Cape Peninsula
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THE USE OF OPERATIONS RESEARCH/QUANTITATIVE ANALYSIS
TECHNIQUES AS A DECISION MAKING TOOL AT THE CITY OF CAPE TOWN'S
WATER AND SANITATION DEPARTMENT

By

SIPHOKAZI MADIKANE

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Supervisor: Stanley Fore

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DECLARATION

I, Siphokazi Madikane, declare that the contents of this dissertation represent my own unaided work, and that the dissertation has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.

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Signed   **Date**

ABSTRACT

This research seeks to investigate the relationship between the use of Operational Research (OR) tools or techniques or the lack thereof, and the possible impact on decision-making amongst management of the City of Cape Town's (CoCT) Water and Sanitation Department (WSD) and its impact on service delivery. The CoCT is the municipality, which governs the city of Cape Town, its suburbs and exurbs, and falls under the South African local government sphere. The Department is responsible for ensuring water quality. WSD extracts and analyses water samples to identify bacteria or chemicals that may be present, whilst taking action to resolve problems when necessary. For actions to be taken to resolve problems, decisions are taken, and these decisions determine how problems are resolved to deliver quality services to the public on time and in a cost effective manner. OR is a scientific approach to managerial decision making which eliminates guesswork and emotions from decision making. OR is also described as a discipline that focuses on application of information technology for informed decision-making. The research question this study set out to answer is to what extent do managers at the CoCT' s WSD use OR. It also seeks to discover the relationship between OR and decision-making, whether any relationship between decision-making at the WSD and service delivery exists, and whether there is any link between politics and decision making in the organisation. This research investigated the efficiency of current decision-making tools that are utilized at the WSD. A questionnaire was developed and used as a tool to acquire inputs to satisfy the research question. The analysed data lead to recommendations for the WSD to support and improve on its existing decision-making tools. This study is based on material that was collected from a wide range of journals, extending from regular OR literature to many application journals, articles and published books.

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DEDICATION

I would like to dedicate this dissertation to my mother, Yoliswa Madikane. There is no doubt in my mind that without her continued support emotionally from my matric years to tertiary, I would not have made it this far. To my husband, Jewis September and my kids for their understanding and for tolerating my absence from home while completing my research.

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GLOSSARY

Terms/Acronyms/Abbreviations	Definition/Explanation
Operational Research	Also known as quantitative analysis, operational research is the scientific approach to managerial decision making.
Information Technology	Information technology is the use of computers and software to manage information.
Mathematical Models	A description of a system that is used by operational research analysts using mathematical language, which can take many forms, including but not limited to dynamical systems, statistical models, differential equations, or game theoretic models.
Scientific Techniques	A scientific technique is any systematic method to obtain information of a scientific nature or to obtain a desired material or product.
Operational Research tools	These are the tools that are used by operational researchers, namely statistics, optimization, probability theory, queuing theory, game theory, graph theory, decision analysis, mathematical modelling and simulation.
City of Cape Town	Cape town's local government is the City of Cape Town, which is a metropolitan municipality.
Politics	For the sake of this study, politics is described as the art of government; as public affairs; as compromise and consensus; as power and distribution of resources.
ORSSA	Operations Research Society of South Africa
OR	Operations Research
CSIR	Council of Scientific and Industrial Research
NRIMS	National Research Institute for Mathematical Sciences
SANDF	South Africa National Defence Force
SAPS	South African Police Services
GIS	Geographic Information Systems
SCM	Supply Chain Management
HR	Human Resource
SALGA	South African Local Government Association
CoCT	City of Cape Town

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CHAPTER ONE

CHAPTER 1:   BACKGROUND OF THE STUDY

1. Introduction

This chapter presents the background of the study; the research problem and its significance, as well as the scope and delimitation of the study. It also introduces the organisation that is the subject of this research, its background, its organisational functions, and how it relates to the study. The background of the research problem, the statement of the research problem and the objectives of the study are also discussed in this chapter.

