improved water sources and the percentage of children under five who are underweight.

Calculating the HPI-1 is more straightforward than the HDI. The indicators used to measure the deprivations are already normalised between 0 and 100 (because they are being expressed as a percentage), so there is no need to create dimension indices as for the HDI.

Figure 3.8 schematically describes the construction of the HPI-1.

Figure 3.8: Construction of the HPI -1



UNDP (2001a)

Analysis of the suitability of the HDI and the HPI-1

The HDI and its derivatives are undisputedly the best indicators developed to date (and also the most credible) for measuring human development. The philosophy in the development, although very crude, is sound and credible. The refinement of the HDI into its derivatives of human poverty index and others is useful and applicable. The fact that intellectuals, institutions, organisations and governments worldwide are using these indices to measure and compare nations and themselves over time is a huge step towards performance management of human development. Its suitability with regards to municipalities is however limited due to the fact that municipalities, with the exception of the provision of improved water sources, do not have a direct influence on the performance indicators constituting the indices.

3.5 City Development Index

The United Nations Centre for Human Settlements UNCHS (Habitat) recently developed a City Development Index (CDI) as a prototype for Habitat II to rank cities according to their level of development. The UNCHS (2001a) report argues that the CDI is to date, the best single measure of the level of development in cities. The technique used to construct the City Development Index is similar to that used by the UNDP for their Human Development Index. Separate sub-indices are constructed and combined to create a composite index. Thus, the CDI is based on five sub-indices- City Product, Infrastructure, Waste, Health and Education- the values of which range from 0-100.

The two most useful urban indices devoloped to date have been the City Product per person, which is analogous to the GDP at city level, to the economic output of the city and the City Development Index (CDI)

The CDI correlates well with the national Human Development Index (HDI), but because there is considerable variation between cities in any particular country, the UNCHS believes that the CDI provides a better measure of real city conditions than the national HDI.

They also believe that the CDI actually measures something real and it appears that the CDI is actually a measure of depreciated total expenditure over time on human and physical urban services and infrastructure, and it is a proxy of the human and physical capital assets of the city. There could be some support for this idea, in that more expensive services such as water treatment tend to be more heavily weighted. Although it cannot be confirmed with present data, it seems likely that that a monetary cost can be associated with lifting the CDI by a percentage point.

The CDI could therefore be taken as *a measure of average well-being and access to urban facilities by individuals.*

3.6 City Development versus Human Development

The City Development Index is calculated according to the formulae in **Table 3.3**. It has separate sub-indices for Infrastructure, Waste Management, Health, Education and City Product, which are averaged to form the CDI. Each sub-index is a combination of several indicators that have been normalized to give a value between 0 and 1. The weightings given to each indicator have been initially calculated by a statistical process called Principle

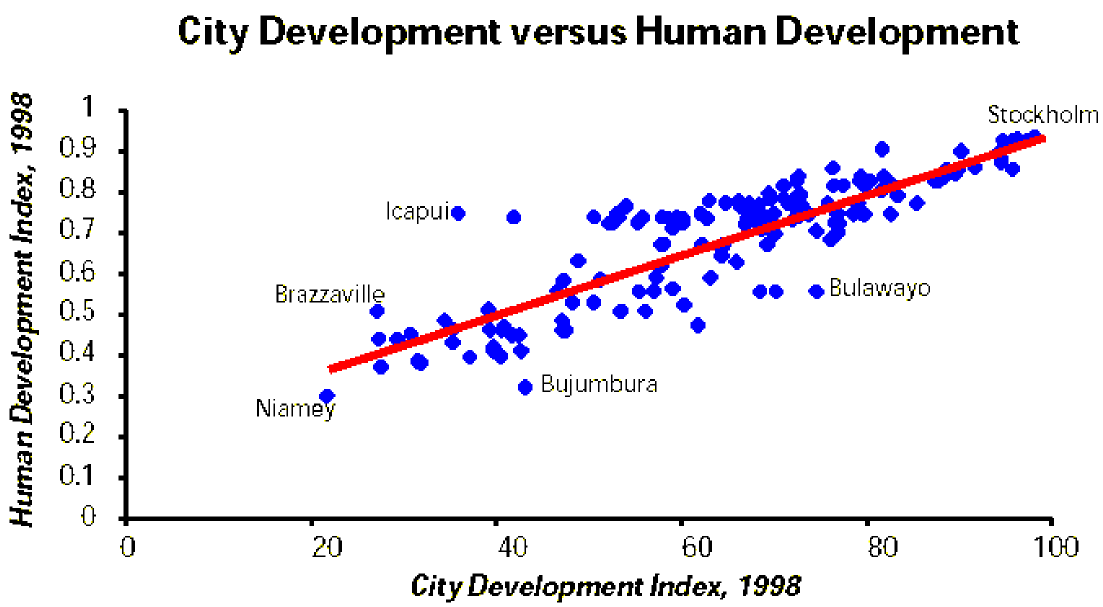
Components Analysis and then simplified. This formulation of the index by and large uses the same components as in the Human development report for Health, Education and City Product sub-indices.

Table 3.3: Calculating the CDI

Index	Formula
Infrastructure	25 x Water connections + 25 x Sewerage + 25 x Electricity + 25 x Telephone
Waste	Wastewater treated x 50 + Formal solid waste disposal x 50
Health	(Life expectancy - 25) x (32 – Child mortality) x 50/31.92
Education	Literacy x 25 + Combined enrolment x 25
Product	(log City Product – 4.61) x 100/5.99
City Development	(Infrastructure index + Waste index + Education index + Health index + City Product index)/5

UNCHS (2000a)

Figure 3.9: CDI vs HDI



UNCHS (2000a)

Urban poverty- health, education and infrastructure components are good variables for measuring poverty outcomes in cities.

Urban governance- Infrastructure, waste and city product components are key variables for measuring the effectiveness of governance in cities. The CDI correlates well with the city product- high-income cities reflect a higher CDI.

3.6.1 Analysis of the suitability of the CDI

The development of the CDI is probably the nearest indicator to a service delivery indicator that can be found in existing literature and contains all the elements required for the measurement of a city's performance. It is however, pitched at too high a level for measurement of a municipality's service delivery, due mostly to the fact that some of the indicators such as life expectancy, infant mortality, literacy, combined enrollment, and city product are not necessarily directly influenced by the service delivery mandate of municipalities.

The fact that the HDI and the CDI correlate well could also be construed as problematic. Perhaps they correlate well simply because the CDI is equal to a factor times the HDI. The CDI does in fact contain all the elements of the HDI namely: Life expectancy, literacy rate and GDP per capita.

If the CDI= C x HDI (C= constant), then why not only measure C and keep it a unique indicator? Perhaps it is because a broader picture of city development is required. Never the less, the good correlation between the CDI and the HDI cannot simply be construed as advantageous. Broader divisions or categories within the CDI would probably provide for better understanding and acceptance of the CDI.

Still, the CDI does not measure municipal service delivery and this being the *core* function of municipalities requires greater scrutiny and further investigation.

3.7 Stats SA indices on poverty

Another example of the development of a composite index is the poverty index developed by Statistics South Africa (Stats SA). Poverty is measured worldwide using different formulas and methods. Stats SA (2000a) developed two indices in their report, which they named the Household Infrastructure Index and the Household Circumstances Index. The indices were constructed to measure the extent of under-development in different parts of South Africa, using both the available data from Census '96 and the imputed expenditure values from a series of regression analyses using annual household expenditure as the dependent variable, and the poverty-related variables common to the October household survey (OHS) and the census as the explanatory variables.

Stats SA (2000a) believe that the poverty index could be used in conjunction with fund-allocating formulas of the Financial and Fiscal Commission, or the Department of Constitutional Development as instruments to monitor change in the life circumstances of poor households over time.

The methodology adopted for the development of the indices is important, as similar methods will be adopted for the development of the service delivery index. The Stats SA methodology is summarised in the following paragraphs.

The two Stats SA development indices are based on the statistical technique of factor analysis which determined that there were two principle components, when the technique was applied to items (a) to (k) in **Table 3.4**. The items comprise a theoretical plausible list of relevant indicators available from the census.

Table 3.4: Items used for calculating the Stats SA indices

Item	Description
(a)	Living in formal housing (brick dwelling, flats, townhouses, backyard rooms, etc)
(b)	Access to electricity for lighting from a public authority or supply company
(c)	Tap water inside the dwelling
(d)	A flush or chemical toilet
(e)	A telephone in the dwelling or cellular phone
(f)	Refuse removal at least once a week by a local district authority
(g)	Level of education of the head of the household
(h)	Average monthly household expenditure
(i)	Unemployment rate (expanded definition)
(j)	Average household size
(k)	The portion of children in the household under the age of five years

The indices ultimately also take the number of households in each area into account.

Table 3.5: Scores per Province

	Formal dwell-ing	Elec light	Tap in dwell-ing	Flush/ chem. toilet	Tel/ cell	Ref-use	Edu-cation hhh	Mean month exp	Un-empl rate	Ave hhld size	Child < 5 y
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)
Province	%	%	%	%	%	%	Years	Rand	%	N	%
Eastern Cape	46.9	31.2	24.4	30.6	15.6	33.8	5.1	1403	48.5	4.3	12.0
Free State	62.5	58.8	40.2	45.1	22.9	60.4	5.5	1543	30.0	3.8	9.5
Gauteng	73.8	9.4	66.9	82.9	45.3	81.4	7.1	3594	28.2	3.3	8.9
KwaZulu-Natal	55.3	53.2	39.2	41.7	26.9	41.9	5.4	2138	39.1	4.5	11.5
Mpumalanga	64.9	56.3	36.5	37.8	18.2	37.7	5.0	1899	32.9	4.2	11.6
Northern Cape	80.1	68.8	49.7	59.5	30.8	67.4	5.1	2023	28.5	4.0	10.6
Northern Prov	62.0	36.2	17.3	13.1	7.4	11.2	4.6	1418	46.0	4.6	13.1
North West	69.5	43.7	29.5	32.0	16.8	34.3	5.1	1820	37.9	0.2	11.2
Western Cape	81.3	84.9	75.3	85.8	55.2	82.2	7.0	3324	17.9	3.7	9.6

Once the percentages and scores for each of the 11 variables had been calculated for each province, these were subjected to a factor analysis, with rotation, to determine the Principle components. This statistical technique reduces a large set of variables to a smaller set of components by grouping together those variables which co-vary or which are correlated.

The analysis indicated that the variables were grouped into two Principle components, which explained 74% of the variance, as shown in **Table 3.6**. The first being Stats SA's household infrastructure index, which explained 57% and the second, Stats SA's household circumstances index explained a further 17% of the variance. The values in the table reflect the loadings obtained by each variable on each component constituting two Stats SA development indices (after rotation)

Table 3.6: Loading obtained for each component

	Variables	Household infrastructure index	Household circumstances index
(a)	Living in formal housing	0.65	-0.01
(b)	Access to electricity for lighting	0.78	0.07
(c)	Tap water inside the dwelling	0.83	0.12
(d)	A flush or chemical toilet	0.84	0.19
(e)	A telephone in the dwelling or cellular phone	0.77	0.05
(f)	Refuse removal at least once a week	0.74	0.19
(g)	Level of education of the household head	0.60	0.25
(h)	Average monthly household expenditure	0.84	-0.08
(i)	Unemployment rate (expanded definition)	0.39	0.45
(j)	Average household size	-0.02	0.90
(k)	Children under the age of five years	0.05	0.80

The household infrastructure index comprised variables (a) – (h), and since the variables used for this index obtained a relatively high loading on the first factor, each was given a weight factor of one.

The household circumstances index comprised variables (i) – (j), and since the variables used for this index obtained a relatively high loading on this second factor, each was given a weight factor of *one*.

3.7.1 Stats SA Household Infrastructure Index

The variables constituting each index were arranged from highest to lowest scores or percentages, to establish cut-off points, and to divide each variable into three new categories.

Table 3.7, which indicates these cut-off points for the household infrastructure index, is read as follows: in column (a) indicating the percentage of households in each province living in formal dwellings, the lowest score was 46%, while the highest was 81.3%. The cut-off points for grouping provinces in the lowest third on this variable was 58.3% and for the middle third, 69.8%.

Table 3.7: Cut-off points for the Household Infrastructure Index

Scoring	Formal dwell-ing (a) %	Elec light (b) %	Tap in dwell-ing (c) %	Flush/ chem. toilet (d) %	Tel/ cell (e) %	Ref-use (f) %	Edu-cation hhh (g) Years	Mean month exp (h) Rand
Lowest score	46.9	31.2	17.3	13.1	7.4	11.2	3.63	1403
Upper limit: bottom third	58.3	49.1	36.6	37.4	23.4	34.8	4.75	2133
Lower limit: middle third	69.8	67.0	56.0	61.6	39.3	58.5	5.78	2863
Highest score	81.3	84.9	75.3	85.8	55.2	82.2	6.99	3594

Provinces were divided into the three categories as reflected in **Table 3.8**.

Table 3.8: Scores per Province for Household Infrastructure Index

Province	Formal dwell-ing (a) %	Elec light (b) %	Tap in dwell-ing (c) %	Flush/ chem. toilet (d) %	Tel/ cell (e) %	Ref-use (f) %	Edu-cation hhh (g) Years	Mean month exp (h) Rand	Interim score	Rank
Eastern Cape	3	3	3	3	3	3	3	3	24	9.0
Free State	2	2	2	2	3	1	2	3	17	4.5
Gauteng	1	1	1	1	1	1	1	1	8	1.5
KwaZulu-Natal	3	2	2	2	2	2	2	2	17	4.5
Mpumalanga	2	2	3	2	3	2	3	3	20	6.0
Northern Cape	1	1	2	2	2	1	3	3	14	3.0
Northern Prov	2	3	3	3	3	3	3	3	23	7.5
North West	2	3	3	3	3	3	3	3	23	7.5
Western Cape	1	1	1	1	1	1	1	1	8	1.5

This ranking method is useful as a measure of relative infrastructure development, but excludes the number of households in each province. For policy decisions, such as the amount of money to be allocated for specific public works programmes in each province, the population of households should be taken into account.

The following stage in the development comprised the following process:

- First the total score across the eight trichotomised items was divided by eight, to eliminate the effect of the number of items, then
- the square root of the number of households in each province was calculated to yield a multiplier with a suitable range and finally
- the product of these two figures were then calculated

The process is reflected in **Table 3.9** where the minimum possible score in the least populous province was taken as the baseline and given a value of 100. The provinces were then compared to this base, as indicated in the last column.

Table 3.9: Final calculated Household Infrastructure Index

Province	Interim score	Interim score divided by the number of items (8)	Number of households (1 000)	Square root of the number of households vhh	Index	Rank
Eastern Cape	24	3.0	1 332	1 154,3	458	9
Free State	17	2.1	626	790,8	222	4
Gauteng	8	1.0	1 964	1 401,5	185	3
KwaZulu-Natal	17	2.1	1 661	1 288.8	362	7
Mpumalanga	20	2.5	604	777.2	257	5
Northern Cape	14	1.8	187	432.4	100	1
Northern Prov	23	2.9	982	991.2	377	8
North West	23	2.9	721	848.9	323	6
Western Cape	8	1.0	983	991.5	131	2

The index can be utilised to allocate money to the provinces for public works programmes of infrastructure development. The index shows that for every R100 that Northern Cape gets, Eastern Cape should get R458, Northern Province should get R377, KwaZulu-Natal should get R362, etc.

If the number of households were not taken into account, a slightly different ranking order would have resulted. The index and ranking should be chosen appropriately according to need. In apportioning a total amount of money (the original stimulus of this calculation), it is obviously desirable to take the number of households into account.

The same procedure was repeated to calculate the Stats SA Household Circumstance Index and is reflected in **Table 3.10**.

The scores and rankings of the two indices are compared in **Table 3.11**. Stats SA believe that the household infrastructure index is directly related to improving the quality of life of people by ensuring that their basic needs, for example access to clean water, sanitation, and basic education, are met. They also believe that the Household Circumstance Index is related to giving people more empowerment, for example, through job creation and population development programmes.

Table 3.10: Final calculated Household Circumstances Index

Province	Unemploy-ment rate (i) (%)	Average hh size (j) (%)	Child <5 years (k) (%)	Interim score	Interim score /no items (3)	Square root of the number of households vhh	Index	Rank
Eastern Cape	3	3	3	9	6.0	1 154,3	400	9
Free State	2	2	1	5	1.7	790,8	152	3
Gauteng	2	1	1	4	1.3	1 401,5	216	6
KwaZulu-Natal	3	3	2	8	2.7	1 288.8	397	8
Mpumalanga	2	3	2	7	2.3	777.2	210	5
Northern Cape	2	2	2	6	2.0	432.4	100	1
Northern Prov	3	3	3	9	3.0	991.2	344	7
North West	2	2	2	6	2.0	848.9	196	4
Western Cape	1	1	1	3	1.0	991.5	115	2

Table 3.11: Comparisons of indices

Province	Stats SA Household Infrastructure Index		Stats SA Household Circumstances Index	
	Index	Rank	Index	Rank
Eastern Cape	458	9	400	9
Free State	222	4	152	3
Gauteng	185	3	216	6
KwaZulu-Natal	362	7	397	8
Mpumalanga	257	5	210	5
Northern Cape	100	1	100	1
Northern Province	377	8	344	7
North West	323	6	196	4
Western Cape	131	2	115	2

3.7.2 Analysis of the suitability of the Poverty Index

Except for the access to services, very few of the indicators are affected directly through municipal service delivery. The methodology for the development of a composite indicator by Stats SA is however, useful.

3.8 Infrastructure index

During 1992, the World Bank mission to South Africa compiled extensive data on black townships in the PWV area (now Gauteng). The services investigated were roads, stormwater, water, sanitation, waste management and electricity. Coetzee and Naude' (1995) developed a unique infrastructure index method to describe the level of installation and operational efficiency of the infrastructure data compiled by the World Bank.

3.8.1 Evaluation of World Bank data by Coetzee and Naude

In short, the methodology used comprised the allocation of numerical values 1, 2, 3, and 4 to the four levels of services installed to each household in the township, 1 being the lowest level and 4 representing the highest level of service. The "average" level of service of the township is then calculated through a simple weighted average calculation. This level of infrastructure service installed was termed the "quality" of the service.

It should be noted that a township can have a high level of infrastructure installation, but if this is not managed efficiently, residents may still suffer inconvenience and misery. Conversely, a well-managed township can still have a reasonable level of service delivery, even if the level of service infrastructure is inferior.

The extent to which the local authority or service provider maintained the service infrastructure was also determined. Again numerical values of 0, 1, 2, and 3 were allocated to the level of maintenance service provided by the municipality, 0 being the worst and 3 the best. The value chosen differ from the quality values in that the value 0 was allocated to the minimal level of service. This was done deliberately in order to arrive at zero values when eventually multiplied. The average level of maintenance being delivered to the township was then again calculated through the use of a weighted average calculation. This level of infrastructure service maintained was termed the efficiency of the service.

The services in the different township were then compared by comparing the results of the average calculations. This method of describing township services and service delivery by Coetzee and Naude' (1995) was definitely useful and required further investigation.

3.8.2 Infrastructure quality index

The infrastructure index method briefly comprises the following:

The quality of infrastructure is categorised according to four levels namely minimum, basic, intermediate and full standard. Values of 1, 2, 3, or 4 are assigned to the levels respectively. The classification of infrastructure quality is reflected in **Table 3.12**. The four levels of service are in terms of the classifications used by the World Bank.

The level of service provided is calculated as the average of the percentage of the population receiving the service and is a figure between 1 and 4. This figure is an indication of the *quality* of the service provided. The quality index provides an indication of the qualitative level of infrastructure provided.

Table 3.12: World Bank's classification of infrastructure quality

Service level	Minimal = 1	Basic = 2	Intermediate = 3	Full = 4
Water	Communal standpipe	Standpipe within 250m	Yard standpipe	Metered in-house supply
Sewerage	Buckets/ communal toilets	On-site sanitation	Intermediate sewerage	Conventional water-borne
Roads	Unsurfaced	Gravel surface roads	Paved bus routes, rest gravel	All roads kerbed and paved
Stormwater	No stormwater drainage	Unlined channels, lined crossings	Lined, channels on bus routes, rest unlined	On-road drainage and pipes and culverts on main routes
Waste removal	No formal solid waste collection	Ad-hoc solid-waste collection	Regular collection from communal collection points	Regular weekly collections from houses
Electricity	No electricity	High masts with some house connections	High masts with restricted house connections	Streetlights & unrestricted metered house connections

Table 3.13 and **Table 3.15** reflect the quality indices and delivery efficiency indices respectively of the townships in which this survey was carried out.

3.8.3 Infrastructure efficiency index

There is little value in having high quality services installed if the local authority neglects its service delivery ie frequent and extended power failures, potholes not repaired, leaking water pipes unattended to, blocked sewers and drainage pipes disregarded, or infrequent refuse collections. The efficiency index is an indication of efficient management of the infrastructure facilities.

Table 3.13: Infrastructure Quality indices

Township	Water	Sewer	Roads	Storm water	Waste removal	Electricity	Ave
Alexandra	3.410	3.410	3.410	3.410	3.410	3.030	3.347
Bekkersdal	2.530	2.530	2.530	2.530	3.350	2.360	2.638
Daveyton	2.598	2.598	2.150	2.150	1.000	2.598	2.182
Diepmeadow	2.980	2.980	2.490	2.490	2.490	2.980	2.735
Dobsonville	3.320	3.320	2.660	2.660	3.320	3.320	3.100
Duduza	2.580	2.580	1.670	1.670	1.670	1.670	1.973
Kagiso	3.940	3.940	3.000	3.000	3.940	2.880	3.450
Katlehong	3.128	3.133	3.133	2.958	3.133	3.017	3.084
Kwa-Thema	3.300	3.300	2.640	2.640	1.980	2.640	2.750
Molakeng	3.020	3.020	3.020	3.020	3.020	3.020	3.020
Soweto	3.637	3.682	2.789	2.789	2.807	3.637	3.224
Tembisa	2.780	2.780	2.390	2.390	2.780	2.660	2.630
Tokoza	2.680	2.680	2.280	2.280	2.680	2.680	2.547
Tsakane	3.120	3.120	2.000	2.000	2.000	2.340	2.430
Vosloorus	4.000	4.000	4.000	4.000	4.000	4.000	4.000
Wattville	3.760	3.760	3.760	2.940	3.760	2.940	3.487
Average	3.174	3.177	2.745	2.683	2.834	2.861	**2.912**

In order to obtain an infrastructure efficiency index, the values 0, 1, 2 and 3 are assigned to the World Bank's categories for infrastructure efficiency, being non-functional; having major problems, minor problems, or no problems, respectively. See **Table 3.14**. The same methodology that is used for quality index calculations is then used to calculate efficiency indices namely, by means of weighted area averages. Therefore, by comparing indices, infrastructure efficiency comparisons can also be made.

Table 3.14: Efficiency indices

Service efficiency	Index
Non-functional	0
Major problems	1
Minor problems	2
No problems	3

Similarly, the efficiency of infrastructure management in different townships can be compared by comparing indices reflected in **Table 3.15**.