1.1   Background of the research problem

The metropolitan municipality that is the subject of this paper governs the city, its suburbs and exurbs, falling under the South African local government sphere. According to Denby (2009) the entity was founded through the combination of seven municipal councils between 2004-2005, within which lies the Water and Sanitation Department (WSD) as a leg of the Utility Services Directorate, which will form the focus of this research. The Department is responsible for ensuring the quality of water and investigates and responds to public complaints and concerns regarding water quality. WSD promotes and emphasises the health importance of water supply services to informal communities within the city; extracts and analyses water samples to identify any bacteria or chemicals that may be present; and investigates the possible causes of water pollution, taking action to resolve the problems when necessary (Pithey, 2007). For actions to be taken to resolve problems decisions have to be taken, it is those decisions that determine how problems are resolved to deliver quality services to the public on time, and in a cost effective manner.

The department is guided by a mandate that also stipulates that service delivery must be monitored constantly to improve the level thereof; however there are sometimes challenges in executing this service delivery effectively, the public service delivery strikes and the number of complaints received through the complaints departments are proof to that effect. The municipality has a 30-year plan that will guide City planning, decision making, budgets, as well as the future five-year Integrated Development Plans (IDP) (Ebrahim 2010). The IDP is however not enough to be used merely as the only decision making tool as it only addresses qualitative factors affecting the organisation. The nature of the municipal business especially in the

WSD requires other quantitative factors to be considered when making decisions. As a result, the research will endeavour to discover if the use of quantitative analysis otherwise known as operational research (OR) tools would improve decision making in the WSD of the CoCT by conducting research into the following aspects:

- Decision making in local government
- Current use of OR / Qualitative Analysis tools in the CoCT, in local and in government at large
- The application of OR in other industries and its effectiveness thereof

According to Smart Living Handbook (2009, p. 73) water is a natural resource on which all living matter depends. Demand often exceeds supply and there are significant costs in getting water from the natural environment to the tap in an acceptable form. The Smart Living Handbook (2009, p. 74) articulates that water is one of the key building blocks for life – human beings cannot survive without it, it is essential for use in agriculture and industry. Water is even used to generate electricity. The water services act 108 (1997) says that all water services authorities, such as the CoCT, must provide water and sanitation services that are efficient, affordable, economical and sustainable.

The above means that the poorest of the poor must be able to afford the water they need, but at the same time, the Water and Sanitation Department must efficiently cover the cost of treating and distributing the water. One of the eight United Nations (UN)' millennium development goals is to halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation (United Nations 2014). This is one of the qualitative factors that influence decision making in the national, provincial and local government sphere. Within government, there is a unique situation in South Africa. Since 1994, when the new democratically elected government came into power, most of the government officials have been replaced by new, inexperienced officials at all levels — national, provincial and local. This has impacted not only the use of OR tools, but also all modern and sophisticated tools. The reality is that the new cadre of officials first needed to understand the intricacies of their new environments before they could venture into using modern tools. The lack of communication and continuity within the ranks of government officials further complicates matters. This has resulted in the discontinuation of OR in most government departments (Weintraub and Horner 2003, p. 4). What Weintraub and Horner suggest is that in government officials post 1994 mostly take into account qualitative instead of quantitative factors in their decision making. This discontinuation of OR could be a problem as OR is described as the discipline of

applying advanced analytical methods to help make better decisions by using techniques such as mathematical modelling to analyse complex situations, OR gives executives the power to make more effective decisions and build more productive systems (Manson, 2006). Therefore, not using it means these elements will be missing in government's decision making and it could be detrimental for government as decisions cannot be based on mostly qualitative factors.

Qualitative factors are those factors that are immeasurable therefore decisions cannot be based solely on these factors. The weather, a country's legislation, new technological breakthroughs and a result of an election are all factors that are difficult to quantify (Render *et al.* 2006). The public's service delivery satisfaction is not measurable and not quantifiable either; hence it is also a qualitative factor. Dayananda *et al.* (2002, p. 7) concur and articulate that qualitative factors have an effect in the decision making but can be impossible to evaluate accurately in monetary terms and make it impossible for proper and informed decisions to be taken.

Any decision making at the Water and Sanitation Department can have a major effect on how service is delivered to the public. The department currently uses an Enterprise Resource Planning (ERP) tool namely SAP as input to their decision making (Lenovo *et al.* 2007). This is not merely a planning tool; it assists by providing data which can be used as input data into the decision making towards the delivery of the end product which is water. Decisions at the WSD are taken with regards to the engineering equipment which has to be availed and maintained for the water treatment processes. Budget forecasting, water demand forecasting, and revenue generation are also issues that are considered when decisions are made. This is because decisions cannot mainly be based on what is stipulated in the IDP, government policies, acts and political agendas as these are only qualitative factors.

It is therefore important in government to ensure that decision making combines credible scientific tools for both the use of qualitative factors (the government acts, political interests and mandate, public interests in this case), planning tools like ERP and credible quantitative factors (scientific approach, engineering technologies, information technology tools, OR tools). Render *et al.* (2006) concurs that because of the importance of qualitative factors, the role of quantitative analysis in the decision-making process can vary. The results of quantitative analysis should be combined with other (qualitative) information in making decisions; this will make it better suited for use in different environment. What this articulates is that though the qualitative factors cannot be used solely, they cannot be completely ignored as OR in some instances works better combined with qualitative factor.

The expressions discussed above indicate a gap for research on whether the use of OR tools were indeed discontinued in government specifically at local government level. If they were discontinued, to what extent were? The research would also investigate what the current decision making tools are being used at the municipality that is the subject of this research.

1.2 Statement of research problem

The problem is the discontinuation of the use of OR tools for decision making in government departments and in particular the CoCT. There is currently no evidence that exists that proves that OR tools have been used to the support decision making at the municipal level for the past 20 years. There is however demonstration of other tools used at the CoCT to support decision making. The tools are however not classified as OR tools. The lack of application of OR poses challenge as OR is described as the discipline of applying advanced analytical methods to help make better decisions by using techniques, OR gives executives the power to make more effective decisions and build more productive systems. Without using OR techniques the CoCT will not enjoy the benefits of OR.

In order to combat this, an investigation is required into the current decision making tools used at the CoCT. Recommendations based on the research findings in the application of OR tools to support decision making at the CoCT will have to be considered at the end of this study.

1.3 Research question

The research questions within the ambit of this dissertation, read as follows:
- Do managers of the City of Cape Town's water and sanitation department use operations research as a decision making tool?

1.4 Investigative (sub-) questions

- How does the use of operational research tools or a lack thereof affect management's decision making and service delivery at the City of Cape Town's WSD?
- What current decision making tools are used by management and how appropriate are they for the organisation?

- How do politics, in a parliamentary sense, affect the decision making at the City of Cape Town's WSD?

1.5 Primary research objectives

- The primary objective of this study is to investigate and analyse the current decision making techniques used at the City Of Cape Town's Water and Sanitation Department in relation to OR tools; and
- To investigate and assess the possible impact of the use of OR techniques, analyse its efficiency and the extent of its use at the WSD

1.6 Secondary research objectives

The secondary objectives of the study are:
- To determine to what extent does the qualitative factors such as politics and service delivery satisfaction influence decision making in local government management;
- To determine what the decision making tools are currently being used at the CoCT:
- To determine to what extent the City's decision makers contribute to service delivery or a lack thereof; and
- To understand the impact that OR could have on the decision making process at the Water and Sanitation Department, and the organisation as a whole.

1.7 Research process

The research process will clarify how the research was conducted from the initial developing stage of the proposal to submitting the dissertation. A research problem was formulated and from this the proposal was drafted and submitted for the approval of the topic. Once the approval was granted, the researcher consulted different forms of literature on the research subject. The researcher read journals, articles, books and case studies on the subject of the research. The gaps that were identified in literature review led the researcher to the problem statement, research and sample design. Research questions and objectives were formulated. An appropriate data collection method, in line with the research objectives was chosen, and a questionnaire, which pursued to answer the research questions, was designed. The questionnaire was sent to the selected population and once the responses in Chapter

4 were received, the data was analysed, and the analysis is presented and discussed in Chapter 5.