Table 3.15: Efficiency indices

Township	Water	Sewer	Roads	Storm water	Waste removal	Electricity	Ave
Alexandra	2.220	1.480	2.220	1.480	2.220	2.220	1.973
Bekkersdal	0.870	0.870	0.870	0.870	1.790	1.180	1.065
Daveyton	2.598	2.598	2.150	2.150	1.000	2.598	2.182
Diepmeadow	1.150	1.510	2.000	2.000	2.000	2.000	1.777
Dobsonville	2.000	2.000	2.000	2.000	2.000	2.000	2.000
Duduza	2.000	0.760	1.720	1.000	1.380	0.760	1.270
Kagiso	2.970	2.970	2.000	2.000	2.970	2.000	2.485
Katlehong	2.037	2.133	2.133	1.963	2.133	1.973	2.068
Kwa-Thema	2.940	2.940	1.960	1.960	1.960	2.940	2.450
Molakeng	2.000	1.000	2.000	3.000	3.000	3.000	2.333
Soweto	1.009	1.033	1.933	1.860	1.867	1.933	1.606
Tembisa	1.390	2.000	2.000	2.000	1.000	1.000	1.565
Tokoza	1.680	1.680	1.680	1.280	1.680	0.880	1.480
Tsakane	2.000	2.450	2.000	2.000	2.000	1.340	1.965
Vosloorus	3.000	3.000	3.000	3.000	3.000	3.000	3.000
Wattville	1.920	2.800	1.920	1.920	1.920	0.040	1.753
Average	1.989	1.952	1.974	1.901	1.995	1.804	**1.936**

A composite index was also developed by multiplying the quality and efficiency indices with one another. This, Coetzee & Naude (1995) claim, gives an indication of the interaction between the quality and the efficiency of the infrastructure services. To normalise the calculated value to an index value between 0 and 1, is necessary to divide the figure by 12. **Table 3.16** reflects the composite infrastructure index for the townships.

Table 3.16: Composite Infrastructure Index

Township	Water	Sewer	Roads	Storm water	Waste removal	Electricity	Ave
Alexandra	0.63	0.42	0.63	0.42	0.63	0.56	0.548
Bekkersdal	0.18	0.18	0.18	0.17	0.50	0.23	0.240
Daveyton	0.56	0.56	0.39	0.39	0.08	0.56	0.423
Diepmeadow	0.29	0.37	0.42	0.42	0.42	0.50	0.403
Dobsonville	0.55	0.55	0.44	0.44	0.55	0.55	0.513
Duduza	0.43	0.16	0.25	0.14	0.19	0.11	0.212
Kagiso	0.98	0.98	0.50	0.50	0.98	0.48	0.737
Katlehong	0.54	0.56	0.56	0.48	0.56	0.50	0.533
Kwa-Thema	0.81	0.81	0.43	0.43	0.32	0.65	0.575
Molakeng	0.50	0.25	0.50	0.76	0.76	0.76	0.588
Soweto	0.31	0.32	0.45	0.43	0.44	0.59	0.423
Tembisa	0.32	0.46	0.40	0.40	0.23	0.22	0.338
Tokoza	0.38	0.38	0.32	0.24	0.38	0.20	0.317
Tsakane	0.52	0.64	0.33	0.33	0.33	0.26	0.402
Vosloorus	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Wattville	0.60	0.88	0.60	0.47	0.60	0.01	0.527
Average	0.54	0.53	0.46	0.44	0.50	0.45	**0.487**

3.8.4 Analysis of the suitability of the Infrastructure Index

Extensive work and research has been done on service levels and they are absolutely measurable and conform to the requirements of a good indicator. Unlike the quality indicator, where known service levels are used to compile the index, the efficiency indicator in its present form is dependent on a subjective opinion. This is clearly problematic and needs refinement.

In order to be able to make a judgment whether a particular service being rendered (how it is maintained) by the service provider has deteriorated from *minor* problems to *major* problems, a comparison needs to be made between the current service and predetermined benchmarks.

Different communities could also have different agreed levels of service being rendered or different communities could have different expectations of the service provider. It is clear that additional work and research would still be required to formulate and develop an appropriate and quantifiable efficiency indicator.

Although this is a “crude” and “average” description of service delivery, it is definitely the best and quickest way found to date to describe, in numeric terms, how municipalities are delivering services.

The terminology used for installed infrastructure and maintenance namely, service quality and service efficiency is confusing and will need to be redefined. For the average person, the quality of services could possibly have a different meaning, such as experiencing the delivery of the service as a whole (including maintenance) and not necessarily only the infrastructure installed.

In terms of our previously defined terminology also, efficiency refers to the ratio of output to input. This is clearly not the definition used by Coetzee & Naude’ (1995) and in order to utilise the concepts of distinguishing between infrastructure installed and maintenance, more acceptable terminology will be required.

Another criticism of the process of averaging service levels in townships is that larger areas with great differences in service levels could appear to have an *average* level of service when in fact it hasn’t - like having one foot in a bucket of boiling water, the other in ice water and saying you are comfortable. Such is however, the nature of indices. Without drilling down and exploring the data of its composition, incorrect deductions and conclusions can easily be drawn.

The index method of describing service levels used by Coetzee and Naude’ (1995) is definitely a powerful and scientific technique and can, with some refinement, be utilised for the development of a service delivery indicator.

3.9 Other indices

3.10 Living Planet Index

The Living Planet Index is an indicator of the state of the world's natural ecosystems. It is calculated as an average of three separate indices, which relate to the abundance of forest, freshwater and marine species. The index is calculated annually and is reflected in the World Wildlife Fund (WWF) reports. The index is generated by averaging the three separate indices for forest, freshwater, and marine species populations. Each is set to 1.00 in 1970 and given an equal weighting. The population data for all species used in the index were gathered by

United Nations Environment Programme, World Conservation Monitoring Centre (UNEP-WCMC).

According to WWF (2000), the Living Planet Index is a useful measure of the natural wealth of the earth's forests, freshwater ecosystems and oceans and coasts in a given year. It integrates information contained in three constituent indices:

Forrest Species Population Index is the average of two indices relating to temperate and tropical forest respectively. The temperate forest component of the index is calculated from the change over time in the populations of 231 temperate forest species. The tropical forest component is based on the change over time in populations of 51 tropical forest species. The species in the index are predominantly birds and mammals.

Freshwater Species Population Index is the average of six regional indices relating to Africa, Asia-Pacific, Australasia, Europe, Latin America and the Caribbean, and North America respectively. The six indices between them contain time-series data on 195 species. Each region received equal weighting.

The Marine Species Population Index is the average of six sub-indices that relate to the North Pacific, North Atlantic, Indian, South Pacific, South Atlantic and Southern oceans respectively. The six indices between them contain time-series data on 217 species. Each ocean sub-index receives equal weighting.

In its 2002 report WWF (2002) reported that the Living Planet Index showed an overall decline of about 37 percent between 1970 and 2000.

The *Living Planet Index* is a useful tool to track and monitor progress (or regression) of the environment over time in the same manner as the HDI and CDI monitors human development and city development respectively.

3.11 Evaluation

A substantial portion of this literature review chapter consisted of terminology formulation and performance management models, which was necessary to gain a broader perspective of the performance management culture that has taken the business and public service worldwide by storm. The terminology explained will undoubtedly become everyday terminology and will rule work environments in the future. It was also necessary in order to understand the environment and the necessity for the development of an indicator to measure municipal service delivery.

The usefulness of composite indices is indisputable. The numerous examples of indices being used by the UNDP, UNFPA and other world organisations enjoy great credibility and general acceptability of their existence. What should however, be clear is that great care needs be taken with the philosophy of its development as well as the mathematical relationships of the different elements of its composition.

Through the culture of transparency and good governance, municipal officials and councilors will have to explain to the community and stakeholders how they intend delivering services in future and how they expect to be measured. There is definitely merit in having a single numerical indicator to measure the wide variety of services being delivered by municipalities.

Considering the complexity of such an indicator, there can be no doubt as to its nature namely, a composite index. The literature examined in this chapter was therefore related to developments and research done primarily with:

- Composite index development.
- Service delivery in public institutions and/or
- Geographically or citywide applications.

The evaluation of the literature is therefore also done in this context.

The Human Development Index (HDI)

Apart from it relevance and appropriateness with regards to the development of a municipal service indicator, the philosophy behind the development of the HDI is probably the most commendable and admirable aspect of its existence ie the basic things that distinguish us from our ancestors are: our health, our knowledge and our standard of living.

The developmental procedure of first determining the basic components of human development and then developing derivatives and elaborations is a fundamental developmental methodology that hopefully, could be emulated with the development of a service delivery indicator. Its suitability in measuring municipal performance is regarded at too high a level to be applicable although some of the core indicators of the HPI-1 are the direct responsibility of municipalities, particularly the provision of clean and safe water sources and primary health care. The other components namely illiteracy rates, underweight children and life expectancy are not directly influenced through municipal service delivery.

The City Development Index (CDI)

Arguably, the City Development Index is to date, the best single measure of the level of development in cities. The technique used to construct the CDI is similar to that used by the UNDP for their Human Development Index. Separate sub-indices are constructed and combined to create a composite index. Thus, the CDI is based on five sub-indices- City

Product, Infrastructure, Waste, Health and Education of which infrastructure provision, waste water and solid waste removal, and primary health care are core responsibilities of a municipality.

The financial and educational components of the CDI are not direct municipal responsibilities and therefore render it unsuitable for measuring primarily municipal service delivery.

In comparing the HDI and CDI, the UNCHS believes that the CDI provides a better measure of real city conditions than the national HDI. The fact that the HDI and the CDI correlated well could also be regarded as problematic. The developmental philosophy of the CDI can thus be regarded as being in essence only an elaboration or expansion of the HDI to reflect development at a city- wide level.

Still however, the CDI does not measure specifically municipal service delivery and this being the *core* function of municipalities and the basis of this study, refinement will be required.

The Stats SA Poverty Index

The methodology adopted by *Stats SA* in developing the Poverty Index is important in that it clearly describes the mathematical and statistical processes required for the development of a composite indicator.

The statistical technique employed for grouping variables that are related namely: factor analysis with rotation, may become useful for grouping the large number of variables in the municipal service delivery indicator- if, of course, the groupings are not immediately obvious.

The utilisation of census data (which are extensive and available) must also be considered in the development of indicators, as data collection (its availability and cost) could become influential factors for its usefulness and suitability for adoption in municipalities.

Further development

The literature review process was useful in gaining a more detailed perspective on the development of indices. The methodologies adopted by institutions and organisations with index development should assist in the development of the service delivery index for municipalities which is discussed in the next chapter.

CHAPTER 4

4 Development methodology

4.1 Introduction

There are already comparable international indicators, why then is it necessary to develop something similar?

The answer lies in the understanding of who is responsible or accountable for influencing the measurables. Although cities can now be measured and compared in terms of development, the real impact of good (or bad) governance of the municipality remains unclear. This is due to the fact that municipalities do not have a direct impact on certain measurables such as the economy. (Municipalities are not directly responsible for economic development in their region and can at best only become agents of economic development.) Therefore, to be more specific with regard to accountability and responsibility, the indicators that have a direct relevance to municipal service delivery, should be focused on. The service delivery index is developed, specifically to focus on the impact that municipalities have on their inhabitants and their environment through service delivery.

4.2 Development philosophy

A philosophical approach to the service delivery indicator will form the basis of its design and is necessary to provide the correct feel and its eventual acceptability.

A first reaction to a developmental methodology will probably be to list all the functions and services that municipalities deliver and then attempt to establish some sort of a priority list in order to provide weighting and rankings to them. Although not incorrect, it would probably be more sensible to explore the reasons why municipalities exist in order to determine the key dimensions of service delivery.

The most fundamental function of a municipality is to deliver services to its residents in terms of its mandate, which is not dissimilar to the functions of a sports club such as a country or golf club. By comparing a golf club with a municipality, interesting conclusions can be made.

The basis of the formation of a club is to provide access for its members to infrastructure and services in a collective manner that is cheaper and more sustainable than what the members can provide for themselves individually. Golf courses for example, are expensive to establish and maintain, and if attempted individually, most golfers would not be able to afford it. Members of the golf club pay membership fees to belong to the club. They pay playing fees every time they play a round of golf and utilise the facilities. That way it becomes more affordable for people to participate in the sport and consequently more people can afford to join the club. This principle is also applicable to other similar sports clubs such as: tennis, cricket, rugby, squash, gymnastics, etc.

Similarly, the residents of a municipality pay rates and taxes (membership fees) to be able to utilise the facilities provided by the municipality and then pay service charges (playing fees) for the services received from the municipality, for example water and electricity used.

The golf club is managed by the management committee who are periodically elected by the members to represent them- similarly in municipalities councilors are elected to represent residents every four years.

4.2.1 The club

Although this analogue drawn between a golf club and a municipality is probably too simplistic, the comparisons are valid and can be useful for the determination of the core functions or main roles of the institutions.

In order to establish the fundamental dimensions of a golf club, the following logic should be considered:

1) Establishing a golf course requires large amounts of capital, and the size, form, geographical location (where the golf course should be placed) and type of course will form some of the influencing factors that will determine the quality of the golf course ie whether the course consists of 9 or 18 holes, links or parklands type course, the size of the club house, etc. The first aspect to consider is, the quality of the physical infrastructure to provide. In making such a decision consideration should be given inter alia to:
   - The initial capital outlay and the redemption period.
   - The number of members and the membership fees.
   - Membership profile and their affordability.
   - Membership needs.

   Different golf clubs will require different golf types of courses, depending on their membership and their needs. The difference will be in the quality or the level of the golf course infrastructure. A golf club should therefore, first determine the quality of the course required.
2) Once a golf course is established, it requires continuous maintenance, manicuring, and upgrading. The golf course should always be in perfect condition in order to be utilised to the maximum. This requires the appointment of a full time greens keeper and

maintenance personnel as well as expensive maintenance equipment such as lawn mowers, fertilizing machines, tractors, etc. The degree to which the golf course is prepared for daily use is an indication of the efficiency of the management service. It should be noted that a golf course can have a high level of infrastructure quality, but if it is not managed efficiently, members will suffer inconvenience. Conversely, a well-managed golf course can still have a reasonable level of playability even if the infrastructure is inferior. Thus the second-most important aspect to consider would be the maintenance **efficiency** of the golf club.

3) A fundamental principle of financial sustainability is sufficient revenue collection. The frequency of use and continued support from the members and visitors are dependant on the cost of the service or its affordability. A golf club cannot survive financially unless members pay their membership fees and regularly play and support the club. This can only be possible if membership and playing fees are affordable. Affordability is dependant upon a whole rage of factors, such as the quality of the original infrastructure installed (capital redemption), maintenance costs, daily operational costs of the club and monthly earnings of the members. The influence of competing golf clubs should also be considered. The third most important aspect for the club to consider is **affordability** to its members.

4) There can be little use of the golf club if the three preceding factors have been taken into consideration namely a good quality golf course and facilities, well-maintained and affordable fees, but due to its popularity and increasing membership numbers, it becomes difficult to find available playing times. Members will soon become frustrated if they cannot utilise the facilities. Unless reasonable access can be guaranteed for the members, the club will find itself in serious trouble. Members and visitors will simply turn elsewhere and the club will eventually suffer. It is clear that **access** to the course is another very important aspect to consider.

The four dimensions described form the basis on which the success or failure of the club will largely depend. Incorrect assessments and bad management of the club will have negative effects on these four aspects.

There are also other aspects to consider such as the status of belonging to the club, the level of technical skills required, personal security of the members, etc. They may not be less important than the quality of infrastructure, maintenance efficiency, access to the facilities and affordability but are clearly not the fundamental dimensions of the establishment and operations of the club.

Turning again to the possibly over simplistic analogue between a club and a municipality, it is interesting to note how politics completely distort the fundamental principles of belonging to a club. One simply cannot imagine how committee members of a club could convert from "running a club" to "ruling its members". Despite this political distortion, similarities between them make sense and are useful to gain a better perspective of the fundamentals of municipal service delivery.

4.2.2 The municipality

Using the club analogue, municipalities also need to consider the following aspects:

1) Municipalities need to determine the extent and the quality of the infrastructure required for the provision of engineering and social services. For example, the type and class of roads for the volumes or types of traffic expected. The size, type and location of sewer purification works; the type of sewer systems required, VIP, waterborne etc. The capital cost required for the installation of these services are huge and the level of services required must be installed in consultation with the community in order to meet their requirements. Considerations should be given to its desirability, the affordability of the community and acceptability of the level of service provided. The first dimension for service delivery of a municipality is therefore, infrastructure quality.
2) High quality roads with potholes are worthless equally so are blocked sewers or leaking water pipes. Townships can have high levels of infrastructure installation, but if this is not managed and maintained efficiently, residents will suffer inconvenience and misery. Conversely, a well-managed township can still have a reasonable level of service delivery, even if the level of service infrastructure is inferior. The continuous operations and daily maintenance of service infrastructure will determine the level of maintenance efficiency of the municipality.
3) The fundamental principle of financial sustainability for businesses is equally relevant to municipalities and as with any business, municipalities cannot survive unless revenue is collected. This is only possible if municipal rates and taxes and service charges are paid. High levels of services can be acceptable, even desirable, but unless they are affordable to the community, other complex issues come to the fore. Cross-subsidisation, sliding scale payments for usage and other moral considerations are the political issues that municipalities must grapple with. Affordability is the third dimension to consider in municipal service delivery.
4) In **CHAPTER 2** the importance of access to services was reflected on. The comparison between a club and a municipality in this regard is somewhat different. Where members of golf clubs suffer inconvenience with access due to popularity of the facility, access to municipal services are directly linked to poverty. In the case of a golf club, access is denied unless paid for. In the case of municipalities, access to clean water for example,

is a basic human right and municipalities are obliged to provide access. (The Constitution is however, silent about whether this right should come at a price or not.) In order to create an environment where human and economic development can take place, access to basic services become hugely important. This dimension of human development in municipalities is captured in the HDI/(HPI-1). Access to services is the fourth dimension to consider in municipal service delivery.

The four dimensions discussed will form the basis of measurement of the respective services that municipalities should provide to the community and businesses.

4.2.3 Powers and functions of municipalities

Disappointingly, the White Paper on Local Government (1997) does not provide a philosophical viewpoint on the role of municipalities, neither does the Ordinance. The historical overview of South African municipalities given in the White Paper focuses on the distortions brought about by the system of apartheid and approaches the functions of municipalities from a political perspective instead of a human development perspective. Being a political document, this should of course be expected.

Local government has a range of powers and functions in terms of the 1996 Constitution, Part B of Schedule 4 and 5.

Municipalities also have powers and functions that may be devolved or delegated to them from provincial and national government. These national and provincial powers are listed in Part A of Schedules 4 and 5 of the Constitution. The Constitution provides for the delegation of powers and functions to local government by agreement, if municipalities have the necessary capacity and are regarded as the most effective site from which these powers may be exercised.

The powers and functions listed in Schedule 4, over which national and provincial government have concurrent legislative competence, include:

- air pollution
- building regulations
- childcare facilities electricity and gas reticulation
- fire fighting services
- local tourism
- municipal airports
- municipal planning
- municipal health services
- municipal public transport

- municipal public works
- pontoons, ferries, jetties, piers and harbours
- stormwater management systems in built-up areas
- trading regulations
- water and sanitation services.

National and provincial governments have the right to legislate on these powers and functions, and the executive authority to ensure that municipalities perform these functions.

The powers listed in Schedule 5, over which provincial government has exclusive legislative competence, include:

- beaches and amusement facilities
- billboards and the display of advertisements in public places
- cemeteries, funeral parlours and crematoria
- cleansing
- control of public nuisances
- control of undertakings that sell liquor to the public
- facilities for the accommodation, care and burial of animals
- fencing and fences
- licensing of dogs
- licensing and control of undertakings that sell food to the public
- local amenities
- local sport facilities
- markets
- municipal abattoirs
- municipal parks and recreation
- municipal roads
- noise pollution
- pounds
- public places
- refuse removal
- refuse dumps and solid waste disposal
- street trading
- street lighting and traffic and parking.

In addition to the list, legislation also enables municipalities:

- To establish municipal police forces. Municipal public safety committees will replace community-policing forums.

- To perform the function of protectors of the environment and enhance environmental sustainability.
- To ensure that the provision of municipal health services is extended to include primary health care.
- To establish transport authorities.

It is difficult to imagine how any private organisation can cope with so many and such diverse functions as what is expected from municipalities. A re-examination of the lists reveals however, that these functions can be grouped or categorised. Another option to simplify, reduce or prioritise the functions would be to evaluate the extent of influence a certain function has on human and economic development.

In terms of the White Paper for Local Government (1997) local government is responsible for the provision of household infrastructure and services, which is an essential component of social and economic development. This includes services such as water, sanitation, local roads, stormwater drainage, refuse collection and electricity.

The White Paper stated:

> Good basic services, apart from being a constitutional right, are essential to enable people to support family life, find employment, develop their skills or establish their own small businesses. The provision of household infrastructure can particularly make a difference to the lives of women, who usually play the major role in reproductive (domestic) work which sustains the family and the local society.

It is clear, even from a political perspective, that the provision of engineering infrastructure is a fundamental requirement in pursuit of the creation of an environment conducive for human and economic development. This is also in line with the golf club analogue where the provision of infrastructure at a predetermined quality is the first and fundamental requirement.

4.3 Engineering services

The six basic engineering services that municipalities in South Africa have traditionally been responsible for are:

- water
- sanitation
- local roads
- stormwater drainage
- refuse collection and
- electricity.

Before each service is examined individually it should be noted that access and utilisation of telecommunications is monitored worldwide and is being considered an important requirement, even essential, for communities to be part of a global economy. The provision of telecommunications in South Africa by municipalities has traditionally been prohibited through legislation and should perhaps be challenged and revisited to ensure rapid rollout of telecommunication services to all communities. For the time being, and for the purposes of this thesis, the provision of telecommunications is excluded as a municipal function.

Monitoring of engineering services can now be done in terms of the prescribed categories of quality of infrastructure, efficiency of delivery, access and affordability.

4.3.1 Quality of engineering infrastructure

Describing engineering services infrastructure through reference to the level of service is internationally acknowledged and applied. The method allows for accurate descriptions and measurements of engineering services. Although the categories and descriptions of the different levels of services differ with nearly every handbook, it is easily understandable. Similar descriptions can be found in CSIR (1995). This method of measurement was also previously used to measure services in South Africa, as was the case with the World Bank studies done during 1993.

It therefore, made sense to continue with this method of measuring services infrastructure, seeing that it would be possible to compare data with studies previously undertaken.

For the purposes of this thesis, level of services was chosen to measure the quality of engineering infrastructure. The classification of the levels of services was chosen to be as simple as possible and for that reason, the exact same classification was chosen as the categories used in the previous World Bank studies and are described in **Table 4.1**.

This method of classification is easy to understand and simple to apply. It is however, not without criticism. The biggest of which is perhaps the fact that no electricity, no refuse collection and no stormwater ditches are classified as a minimal service when in fact no service is provided.

Its biggest utility lies in its previous acceptance by the World Bank and others and the fact that the data previously collected in South Africa conformed to this classification.

Table 4.1: Standards used to describe service levels

	Level of Service	Service	Description
1	Minimum	Water	Communal standpipes
		Sanitation	Bucket or community toilets
		Roads	Unsurfaced tracks or path s
		Stormwater	No drainage ditches
		Refuse collection	No formal collection of refuse
		Electricity	No electricity service
2	Basic	Water	Standpipe within 250 meters of each other
		Sanitation	Ventilated or Aqua Privy without sewer connection
		Roads	Gravel roads
		Stormwater	Unimproved drainage ditches and improved ditches at crossings
		Refuse collection	Irregular collection
		Electricity	Light masts for streets and few house connections
3	Intermediate	Water	Yard standpipe
		Sanitation	Aqua privy connected to small piped sewer
		Roads	Bus routes paved, other roads graveled
		Stormwater	Main roads have improved drainage channels, smaller roads have improved ditches
		Refuse collection	Regular collection from community collection points
		Electricity	Mast lighting for streets. Restricted house connections (prepaid meters)
4	Full	Water	Metered in-house water supply
		Sanitation	Conventional sewer connection
		Roads	All roads kerbed and paved
		Stormwater	On-road drainage and pipes and culverts on main roads
		Refuse collection	Regular weekly collection from houses
		Electricity	Street lighting. Unrestricted metered house connections

4.3.2 Delivery efficiency

Developing key performance indicators for efficiency of delivery was undoubtedly the most difficult and will probably become the most controversial element of measuring the index. It is probably also due to the fact that a somewhat subjective opinion is required to determine the extent of the efficiency of the service being supplied ie whether services being delivered can be described as "good", "adequately" or "bad". Apart from the electricity supply services, which developed technical supply standards in terms of reliability, frequency deviations, etc little other international benchmarking exists for the other services.