Kumar (2005) articulates that the research process consists of eight specific phases, which was applied to this research study. The steps in research process are, as observed in the listed chapters:

1. Formulating the research problem, chapter 1;

2. Extensive literature review, chapter 2;

3. Developing the objectives, chapter 1;

4. Preparing the research design including sample design, chapter 1;

5. Collecting the data, which in this research took place after receiving responses from the respondents and gave input to chapter 4;

6. Analysis of data, chapter 4;

7. Generalisation and interpretation, all the chapters presenting the author's understanding not referenced; and

8. Preparation of the report or presentation of results-formal writes ups of conclusions reached, in the last chapter.

1.8   Research justification

This research investigates decision making tools, which are utilized in the Water and Sanitation Department of the City of Cape Town. It also investigated the efficiency of the current decision making tools.   The different approaches were studied and appropriate OR decision making tools were recommended to the WSD to support its existing decision making tools.

The benefits of conducting the research were:

- Improving the decision making process at the WSD;

- Opening debate with regard to better decision making in the public sector;

- It provided, bases for the body of knowledge and input into future research; and

- It suggested available tools to WSD that could assist and support decision making in the department.

- It reviewed the current decision making tools like ERP.

1.9   Structure and Overview of the Chapters

- Chapter 2 Literature review
- Chapter 3 Research methodology
- Chapter 4 Results

- Chapter 5 Discussion of results
- Chapter 6 Conclusion

1.10   Summary

In this chapter WSD was positioned within the organisation and its mandate was discussed to allow the reader more insight into the department and the organisation in which it operates. WSD's current factors that influence decision making tools were also discussed in detail. Qualitative factors, which affect decision were highlighted and compared to the use of qualitative analysis methods in decision making, in general. In this chapter the background of the research problem was stated and most of what was discussed in this chapter forms bases for the next chapter's literature review. The research questions were also formulated, which gives input to the design of the questionnaire. The questionnaire served to answer these questions, as well as the research objectives. Also conferred in this chapter was the research process that was followed for the completion of this thesis. The benefits of the research for the organisation that is the subject of the research were also highlighted in the research justification section. The techniques that were mentioned in the chapter have been proven in the past and were used as a guideline in administering the questionnaire, validating data and ensuring that the research was conducted in an ethical manner without compromising any of the participating parties' confidentiality.

CHAPTER TWO

CHAPTER 2:   LITERATURE REVIEW

2.   Introduction

The purpose of this chapter is to conduct a critical and in depth evaluation of previous research related to the topic. It involves a summary and synopsis of a large part of the research, which allows the reader to establish why this particular research topic was pursued. Discussions on this chapter are based on different topic-related sources or documents such as previously published journals, published books and previously researched papers. This chapter discusses important variables, which relate to the topic, and established context of the topic. The chapter places the research in a historical context to show familiarity with new developments that are used in the researched organisation, and in other organisations.

2.1.   Organisational background
2.1.1   Local Government

Local government is regarded as the sphere of government, which is 'closest to the people', and municipalities are at the coalface of a deepening democracy and accelerating the delivery of services (South African Local Government Association, 2006). Former South African president concurred and suggested that it must be ensured that the machinery of government, especially the local government sphere, discharges its responsibilities effectively and efficiently, honouring the precepts of Batho Pele – The People First (Mbeki, 2006). SALGA (2006) continues to describe the concept of Batho Pele as a Sesotho saying, which means 'The People First'. This means that service delivery is the core objective of municipalities, and unlike ordinary companies, municipalities are not profit generated, as they collect revenue in order to sustain the organisation and be able to deliver on its mandate with the help of national government funding.

2.1.2   The City of Cape Town

The City of Cape Town, under the local government umbrella, is the metropolitan municipality that governs the city of Cape Town, South Africa, and its suburbs and exurbs. The entity was founded through a combination of seven municipal councils between 2004 to 2005, within which lies the Water and Sanitation Department (WSD)

as a leg of the Utility Services Directorate (Denby, 2009). Denby also states that the WSD is responsible for ensuring the quality of water, while the department also:

- investigates and responds to public complaints and concerns regarding water quality;
- promotes and emphasises the health importance of water supply services to informal communities within the city;
- extracts and analyses water samples to identify any bacteria or chemicals that may be present; and
- investigates the possible causes of water pollution, taking action to resolve the problem when necessary.

This department, therefore, delivers one of the most vital services to the public and, therefore, is one of the most crucial departments in any municipality.