Taking into consideration the conditions for good KPIs as described in **CHAPTER 3**, the system of the World Bank was once again adopted, namely to classify delivery efficiency or the functioning of the service as no service, major problems, minor problems or no problems. The real test for its usefulness lies however in the determination of exactly what is measured and how to determine when exactly efficiency of service delivery shifts from one category to another, for example when do we classify service delivery a "major problems" and when does it become "minor problems". This needs to be done objectively and preferably scientifically, otherwise we will have failed to progress past the stage of the emotional subjective categorization of service delivery.

The different key performance indicators chosen for the respective services are listed in **Table 4.2** and depending on standards set prior to measurement, service efficiencies can be determined and classified. Unless standards or limits are set for acceptable (or not acceptable) service delivery, the credibility of the index will be lost.

This is best demonstrated in the World Bank's report on services in Vosloorus where despite "very poor" descriptions (in the author's opinion) for service delivery were used, all the services were allocated the type "no problems". For example it was stated that water loss is 32% requiring the old network to be upgraded. Also that the 13.6 Ml reservoir was leaking. Perhaps a classification of "major problems" or at least "minor problems" would be a more appropriate description of the water service.

Another "no problems" rating was given to the sanitation system despite comment that 10% of the system has capacity problems and that 5 to 6 blockages per day occurred. Clearly, the service was not functioning as it was intended and perhaps a rating of "minor problems" would have been more appropriate.

Also the report states that the stormwater drainage system is inadequate to handle runoff, yet a rating of "no problems" appears in the service functionality column.

It is therefore clear that unless predetermined limits are set for service delivery to be measured against, only subjective assessments can be made. To avoid similar indistinctness where arguments could occur whether a service should be classified a "major" or perhaps a "minor" problem, the following system was incorporated for the service delivery index development as is indicated in **Table 4.2**.

In each case, the average value (normally a percentage) for the key performance indicators is calculated. By then assessing in which bracket the value lies, for example, if the value lies between 5 and 10 percent, the service is regarded to be functioning with "minor problems". In some cases key performance indicators need to be assessed individually, as it might be possible for a single indicator to render the whole system inoperative or deficient.

Table 4.2: Key performance indicators for service delivery efficiency

	Service	KPIs	Limits	Description
1	Water	• Unplanned interruptions: percentage days per year (Pipe bursts-response time) • Leakages: percentage of piped water unaccounted for • Percentage days per annum not compliant with purification standards	No service >10% 10% - 5% Less than 5%	No service Major problems Minor problems No problems
2	Sewer	• Unplanned service interruptions (pipe bursts and blockages) % days per annum • Percentage days per annum not compliant with treatment and pollution standards • Percentage of wastewater not treated per annum	No service >10% 10% - 5% Less than 5%	No service Major problems Minor problems No problems
3	Roads	• Lack of rideability (surface condition) of roads • Response time to pothole repairs	No service >10% 10% - 5% Less than 5%	No service Major problems Minor problems No problems
4	Stormwater	• Inability of the drainage system to cope with design floods • Response time to blockages	No service >10% 10% - 5% Less than 5%	No service Major problems Minor problems No problems
5	Refuse collection	• Percentage scheduled rounds not performed on time per annum • Measure of un-cleanliness	No service >10% 10% - 5% Less than 5%	No service Major problems Minor problems No problems
6	Electricity	• Unplanned interruptions: percentage days per year • Line losses: percentage power unaccounted for	No service >10% 10% - 5% Less than 5%	No service Major problems Minor problems No problems

4.3.3 Access to services

As was earlier explained, the term access in a m unicipal services context has direct reference to poverty and in the South African Post apartheid era in particular, access refers to people in previously disadvantaged areas where access to services was limited.

After 1994, great effort and large amounts of funding were directed to the provision of basic services in these disadvantaged areas in order to eliminate backlogs. In spite of the term not being clearly defined, it was generally being understood as to mean (and include): every household not connected to the municipal service. It became clear after a while that different people in different places had different perceptions of exactly what level of service was being referred to as a backlog.

Previously, some backlog figures included upgrading of services from basic to full, which caused enormous confusion and highly inflated backlog figures. Final cost estimates to eliminate backlogs were therefore also inflated and skewed.

Nowadays, backlogs in the sense of municipal services refer to "households not having access to a basic level of service".

"Access to services" is measured worldwide and countries are classified in terms thereof. In **CHAPTER 2** the importance of access to services reflected were reflected on. Access to clean water is a basic human right and municipalities are obliged to provide access.

When access to basic services in South African metropolitan areas are compared with other large cities worldwide, the figures are higher on average than middle-income countries such as Argentina, Brazil and developing countries such as Pakistan and India, which could perhaps indicate that access to services should not be South African cities' highest priority. It is however understandable that this is a sensitive issue due to our legacy and that access will for years to come be carefully monitored.

Unfortunately, access to basic services as defined in national policies (which is incidentally the same as the definitions and levels of services used for his thesis), cannot tell a complete story about backlogs and capital costs required for upgrading. For this purpose, households that are connected to the service were also included. **Table 4.3** reflects the indicators used to measure access to services.

Table 4.3: Key performance indicators for access to services

	Service	KPIs	Limits	Description
1	Water	• Percentage households connected to the service • Percentage households with access to safe potable water within 250 metres of the dwelling	More than 95% 95% - 90% 89% - 85% <85%	Full access Part access Limited No access
2	Sewer	• Percentage households connected to the service • Percentage households with access to minimum level of service	More than 95% 95% - 90% 89% - 85% <85%	Full access Part access Limited No access
3	Roads	• Percentage households within 500m of all weather roads	More than 95% 95% - 90% 89% - 85% <85%	Full access Part access Limited No access
4	Stormwater	• Percentage households with access to minimum level of service	More than 95% 95% - 90% 89% - 85% <85%	Full access Part access Limited No access
5	Refuse collection	• Percentage households with access to minimum level of service	More than 95% 95% - 90% 89% - 85% <85%	Full access Part access Limited No access
6	Electricity	• Percentage households connected to the service	More than 95% 95% - 90% 89% - 85% <85%	Full access Part access Limited No access

4.3.4 Affordability of services

The Collins dictionary defines affordable as: “to be able to do or spare something without incurring financial difficulties or without risk of undesirable consequences”. The term is normally used to express the financial implications of acquiring stuff to satisfy basic needs such as clothes, food, transport and services. It generally refers to the price of items, which would normally affect the cost of living.

It is understandable that the cost of living varies geographically due to the fact that goods and materials vary in price. Prices of goods and materials vary depending on the transport distance. It should be clear that the cost of engineering services vary in proportion to the distance required to provide the service.

Much has been said about the spatial disorientation of the South African cities, mostly due to the segregation policies of the apartheid government. People were spatially segregated. Affluent people could afford to live close to city centres while poorer people were placed further away normally on the outskirts of the cities. Providing transport to people living on the outskirts of the cities to access job opportunities became a costly exercise. Similarly, the provision of expensive bulk infrastructure for engineering services became uneconomical hence the lack of basic services to these areas.

The cost of living on the city's edge was much higher that inside the city. Transport costs and basic services were simply unaffordable. It was therefore, a natural economical phenomenon to see millions of squatters appearing on vacant land to settle closer to the cities, after the restrictions of movement of people were abolished.

The affordability of basic services is dependant on how much is earned. The best way found to date to describe affordability is to express the cost of the service as a percentage of household income. This percentage is then compared to national and international benchmarks. For example, the average international proportion of transport cost per household income is 10%. This means that if by comparison, the average household cost for a South African family exceeds 10% savings need to be found on other basic needs costs.

Another way of determining the affordability of services is to assess payment levels. Unfortunately, the culture of non-payment for services still exists. A large proportion of people who now can afford to pay for their services, still refuse to do so. Until adequate measures have been introduced to deal with this situation, payment levels will have to be carefully monitored.

For the purposes of this thesis and despite the additional work required to acquire the information, it was deemed necessary to utilise both indicators to assess affordability. **Table 4.4** reflects the different key performance indicators and limits for evaluation to assess affordability of engineering services. Depending on the predetermined limits, affordability is classified as: affordable, cheap, expensive and unaffordable. Perhaps these terms do not clearly describe a condition of affordability and perhaps other labels could be more appropriate. They are however, only labels and for the sake of progress, they were adopted to describe affordability in the sense of engineering services.

Table 4.4: Key performance indicators for assessing services affordability

	Service	KPIs	Limits	Description
1	Water	• Percentage ratio of cost per six kiloliters to household income • Non-payment levels	Less than 1% 1% - 5% 5% - 10% >10%	Cheap Affordable Expensive Unaffordable
2	Sewer	• Percentage ratio of cost per month to household income • Non-payment levels	Less than 1% 1% - 5% 5% - 10% >10%	Cheap Affordable Expensive Unaffordable
3	Roads	• Percentage ratio of transport cost per month to household income • Non-payment levels	Less than 1% 1% - 5% 5% - 10% >10%	Cheap Affordable Expensive Unaffordable
4	Stormwater	• Percentage ratio of transport cost per month to household income • Non-payment levels	Less than 1% 1% - 5% 5% - 10% >10%	Cheap Affordable Expensive Unaffordable
5	Refuse collection	• Percentage ratio of refuse collection cost per month to household income • Non-payment levels	Less than 1% 1% - 5% 5% - 10% >10%	Cheap Affordable Expensive Unaffordable
6	Electricity	• Percentage ratio of electricity cost per month to household income • Non-payment levels	Less than 1% 1% - 5% 5% - 10% >10%	Cheap Affordable Expensive Unaffordable

4.4 Water

There can be no question as to the state's responsibility of providing water to the citizens. This basic commodity is a requirement to live and it is clear that human development, even human existence, is impossible without water. Most people in most countries, including the wealthier industrial countries, rely on public service for the provision of water services and will continue to do so, since profit-oriented services cannot guarantee access and equity. Access to basic water services is a national KPI and must be monitored by municipalities and reported to government annually.

4.4.1 Water services quality

Different municipalities and consultants compiled different categories of levels of service for engineering services. Others also exist such as those described in the **Red Book** and some international classifications. The categories opted for in this thesis are those employed by the World Bank as was described in **CHAPTER 3**. The quality of infrastructure is categorized according to four levels namely minimum, basic, intermediate and full standard and are listed in **Table 4.5**.

- *Level of service 1 (Minimal)*: The lowest level of service is listed as a communal standpipe. This category includes the provision of temporary storage tanks with communal taps or tankers providing 200 liters if water per household. This level of service is normally considered as an emergency or temporary settlement water service provision- also referred to as a "minimum" level of service.
- *Level of service 2 (Basic):* It was considered necessary to indicate what is generally known as a "basic" level of service (standpipe within 250m). Unless a basic level of water service is available, the quality of life of even low-income households will decline, in a time where we seek to eradicate poverty.
- *Level of service 3 (Intermediate)*: In order to provide piped sanitation services, it is necessary to provide water connections to each stand. Yard standpipes form the third category level of water service. At this level, the need to walk to access water is eliminated and there is a notable difference in the quality if life of communities of the previous level.
- *Level of service 4 (Full):* Metered in-house water supply is provided with piped sanitation.

Table 4.5: Water services quality categories

Category	Level of Service	Description	Value
1	1	Communal standpipe	1
2	2	Standpipe within 250m	2
3	3	Yard standpipe	3
4	4	Metered in-house supply	4

The values allocated to each of the categories are similar to each particular level of service ie Level of service 1 has a value of 1, Level of service 2 has a value of 2, etc.

The *infrastructure quality* index is then calculated by allocating numerical values 1, 2, 3, and 4 to the four levels of services installed to each household in the township, 1 being the lowest level and 4 representing the highest level of service. **Table 4.6** explains the average service level calculation. The average level of service of the township is calculated through a simple weighted average calculation.

Table 4.6: Average service level calculation

Service quality	No. of users	Value	Index Calculation
Minimal	N_{min}	1	$i_{min} = N_{min} \times 1/ N_{tot}$
Basic	N_{bas}	2	$i_{bas} = N_{bas} \times 2/ N_{tot}$
Intermediate	N_{int}	3	$i_{int} = N_{int} \times 3/ N_{tot}$
Full	N_{full}	4	$i_{full} = N_{full} \times 4/ N_{tot}$
Total	N_{tot}		$i = i_{min} + i_{bas} + i_{int} + i_{full}$

4.4.2 Water services delivery efficiency

Numerous factors influence the efficiency with which water services are supplied. **Table 4.7** reflects what can be considered the three most important or most relevant factors to South African municipalities. These are: reliability or continuous supply, water losses, and the drinkability of the water.

Table 4.7: Water services delivery efficiency categories

Category	Description	Rating
1	Unplanned interruptions: percentage days per year (Pipe bursts-response time)	%
2	Leakages: percentage of piped water unaccounted for	%
3	Percentage days per annum not compliant with purification standards	%

The three categories are evaluated as follows:

- The reliability of the service is expressed in downtime, which will also reflect response time to pipe bursts.
- Water losses obviously affect the profitability of the utility. Leakages and water unaccounted for have enormous financial consequences, especially in a water scarce country such as South Africa. Unaccounted for water in Johannesburg runs into hundreds of millions of Rand per annum at an estimated 43%.
- Although the water supplied in the Gauteng region is purified by Rand Water prior to being pumped to the supply regions, various complaints of bloodworms (especially during the summer months) and other impurities are received regularly. The cleanliness of reservoirs and pressure towers need to be confirmed. Smaller municipalities are

responsible for their own purification. The drinkability of the water is measured in terms of being compliant with purification standards.

All three factors are expressed in terms of a percentage. The average percentage of the three categories can again be categorised as shown in **Table 4.8**.

Table 4.8: Water services delivery efficiency values

Average rating of the three categories	Description	Value
	No service	1
More than 10%	Major problems	2
10% - 5%	Minor problems	3
Less than 5%	No problems	4

Note: If any of the three categories scores higher than 15% individually namely: down time; water unaccounted for; and non-compliance with purification standards - the service must be considered inefficient, and a value of 1 (major problems) should be allocated to it.

In order to obtain a delivery efficiency index, the values 1, 2, 3 and 4 are assigned to the categories, being non-functional; having major problems; minor problems; or no problems, respectively.

The same methodology that is used for infrastructure quality index calculations is then used to calculate delivery efficiency indices namely, by means of weighted area averages. **Table 4.9** explains the average service level calculation. The average level of service of the township is calculated through a weighted average calculation.

Table 4.9: Average service level calculation

Service quality	No. of users	Value	Index Calculation
No service	N_{nos}	1	$i_{nos} = N_{nos} \times 1 / N_{tot}$
Major problems	N_{maj}	2	$i_{maj} = N_{maj} \times 2 / N_{tot}$
Minor problems	N_{min}	3	$i_{min} = N_{min} \times 3 / N_{tot}$
No problems	N_{nop}	4	$i_{nop} = N_{nop} \times 4 / N_{tot}$
Total	N_{tot}		$i = i_{nos} + i_{maj} + i_{min} + i_{nop}$

4.4.3 Affordability of water services

Affordability of water services is a national concern. The socio-economic conditions in South Africa demand that water not only be accessible (as being part of a Constitutional right) but naturally affordable.

In its last election manifesto, the ANC promised free water to all. Although nothing was prescribed in terms of quantity or delivery period, it was assumed that six kilolitres free water per household per month would be the norm. This was calculated on the basis that a household would require 200 liters (44 gallon drum) per day for drinking, cleaning and personal hygiene.

Anything more than this quota needs to be paid for. It is assumed at this stage, that national government would assist municipalities, financially, to give effect to this very honorable promise. If not, other means of financing this additional expense would need to be found. Although larger municipalities might be in a position to absorb this expense, smaller municipalities would clearly find it difficult to implement.

This does not however, mean that the cost of water provision and its affordability shouldn't be measured. Somebody will still be paying for the water- probably the more affluent sector of the population or more likely- businesses.

Being transparent also means that cross-subsidisation should be quantified. Stakeholder and voters should know exactly how services are being financed. The two most important aspects to be measured in terms of affordability of water services are reflected in **Table 4.10**. They are: the percentage of household income paid for water and payment levels.

- The percentage of household income spent on water should continually be calculated to determine the actual effect on poor and low-income households. It will also help to compare the situation with other municipalities nationally and also internationally. If perhaps, large amounts of residential funds will be cross subsidised, the situation could arise where this figure could become exorbitant for the middle to high-income households and a possible decline in their payment levels.
- Payment levels are expressed in terms of a percentage and this could be completely misleading. Small variations in payment levels of high-income groups will have a large impact on municipal finances- as the Johannesburg City Council soon discovered with the Sandton rates boycott during 1995. The effect of the boycott after six months was greater than the combined effect of nearly ten years of total services boycott in Soweto and subsequently brought Johannesburg City Council to the brink of bankruptcy.

Another aspect to consider is the effect of water cross-subsidisation on businesses. Businesses are a very likely target for cross-subsidised municipal services and despite political rhetoric, businesses are a major source of a municipality's income. Scaring away businesses can have catastrophic effects on a municipality. By comparing the cost of water services in Johannesburg to other South African and international cities it is clear that businesses in Johannesburg rated water services "good" to "average". Monitor Group (2001). The financial or negative implications of free water provision on businesses require careful monitoring and analysis.

Table 4.10: Water services affordability categories

Category	Description	Rating
1	Percentage ratio of cost per six kiloliters to household income	%
2	Non-payment levels	%

For the purposes of this thesis the average value of the two measurements should be categorised as set out in **Table 4.11**.

Table 4.11: Water services affordability values

Average rating of the two categories	Description	Value
Less than 1%	Cheap	4
1% - 5%	Affordable	3
5% - 10%	Expensive	2
>10%	Unaffordable	1

Note: If the percentage cost per six kiloliters of water per month to household income exceeds 5%, the service should be classified "unaffordable".

4.4.4 Access to water services

Services statistics in Johannesburg (CoJ, 2002) show that 96,4 percent of households have basic access to water, 84 percent to basic sanitation, 85 percent to electricity and 88 percent to waste removal. These figures are higher on average than middle-income countries such as Argentina, Brazil and developing countries such as Pakistan and India. This means that, with only 16 percent of households receiving services below the minimum statutory standards, service access is not the greatest challenge facing Johannesburg. Access to services is however, a greater challenge in other South African cities and indeed so in the more rural municipalities.

"Access to safe water is a fundamental human need and, therefore, a basic human right", according to United Nations Secretary-General Kofi Annan. This basic commodity is a requirement to live and human development, even human existence, is impossible without water. Most people rely on public service for the provision of water services since profit-oriented services cannot guarantee access and equity. It is therefore the state's responsibility to provide water to its citizens. Access to basic water services is a national KPI and must be monitored by municipalities and reported to government annually.

Experts have outlined a basic daily water requirement (BWR)- 50 liters per capita per day for the purposes of drinking, sanitation, bathing, cooking and kitchen needs- and urged its recognition as a standard against which to measure the right to safe water. This minimal standard does not take into account other necessary uses of water- for agriculture, ecosystem protection and industry. A consumption standard of 100 liters per person per day would reflect these additional needs. Assuming an average of four persons per household at 50 liters per day brings us to the 200 liters per household per day free water.

Due to the nature of the bulk and connector water infrastructure in most large South African cities and large urbanised areas, access is considered "adequate"- even "good" compared to other international cities. This is due to economies of scale or what economists like to term "economies of urbanisation". Access to the intermediate Level of Service 2 (standpipe within 250m) in Johannesburg is currently 96.4 percent.

Access to water services declines to around 50 percent in rural areas with district and local municipalities where large distances need to be covered to provide water services rendering the service uneconomical and financially unsustainable. Unless larger concentrations of people move closer to existing infrastructure in order to increase densities, all engineering services will be expensive and uneconomical to supply.

Table 4.12 lists two KPIs to measure the success of a municipality's water provision in terms of access namely: the percentage of people connected to the service and the percentage of people with less than a basic level of service (level2).

Table 4.12: Water services accessibility categories

Category	Description	Rating
1	Percentage households connected to the service	%
2	Percentage households with access to safe potable water within 250 metres of the dwelling	%

For the purposes of this thesis the average value of the two measurements is categorised as set out in **Table 4.13**.

Table 4.13: Water services accessibility values

Average rating of the two categories	Description	Value
More than 95%	Full access	4
95% - 90%	Part access	3
89% - 85%	Limited	2
<85%	No access	1

Note: If the average value of any of the two categories individually falls below 85%, the service should be classified "inaccessible".

4.5 Sanitation

As with water services, most people rely on public service for the provision of sanitation services. Access to basic sanitation services is also a national KPI and must be monitored by municipalities and reported to government annually.

4.5.1 Sanitation services quality

Different municipalities produced different categories of levels of service for sanitation services. The categories opted for in this thesis are those employed by the World Bank as was described in **CHAPTER 3**. The quality of the sanitation infrastructure installed is categorized by the four classifications for residential use and are listed in **Table 4.14**.

- *Level of service 1 (Minimal):* The lowest level of service is the bucket or communal toilet system. This level of service is normally considered as an emergency or temporary settlement sanitation service provision.
- *Level of service 2 (Basic):* Generally known as on-site sanitation. This level includes VIP systems and chemical toilet systems. These types of systems are normally associated with households having a similar level of water service, namely communal stand pipes or standpipes for every 20 stands.
- *Level of service 3 (Intermediate):* The third level of service include VIPs as well as flush toilets with soakaways. Again, these types of systems are normally associated with households having a similar level of water service, name yard taps, where the need to walk to access water is eliminated and there is a notable difference in the quality if life compared to communities with a lower level of service.
- *Level of service 4 (Full):* Conventional waterborne sewer system is provided to every stand.

Table 4.14: Sanitation services quality categories

Category	Level of Service	Description	Value
1	1	Buckets/ communal toilet	1
2	2	On-site sanitation	2
3	3	Intermediate sewerage	3
4	4	Conventional water-borne	4

The numerical values allocated to each of the categories are similar to each particular level of service ie Level of service 1 has a value of 1, Level of service 2 has a value of 2, etc.

4.5.2 Sanitation services delivery efficiency

Numerous factors influence the efficiency with which sanitation services are supplied. **Table 4.15** reflects what can be considered the three most important or most relevant factors to South African municipalities, which are: blockages, compliance with treatment and pollution standards, and untreated wastewater.

Table 4.15: Sanitation services delivery efficiency categories

Category	Description	Rating
1	Unplanned service interruptions (pipe bursts and blockages) % days per annum	%
2	Percentage days per annum not compliant with treatment and pollution standards	%
3	Percentage of wastewater not treated per annum	%

- The reliability of the service is expressed in downtime, which will also reflect response time to blockages. By monitoring unplanned service interruptions or blockages, the reliability of the service can be determined.
- Although very few residents notice the effect of untreated sewerage being released in the natural water streams, the effect can be catastrophic. The standard to which sanitation water is purified prior to being released into the natural river system has an important effect on our health as well as the environment.
- To this end, the percentage of wastewater treated prior to being released into the natural environment is an indication of the effectiveness of the sanitation delivery system.

All three factors are expressed in terms of a percentage. The average percentage of the three categories can again be categorised as indicated in **Table 4.16**.

Table 4.16: Sanitation services delivery efficiency values

Average rating of the three categories	Description	Value
	No service	1
More than 10%	Major problems	2
10% - 5%	Minor problems	3
Less than 5%	No problems	4

Note: If any of the three categories scores higher than 15% individually namely: down time; water unaccounted for; and non-compliance with purification standards - the service must be considered inefficient, and a value of 1 (major problems) should be allocated to it.

4.5.3 Affordability of sanitation services

The two most important aspects to be measured in terms of affordability of sanitation services are reflected in **Table 4.17**. They are: the percentage of household income paid for sanitation services and payment levels.

- The percentage of household income spent on sanitation will also help to compare municipalities nationally. The cost of sanitation services is normally expressed as a fixed cost per residential dwelling and not calculated on a usage basis. Despite this anomaly, sanitation costs should preferably be kept separately and expressed as a percentage of household income
- Payment levels or the non-payment of sanitation services must also be expressed in terms of a percentage in order to determine real affordability.

Table 4.17: Sanitation services affordability categories

Category	Description	Rating
1	Percentage ratio of cost per month to household income	%
2	Non-payment levels	%

For the purposes of this thesis the average value of the two measurements are categorised as set out in **Table 4.18**.

Table 4.18: Sanitation services affordability values

Average rating of the two categories	Description	Value
Less than 1%	Cheap	4
1% - 5%	Affordable	3
5% - 10%	Expensive	2
>10%	Unaffordable	1

Note: If the percentage cost of sanitation per month to household income exceeds 5%, the service should be classified "unaffordable".

4.5.4 Access to sanitation services

Access to basic sanitation services is a national KPI and must be monitored by municipalities and reported to government annually.

As with water services, extensive reticulation networks for the bulk and connector sewer infrastructure exist in most large South African cities and urbanised areas. Access is therefore considered "adequate" to "good" compared to other international cities. Access to the intermediate Level of Service 2 (on-site sanitation) in Johannesburg Monitor Group (2001) is currently 84 percent.

Table 4.19 lists two KPIs to measure the success of a municipality's sanitation provision in terms of access namely: the percentage of people connected to the service and the percentage of people with less than a basic level of service (level2).

Table 4.19: Sanitation services accessibility categories

Category	Description	Rating
1	Percentage households connected to the service	%
2	Percentage households with access to minimum level of service	%

For the purposes of this thesis the average value of the two measurements are categorised as set out in **Table 4.20**.

Table 4.20: Sanitation services accessibility values

Average rating of the two categories	Description	Value
More than 95%	Full access	4
95% - 90%	Part access	3
90% - 85%	Limited	2
<85%	No access	1

Note: If the average value of any of the two categories individually is less than 85%, the service should be classified "No access".

4.6 Local roads

One of the key advantages of urban over rural areas, and hence the ability of cities to generate higher standards of living for their citizens, is based on proximity. This means that the movement of goods and people within a city is critical.

With respect to the movement of people in Johannesburg, the most common form of transport is road transport, although the proposed rail initiative by the Gauteng government will impact on this pattern considerably. Fourty nine percent of trips are made in private cars, 29 percent in taxis and 13 percent in busses. In the last three years alone, road traffic volumes have increased by 26 percent. (CoJ, 2002) This means that congestion and pollution are issues that need to be addressed for the future growth of the City.

4.6.1 Roads infrastructure quality

The categories used for roads classification in terms of levels of service are the same as those used by the World Bank as was described in **CHAPTER 3**. The quality of the roads infrastructure installed is categorized by the four classifications for residential use and is listed in **Table 4.21**.

- *Level of service1 (Minimal):* The lowest level of service is listed as "Unsurfaced". This type of road normally only refers to a graded or even un-graded road reserve with no layer work constructed.
- *Level of service 2 (Basic):* This level normally refers to gravel surface roads. This type of road construction provides access to residential stand. Although the initial construction cost is minimal, high maintenance costs can be expected, especially in sloping terrain and wet regions. The nuisance factor caused by dust in dry regions or higher traffic areas can greatly reduce the quality of life of residence. It is normally argued that private car ownership in these areas is low requiring little or maintenance.
- *Level of service 3 (Intermediate):* This level of roads infrastructure is normally found in higher density areas where public transport utilizes bus routes and limited private vehicles and pedestrians utilise access roads.
- *Level of service 4 (Full):* All roads are kerbed and paved.

Table 4.21: Roads infrastructure quality categories

Category	Level of Service	Description	Value
1	1	Unsurfaced	1
2	2	Gravel surface roads	2
3	3	Paved bus routes, rest gravel	3
4	4	All roads kerbed and paved	4

The numerical values allocated to each of the categories are similar to each particular level of service ie Level of service 1 has a value of 1, Level of service 2 has a value of 2, etc.

4.6.2 Roads maintenance efficiency

Numerous factors influence the efficiency with which roads infrastructure is maintained. **Table 4.22** reflects what can be considered the two most important or most relevant factors to South African municipalities, which are, rideability and response time to pothole repairs.

Table 4.22: Roads maintenance efficiency categories

Category	Description	Rating
1	Lack of rideability (surface condition) of roads	%
2	Response time to pothole repairs	%

- The rideability of a road, or the lack thereof, could render the best and most expensive road constructed useless. The value allocated to this rideability category should be expressed as a percentage of the ultimate designed condition per annum.
- Formation of potholes not only affect the rideability of a road, it poses serious hazards to vehicles and occupants. Response time to fixing potholes should be monitored and strived to improve continuously. Response time should be expressed in hours, using one hour as a 100 percent baseline an 50 hours as 0.

Both factors are expressed in terms of a percentage. The average value of the two categories can again be categorised as indicated in **Table 4.23**.

Table 4.23: Roads maintenance efficiency values

Average rating of the two categories	Description	Value
	No service	1
More than 10%	Major problems	2
10% - 5%	Minor problems	3
Less than 5%	No problems	4

Note: If any of the two categories scores higher than 15% individually, the service must be considered inefficient, and a value of 1 (major problems) should be allocated to it.

4.6.3 Affordability of roads infrastructure

Affordability of very expensive infrastructure such as roads is difficult, if not impossible to measure. Allocations for roads infrastructure investment as well as operating costs are made annually out of the property tax revenue.

Unless the system is simplified by, for example, toll roads where the direct cost can be measured, vague measures must suffice.

1) The single-most important aspect to be measured in terms of affordability of roads infrastructure is the percentage of household income paid for transportation. Although this cost has no direct relation to the cost of providing or maintaining roads infrastructure, it reflects the appropriateness of the infrastructure. Roads are maintained through property taxes levied on residents and businesses.
2) The second aspect to consider in terms of affordability is then perhaps the willingness and ability to pay property tax.

Table 4.24: Roads infrastructure affordability categories

Category	Description	Rating
1	Percentage ratio of transport cost per month to household income	%
2	Non-payment levels	%

For the purposes of this thesis the average value of the two measurements are categorised as set out in **Table 4.25**.

Table 4.25: Roads infrastructure affordability values

Average rating of the two categories	Description	Value
Less than 1%	Cheap	4
1% - 5%	Affordable	3
5% - 10%	Expensive	2
>10%	Unaffordable	1

Note: If the percentage cost of roads infrastructure per month to household income exceeds 5%, the service should be classified "unaffordable".

4.6.4 Access to roads infrastructure

Roads infrastructure is not considered to be a basic service and as yet need not be monitored by municipalities and reported to government annually.

As with all other engineering services, extensive reticulation networks for the bulk and connector roads infrastructure exist in most large South African cities and urbanised areas. Access is therefore considered "adequate" to "good" compared to other international cities. Access to the intermediate Level of Service 2 (gravel surface roads) in Johannesburg is currently nearly 90 percent. (CoJ, 2002)

Table 4.26 lists the only KPI to measure the success of a municipality's roads provision in terms of access namely: percentage households within 500m of all weather roads

Table 4.26: Roads infrastructure accessibility measure

Category	Description	Rating
1	Percentage households within 500m of all weather roads	%

For the purposes of this thesis the value of the rating should be categorised as set out in **Table 4.27**.

Table 4.27: Roads infrastructure accessibility values

Average rating of the two categories	Description	Value
More than 95%	Full access	4
95% - 90%	Part access	3
89% - 85%	Limited	2
>85%	No access	1

4.7 Stormwater drainage

Much consideration was given by the author whether roads and stormwater services should be split. In practice, most municipalities combine these two services under one department and the same personnel usually perform both function. For the purposes of this thesis the two functions were split although access and affordability of stormwater services become difficult to measure.

Unlike the other engineering services, stormwater systems only pose problems when it rains. It is therefore probably the most neglected service during the dry season. However, when these systems fail, the consequence is seldom of nuisance value, instead damage to property is normally extensive. Municipal engineers would be well advised to consider the implications of system failures on shorter sections of drainage systems instead of simply designing for a general storm recurrence intervals prescribed in manuals.

4.7.1 Stormwater infrastructure quality

The categories used for stormwater classification in terms of levels of service are the same as those used by the World Bank as was described in **CHAPTER 3**. The quality of the stormwater infrastructure installed is categorised by the four classifications for residential use and are listed in **Table 4.28**.

1) *Level of service 1 (Minimal):* The lowest level of service is listed as "no stormwater drainage". Townships layouts can be designed in such a manner that all stormwater can be accommodated on the road surface that eventually discharge into the natural streams. These types of stormwater systems are also normally designed for a very low recurrence interval. In townships where access roads are also un-surfaced (level of service 1), it is normally preferable not to grade road surfaces in order not to canalize overland stormwater flows causing soil erosion and treacherous road surfaces.

2) *Level of service 2 (Basic):* This level normally refers to townships with unlined channels with lined crossings. This type of stormwater system is normally associated with intermediate level road construction. To prevent scouring of gravel road surfaces, roads are designed to be higher than the surrounding landscape. Stormwater is canalized to flow along the road reserve but off the road surface. The stormwater channels are unlined except where road crossings occur. Crossing stormwater channels to access individual stands is problematic and would either require some form of bridge or a wide enough flat lined-channel at stand entrances.

3) *Level of Service 3 (Intermediate):* The third category of stormwater infrastructure is normally found in higher density areas where public transport utilises bus routes and limited private vehicles and pedestrians utilise access roads. Lined channels or piped systems ensure adequate protection to vehicles, pedestrians and property along the bus routes.

4) *Level of service 4 (Full):* Paved roads are constructed to be lower than the surrounding landscape in order to intercept and canalize stormwater. Stormwater is initially accommodated on top of the road surfaces where after it gravitates along underground pipe systems into stormwater culverts and streams.

Table 4.28: Stormwater infrastructure quality categories

Category	Level of Service	Description	Value
1	1	No stormwater drainage	1
2	2	Unlined channels, lined crossings	2
3	3	Lined, channels on bus routes, rest unlined	3
4	4	On-road drainage and pipes and culverts on main routes	4

The numerical values allocated to each of the categories are similar to each particular level of service ie Level of service 1 has a value of 1, Level of service 2 has a value of 2, etc.

4.7.2 Stormwater maintenance efficiency

In order to determine the efficiency of stormwater systems, it would be necessary to monitor its ability to continuously cope with design floods. It is clear that blockages and obstructions could seriously hamper the system's capacity. Well-maintained systems and good response times to blockages are the best ways of assessing the municipality's ability to provide efficient stormwater services.

Table 4.29 reflects the two most important factors to monitor in South African municipalities, which are, a measurement of the ability or inability of the stormwater system to cope with design floods and response times to blockages.

Table 4.29: Stormwater maintenance efficiency categories

Category	Description	Rating
1	Inability of the drainage system to cope with design floods	%
2	Response time to blockages	%

- An assessment should be made of the performance or ability of the stormwater system to cope during the rainy season. Its ability to cope with design floods or the lack thereof should be expressed as a percentage of the ultimate designed condition as a ratio for the normal rainy season. For example a system that coped with 80 percent of the design floods during the season was therefore, 20 percent ineffective.
- Blockages and obstructions can render the best and most expensive stormwater system useless. They not only affect the capacity of the system, but also pose serious hazards to properties and people. Response time to stormwater blockages should be monitored and strived to improve continuously. Response time should be expressed in hours, using one hour as a 100 percent baseline and 50 hours as 0. The values were arbitrarily chosen by the author and are not based on any factual documentation. They are best estimates and could possibly be refined at a later stage.

Both factors are expressed in terms of a percentage. The average value of the two categories were again categorised as indicated in **Table 4.30**.

Table 4.30: Stormwater maintenance efficiency values

Average rating of the two categories	Description	Value
	No service	1
More than 10%	Major problems	2
10% - 5%	Minor problems	3
Less than 5%	No problems	4

Note: If any of the two categories scores higher than 15% individually, the service must be considered inefficient, and a value of 1 (major problems) should be allocated to it.

4.7.3 Affordability of stormwater service

The costs associated with stormwater systems are very dependant on the layout and construction of roads infrastructure. Access and utilisation of the system is nearly impossible to determine effectively as neither are levied or collected at point of sale. It is therefore suggested that affordability of stormwater systems not be determined separately from roads systems and that the same values for payment levels of roads infrastructure be used.

Table 4.31: Stormwater infrastructure affordability categories

Category	Description	Rating
1	Percentage ratio of transport cost per month to household income	%
2	Non-payment levels	%

For the purposes of this thesis the average value of the two measurements should be categorised as set out in **Table 4.32**.

Table 4.32: Stormwater infrastructure affordability values

Average rating of the two categories	Description	Value
Less than 1%	Cheap	4
1% - 5%	Affordable	3
5% - 10%	Expensive	2
>10%	Unaffordable	1

4.7.4 Access to stormwater services

Stormwater infrastructure is not considered to be a basic service and as yet need not be monitored by municipalities or reported to government annually.

Extensive reticulation networks for the bulk and connector stormwater infrastructure exist in most large South African cities and urbanised areas. Access is therefore considered "adequate" to "good" compared to other international cities (CoJ, 2002). **Table 4.33** lists the only KPI to measure the success of a municipality's stormwater provision in terms of access namely: percentage households with access to minimum level of service

Table 4.33: Stormwater accessibility measure

Category	Description	Rating
1	Percentage households with access to minimum level of service	%

For the purposes of this thesis the value of the rating should be categorised as set out in **Table 4.34**.

Table 4.34: Stormwater infrastructure accessibility values

Average rating of the two categories	Description	Value
More than 95%	Full access	4
95% - 90%	Part access	3
89% - 85%	Limited	2
>85%	No access	1

4.8 Refuse collection

The primary disposal method of solid waste in South African municipalities is via land refill. This is in line with international benchmarking which deems landfill usage the most cost effective manner of disposal in countries where land is abundant.

The long-term vision of the waste authorities should be to reduce disposal to landfills to zero. This approach, which is modeled on the successes of countries such as Denmark, seeks to reduce the amount of waste needing disposal to about 5 percent of current volumes. This reduction can be achieved via a system whereby, in the first place, less waste is generated at source; in the second, the re-use of waste materials is encouraged and, in the third, waste is recycled. By these means, it will be possible to decrease the volumes that need to be disposed of to such a manageable size that incineration rather than landfill disposal becomes an option.

In the meantime, while landfills are still required, utilities need to contend with the legislative processes enforced at national government level, which are so onerous, time consuming and expensive that permits for additional sites and the ability to manage them into the future is undermined.

Residential waste volumes are expected to grow, but forecasting is difficult. Disposable income impacts strongly on waste generated per person per day. According to CoJ (2002), high-income individuals generate on average 1,3 to 1,6 kilograms of waste a day. Middle-income earners generate 0,7 to 1 kilograms of waste a day and low-income earners generate 0,35 to 0,6 kilograms of waste per day.

Besides population growth and income, another important determinant of waste volumes concerns the degree of recycling. Curibata in Brazil is regarded as the benchmark regarding waste disposal and is especially relevant because of its linkages to poverty alleviation programmes, its response to low income settlements where weekly waste collection is impossible in terms of access and in terms of recycling and small business development. Sixty-seven percent of Curibata's waste is recycled in a way that is no more expensive to its city council than landfill disposal. Waste recycling needs to become an industry in South Africa.

4.8.1 Refuse collection services quality

The four categories used for solid waste collection classification in terms of levels of service are the same as those used by the World Bank. The quality of the solid waste infrastructure is categorized by the four classifications for residential use and is listed in **Table 4.35**.

- *Level of service 1 (Minimal):* The lowest level of service is listed as "no formal refuse collection". Residents in these townships are expected to dispose their own waste either by incineration or burial.
- *Level of service 2 (Basic):* This level refers to ad-hoc waste collection. Refuse is collected on an "as and when" basis, normally from communal collection points.
- *Level of service 3 (Intermediate):* The third category of refuse collection expects residents of townships to transport their waste to communal collection points, where it will be collected on a regular basis, usually in large skips or buckets.
- *Level of service 4 (Full):* Regular weekly refuse collections occur and the service is extended to each stand in the township.

Table 4.35: Refuse collection services quality categories

Category	Level of Service	Description	Value
1	1	No formal refuse collection	1
2	2	Ad-hoc refuse collection	2
3	3	Regular collection from communal collection points	3
4	4	Regular weekly collections from houses	4

The numerical values allocated to each of the categories are similar to each particular level of service ie Level of service 1 has a value of 1, Level of service 2 has a value of 2, etc.

4.8.2 Refuse collection efficiency

Having outlined the challenges of municipal waste managers with increasing waste volumes and the expectancy and linkages to poverty alleviation with regards to recycling, municipalities still need to perform their core functions in terms of service delivery. Inefficient refuse collection is probably the first thing noticeable when visiting a new city. Conversely, clean cities normally leave lasting impressions.

Table 4.36 reflects the two most important factors to monitor in South African municipalities, which are, a measurement of cleanliness and punctuality.

Table 4.36: Refuse collection efficiency categories

Category	Description	Rating
1	Percentage scheduled rounds not performed on time per annum	%
2	Measure of un-cleanliness	%

- Punctuality is certainly a good business practice. In the sense of waste management, it means that the waste bags or bins will be collected promptly without leaving the township untidy for too long. It also leaves little time for the elements and stray dogs to litter the area. The percentage rounds not performed on time annually measures the utility's punctuality with regards to collection.
- Punctuality means little if not enough rounds are performed or streets are left unclean. The photo measure of cleanliness by waste collectors, where the number of papers and rubbish per photo is counted, is probably the best and most useful measure of cleanliness. Percentage unclean areas per annum need to be monitored.

Both factors are expressed in terms of a percentage. The average value of the two categories can again be categorised as indicated in **Table 4.37**.

Table 4.37: Refuse collection efficiency values

Average rating of the two categories	Description	Value
	No service	1
More than 10%	Major problems	2
10% - 5%	Minor problems	3
Less than 5%	No problems	4

Note: If any of the two categories scores higher than 15% individually namely: punctuality or cleanliness - the service must be considered inefficient, and a value of 1 (major problems) should be allocated to it.

4.8.3 Affordability of refuse collection services

As stated in the opening paragraphs, high-income households generate nearly three times as much waste per capita as low-income households. Again, solid waste collection is not billed at the point of sale but normally appears on municipal rates accounts. Municipalities should allow for this discrepancy in the billing stage.

Affordability is therefore also difficult to measure and perhaps the best way to measure access is to monitor the "percentage households enjoying regular waste collections". The same method of determination as for of the other municipal services is to be followed as is reflected in Table **4.38**, namely: percentage cost per household income and payment levels.

- Affordability of refuse collection services can best be compared to other expenses by measuring the percentage of waste collection cost per month to household income.
- Payment or non-payment levels can reflect the ability or willingness to pay for the collection service and is therefore also an indication of the affordability of the service.

Table 4.38: Refuse collection affordability categories

Category	Description	Rating
1	Percentage ratio of refuse collection cost per month to household income	%
2	Non-payment levels	%

For the purposes of this thesis the average value of the two measurements are categorised as set out in **Table 4.39**.

Table 4.39: Refuse collection affordability values

Average rating of the two categories	Description	Value
Less than 1%	Cheap	4
1% - 5%	Affordable	3
5% - 10%	Expensive	2
>10%	Unaffordable	1

Note: If the percentage c ost of refuse collection per month to household income exceeds 5%, the service should be classified "unaffordable".

4.8.4 Access to refuse collection services

Unlike water and sanitation, refuse collection services is not considered to be a basic service and as yet need not be monitored by municipalities or reported to government annually.

Most large South African cities and municipalities have huge waste collection departments and infrastructure. Street cleaning and solid waste removal are considered “adequate” compared to other international cities. Access to refuse collection services in Johannesburg according to CoJ (2002) is currently at 88 percent. **Table 4.40** lists the only KPI to measure the success of a municipality’s solid waste collection service in terms of access namely: percentage households with access to minimum level of service

Table 4.40: Refuse collection accessibility measure

Category	Description	Rating
1	Percentage households with access to minimum level of service	%

For the purposes of this thesis the value of the rating should be categorised as set out in **Table 4.41**.

Table 4.41: Refuse collection accessibility values

Average rating of the two categories	Description	Value
More than 95%	Full access	4
95% - 90%	Part access	3
89% - 85%	Limited	2
>85%	No access	1

4.9 Electricity

The last of the engineering services for discussion is electricity.

Electricity is undoubtedly the most profitable engineering service that generates large amounts of income for municipalities. Major restructuring is currently under way in the bulk electricity supply arena. Regional electricity distributors or REDs will in future be the suppliers of electricity to users in municipal areas. It is clear that the role that municipalities play in alleviating poverty through cross subsidisation of services is hugely important. The possible negative financial effects that the establishment of REDs will have on municipalities and indeed on poverty alleviation need to be investigated and quantified.

Still, South Africa exhibits an enormous competitive advantage with respect to the cost of power. The average cost per kWh in Johannesburg according to CoJ (2002) is just $0,038 compared to $0,14 in New York and $0.20 in London. Tariff determination is always a complex issue and, in South Africa, where the industry is undergoing transformation, this is particularly so.

4.9.1 Electricity infrastructure services quality

The four levels of service adopted are again similar to those used by the World Bank. Table 4.35 reflects the levels and values associated with them. The levels of service for electricity are:

- *Level of service 1 (Minimal):* “No electricity” supplied by a service provider. The owner of the house is required to provide his own electrical power if required. No street lighting is provided to the township either.
- *Level of service 2 (Basic):* With the second level, some dwellings are connected to the electrical distribution network, while high masts provide street lighting.
- *Level of service 3 (Intermediate):* The third level is normally found in townships where dwellings have restricted electrical connections and high masts are erected for street lighting.
- *Level of service 4 (Full):* A full electrical service is provided, namely: streetlights and metered house connections.

Table 4.42: Electricity infrastructure services quality categories

Category	Level of Service	Description	Value
1	1	No electricity	1
2	2	High masts with some house connections	2
3	3	High masts with restricted house connections	3
4	4	Streetlights & unrestricted metered house connections	4

The numerical values allocated to each of the categories are similar to each particular level of service ie Level of service 1 has a value of 1, Level of service 2 has a value of 2, etc.

4.9.2 Electricity infrastructure delivery efficiency

In terms of technical standards of reliability for forced interruptions, voltage regulation, harmonics, unbalance dips and frequency deviations, the National Electricity Regulator (NER) will enforce the NRS 048 quality of supply standards, which have been internationally benchmarked and will become a precondition for continued licensing. Operators have been given a window of time to comply with these standards.

Transmission and distribution losses in Johannesburg average 8 percent of output, which puts it just 1 percent higher than the USA, 11 percent below the average for lower income countries, 3 percent below Europe as a whole and 8 percent below Latin America.

In terms of efficiency of supply, two KPIs need to be monitored as indicated in **Table 4.43**, namely: unplanned interruptions and power unaccounted for.

1) Unplanned interruptions should be expressed as a percentage of days per year.
2) Power unaccounted for and line losses should also be expressed as a percentage of the total supplied.

Table 4.43: Electricity services supply efficiency categories

Category	Description	Rating
1	Unplanned interruptions: percentage days per year	%
2	Line losses: percentage power unaccounted for	%

The average value of the two measurements should be categorised as set out in **Table 4.44**.

Table 4.44: Electrical services supply efficiency values

Average rating of the two categories	Description	Value
	No service	1
More than 10%	Major problems	2
10% - 5%	Minor problems	3
Less than 5%	No problems	4

Note: If any of the two categories scores higher than 15% individually, the service must be considered inefficient, and a value of 1 (major problems) should be allocated to it.