According to Ebrahim (2010), to this end, the City is in the process of developing its long-term city development strategy, which represents a 30-year view of the kind of city in which all residents would like to live and, which they would be proud to leave as a legacy for future generations. This 30-year plan will guide City planning, decision making, budgets, as well as the future five-year IDP. Ebrahim (2010) continues to describe the Integrated Development Plan (IDP) as essentially a five-year strategic blueprint, which serves to guide local government and its key stakeholders such as residents, commerce and industry in their endeavours to position Cape Town not only as a preferred international tourist destination, but also as a highly attractive investment destination. The IDP, therefore, guides the decision making processes in the organisation.

The IDP is the strategic plan of the City that seeks to achieve the above and link, integrate and coordinate plans taking into account proposals for development of the municipality. The IDP also aligns the resources and capacity of the municipality with the plan's implementation, and forms the policy framework and general basis on which annual budgets are based, while it is compatible with provincial and national development plans (COCT's Finance Directorate, 2007). This therefore means that decision making happens in line with the strategic intents that are stipulated on the IDP.

The COCT's Finance Directorate (2007) suggests that in terms of the Municipal Systems Act (MSA), every municipality is required to undertake development orientated planning to ensure that it strives to achieve local government's objectives and developmental duties as contained in and required by the Constitution, and

together with other organs of state, contribute to the progressive realisation of the fundamental rights contained therein. For the CoCT, the IDP is the main part of this orientated planning, as stipulated in the MSA.

The MSA is an act that serves to provide for the core principles, mechanisms and processes that are necessary to enable municipalities to move progressively towards the social and economic upliftment of local communities, and to ensure universal access to essential services that are affordable to all who work in partnership with the municipality's political and administrative structures (Government Gazette, 2000:2). This act is one of the many that determines the nature of decisions, which are made by CoCT's management. The CoCT's strategic intent, therefore. should reflect and comply with all, but is not limited to the above-mentioned aspects.

2.2   Operations Research

Quantitative analysis, which is also known as operational research (OR), is the scientific approach to managerial decision making (Render *et al.*, 2006:2). Render et al continue to suggest that that whim, emotions, and guesswork are not part of the quantitative analysis approach. Data is manipulated or processed into information that is valuable to people decision making.

Heger (2006) continues and suggest that the term operations research describes the discipline that is focused on the application of information technology for informed decision-making. He continues to explain how people have been using mathematical tools to help to solve problems. These mathematical tools include the following, amongst others:

- Probability concepts and applications;
- Decision analysis;
- Regression models;
- Forecasting;
- Inventory control models;
- Linear programming models;
- Transportation and assignment models;
- Integer and goal programming;
- Simulation models;
- Markov analysis;
- Decision theory, and
- Game theory.

Operations or operational research is similarly described as an interdisciplinary sub-discipline of applied mathematics that uses various methods (for example mathematical modelling, statistics, algorithms) to derive optimal or optimised solutions to complex problems (Peterson, 2009:22). Peterson (2009) continues to argue that

operations research could also be defined as the science of better and as management science and quantitative management.

According to Heger (2006) the goal of OR is to provide rational bases for decision making by seeking to understand and structure complex situations, and to utilize this understanding to predict system behaviour such as machinery behaviour and trends and improved system performance, in this case decision making. Much of the actual work is conducted by using analytical and numerical techniques such as SAP, IT systems and billing systems to develop and manipulate mathematical models of organizational systems that are comprise of people, machines, and procedures (Heger, 2006). The WSD encompasses human resources (people), operating equipment for the treatment processes and fabrications/productions (machinery), and has also documented procedures and processes that can be improved by using these mathematical models and programs. The WSD is, therefore, ideal for the purpose of this research.

2.3   OR in developing countries

According to White, Smith and Currie (2011), the relevance of OR in developing countries has increasingly engaged the attention of operational researchers in both the industrialised and less developed countries. Aronson (2006) defines a developing country as a country, which has a relatively low standard of living, undeveloped industrial base, and a moderate to low Human Development Index (HDI). White *et al.* (2011) concur and describe a developing country as a term, which is still used to describe a nation with a low level of material wellbeing. White *et al.* (2011) continue and state that International organizations such as the World Bank considers all low- and middle- income countries as 'developing', and in 2008, it defined countries with a Gross National Income per capital below US$11,905, as developing. The relevance of the kind of OR that is relevant to these countries depends on how complex the issues of each country are in terms of poverty, politics, technology challenges and infrastructure. McCarthy (2005) believes that South Africa is a middle-income, developing country.