4.9.3 Affordability of electricity services

Other aspects of the electricity sector that raise concern are the areas of financial management and sustainability. The first issue involves payment for services. Non-technical losses (or non payment for services) present a problem. For City Power (the City of Johannesburg's power supply company), non-technical losses run at approximately 11 percent in comparison to the international standard of 1 to 2 percent. Eskom, which services 60 percent of low-income households in the Johannesburg area, suffers losses of a non-technical nature of up to 80 percent. These lower payment levels are partly seen in a relatively poorer operating and maintenance to income ratio of 16 percent in Johannesburg compared to an equivalent ratio of 11 percent in New York City.

Table 4.45: Electrical services affordability categories

Category	Description	Rating
1	Percentage ratio of electricity cost per month to household income	%
2	Non-payment levels	%

The average value of the two measurements should be categorised as set out in **Table 4.46**.

Table 4.46: Electrical services affordability values

Average rating of the two categories	Description	Value
Less than 1%	Cheap	4
1% - 5%	Affordable	3
5% - 10%	Expensive	2
>10%	Unaffordable	1

Note: If the percentage cost of electricity supply per month to household income exceeds 5%, the service s hould be classified "unaffordable".

4.9.4 Access to electricity services

As is the case with other engineering services, urban sprawl both with respect to business and residential property development fundamentally curbs efficient asset utilisation and optimal planning and creates an enormous burden for the utility operators. While acknowledging the principle that densification is crucial to the load factor and optimal utilisation of existing networks in order to harness economies of scale, authorities bemoan the implications of the kind of ad hoc densification that has occurred in South African cities previously.

In most cases, it is the urban poor living on the periphery of the city who suffer most with access to engineering services and in particular electricity. In Johannesburg currently, 85 percent of the residents are connected to the electricity supply service.

Table 4.47: Electricity services accessibility categories

Category	Description	Rating
1	Percentage households connected to the service	%

The value should be categorised as set out in **Table 4.48**.

Table 4.48: Electricity services accessibility values

Average rating of the two categories	Description	Value
More than 95%	Full access	4
95% - 90%	Part access	3
89% - 85%	Limited	2
>85%	No access	1

Note: If the average value of any of the two categories individually falls below 85%, the service should be classified “inaccessible”.

4.10 Social services

With the development of a service delivery index, the primary aim was to develop a measure for engineering services. Municipalities, however, provide much wider services to the community than merely waste removal and water supply. In fact, major cities such as Johannesburg and Durban have privatised these services and although municipalities remain ultimately responsible for the provision of engineering services in terms of the legislation, municipal employees no longer deliver these services directly.

Social services rendered by municipalities include inter alia: health, safety and security, emergency services (ambulance and fire brigade), other community services such as parks and recreation services as well as library facilities. The way in which social services are delivered probably also warrants investigation and a similar approach to the development of a service delivery index for engineering services could perhaps be followed to develop an index for measuring municipal social service delivery. The author does not attempt to demonstrate the adaptability of the methodology in this thesis in any way. It might however, become a topic for research at a later stage.

4.11 Aggregation of the composite index

From the methodology described, it should be clear that the construction of a composite service delivery index for municipalities required a fair understanding of the intricate political workings of municipalities as well as a fair technical understanding of the services they provide. It also required a fair understanding of sound performance management principles, which was useful in reducing and developing indicators to measure quantity, quality, efficiency, effectiveness and impact of the service delivery on communities. The awareness was useful to reduce the number of indicators to the bare essentials of key performance indicators for the respective services.

The next part of the development of the index required a holistic approach on public service provision. It was necessary to understand the importance of each service individually as well as the interrelationship of the different services provided to communities.

It is only natural for engineers and managers in the different service clusters to regard the work they do and the service they provide as the most important service. Support services and some of the core services are normally regarded as less important services by engineers. In support of these non-engineering services, one should not underestimate the devastating effect that the suspension of a library service or a clinic has on a community. These services have traditionally received far less funding and the departments are much smaller that the engineering service departments, perhaps being the cause also of their decreased perceived importance.

The understanding of the interrelationship of the services was necessary to mathematically connect the services in order to construct a single index that could describe municipal service delivery. This mathematical relationship expressed the importance of the different indicators by allocating different weightings to them. Numerous other methods are used by statisticians to describe the importance and the relationship between different variables in the construction of an index.

The reason for this mathematical relationship is help make sense of aggregating different variables, for example, the most common criticism by statisticians of the HDI is that it simply adds three different components namely life expectancy, literacy rate and income to aggregate into one figure to describe human development. The unit of measure for the three components is different; longevity is measured in years, standard of living is measured in US dollars and knowledge is measured by literacy rate. They argue that the simple addition of the three components becomes meaningless.

Maqutu, D. (2002) proposed that the Principle Component Analysis procedure be applied to the HDI in order to examine the relationship between the three components and to appropriately scale the components to allow one to add life expectancy to literacy and GDP. This is not dissimilar to the methods adopted by Stats SA in the development of their Poverty Index described in **Chapter 3**.

Taking cognizance of the warning from DPLG (20001b) that it is unwise to aggregate a set of indicators into one composite where the mathematical relationship between them is not fully understood, tested or valid, the development of a composite index in this instance, is regarded as a natural progression of combining the different service delivery indicators. The different components of the municipal services indices are perhaps not as different to one another or as complicated to construct as components used in compilation the Poverty Index or the Human Development Index. Determination of principle components for the different services appears unnecessary and all engineering services could be regarded as equally important. A debate on which service could perhaps take precedence over the other service is also regarded futile.

Similarly, a cluster analysis would add little value to the purpose of this index development.

For the purposes of this thesis and to demonstrate its effectiveness, the following method of aggregation was adopted:

- All engineering services (water, sanitation, roads, stormwater, electricity and refuse) were regarded equal and therefore, each was allocated equal weighting.
- All four components (quality, efficiency, access and affordability) of the respective services were regarded equal and allocated equal weighting.

The option remains to (at a later stage) refine the mathematical relationship of the index if it was found to be biased towards any particular service or component. For demonstration purposes and for the sake of progress, allocating equal weightings to the respective components seemed reasonable.

The indicator is therefore, a composite index consisting of various components that aggregate into a single number to reflect the quality, efficiency, affordability and accessibility of the various services rendered by the municipality. Its usefulness lies in its ability to describe numerically how a municipality is delivering services as well as being able to track progress over time. If, of course, other municipalities measure their services in the same manner, comparisons between municipalities can be made.

Table 4.49 summarizes the different components of the services and the different criteria for evaluation. A similar Excel spreadsheet was compiled for easy calculation of the index. Copies of the spreadsheets are attached as **ANNEXURE 2**. The spreadsheet performs the calculations and evaluations in terms of the different criteria prescribed. In order to populate the model, an example was compiled using data from a particular region in the City of Johannesburg. Unless indicated as best estimates, all data utilised were acquired from the different utilities and departments and are actual figures for the region.

4.12 Evaluation

During the development stages of the service delivery index great care was taken to maintain consistency between the different services and to follow a trail of reasonable logical development The different engineering services were not only evaluated in terms of quality, efficiency, access and affordability, attempts were also made to keep the evaluating envelopes and percentages constant for all the services. This characteristic of the index development was not a requirement but the format was merely chosen for the purpose of simplification and ease of use. It was previously stated and could possibly become necessary at a later stage, to refine these envelopes.

The final assembling or aggregation of the different services indicators created the index that this thesis is all about. The usefulness of the index can only be demonstrated with real data where trends, peaks and changes in delivery or merely comparisons between townships and services can be made.

All the stages with regard to the development of an index for service delivery were completed. A final model for index calculation for townships could be complied in a spreadsheet. The real test for usefulness starts with the gathering of data in the next chapter to populate the model.

Table 4.49: Performance Areas and Key Performance Indicators of a Service Delivery Index

Type	Infrastructure quality	Val	Delivery efficiency	Level of Efficiency	Val	Access	Level of Access	Val	Affordability	Level of Affordability	Val
EngIneerIng ServIces											
Water	• Communal standpipe • Standpipe within 250m • Yard standpipe • Metered in-house supply	1 2 3 4	• *Unplanned interruptions*: percentage days per year (Pipe bursts-response time) • Leakages: percentage of piped water unaccounted for • Percentage days per annum not compliant with purification standards	No service Major problems Minor problems No problems	1 2 3 4	• Percentage households connected to the service • Percentage households with access to safe potable water within 250 metres of the dwelling	Full access Part access Limited No access	4 3 2 1	• Percentage ratio of cost per six kiloliters to household income • Non-payment levels	Cheap Affordable Expensive Unaffordable	4 3 2 1
Sanitation	• Buckets/ communal toilet • On-site sanitation • Intermediate sewerage • Conventional water-borne	1 2 3 4	• Unplanned service interruptions (pipe bursts and blockages) % days per annum • Percentage days per annum not compliant with treatment and pollution standards • Percentage of wastewater not treated per annum	No service Major problems Minor problems No problems	1 2 3 4	• Percentage households connected to the service • Percentage households with access to minimum level of service	Full access Part access Limited No access	4 3 2 1	• Percentage ratio of cost per month to household income • Non-payment levels	Cheap Affordable Expensive Unaffordable	4 3 2 1
Local Roads	• Unsurfaced • Gravel surface roads • Paved bus routes, rest gravel • All roads kerbed and paved	1 2 3 4	• Lack of rideability (surface condition) of roads • Response time to pothole repairs	No service Major problems Minor problems No problems	1 2 3 4	• Percentage households within 500m of all weather roads	Full access Part access Limited No access	4 3 2 1	• Percentage ratio of transport cost per month to household income • Non-payment levels	Cheap Affordable Expensive Unaffordable	4 3 2 1
Stormwater	• No stormwater drainage • Unlined channels, lined crossings • Lined, channels on bus routes, rest unlined • On-road drainage and pipes and culverts on main routes	1 2 3 4	• Inability of the drainage system to cope with design floods • Response time to blockages	No service Major problems Minor problems No problems	1 2 3 4	• Percentage households with access to minimum level of service	Full access Part access Limited No access	4 3 2 1	• Percentage ratio of transport cost per month to household income • Non-payment levels	Cheap Affordable Expensive Unaffordable	4 3 2 1

Performance Areas and Key Performance Indicators of a Service Delivery Index

Type	Infrastructure quality	Val	Delivery efficiency	Level of Efficiency	Val	Access	Level of Access	Val	Affordability	Level of Affordability	Val
Electricity	• No electricity • High masts with some house connections • High masts with restricted house connections • Streetlights & unrestricted metered house connections	1 2 3 4	• Unplanned interruptions: percentage days per year • Line losses: percentage power unaccounted for	No service Major problems Minor problems No problems	1 2 3 4	• Percentage households connected to the service	Full access Part access Limited No access	4 3 2 1	• Percentage ratio of electricity cost per month to household income • Non-payment levels	Cheap Affordable Expensive Unaffordable	4 3 2 1
Refuse collection	• No formal refuse collection • Ad-hoc refuse collection • Regular collection from communal collection points • Regular weekly collections from houses	1 2 3 4	• Percentage scheduled rounds not performed on time per annum • Measure of un-cleanliness	No service Major problems Minor problems No problems	1 2 3 4	• Percentage households with access to minimum level of service	Full access Part access Limited No access	4 3 2 1	• Percentage ratio of refuse collection cost per month to household income • Non-payment levels	Cheap Affordable Expensive Unaffordable	4 3 2 1

5 Data collection

5.1 Background

It seems that the phrase "Data rich but information poor" is particularly relevant to South African municipalities. Although municipalities are known for being collectors of enormous volumes of data, one cannot help to be amazed at how little information South African municipalities are able to provide on request. The seemingly endless changing of municipal boundaries over the last eight years aggravated this apparent inability to find data previously gathered by local authorities.

The high defection rate of skilled and knowledgeable staff due to affirmative action, in particular those who knew where and how to access data, have now left new people who are unfamiliar with previous administrative structures. In most instances, information kept by South African municipalities can only be obtained from staff who were previously involved in the processes.

Large volumes of data are also still in the hands of consultants who failed to transfer information to the municipalities after their assignments were completed. Unless one is aware of these particular projects, the disappearance of these consultants in future will probably also be the end of that information.

In order to populate the model for the development of a service delivery index, an area had to be chosen which was relatively familiar to the author as well as being able to acquire relevant data on for at least the last decade.

The area chosen for data collection is indicated on **Map1**, **ANNEXURE 1**. All the townships fall within the Roodepoort Magisterial District as is indicated in the maps compiled by the 1996 Population Census. The five townships chosen were:

- Davidsonville
- Dobsonville
- Doornkop
- Lindhaven and
- Princess

5.2 Data sources

5.2.1 World Bank reports

The research work originally done for this thesis as well as the projects executed and published by the World Bank were useful sources of information to start off with. Data collected by the World Bank include all six engineering services and became a useful platform from which comparisons were made and trends determined.

5.2.2 Johannesburg Metropolitan Municipality

The most recent information with regards to infrastructure quality and delivery efficiency was sourced from Johannesburg Roads Agency, Johannesburg Water, City Power and Pikitup (the city's refuse removal company). Information regarding payment levels for services were sourced from the Executive Director: Finance and the regional office of Region 5 in Roodepoort.

Surprisingly, an additional source of information was obtained from the Corporate Planning Unit (a group of people doing research, policy formulation and strategic planning for the city). Numerous surveys were conducted during 1999 in the formulation of the city's iGoli 2010 plans. An additional survey completed during 2002 by the World Bank regarding services in low-income areas assisted greatly in finalizing data for the compilation of the service delivery index.

5.2.3 1996 Population Census

Valuable information regarding household services were obtained from the 1996 Population Census data. Unfortunately only data for four engineering services are available in the census database namely, water, sewer, electricity and refuse removal. Roads and stormwater data for that period needed to be collected from other sources. The census data also provided information on household income, which were useful for calculating affordability of services.

The data collected for the determination of the service delivery index is listed in the tables following. Notes attached to the tables explain the relevance and correctness of the data sets acquired.

General information regarding the five townships were extracted from the 1996 Population Census and are tabulated in **Table 5.1** & **Table 5.2**.

Table 5.1: Population group of head of household, 1996

Race	Davidsonville	Dobsonville	Doornkop	Lindhaven	Princess
African / Black	85	19 147	10 727	157	295
Coloured	739	28	19	70	106
Indian / Asian	4	1	0	16	2
White	12	32	3	853	571
Unspecified / Dummy	25	34	17	9	11
Total	865	19 242	10 766	1 105	985

The results of population Census that was undertaken in November 2000 are still outstanding. Real comparisons in terms of demographic changes that took place since 1996 are not possible and hopefully someone could make it an extension to the thesis when the results become available. At present, its relevance is limited. The only township where major racial demographic changes occurred was Princess where a large influx of squatters have tipped the scale from the head of the household being predominantly white to being predominantly black.

Table 5.2: Gender of head of household, 1996

Sex	Davidsonville	Dobsonville	Doornkop	Lindhaven	Princess
Male	626	13 534	7 159	996	720
Female	239	5 708	3 607	109	265
Total	865	19 242	10 766	1 105	985

It is interesting to note that while less than 10 percent of the heads of the households in Lindhaven during 1996 were female, more than 33 percent of the household heads were female in Doornkop.

Table 5.3 reflects the income distribution of households in the respective townships during 1996. This information is particularly important for the determination of affordability of services.

Table 5.3: Derived annual household income, 1996

Income group	Davidsonville	Dobsonville	Doornkop	Lindhaven	Princes
None	35	1 654	1 253	1	177
R 1 - 2 400	7	585	863	2	18
R 2 401 – 6 000	46	1 456	1 217	14	76
R 6 001 – 12 000	44	2 371	1 660	30	54
R 12 001 – 18 000	57	3 045	2 003	35	62
R 18 001 – 30 000	98	3 217	1 549	54	94
R 30 001 – 42 000	72	1 752	687	77	63
R 42 001 – 54 000	60	1 124	251	68	71
R 54 001 – 72 000	71	997	160	128	72
R 72 001 – 96 000	40	428	91	160	47
R 96 001 – 132 000	30	303	55	205	45
R 132 001 – 192 000	14	106	16	131	17
R 192 001 – 36 0000	3	55	10	38	11
R 360 001 or more	1	13	4	5	0
Unspecified / Dummy	287	2 136	947	157	178

Table 5.4 reflects the average income per household per month calculated for the respective townships during 1996.

Table 5.4: Average household income per month, 1996

Income group	Average income
Davidsonville	R 2 293
Dobsonville	R 1 889
Doornkop	R 1 201
Lindhaven	R 6 462
Princess	R 2 461

5.3 Water

Since the formation of the city's water utility in 2000, a database was compiled to assist in the extraction of data gathered by all the different amalgamated municipalities. Although the database was commissioned, information prior to 1997 is inaccessible and needed to be obtained by manual manipulation of old files and plans. It was however, possible to obtain data in the required format for the townships from 1999 to the present at the Hamburg Depot in Roodepoort.

Information regarding the Driefontein and Olifantsvlei purification works were obtained from the utility's head office in Johannesburg.

5.3.1 Water infrastructure quality

The levels of service defined for water infrastructure are not too dissimilar from the information available in the Population Census. Utilizing the 1996 Census database, **Table 5.5** was constructed for the 5 townships chosen.

Table 5.5: Water infrastructure quality

Township	Number of Households 1993	Number of Households 1997	Number of Households 2001	Level of Service	Index 1993	Index 1997	Index 2001
Davidsonville	*	0	0	Minimal			
	*	0	0	Basic			
	*	136	136	Intermediate	3.84	3.84	3.84
	*	728	728	Full			
Dobsonville	0	17	17	Minimal			
	6 980	1 061	1 061	Basic			
	0	7 190	7 190	Intermediate	3.31	3.51	3.51
	13 200	10 974	10 974	Full			
Doornkop	0	13	0	Minimal			
	6 065	4 139	1 366	Basic	2.00	2.79	
	0	4 733	7 500	Intermediate			3.06
	0	1 881	2 000	Full			
Lindhaven	*	1	1	Minimal			
	*	0	0	Basic			
	*	54	54	Intermediate	3.95	3.95	3.95
	*	1 050	1 050	Full			
Princess	*	2	0	Minimal			
	*	29	2 000[1]	Basic			2.55
	*	275	275	Intermediate	3.66	3.66	
	*	679	679	Full			

Notes: * No reliable data available. Data used from 1996 census
1 Estimated number of squatter households settled on Plot 61 south of Westgate

5.3.2 Water delivery efficiency

Table 5.6 reflects delivery efficiency values. Data was obtained by interviewing officials from the Water Utility as well as through accessing databases of logged complaints.

Table 5.6: Water delivery efficiency

Township	KPI	Value 1993	Value 1997	Value 2001	Level of Service	Index 1993	Index 1997	Index 2001
Davidsonville	• Unplanned interruptions: percentage days per year	*	1	3	No service			
	• Leakages: percentage of piped water unaccounted for	*	5	6	Major problems			
	• % days per annum not compliant with purification standards	*	0	0	Minor problems			
					No problems	4	4	4
Dobsonville	• Unplanned interruptions: percentage days per year	#	7	8	No service			
	• Leakages: percentage of piped water unaccounted for	#	35	35	Major problems	2[1]	2	2
	• % days per annum not compliant with purification standards	#	0	0	Minor problems			
					No problems			
Doornkop	• Unplanned interruptions: percentage days per year	#	1	8	No service			
	• Leakages: percentage of piped water unaccounted for	#	35	35	Major problems	2[1]	2	2
	• % days per annum not compliant with purification standards	#	0	0	Minor problems			
					No problems			
Lindhaven	• Unplanned interruptions: percentage days per year	*	1	3	No service			
	• Leakages: percentage of piped water unaccounted for	*	3	3	Major problems			
	• % days per annum not compliant with purification standards	*	0	0	Minor problems			
					No problems	4	4	4
Princess	• Unplanned interruptions: percentage days per year	*	1	5	No service			
	• Leakages: percentage of piped water unaccounted for	*	0	16	Major problems			2
	• % days per annum not compliant with purification standards	*	0	0	Minor problems			
					No problems	4	4	

Notes:
* No reliable data available. Data used from 1996 census
# World Bank's evaluation for the period utilised namely "no problems" for both Dobsonville & Doornkop
1 The 1993 World Bank report is silent about water unaccounted for in Dobsonville and Doornkop. Their classification of "no problems" is noted. In terms of the SDI, classification should be "major problems" due to the very high UFW.

5.3.3 Access to water service

Utilizing the information available in the 1996 Census database, **Table 5.7** was constructed for the 5 townships chosen. Calculations were made on the spreadsheets attached as annexures.

Table 5.7: Access to water service

Township	KPI	1993	1997	2001	Level of Access	Index 1993	Index 1997	Index 2001
Davidsonville	• % households connected	100	100	100	No			
					Limited			
	• % households with water within 250m	100	100	100	Part			
					Full	4	4	4
Dobsonville	• % households connected	65.4	94.4	94.4	No			
					Limited	2		
	• % households with water within 250m	100	99.9	99.9	Part			
					Full		4	4
Doornkop	• % households connected	0	61.5	61.5	No	1		
					Limited		2	
	• % households with water within 250m	100	100	100	Part			3
					Full			
Lindhaven	• % households connected	99.9	99.9	99.9	No			
					Limited			
	• % households with water within 250m	99.9	99.9	99.9	Part			
					Full	4	4	4
Princess	• % households connected	96.9	96.9	32.3	No			
					Limited			2
	• % households with water within 250m	99.8	99.8	100	Part			
					Full	4	4	

5.3.4 Affordability of water services

Utilizing the information available in the 1996 Census database, **Table 5.8** was constructed for the 5 townships chosen. The cost per six kiloliters of water per month was used as a basis for calculating affordability. Payment levels were obtained from interviews with officials of the city's Finance Department.

Table 5.8: Affordability of water service

Township	KPI	1993	1997	2001	Level of Affordability	Index 1993	Index 1997	Index 2001
Davidsonville R2 293/m R9.00/6kl	• % of cost per six kiloliters to household income	0.4	0.4	0.4	Cheap			
					Affordable			
					Expensive	2	2	2
	• Non-payment levels	10	15	15	Unaffordable			
Dobsonville R1 889/m	• % of cost per six kiloliters to household income	0.5	0.5	0.5	Cheap			
					Affordable			
					Expensive			
	• Non-payment levels	50	50	50	Unaffordable	1	1	1
Doornkop R1 201/m	• % of cost per six kiloliters to household income	0.75	0.75	0.75	Cheap			
					Affordable			
					Expensive			
	• Non-payment levels	30	30	30	Unaffordable	1	1	1
Lindhaven R6 462/m	• % of cost per six kiloliters to household income	0.1	0.1	0.1	Cheap	4	4	4
					Affordable			
					Expensive			
	• Non-payment levels	1	1	1	Unaffordable			
Princess R2 461/m	• % of cost per six kiloliters to household income	0.4	0.4	0.2	Cheap			
					Affordable	3	3	
					Expensive			
	• Non-payment levels	2	2	40	Unaffordable			1

5.4 Sanitation services

Various reports and documentation regarding sanitation are available for data extraction. The best source remains the 1996 Population Census. Data from the World Bank reports were also helpful in constructing the data tables for sanitation services.

5.4.1 Sanitation infrastructure quality

The levels of service defined for sanitation infrastructure are slightly different from the levels defined in the 1996 Census. The following categories were grouped for comparison and are indicated in **Table 5.9**.

Table 5.9: Comparison of sanitation levels of service

World Bank	Census 96	Level used
Communal standpipe	Communal standpipe	1
Standpipe within 250m	Standpipe within 2 50m	2
Yard standpipe	Yard standpipe	3
	Borehole/rainwater tank/well	3
	Dam/rivers/streams/spring	3
	Other	3
	Unspecified/dummy	3
Metered in-house supply	Metered in-house supply	4

Utilising the 1996 Census database, **Table 5.10** was constructed for the 5 townships chosen.

Table 5.10: Sanitation infrastructure quality

Township	Number of Households 1993	Number of Households 1997	Number of Households 2001	Level of Service	Index 1993	Index 1997	Index 2001
Davidsonville	*	4	4	Minimal			
	*	1	1	Basic			
	*	1	1	Intermediate	3.98	3.98	3.98
	*	859	858	Full			
Dobsonville	0	205	205	Minimal			
	6 980	130	130	Basic			
	0	86	86	Intermediate	3.31	3.95	3.95
	13 200	18 821	18 821	Full			
Doornkop	0	233	233	Minimal			
	6 065	2 818	2 818	Basic	2.34		
	0	519	519	Intermediate		3.36	3.36
	0	7 196	7 196	Full			
Lindhaven	*	0	0	Minimal			
	*	2	2	Basic			
	*	0	0	Intermediate			
	*	1 103	1 103	Full	4.00	4.00	4.00
Princess	*	9	9	Minimal			
	*	260	2 000[1]	Basic			2.52
	*	2	2	Intermediate	3.44	3.44	
	*	714	714	Full			

Notes: * No reliable data available. Data used from 1996 census
1 Estimated number of squatter households settled on Plot 61 south of Westgate

5.4.2 Sanitation delivery efficiency

Table 5.11 was constructed for the 5 townships chosen. The values were obtained by interviewing officials from the Water Utility's depot in Hamburg, Roodepoort as well as through accessing databases of logged complaints.

Table 5.11: Sanitation delivery efficiency

Township	KPI	Value 1993	Value 1997	Value 2001	Level of Service	Index 1993	Index 1997	Index 2001
Davidsonville	• Unplanned service interruptions % days per annum	*	5	9	No service			
	• % days per annum not compliant with treatment and pollution standards	*	0	0	Major problems			
	• % of wastewater not treated per annum	*	0.6	0.6	Minor problems			
					No problems	4	4	4
Dobsonville	• Unplanned service interruptions % days per annum	#	6	6	No service			
	• % days per annum not compliant with treatment and pollution standards	#	0	0	Major problems			
	• % of wastewater not treated per annum	#	1.7	1.7	Minor problems	3		
					No problems		4	4
Doornkop	• Unplanned service interruptions % days per annum	#	5	6	No service			
	• % days per annum not compliant with treatment and pollution standards	#	3	3	Major problems			
	• % of wastewater not treated per annum	#	8.5	8.5	Minor problems	3	3	3
					No problems			
Lindhaven	• Unplanned service interruptions % days per annum	*	1	2	No service			
	• % days per annum not compliant with treatment and pollution standards	*	0	0	Major problems			
	• % of wastewater not treated per annum	*	0.2	0.2	Minor problems			
					No problems	4	4	4
Princess	• Unplanned service interruptions % days per annum	*	3	7	No service			
	• % days per annum not compliant with treatment and pollution standards	*	2	5	Major problems	2	2	2
	• % of wastewater not treated per annum	*	27.3	73.7	Minor problems			
					No problems			

Notes: * No reliable data available. Data used from 1996 census
World Bank's evaluation for the period utilised namely "minor problems" for both Dobsonville & Doornkop

5.4.3 Access to sanitation service

Utilising the information available in the 1996 Census database, **Table 5.12** was constructed for the 5 townships chosen. Spreadsheet calculations were performed to calculate accessibility and are attached as annexures.

Table 5.12: Access to sanitation service

Township	KPI	1993	1997	2001	Level of Access	Index 1993	Index 1997	Index 2001
Davidsonville	• % households connected to the service	99.4	99.4	99.4	No			
					Limited			
	• % households with access to minimum level of service	99.5	99.5	99.5	Part			
					Full	4	4	4
Dobsonville	• % households connected to the service	65.4	98.3	98.3	No			
					Limited	2		
	• % households with access to minimum level of service	100	98.9	98.9	Part			
					Full		4	4
Doornkop	• % households connected to the service	0	91.5	91.5	No	1		
					Limited			
	• % households with access to minimum level of service	100	100	100	Part			
					Full		4	4
Lindhaven	• % households connected to the service	99.8	99.8	99.8	No			
					Limited			
	• % households with access to minimum level of service	100	100	100	Part			
					Full	4	4	4
Princess	• % households connected to the service	72.7	72.7	26.3	No			
					Limited	2	2	2
	• % households with access to minimum level of service	99.1	99.1	99.7	Part			
					Full			

5.4.4 Affordability of sanitation services

Utilizing the information available in the 1996 Census database, **Table 5.13** was constructed for the 5 townships chosen. Payment levels and sanitation costs were obtained from interviews with officials from the city's Finance Department.

Table 5.13: Affordability of sanitation service

Township	KPI	1993	1997	2001	Level of Affordability	Index 1993	Index 1997	Index 2001
Davidsonville R2 293/m R23	• % cost per month to household income	0.4	0.4	0.4	Cheap			
					Affordable			
	• Non-payment levels	10	15	15	Expensive	2	2	2
					Unaffordable			
Dobsonville R1 889/m	• % cost per month to household income	0.6	0.6	0.6	Cheap			
					Affordable			
	• Non-payment levels	50	50	50	Expensive			
					Unaffordable	1	1	1
Doornkop R1 201/m	• % cost per month to household income	1.0	1.0	1.0	Cheap			
					Affordable			
	• Non-payment levels	30	30	30	Expensive			
					Unaffordable	1	1	1
Lindhaven R6 462/m	• % cost per month to household income	0.2	0.2	0.2	Cheap	4	4	4
					Affordable			
	• Non-payment levels	1	1	1	Expensive			
					Unaffordable			
Princess R2 461/m	• % cost per month to household income	0.5	0.5	0.5	Cheap			
					Affordable	3	3	
	• Non-payment levels	2	2	40	Expensive			
					Unaffordable			1

5.5 Local roads

Although roads infrastructure are the most obvious and noticeable engineering service under discussion, information regarding the level of service and especially the maintenance portion was difficult to compile. No information regarding roads or even transport is available from Census data. Various assumptions were necessary in this regard. It was also necessary to consult old layout plans of the areas involved. Most of the information is based on best estimates for the year 1993 and even 1997.

5.5.1 Roads infrastructure quality

The levels of service for the roads infrastructure installed in the townships were tabulated and are reflected in **Table 5.14**. The descriptions for the levels of service for roads make it easy to compile data for index calculation.

Table 5.14: Roads infrastructure quality

Township	Number of Households 1993	Number of Households 1997	Number of Households 2001	Level of Service	Index 1993	Index 1997	Index 2001
Davidsonville	0*	0	0	Minimal			
	0*	0	0	Basic			
	165*	165	65	Intermediate	3.81	3.81	3.92
	700*	700	800	Full			
Dobsonville	0	0	0*	Minimal			
	6 980	6 980	4 000*	Basic	2.65	2.65	2.79
	13 200	13 200	15 200*	Intermediate			
	0	0	0*	Full			
Doornkop	0	0	0	Minimal			
	6 056	6 056	0	Basic	2.00	2.00	
	0	0	6 065	Intermediate			3.00
	0	0	0	Full			
Lindhaven	0	0	0	Minimal			
	0	0	0	Basic			
	0	0	0	Intermediate			
	1 105	1 105	1 105	Full	4.00	4.00	4.00
Princess	0	0	0	Minimal			
	0	0	0	Basic			
	100	100	100	Intermediate	3.90	3.90	3.97
	885	885	2 885	Full			

Notes: * No reliable data available. Data used from 1996 census
1 Estimated number of squatter households settled on Plot 61 south of Westgate

5.5.2 Road maintenance efficiency

Table 5.15 was constructed for the 5 townships chosen. The values were obtained by interviewing officials from the Johannesburg Roads Agency as well as through accessing databases of logged complaints.

The Johannesburg Roads Agency has standby units to deal with emergencies such as over silting during thunderstorms and pothole fixing. The normal fixing of reported pothole complaints are completed on a daily basis. Potholes reported during the afternoon are therefore only fixed during working hours the following day resulting in a lower than expected response time.

Table 5.15: Road maintenance efficiency

Township	KPI	Value 1993	Value 1997	Value 2001	Level of Service	Value 1993	Value 1997	Index 2001
Davidsonville	• Lack of rideability of roads	*	*	5	No service			
	• Response time to pothole repairs	*	*	10	Major problems			
					Minor problems	3	3	3
					No problems			
Dobsonville	• Lack of rideability of roads	#	15	9	No service			
	• Response time to pothole repairs	#	10	10	Major problems		2	
					Minor problems	3		3
					No problems			
Doornkop	• Lack of rideability of roads	#	15	15	No service			
	• Response time to pothole repairs	#	10	10	Major problems		2	2
					Minor problems	3		
					No problems			
Lindhaven	• Lack of rideability of roads	*	*	4	No service			
	• Response time to pothole repairs	*	*	5	Major problems			
					Minor problems			
					No problems	4	4	4
Princess	• Lack of rideability of roads	*	*	5	No service			
	• Response time to pothole repairs	*	*	5	Major problems			
					Minor problems			3
					No problems	4	4	

Notes: * No reliable data available. Data used from 1996 census
World Bank's evaluation for the period utilised namely "minor problems" for both Dobsonville & Doornkop

5.5.3 Access to roads infrastructure

Layout plans were consulted to meas ure the number of household outside the 500m access radius to all weather roads. **Table 5.16** reflects the relevant data for the five townships.

Table 5.16: Access to roads infrastructure

Township	KPI	1993	1997	2001	Level of Access	Index 1993	Index 1997	Index 2001
Davidsonville	Percentage households within 500m of all weather roads	100	100	100	No			
					Limited			
					Part			
					Full	4	4	4
Dobsonville	Percentage households within 500m of all weather roads	90	90	95	No			
					Limited			
					Part	3	3	
					Full			4
Doornkop	Percentage households within 500m of all weather roads	50	85	90	No	1		
					Limited		2	
					Part			3
					Full			
Lindhaven	Percentage households within 500m of all weather roads	100	100	100	No			
					Limited			
					Part			
					Full	4	4	4
Princess	Percentage households within 500m of all weather roads	95	95	98	No			
					Limited			
					Part			
					Full	4	4	4

5.5.4 Affordability of roads infrastructure

Utilizing the Household income data available in the 1996 Census database as well as best estimates for transportation costs for commuters, percentage of household incomes were calculated. These costs are much lower than expected and will perhaps require revising. The analysis of the affordability of roads infrastructure however indicate that the nonpayment levels is the biggest determining factor and small changes in percentage transportation costs do not necessarily effect the index.

Table 5.17: Affordability of roads infrastructure

Township	KPI	1993	1997	2001	Level of Affordability	Index 1993	Index 1997	Index 2001
Davidsonville R80/m	• % ratio of transport cost per month to household income	3.5	3.5	3.5	Cheap			
					Affordable			
					Expensive	2	2	2
	• Non-payment levels	10	15	15	Unaffordable			
Dobsonville	• % ratio of transport cost per month to household income	4.2	4.2	4.2	Cheap			
					Affordable			
					Expensive			
	• Non-payment levels	50	50	50	Unaffordable	1	1	1
Doornkop	• % ratio of transport cost per month to household income	6.7	6.7	6.7	Cheap			
					Affordable			
					Expensive			
	• Non-payment levels	30	30	30	Unaffordable	1	1	1
Lindhaven	• % ratio of transport cost per month to household income	1.2	1.2	1.2	Cheap			
					Affordable	3	3	3
					Expensive			
	• Non-payment levels	1	1	1	Unaffordable			
Princess	• % ratio of transport cost per month to household income	3.3	3.3	3.3	Cheap			
					Affordable	3	3	
					Expensive			
	• Non-payment levels	2	2	40	Unaffordable			1

5.6 Stormwater drainage

As was stated in the previous chapter, splitting of roads and stormwater services for index calculation was a difficult decision as most information is gathered and tasks performed in the same department. Township roads are also designed to act as stormwater channels. Maintenance to a road in some respects could therefore also be classified as stormwater maintenance. Distinct information regarding stormwater was difficult to obtain and best estimates, discussions and memories were tapped to compile the data.

5.6.1 Stormwater infrastructure quality

The levels of service for the stormwater infrastructure installed in the townships were tabulated and are reflected in **Table 5.18**. The descriptions for the levels of service for stormwater make it easy to compile data for index calculation.

Table 5.18: Stormwater infrastructure quality

Township	Number of Households 1993	Number of Households 1997	Number of Households 2001	Level of Service	Index 1993	Index 1997	Index 2001
Davidsonville	0*	0	0	Minimal			
	0*	0	0	Basic			
	165*	165	65	Intermediate	3.81	3.81	3.92
	700*	700	800	Full			
Dobsonville	0	0	0*	Minimal			
	6 980	6 980	4 000*	Basic	2.65	2.65	2.79
	13 200	13 200	15 200*	Intermediate			
	0	0	0*	Full			
Doornkop	0	0	0	Minimal			
	6 056	6 056	0	Basic	2.00	2.00	
	0	0	6 065	Intermediate			3.00
	0	0	0	Full			
Lindhaven	0	0	0	Minimal			
	0	0	0	Basic			
	0	0	0	Intermediate			
	1 105	1 105	1 105	Full	4.00	4.00	4.00
Princess	0	0	0	Minimal			
	0	0	0	Basic			
	100	100	100	Intermediate	3.90	3.90	3.97
	885	885	2 885	Full			

Notes: * No reliable data available. Data used from 1996 census
1 Estimated number of squatter households settled on Plot 61 south of Westgate

5.6.2 Stormwater maintenance efficiency

Table 5.19 was constructed for the 5 townships chosen. The values were obtained by interviewing officials from the Johannesburg Roads Agency as well as through accessing databases of logged complaints.

Officials at the Hamburg depot in Roodepoort provide information regarding catch-pit maintenance, obstruction clearing and routine maintenance for the stormwater systems in the townships.

Table 5.19: Stormwater maintenance efficiency

Township	KPI	1993	1997	2001	Level of service	Index 1993	Index 1997	Index 2001
Davidsonville	• Inability of the drainage system to cope with design floods	*	*	5	No service			
	• Response time to blockages	*	*	10	Major problems			
					Minor problems	3	3	3
					No problems			
Dobsonville	• Inability of the drainage system to cope with design floods	#	*	9	No service			
	• Response time to blockages	#	*	10	Major problems			
					Minor problems	3	3	3
					No problems			
Doornkop	• Inability of the drainage system to cope with design floods	#	*	9	No service			
	• Response time to blockages	#	*	10	Major problems			
					Minor problems	3	3	3
					No problems			
Lindhaven	• Inability of the drainage system to cope with design floods	*	*	4	No service			
	• Response time to blockages	*	*	5	Major problems			
					Minor problems			
					No problems	3	3	3
Princess	• Inability of the drainage system to cope with design floods	*	*	9	No service			
	• Response time to blockages	*	*	10	Major problems			
					Minor problems	3	3	3
					No problems			

Notes: * No reliable data available. Data used from 1996 census
World Bank's evaluation for the period utilised namely "minor problems" for both Dobsonville & Doornkop

5.6.3 Access to stormwater infrastructure

The access to stormwater infrastructure is similar to the access to roads infrastructure. The same data was used to compile **Table 5.20**.

Table 5.20: Access to stormwater infrastructure

Township	KPI	1993	1997	2001	Level of Access	Index 1993	Index 1997	Index 2001
Davidsonville	Percentage households within 500m of all weather roads	100	100	100	No Limited Part Full	 4	 4	 4
Dobsonville	Percentage households within 500m of all weather roads	100	100	100	No Limited Part Full	 4	 4	 4
Doornkop	Percentage households within 500m of all weather roads	100	100	100	No Limited Part Full	 4	 4	 4
Lindhaven	Percentage households within 500m of all weather roads	100	100	100	No Limited Part Full	 4	 4	 4
Princess	Percentage households within 500m of all weather roads	100	100	100	No Limited Part Full	 4	 4	 4

Notes: * No reliable data available. Data used from 1996 census
1 Estimated number of squatter households settled on Plot 61 south of Westgate

5.6.4 Affordability of stormwater infrastructure

The same data used for the compilation of affordability of roads infrastructure was used to compile **Table 5.21** to reflect affordability of stormwater infrastructure.

Table 5.21: Affordability of stormwater infrastructure

Township	KPI	1993	19997	2001	Level of Affordability	Index 1993	Index 1997	Index 2001
Davidsonville	• % ratio of transport cost per month to household income	3.5	3.5	3.5	Cheap			
					Affordable			
	• Non-payment levels				Expensive	2	2	2
		10	15	15	Unaffordable			
Dobsonville	• % ratio of transport cost per month to household income	4.2	4.2	4.2	Cheap			
					Affordable			
	• Non-payment levels				Expensive			
		50	50	50	Unaffordable	1	1	1
Doornkop	• % ratio of transport cost per month to household income	6.7	6.7	6.7	Cheap			
					Affordable			
	• Non-payment levels				Expensive			
		30	30	30	Unaffordable	1	1	1
Lindhaven	• % ratio of transport cost per month to household income	1.2	1.2	1.2	Cheap			
					Affordable	3	3	3
	• Non-payment levels				Expensive			
					Unaffordable			
Princess	• % ratio of transport cost per month to household income	3.3	3.3	3.3	Cheap			
					Affordable	3	3	
	• Non-payment levels				Expensive			
		2	2	40	Unaffordable			1

Notes: * No reliable data available. Data used from 1996 census
1 Estimated number of squatter households settled on Plot 61 south of Westgate

5.7 Electricity

Two different service providers for electricity are operating in the townships. Doornkop and Dobsonville are serviced by ESKOM, while Lindhaven, Davidsonville and Princes are services by City Power. Information regarding these services were obtained from officials at these utilities.

5.7.1 Electricity infrastructure quality

The 1996 Population Census does not classify the levels of electrical services. It only states which energy sources are utilised for lighting. Fairly good assumptions and were made and figures were confirmed by the respective utilities. Data from the reports of the World Bank in 1993 as well as 2001 were scrutiniz ed to compile the information tabulated in **Table 5.22**.

Table 5.22: Electricity infrastructure quality

Township	Number of Households 1993	Number of Households 1997	Number of Households 2001	Level of Service	Index 1993	Index 1997	Index 2001
Davidsonville	*	92	92	Minimal			
	*	0	0	Basic			
	*	0	0	Intermediate	3.69	3.69	3.69
	*	773	773	Full			
Dobsonville	0	937	937	Minimal			
	6 980	6 980	6 980	Basic			
	0	0	0	Intermediate	3.31	3.13	3.13
	13 200	11 325	11 325	Full			
Doornkop	0	2 794	1000	Minimal			
	0	0	0	Basic		2.83	2.83
	6 065	7 972	11 000	Intermediate	3.00		
	0	0	0	Full			
Lindhaven	*	7	7	Minimal			
	*	0	0	Basic			
	*	0	0	Intermediate	3.98	3.98	3.98
	*	1 089	1 089	Full			
Princess	*	7	2 000[1]	Minimal		3.97	1.75
	*	0	0	Basic			
	*	0	0	Intermediate	3.97		
	*	670	670	Full			

Notes: * No reliable data available. Data used from 1996 census
1 Estimated number of squatter households settled on Plot 61 south of Westgate

5.7.2 Electricity supply efficiency

Table 5.23 was constructed for the 5 townships chosen. The values were obtained by interviewing officials from ESKOM and the Water Utility as well as through accessing databases of logged complaints.

Table 5.23: Electricity supply efficiency

Township	KPI	Value 1993	Value 1997	Value 2001	Level of Service	Index 1993	Index 1997	Index 2000
Davidsonville	• Unplanned interruptions: percentage days per year	*	4	4	No service			
					Major problems			
	• Line losses: percentage power unaccounted for	*	5	5	Minor problems			
					No problems	4	4	4
Dobsonville	• Unplanned interruptions: percentage days per year	#	5	5	No service			
					Major problems			
	• Line losses: percentage power unaccounted for	#	10	10	Minor problems	3	3	3
					No problems			
Doornkop	• Unplanned interruptions: percentage days per year	#	5	5	No service			
					Major problems			
	• Line losses: percentage power unaccounted for	#	5	5	Minor problems		3	3
					No problems	4		
Lindhaven	• Unplanned interruptions: percentage days per year	*	2	2	No service			
					Major problems			
	• Line losses: percentage power unaccounted for	*	3	3	Minor problems			
					No problems	4	4	4
Princess	• Unplanned interruptions: percentage days per year	*	4	5	No service			
					Major problems			
	• Line losses: percentage power unaccounted for	*	5	5	Minor problems			3
					No problems	4	4	

Notes: * No reliable data available. Data used from 1996 census
World Bank's evaluation for the period utilised namely "minor problems" for Dobsonville & "no problems" for Doornkop

5.7.3 Access to electricity supply

Table 5.24 was constructed for the 5 townships chosen. Information was calculated using simple spreadsheet operations. The tables are attached as annexure.

Table 5.24: Access to electricity supply

Township	KPI	1993	1997	2001	Level of Access	Index 1993	Index 1997	Index 2001
Davidsonville	% households connected	89.4	89.4	89.4	No			
					Limited			
					Part	3	3	3
					Full			
Dobsonville	% households connected	100	100	100	No			
					Limited			
					Part			
					Full	4	4	4
Doornkop	% households connected	100	74	74	No			
					Limited		2	2
					Part			
					Full	4		
Lindhaven	% households connected	99.4	99.4	99.4	No			
					Limited			
					Part			
					Full	4	4	4
Princess	% households connected	99	99	25.1	No			
					Limited			2
					Part			
					Full	4	4	

Notes: * No reliable data available. Data used from 1996 census
1 Estimated number of squatter households settled on Plot 61 south of Westgate

5.7.4 Affordability of electricity

Utilizing the household income information available in the 1996 Census database, **Table 5.25** was constructed for the 5 townships chosen.

Table 5.25: Affordability of electricity

Township	KPI	1993	1997	2001	Level of Affordability	Index 1993	Index 1997	Index 2001
Davidsonville R2 293/m R12/50kWh	• % cost per month to household income	0.5	0.5	0.5	Cheap			
					Affordable			
	• Non-payment levels	10	15	15	Expensive	2	2	2
					Unaffordable			
Dobsonville R1 889/m	• % cost per month to household income	0.6	0.6	0.6	Cheap			
					Affordable			
	• Non-payment levels	50	50	50	Expensive			
					Unaffordable	1	1	1
Doornkop R1 201/m	• % cost per month to household income	1.0	1.0	1.0	Cheap			
					Affordable			
	• Non-payment levels	30	30	30	Expensive			
					Unaffordable	1	1	1
Lindhaven R6 462/m	• % cost per month to household income	0.2	0.2	0.2	Cheap	4	4	4
					Affordable			
	• Non-payment levels	1	1	1	Expensive			
					Unaffordable			
Princess R2 461/m	• % cost per month to household income	0.5	0.5	0.5	Cheap			
					Affordable	3	3	
	• Non-payment levels	2	2	40	Expensive			
					Unaffordable			1

Notes: * No reliable data available. Data used from 1996 census
1 Estimated number of squatter households settled on Plot 61 south of Westgate

5.8 Refuse collection

Information regarding refuse collection was available from officials at the city's refuse collection utility, PIKITUP. Classifications in the Population Census conform to the classifications used for this thesis. Additional information was extracted from the 1993 and 2001 World Bank reports.

5.8.1 Refuse collection infrastructure quality

The levels of service defined for water infrastructure are not too dissimilar from the information available in the Population Census. Utilizing the 1996 Census database, **Table 5.26** was constructed for the 5 townships chosen.

Table 5.26: Refuse collection infrastructure quality

Township	Number of Households 1993	Number of Households 1997	Number of Households 2001	Level of Service	Index 1993	Index 1997	Index 2001
Davidsonville	*	5	5	Minimal			
	*	51	51	Basic			
	*	7	7	Intermediate	3.86	3.86	3.86
	*	802	802	Full			
Dobsonville	0	534	534	Minimal			
	6 980	1 183	1183	Basic			
	0	186	186	Intermediate	3.31	3.78	3.78
	13 200	17 340	17 340	Full			
Doornkop	0	500	500	Minimal			
	0	308	308	Basic			
	6 065	171	171	Intermediate	3.00	3.79	3.79
	0	9 787	9 787	Full			
Lindhaven	*	1	1	Minimal			
	*	32	32	Basic			
	*	0	0	Intermediate	3.94	3.94	3.94
	*	1 072	1 072	Full			
Princess	*	41	41	Minimal			
	*	17	2 000[1]	Basic			2.54
	*	288	288	Intermediate	3.57	3.57	
	*	699	699	Full			

Notes: * No reliable data available. Data used from 1996 census
1 Estimated number of squatter households settled on Plot 61 south of Westgate

5.8.2 Refuse collection efficiency

Table 5.27 was constructed for the 5 townships chosen. The values were obtained by interviewing officials from PIKITUP as well as through accessing databases of logged complaints.