The main aim of the OR and developing countries' initiatives appears to be to promote an increase in the use of OR as a practical tool for problems in developing countries (White *et al.*, 2011). However, the challenge is with the lack of OR practice in developing countries. White *et al.* (2011) suggest that as much as there are many OR courses in universities in many developing countries, those who teach these may

not have relevant practical experience in applying OR to practical problems of the developing countries, and, therefore, the material may concentrate on the (mathematics) techniques rather than the entire OR process.

OR has been used in developing countries in continents such as India, Asia, Africa and South America.

2.3.1 Application of OR in China's local government

The integrating data envelopment analysis (DEA) and analytic hierarchy process (AHP) were used to evaluate the economic development achieved by local governments in China (Lin, Lee & Ho, 2010). Since most similar evaluations are multi-objection problems, which both DEA and AHP are capable of solving, the integration of these two approaches is shown to be even more powerful. The proposed integrated DEA/AHP model can evaluate and rank different alternatives. Lin et al continue to articulate that in addition, a time-scale comparison of the economic performances of local governments in China was carried out by using the malmquist productivity index (MPI), which indicated that there is a trend of economic growth. DEA and AHP are methods that have been extensively used to evaluate and rank multi-objective decision making alternatives.

Lin *et al.* (2010) assert that Ahmad suggests that AHP has also been applied in several different fields such as activity planning, alternative choosing, optimization, resource allocation and conflict resolution. AHP has been used to evaluate multi-objective design alternatives for facility layouts, and to integrate mathematical linear approaches such as Linear Programming (LP), Integer Linear Programming (ILP), Mixed Integer Linear Programming (MILP), Goal Programming (GP), and Dynamic Programming (DP) (Vaidya and Kumar, 2006). The Multi-Media Authorizing System (MAS) has been in use since 2002 (Lin *et al.,* 2010). This software uses the group decision making technique, which involves six software engineers. MAS has been used to evaluate numerous products. The decision tool for the selection of advanced technology is another proposed model. This model integrated a cost-benefit analysis model, a decision-making effectiveness model, and a common criteria model, and is available from Time Compression Technologies (TCT).

The DEA that was initially developed has been used for the purpose of evaluating the relative efficiency of similar economic production systems. The two applications, namely DEA and AHP were integrated to compare local Chinese governments (Lin *et al.*, 2010). The following steps and methods were followed to reach the conclusions:

- Analytic and evaluation methodology;
- Decision making units (DMUs) generation;
- AHP for qualitative performance evaluation;
- DEA evaluation method;
- Radial model with or without input; and
- Time series analysis-MPI (malmquist productivity index).

The empirical study and illustration were done according to the following steps:
- Empirical design;
- AHP analysis; and
- DEA model analysis.

2.3.2 The implications

The results of the analysis had valuable policy implications for evaluating economic performance and for making investment decisions in China. Additionally, there were those who were always suspicious of the economic statistical reports of China. Lin *et al.* (2010) stresses that the findings of the study were made with critical thought given to the choice of variables.

2.3.3 Conclusions of the application

In this application the economic performance of local governments in China was evaluated by an available model. The results were useful to improve the understanding of the economy in China. Although currently known as the largest market in the world, it would appear that there is potential for even greater growth. China is a mainland, and each local government has unique features and traditions. There are many races, different languages, and different ways of thinking, so a complete understanding of the country is impossible. Therefore, this example is aimed to provide some basic information that allows for a better understanding of this country. The results of this paper show that the economic performances of local governments exhibit a great divergence between different model analyses. For the DEA model that does not consider input factors, the east is the highest ranked region, while the west and central regions are ranked lower. If relevant input factors are considered, then the ranking significantly changes, and the east has a lower ranking. This means that the choice of DEA model (with or without inputs) has a significant effect on the economic conclusions drawn from a study (Lin *et al.*, 2010).

In this study the application of OR eliminated the assumption that all local government organisations in China were doing well. Instead, empirical results indicated that after

discounting the advantages of location and political connections, the east district provinces of China did not have superior economic performance or a better MPI index, as compared with other districts. This was contrary to the original hypothesis.