Table 5.27: Refuse collection efficiency

Township	KPI	Value 1993	Value 1997	Value 2001	Level of Service	Index 1993	Index 1997	Index 2001
Davidsonville	• % scheduled rounds not performed on time pa	*	4	4	No service			
	• Measure of un-cleanliness	*	7	5	Major problems			
					Minor problems	3	3	
					No problems			4
Dobsonville	• % scheduled rounds not performed on time pa	#	5	5	No service			
	• Measure of un-cleanliness	#	10	10	Major problems			
					Minor problems	3	3	3
					No problems			
Doornkop	• % scheduled rounds not performed on time pa	#	5	5	No service			
	• Measure of un-cleanliness	#	10	10	Major problems			
					Minor problems	3	3	3
					No problems			
Lindhaven	• % scheduled rounds not performed on time pa	*	2	2	No service			
	• Measure of un-cleanliness	*	3	5	Major problems			
					Minor problems			
					No problems	4	4	4
Princess	• % scheduled rounds not performed on time pa	*	3	3	No service			
	• Measure of un-cleanliness	*	5	10	Major problems			
					Minor problems			3
					No problems	4	4	

Notes: * No reliable data available. Data used from 1996 census

\# World Bank's evaluation for the period utilised namely "minor problems" for both Dobsonville & Doornkop

5.8.3 Access to refuse collection service

Simple spreadsheet calculations were performed to compile **Table 5.28** for the 5 townships chosen.

Table 5.28: Access to refuse collection service

Township	KPI	1993	1997	2001	Level of Access	Index 1993	Index 1997	Index 2001
Davidsonville	% households with access to minimum level of service	99.4	99.4	99.4	No			
					Limited			
					Part			
					Full	4	4	4
Dobsonville	% households with access to minimum level of service	100	97.2	95.1	No			
					Limited			
					Part			
					Full	4	4	4
Doornkop	% households with access to minimum level of service	100	95.4	95.4	No			
					Limited			
					Part			
					Full	4	4	4
Lindhaven	% households with access to minimum level of service	99.9	99.9	99.9	No			
					Limited			
					Part			
					Full	4	4	4
Princess	% households with access to minimum level of service	99	96.1	98.6	No			
					Limited			
					Part			
					Full	4	4	4

Notes: * No reliable data available. Data used from 1996 census
1 Estimated number of squatter households settled on Plot 61 south of Westgate

5.8.4 Affordability of refuse services

Utilizing the household income information available in the 1996 Census database, **Table 5.29** was constructed for the 5 townships chosen.

Table 5.29: Affordability of refuse service

Township	KPI	1993	1997	2001	Level of Affordability	Index 1993	Index 1997	Index 2001
Davidsonville R20/m	• % refuse collection cost per month to household income	0.9	0.9	0.9	Cheap			
					Affordable			
					Expensive	2	2	2
	• Non-payment levels	10	15	15	Unaffordable			
Dobsonville	• % refuse collection cost per month to household income	1.1	1.1	1.1	Cheap			
					Affordable			
					Expensive			
	• Non-payment levels	50	50	50	Unaffordable	1	1	1
Doornkop	• % refuse collection cost per month to household income	1.7	1.7	1.7	Cheap			
					Affordable			
					Expensive			
	• Non-payment levels	30	30	30	Unaffordable	1	1	1
Lindhaven R40/m	• % refuse collection cost per month to household income	0.6	0.6	0.6	Cheap	4	4	4
					Affordable			
					Expensive			
	• Non-payment levels	1	1	1	Unaffordable			
Princess R35/m	• % refuse collection cost per month to household income	1.4	1.4	1.4	Cheap			
					Affordable	3	3	
					Expensive			
	• Non-payment levels	2	2	40	Unaffordable			1

Notes: * No reliable data available. Data used from 1996 census
1 Estimated number of squatter households settled on Plot 61 south of Westgate

5.9 Evaluation

It became clear after this data collection exercise that unless municipalities find most of the information readily available from other sources such as the population Census, index calculation will merely become another one of that extensive list of functions that municipalities will perform in stead of becoming a useful aid. A large portion of the information was readily available from the Census data. The problem is that census data only becomes available every four years. For planning and performance management purposes, the period of determination of a service delivery index should ideally not exceed one year.

All the data collected was utilised in spreadsheet format per township for a specific period. The different townships can be viewed in **ANNEXURE 2** and easy comparisons are now possible. In order to demonstrate the population and calculation phase of the index, examples are provided in the following chapter.

6 Analysis

6.1 Introduction

All the data necessary to calculate the service delivery index were collected as shown in the previous chapter and the only thing remaining is to aggregate the different indices into a single composite index. The simplified aggregation process of allocating equal weightings to the respective measured components of the engineering services, as was described in **CHAPTER 4**, was used to first, compile engineering services indices and finally, calculate the service delivery index (SDI).

6.2 Engineering services index

In order to avoid repetition, only water services are discussed in detail in the text part of the thesis. All relevant data regarding sewerage, roads, stormwater, electricity and refuse are tabulated and attached as **ANNEXURE 2**.

Tabulating and plotting the values of the respective engineering service indices for a particular township as a function of time displays interesting trends. **Table 6.1** reflects the respective indices for water for the five townships over the eight-year period.

Table 6.1: Water index

Township	Year	Quality Index	Efficiency Index	Accessibility Index	Affordability Index	Water Index
Davidsonville	1993	3.84	4	4	2	3.46
	1997	3.84	4	4	2	3.46
	2001	3.84	4	4	2	3.46
Dobsonville	1993	3.31	2	1	1	1.83
	1997	3.51	2	4	1	2.63
	2001	3.51	2	4	1	2.63
Doornkop	1993	2.00	4	1	1	2.00
	1997	2.79	2	1	1	1.70
	2001	3.06	2	3	1	2.66
Lindhaven	1993	3.95	4	4	4	3.99
	1997	3.95	4	4	4	3.99
	2001	3.95	4	4	4	3.99
Princess	1993	3.66	4	4	3	3.66
	1997	3.66	4	4	3	3.66
	2001	2.55	2	1	1	1.64

Plotting bar charts of the respective water indices for the five townships provided interesting pictorial representations of the trends followed fort he respective indices. **Figures 6.1** to **6.5** clearly reflect these trends.

Figure 6.1: Water index

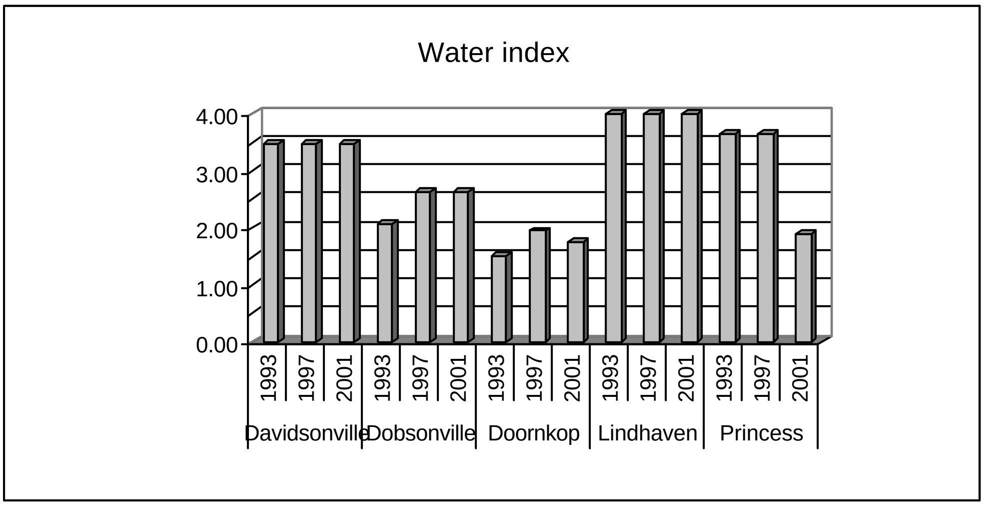


Figure 6.2: Water infrastructure quality index

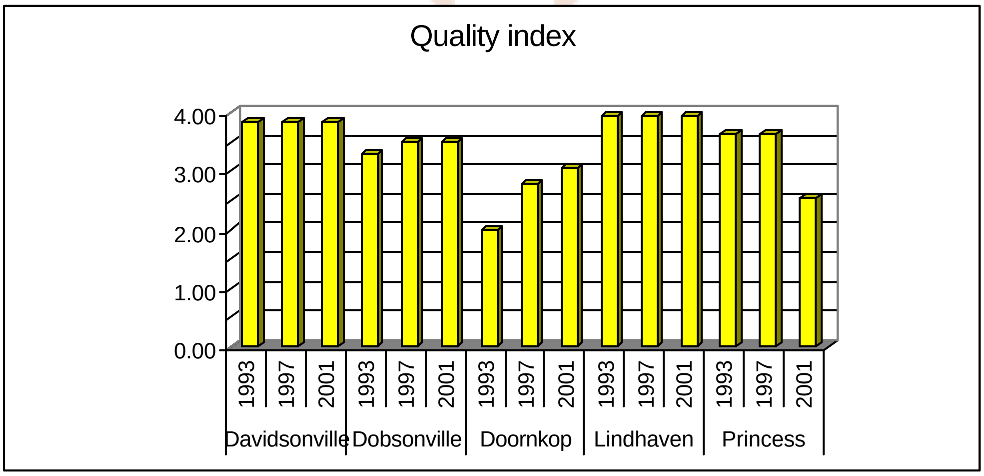


Figure 6.3: Water delivery efficiency index

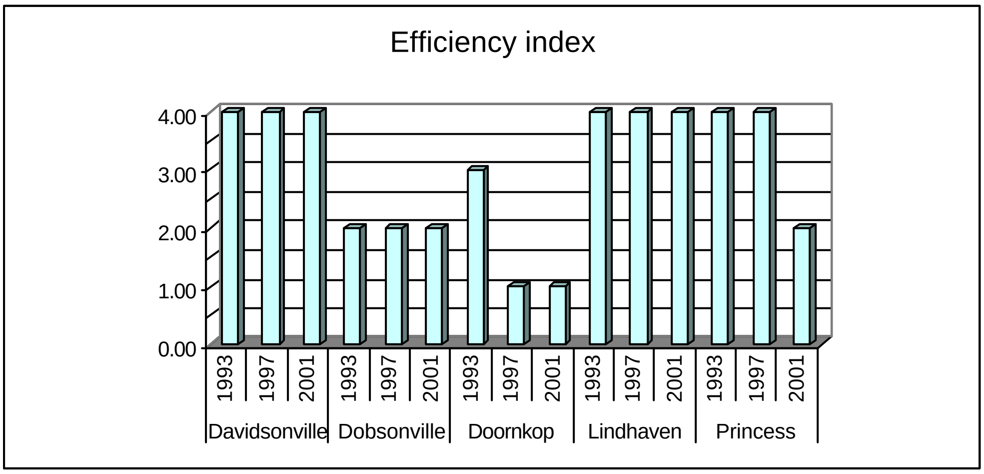


Figure 6.4: Water accessibility index

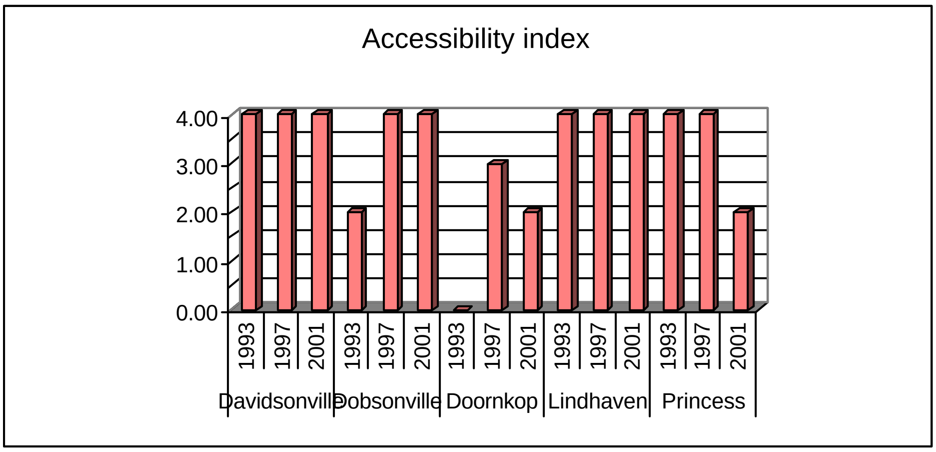
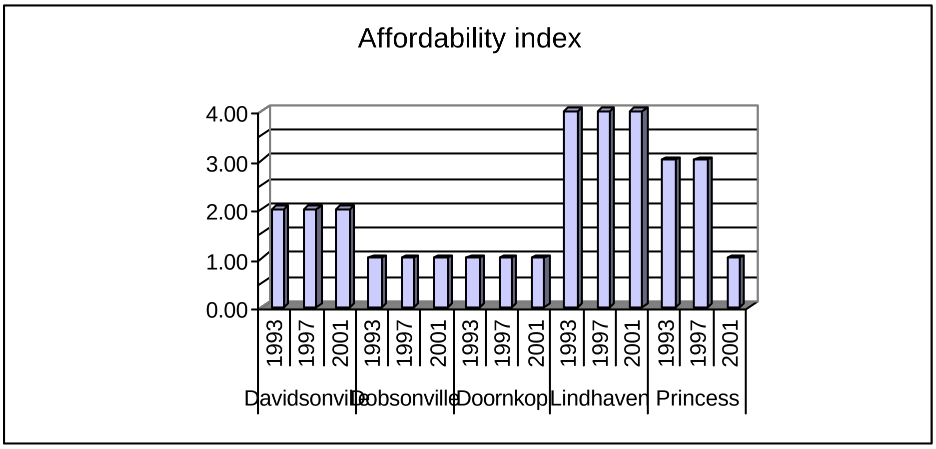


Figure 6.5: Water affordability index



6.3 Service delivery index

In order to calculate the service delivery index for a township at a specific date, it is necessary to determine the average of the engineering services indices. An engineering service index is calculated by determining the average of the four sub-indices for the service.

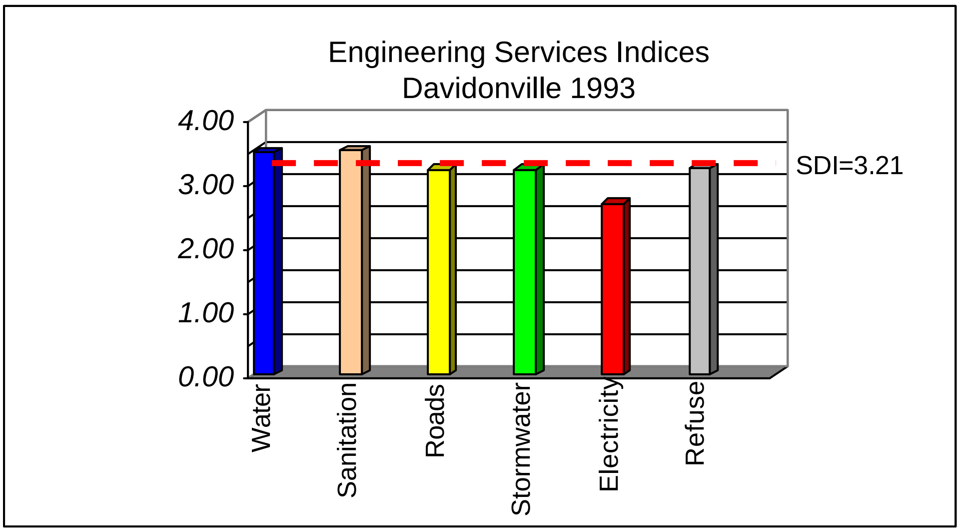
For example, to calculate the service delivery index for Davidsonville in 1993 the following simple calculations are necessary as indicated in **Table 6.2**.

Table 6.2: Service delivery index aggregation: Davidsonville 1993

Township	Quality Index	Efficiency Index	Accessibility Index	Affordability Index	Engineering Service Index	SDI
Water	3.84	4	4	2	3.46	3.21
Sanitation	3.98	4	4	2	3.50	
Roads	3.81	3	4	2	3.20	
Stormwater	3.81	3	4	2	3.20	
Electricity	3.68	4	2	1	2.67	
Refuse	3.86	3	4	2	3.21	

Figure 6.6 reflects the respective engineering services indices for Davidsonville in 1993.

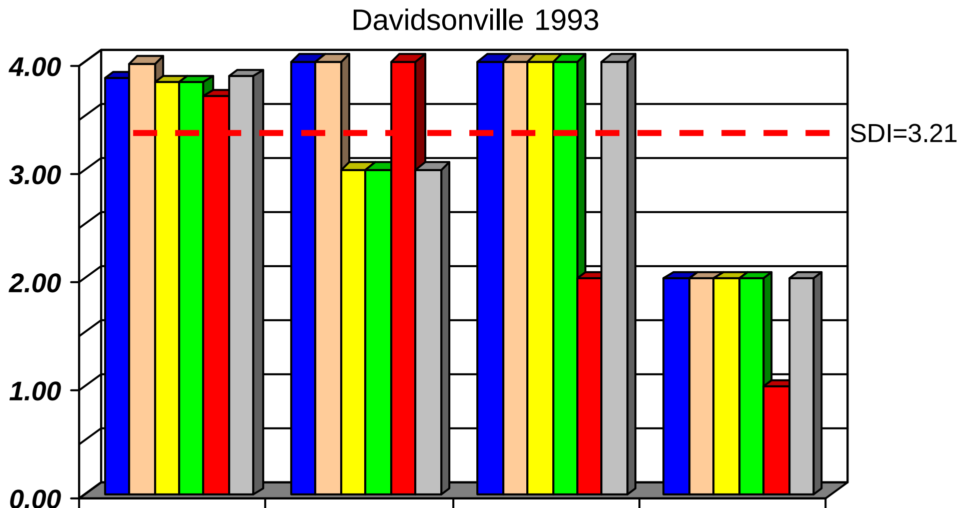
Figure 6.6: Engineering services indices



The service delivery index (SDI) calculated for Davidsonville in 1993 was 3.21. This value is indicated on the graph and clearly indicates where the respective services fall in relation to this average.

Another useful depiction of the service delivery matrix is the data matrix reflected in **Figure 6.7**. All the services sub-indices can be seen at a glance and the values are clearly displayed.

Figure 6.7: Service delivery matrix graph

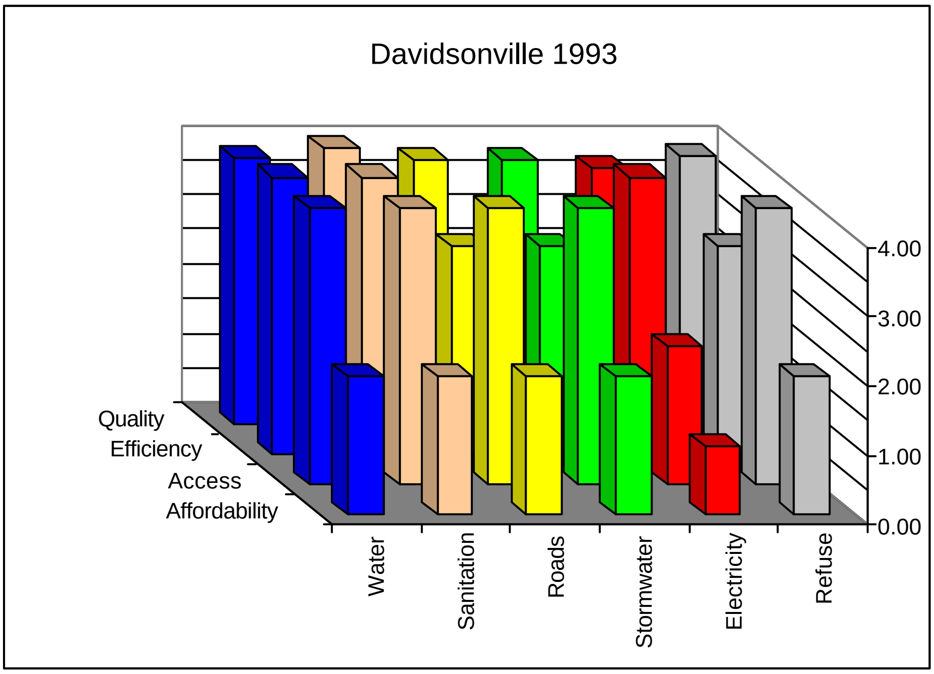


	Quality	Efficiency	Access	Affordability
Water	3.84	4.00	4.00	2.00
Sanitation	3.98	4.00	4.00	2.00
Roads	3.81	3.00	4.00	2.00
Stormwater	3.81	3.00	4.00	2.00
Electricity	3.68	4.00	2.00	1.00
Refuse	3.86	3.00	4.00	2.00

Each aspect of each service can be compared individually to the service delivery index (SDI or average), which is 3.21 in the Davidsonville 1993 instance. It should be easy to observe that affordability of all the services is problematic in this area as all the services plot below the SDI. Reasons for this under par performance can be uncovered easily by simply drilling down in the service delivery matrix. The color-coding of services also assists in immediately identifying respective services without consulting legends.

Perhaps the three-dimensional graph depicted in **Figure 6.8** provides the best snapshot of the township. This graph is also displayed on the service delivery matrix as indicated in the annexure. Together with the locality map, these two pictures provide an excellent image of the township.

Figure 6.8: Three-dimensional graph



6.4 Other graphical presentations

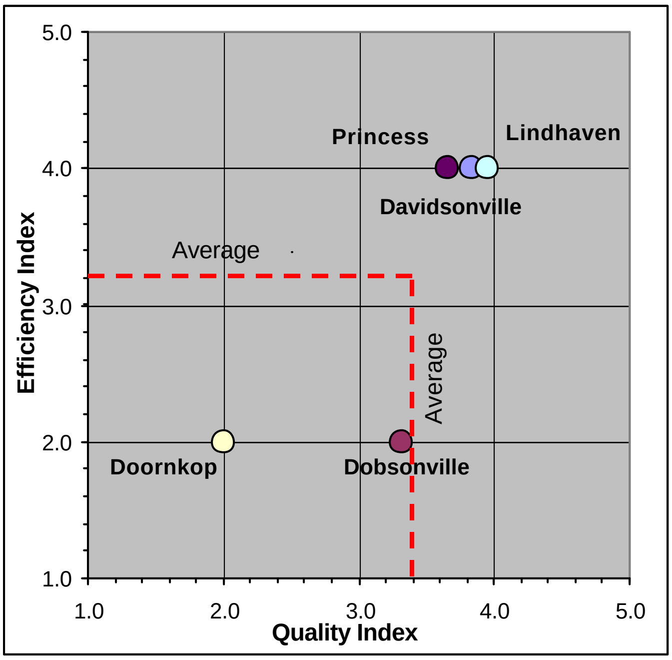
The graphical presentations of the indices provide a mental picture of what is happening in a specific township with regards to engineering services. This was not previously possible without elaborate descriptions and endless perusals of engineering drawings. The index system of describing engineering services also provides the opportunity to compare different indices by plotting them on the same graph. For example, it is possible to plot all the water quality indices and the efficiency indices for different townships on a single graph.

Figure 6.9 depicts the water situation in terms of the infrastructure installed for the different townships, compared to how it actually functions. It is, therefore, possible for a water engineer to understand at a glance, exactly how the water infrastructure is functioning in the different townships.

The graph also provides a snapshot of the water services in 1993. By plotting the water quality index (average) line and the water efficiency index (average) for the townships in 1993, townships can be evaluated relative to these lines. Although these lines do not represent anything specific other than the average, the comparisons (above or below the line) provides an valuable understanding of which townships are lagging and which ones are performing well. This can be seen in **Figure 6.9**, where Doornkop and Dobsonville fall below the average lines and are clearly lagging behind the other three townships.

The graph also tells a story about the water services in the townships. For example, it can be seen that although the infrastructure installed in Dobsonville compares favorably to the rest of the townships, it is not functioning well compared to the other townships.

Figure 6.9: Water services indices 1993

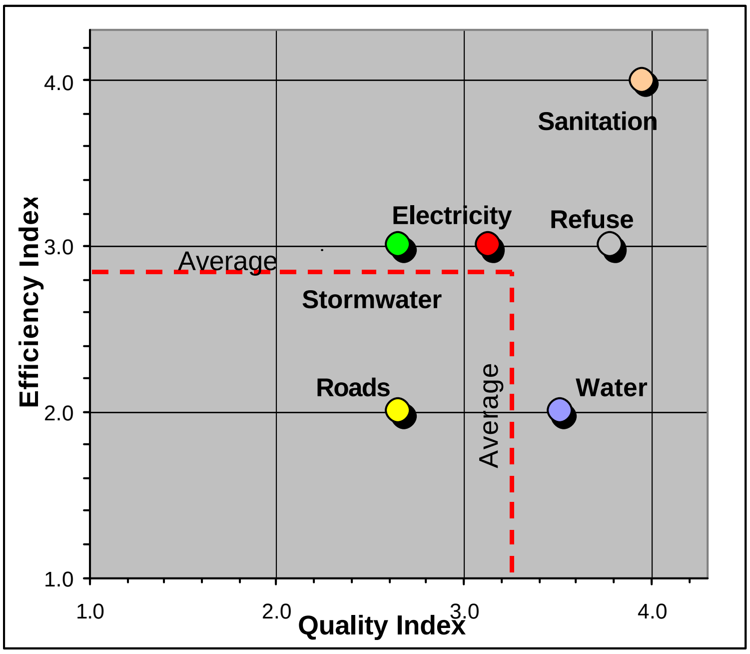


In addition, by plotting the same water graphs for the following years clear trends can be established. Similar graphs can be drawn for all other engineering services, as all the information is now available.

This is an enormously useful tool to monitor and manage service delivery in the respective engineering service departments. Similarly, by plotting all the quality indices and all the efficiency indices of the different services for a specific township on the same graph, a clear picture can be obtained of the respective services in the township. For example, it can be seen from **Figure 6.10** that both the roads infrastructure and the functioning thereof in Dobsonville in 1997 were not up to standard, compared with the other services in the area. The position of the water services dot also indicates that although the water infrastructure in the township is of a high standard (level of service), it is functioning below par.

By plotting the average line for the quality and efficiency indices, services can again be grouped and compared. As was the case with **Figure 6.10**, although this average line does not represent anything in particular, it assists with the mental picture of classification.

Figure 6.10: Dobsonville services 1997



6.5 Upgrading estimates

What should be interesting to note at this stage is that an increase in the quality index would require an increase in capital expenditure. The relationship is much less complicated than expected. The only information required is installation costs for different levels of services.

Much of this work has already been done by the author in a previous Masters Dissertation where calculations were made for different services costs for townships with varying residential densities. Capital costs per stand for services were calculated and compared with townships with different densities. The results were plotted to determine trends. An example is displayed in **Figure 6.11** for water infrastructure.

Similar graphs can be compiled for different levels of service. An example for illustrative purposes is depicted in **Figure 6.12**. By knowing the density of the township, upgrading costs to a higher service level can be read off the graph. Multiplying this cost with the number of stands requiring upgrading gives the total capital cost required. Although these costs are dependant on numerous variables such as location, terrain, materials, size of the project, etc allowances can be made that will provide fairly accurate estimates - at least better than previous estimation method for budget purposes.

Figure 6.11: Water installation costs for varying residential densities

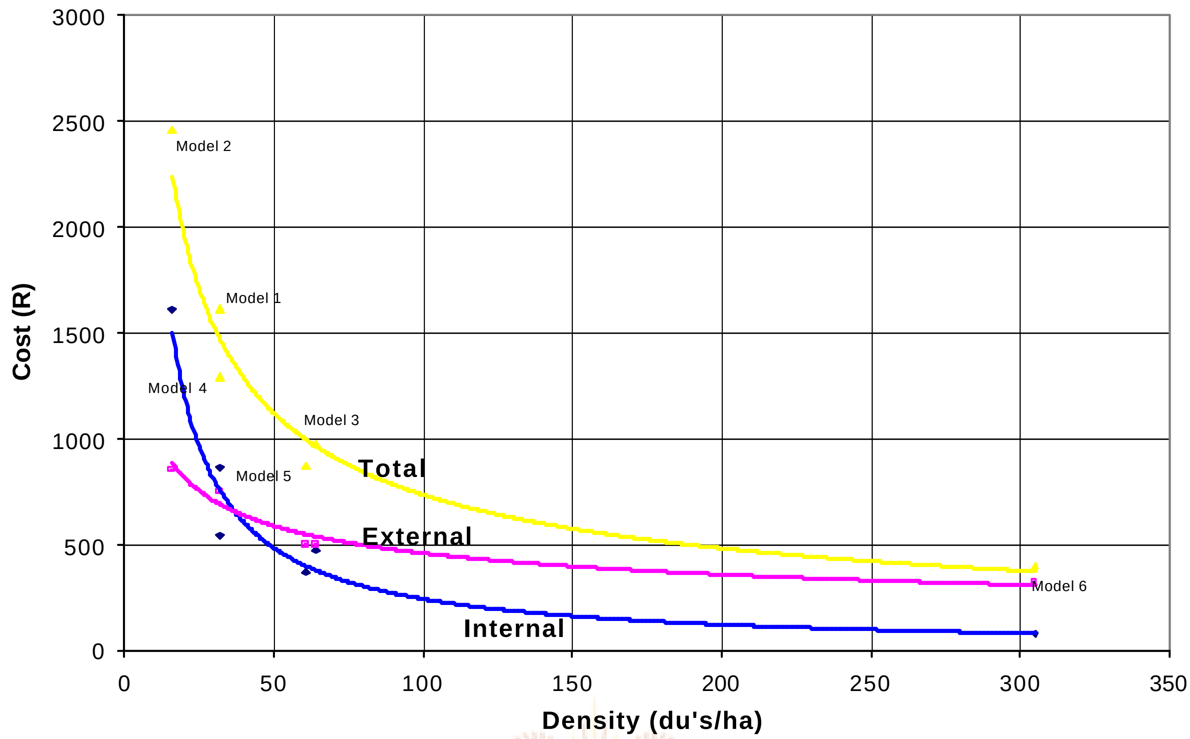
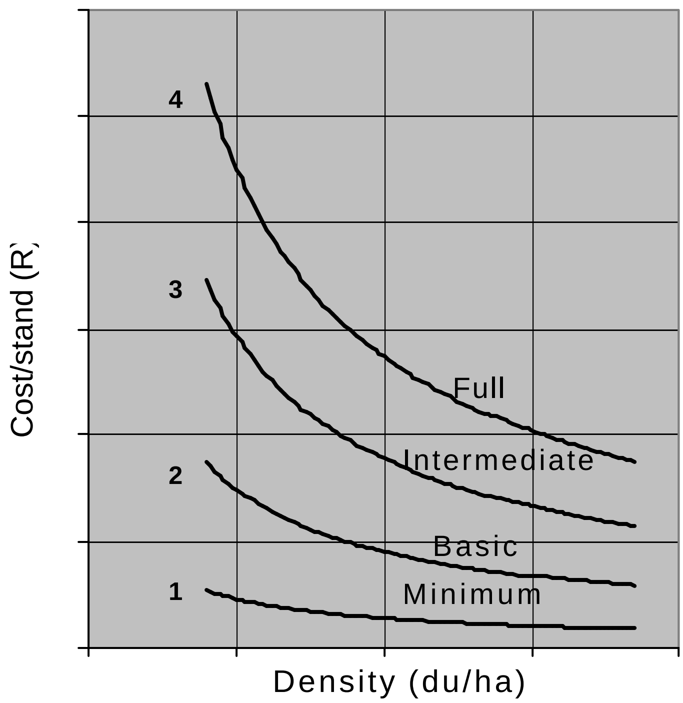


Figure 6.12: Water installation costs for varying residential densities



This simple index method can now be used for benchmarking purposes and with the application of algorithms, a powerful tool can be produced to manage capital and operating resources for township services infrastructure.

6.6 GIS applications

Plotting different aspects of the service delivery index of different townships or different services with the aid of a GIS system is a simple exercise. **ANNEXURE 2** displays some of its applications and depending on the requirements different aspects can be highlighted.

Figure 6.13 demonstrates this feature that can be easily adapted to any GIS system.

Figure 6.13: Water quality indices, 1993

6.7 Evaluation

The systematic approach that was followed to develop the Service Delivery Index has provided some interesting (and very useful) new features along the way that were previously unavailable to municipal managers. Most of the features can be utilised to assist in management decisions simply due to the fact that a graphical representation is available that encompasses accurate information.

A host of information, that could previously only become available with the assistance of piles of engineering drawings, financial statements, job cards and a host of assumptions can now be transformed into a single graph. In fact several graphs can be combined on an A4 page to create a very powerful management information tool.

By having all the information of a specific township available as is displayed in **ANNEXURE 2**, is very useful in that specific queries can immediately be clarified by simply drilling down in the matrix. Comparisons with previous years are also immediately available by simply turning the page or comparing by studying the specific services graphs.

The relationship between the quality index and capital expenditure together with the similarity between the efficiency index and operating costs is useful in understanding the implications of upgrading or neglect. The actual performance of service delivery departments or utilities can be measured by simply measuring these indices.

Linking the index with capital costs of services for budgetary purposes is another very useful tool. Fast and accurate estimations for upgrading are now possible.

By having an average lie on a graph is possibly one of the most useful features in evaluating township services. It does not make any judgment call about a particular service or township, yet it provides a useful perspective of the relative positions of the different services or townships. The way in which the Service Delivery Index was constructed ie by averaging elements and components of the index, resulted in an index that is merely and average of the respective services indicators. Therefore, by plotting the average on the service delivery graphs also plots the Service Delivery Index.

Townships and services can now be compared at a glance. This holistic perspective of engineering service delivery is a new dimension for engineers, technicians, officials and politicians alike, but perhaps the most useful attribute of the index development procedure is the fact that decision-makers can now base their judgments on accurate and reliable information instead of emotions and assumptions.

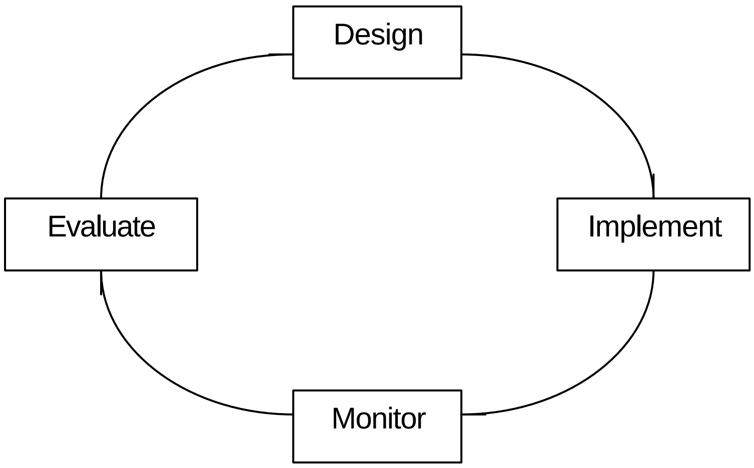
7 Conclusions and Recommendations

7.1 Evaluation

In the last chapter of the thesis, an attempt is made to critically evaluate the development process of the SDI as well as to make a comparison between the objectives set at the onset of the thesis and the product eventually achieved. This evaluation process will be helpful in drawing conclusions on the usefulness of the SDI. It will also be helpful in determining the SDI's shortcomings and strengths and to make constructive recommendations for refinement and better utilisation.

The first comment to make about the development of the SDI is that the index, as it now stands, is by no means a final product. A critical evaluation phase will fist be necessary followed by a refinement process where small adjustments are made to the index. Only after several of iterations (**Figure 7.1**) will a final product emerge that can be practically adopted for regular monitoring and performance management purposes.

Figure 7.1: Development cycle



The index was also developed from the author’s perspective of what is being regarded as critical and important measurements of municipal service delivery, which may not necessarily be important for all municipalities, communities and organisations. Not all stakeholders will regard the same key factors for measurement equally critical, due to their own differences in perceptions of what is important for them. Different people and different organisations in different regions will have varied opinions of what they regard as critical for measurement. Therefore, unless external input into the development of the index has been obtained, finalization will not be possible.

It is also not too difficult to conceive that even when there is agreement about key factors for measurement and incorporation into the index, disagreement with regards to their relative importance in the index would probably exist. Therefore, weightings can only be allocated to the various components of the index through involvement of all stakeholders.

Finality of the SDI will only be possible after several iterations of evaluations and adjustments.

7.2 Evaluation of goals and objectives set

The original goal of the thesis was:

> To develop a credible performance indicator that accurately reflects the quality, efficiency, affordability and accessibility of the services being rendered by the municipality to enable decision makers in public and private institutions to evaluate municipalities in terms of their service delivery mandates so that corrective actions can be taken where required. The aim is to ensure that decision makers have accurate information to prevent that decisions are made based on emotions and assumptions.

A goal is an outcome that can normally only be evaluated after a long period of time. For example, a generalized goal such the improvement of the "quality of life" can normally only be measured after an extended period of time after the output was completed. Similarly, the results of the real value of the SDI will only be available after an extensive period of utilisation, or at least for such a period that a trend could be established. It is however, possible to make a subjective judgment of some of the key elements of the goal description.

7.2.1 Credibility of the SDI

The first element is the development of a credible performance indicator. It is the opinion of the author that the credibility of the index could be measured by its relevancy and correctness. In terms of its relevancy, the index contains all the key elements required to evaluate service delivery with regards to quality, efficiency, affordability and access. It is also the opinion of the author that the results obtained from such an index is accurate and correct and that the information contained in the construction of the index is broad enough to encompass the most important aspects of municipal engineering service delivery. Time will tell.

7.2.2 Adaptability to mandates

With regards to the evaluation of municipalities in terms of their service delivery mandates, the index is broad enough to encapsulate all service delivery aspects of municipal services and it is the author's opinion that this part of the goal was attained.

7.2.3 Accurateness of the SDI

In terms of its accurateness, all data contained in the construction of the index was either gathered by national governmental bodies like Stats SA or from audited council financial statements and job evaluation databases. The index should provide information with very high confidence levels of accuracy.

The original objectives of the thesis were to develop and indicator:

- That can be utilised continuously. The results of a quarterly analysis should yield enough evidence of municipal service delivery so that decisions can be taken to implement actions that will effectively control service delivery in municipalities. It should therefore, serve as an early warning indicator in a monitoring system.
- That is simple enough to understand and to disaggregate into various usable components. The information required to compile the indicator must be therefore, be easily accessible and inexpensive to collect.
- That is sensitive enough to reflect changes over short periods.

7.2.4 Regular utilisation

In terms of its continual utilisation, annual reports should be fairly easy to compile as most reports in municipalities are finalized annually. In terms of Chapter six of the Municipal Systems Act, 2000, most senior managers in municipalities are already employed on some form of a performance contract where their performance (or their department's performance) is measured on at least an annual basis. Accurate and current data is critical, as the extent of annual performance bonuses depend on the accuracy of performance measurements.

Census data

Some of the information contained in the index only becomes available every four years such as with the population census data collection. This information is gathered only by national government and is not only expensive to undertake, but also enormously time consuming. It has been nearly one and a half years since the 2001 census was conducted and the results of the survey is still only expected in May 2003. Several demographers in South Africa make continuous projections in terms of demographics, migration, income, age distributions, etc. The information is accurate (with very high levels of confidence), relevant and can easily be utilised on an annual basis in the SDI model. It should also be remembered that even the most current demographical data is at least 18 months old by the time it is first released for general consumption.

In addition, municipalities should have very accurate information in terms of numbers of stands in their particular area of jurisdiction. Monthly accounts are issued to all property owners and users of municipal services and for property rates and taxes. These databases should in any case be the preferred sources of data for the determination of SDI values instead of population census data.

The use of census data (especially with regard to the numbers of stand, access to different services, as well as for efficiency calculations) should only be used as checks and confirmations or to establish a “first cut” or “chopping block” for further development.

Municipal databases

It seems only practical at first to compile the SDI on an annual basis. Although most information in a municipality (such as payment levels) is available on a monthly basis, capacity issues in municipalities are well known. It is expected that the objective of compiling the index on a quarterly basis will perhaps, at first, be optimistic.

Early warning system

In terms of being an early warning system, the data required to construct the index should be easily available and quickly accessible once utilised. The calculation of the index is a spreadsheet exercise and should not be a constraining factor. It is the opinion of the author that the index can certainly be utilised as an early warning indicator in the monitoring system.

Ease of disaggregation

In terms of its simplicity and disaggregation abilities, it is very clear from the construction and the results of the matrix that the index is uncomplicated and that disaggregation of the index can be done at a glance. Each of the different sub indices of the SDI has great relevance and analysts would undoubtedly evaluate each of these sub indices on their own, as they address particular concerns such as affordability or accessibility. The clear and methodological construction of the SDI enables users to easily understand its components and therefore, easy to disaggregate.

SDI sensitivity

The hypothesis that affordability of services can be expressed not only in terms of a proportion of household income, but also in terms of payment levels, could negatively affect the sensitivity analysis of the SDI. This was already noticeable in some of the low income and poorly serviced areas. An analysis of this combined approach has once again, opened up the debate about "ability" to pay and "willingness" to pay for services.

McDonald (2002) stated that the so-called "culture of non-payment" that exists in some of the communities is an incorrect assessment of the reasons for non-payment for services. He reported that the inability low-income communities to pay for basic services far outweighs the notion of their unwillingness. He argues that non-payment is actually related to issues of affordability and quality of service and linked to the government's political will to upgrade service quality in historically black areas and that as long as the culture of "non-servicing" and gross inequities persist that payment levels are likely to remain low.

According to McDonald (2002) cost recovery has already contributed to the perpetuation of poverty and equality.

Extremely high unemployment rates due to low economic activity, historical legacies and inadequate skills clearly exacerbate the financial problems of poor households who struggle to survive, let alone pay for municipal services.

McDonald's research only strengthens the rationale for introducing the element of non-payment (payment levels) into the SDI model as part of the affordability component. The very high levels of non-payment in South African municipal low-income areas overshadows the second element of the equation namely percentage of household income, which clearly has an effect on the sensitivity of the index at this stage. This does not detract from the principle of non-payment and for that reason, even though sensitivity might be slightly compromised, the revision of the affordability concept should perhaps become a lower priority.

It is the author's opinion that the index is sensitive enough to detect small changes in service delivery. However, only through extensive use over longer periods will its sensitivity be completely known.

Affordability of different services

For the sake of standardization, all services were judged to be unaffordable if the cost for the service exceeded 5% of the household income. By implication, only if the point is reached where 6 x 5% is reached (30%) of household income would it become unaffordable. This I clearly problematic and will require refinement.

Another concern is that different services have different affordability proportions. Five percent of one's income for water might still be acceptable, but to pay 5% of your income towards waste removal is highly inconceivable, especially in poor communities where waste removal is not high on the list of priorities.

7.3 New discoveries

The construction of the Service Delivery Index provided some very useful additional attributes not originally envisaged in the goals and objectives. The three-dimensional matrix graph provides probably the best holistic picture of a township and its respective services as well as its different service components ever produced. This particular graph, combined with the geographical layout of the township, provides a mental imprint of the township, not previously possible. By simply paging through the township data in **ANNEXURE 2**, and comparing the three-dimensional matrixes and astonishing amount of information can be grasped without having to visit any of the townships.

The connection of the index with financial aspects of service delivery namely capital costs and operating costs is valuable, especially due to the fact that accurate upgrading estimates can be done near instantaneously by simply linking the index and the graphs of service level installation costs. This aspect of the index development should be of immense value to engineers during the annual budget periods. A recent evaluation of water and sanitation service in the Rand Water Supply area (Rand Water, 2002) provided insightful and interesting upgrading costs of the services through the utilisation of this method.

The feature of displaying service levels and other different aspects of engineering services geographically on a GIS system is another interesting and helpful by-product of the numerical translation of service delivery.

7.4 Where to next

Stormwater drainage refinement

The development of the SDI not only provided new insights into and comparisons of different aspects of service delivery, it was also helpful in providing a holistic perspective on municipal service delivery in general.

The index provides exiting prospects for analysis and possible refinement. An area of concern is the unclear division between roads and stormwater drainage. By utilizing roads data for stormwater services in some aspects does not appear entirely correct and refinement in this area is clearly required.

A clearer and more discernable picture could possibly emerge from further analysis and research with regards to stormwater drainage.

Adaptability to social services

It has been previously suggested that an extension of the index be investigated with regards to social services. This idea was originally toiled with by the author but time constraints and workload prevented delving into the area of social service delivery. It seems only natural that any type of service being delivered by a municipality can be reduced to the components and elements described in the SDI. For the sake of a holistic approach to municipal service delivery, which would include social services, it would probably make good sense to investigate the extension of this index to that of social services.

Continuous improvement

Only with constant use can the Service Delivery Index be evaluated in terms of practicality and sensitivity. Should the index become an acceptable tool for measuring service delivery in municipalities, constant refinement and improvement will possibly be required. As previously stated, the first area of improvement would probably be within the area of roads and stormwater. Another area will possibly be with the refinement of the affordability criteria for different services.

It would probably also make good sense to workshop the SDI with various stakeholders soon in order to determine priorities which could be used to allocate different weightings to the respective services, or even to the different KPIs.

7.5 A new language

It's only natural for engineers and technicians to be technocrats. Expressing themselves in "normal" language so that non-technical people can understand them seems to be a problem. A different language or perhaps a more common means of communication could greatly assist in bridging the communication gap between technical and non-technical people. The index method of describing engineering service seems to be a step in that direction.

The "level of service" method of describing services is an old concept. Describing services through indices is a new principle that can be used very effectively to monitor and manage performance and service delivery of municipal engineering services departments and utilities. Its usefulness lies in the fact that information regarding engineering services can be conveyed without detailed descriptions or piles of engineering services drawings. Decision makers can utilize the indices confidently, due to its accurateness and can base their decisions on facts instead of emotions and assumptions.

It should be evident from the graphs that regions or townships can be compared at a glance in terms of services. It is no longer necessary to enter into long technical/political debates or descriptions about infrastructure.

A councilor in Johannesburg for example, could now say to a councilor in Cape Town that "the water services index in his ward is 3.5" and the councilor in Cape Town would know exactly what he is talking about. The Cape Town councilor would also have a mental picture of services infrastructure in the ward of the Johannesburg councilor.

Budgeting for services upgrading is never easy. Preparation of estimates takes time and money- the two things municipal engineers are in short supply of. Rough estimates that were done in previous financial years become fixed amounts more often than not when final costs differ greatly from original estimates. The index method of estimating upgrading costs for services is a helpful tool and can assist engineers greatly to compile more accurate budgets.

Perhaps the biggest advantage of describing engineering services by means of indices lies in the fact that a clear mental picture can be formulated of service levels of different services in different areas over time. The graphical presentations compare different aspects of service delivery to suit different types of technical or non-technical people.

The graphs and presentations will hopefully assist engineers to gain a holistic understanding of municipal services and to assist them to communicate important aspects of service delivery to others.

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ANNEXURES

Annexure 1

Locality plan of study area

Annexure 2

Service delivery index calculations