2.4   History of OR in South Africa

Weintraub and Horner (2003:4-5) assert that author Hans W. Ittmann suggests that the use of OR tools and techniques in South Africa is widespread, boosted in large part by non-OR people who employ these tools to solve their specific problems. They continue to suggest that this is mainly because it has user-friendly software that makes it relatively easy to utilize these OR tools and techniques, many of which are embedded in this software.   During the Apartheid years, South Africa experienced a protected economic environment. Weintraub and Horner state that after 1994, things opened up, and large organizations, wanting to compete in the world market, are realizing the value of OR in assisting them to become more competitive.

Within government there is a unique situation in South Africa. Since 1994, when the new democratically elected government came into power, most government officials were replaced with new, inexperienced officials at all levels — national, provincial and local (Weintraub and Horner, 2003). This has impacted not only on the use of OR tools, but also on all modern and sophisticated tools. The reality is that the new cadre of officials first needed to understand the intricacies of their new environments before they could venture into using modern tools. The lack of communication and continuity within the ranks of government officials further complicates matters (Weintraub and Horner, 2003:4). This has resulted in the discontinuation of OR in most government departments.

According to Ittmann *et al.* (2007:7), apart from work done in the mining industry during the 1950s, the first real OR group in South Africa was established at the Council for Scientific Industrial Research (CSIR) in the early 1960s. Those who were initially involved in this group played a significant role in establishing OR at various universities in South Africa. The OR group at CSIR did, however, continue and today the group still exists. The history of OR and CSIR can be traced to the origins of the discipline during World War II. At the outbreak of the war, Basil Schonland, professor of geophysics and director of the Bernard Price Institute at the University of the Witwatersrand, joined many other scientists to assist the allied forces (Ittmann *et al.*, 2007).

In 1961 the National Research Institute for Mathematical Sciences (NRIMS) was established as part of the CSIR and soon the possibility of creating an OR group was explored (Ittmann *et al.*, 2007:74). Ittmann *et al.* continue to suggest that in this regard, Geldenhuys played a significant role; he was instrumental in the establishment of OR at the CSIR. He presented a series of lectures in which he covered a number of OR techniques, including linear programming, game theory, infinite games, queuing theory and dynamic programming. In addition, he compiled a comprehensive literature review on the applications of OR. The report classified different problem applications into a number of areas. These included planning, trade and industry, agriculture, forestry and associated areas, local government, hospitals, postal services and transport, and defence.

2.5 Use of OR tools in Government

2.5.1 Department of Justice

CSIR has done extensive work in the area of crime prevention in recent years for the SAPS and the Department of Justice. The type of work has been a combination of modelling, simulation, statistical analysis linked to GIS to improve the use of crime statistics, crime pattern analysis and crime mapping, as well as addressing the issue of court services throughout the country (Weintraub and Horner 2003). Weintraub and Horner (2003, p. 12) suggest that Hans W. Ittmann stated that he is personally, very optimistic about the future of OR in South Africa. More and more people in industry, in government, in small, medium and micro enterprises, non-governmental organizations and more, are being exposed to OR in one way or another.

2.5.2 Department of Environmental Management

Research into management interventions that create the required enabling environment for growth and development in South Africa are both timely and appropriate. Govender and Kruger (2009:53) embarked on an investigation into the level of efficiency of the Air Quality Units within the three spheres of government viz. National, Provincial, and Local Departments of Environmental Management in South Africa, with the view to develop a resource allocation model. The inputs to the model were calculated from the actual man-hours spent on twelve selected activities relating to project management, knowledge management and change management. The outputs assessed were aligned to the requirements of the mandates of these Departments. Govender and Kruger (2009) continue to sugget that several models

were explored using multiple regressions and stepwise techniques. The model that best explained the efficiency of the organisations from the input data was selected. Logistic regression analysis was identified as the most appropriate tool. This model is used to predict the required resources per Air Quality Unit in the different spheres of government in an attempt at supporting and empowering the air quality regime to achieve improved output efficiency.

The resource allocation model developed was able to predict, with a high degree of accuracy, the output efficiency of the Air Quality Units based on actual resources allocated to project management, change management and knowledge management. This provided a firm guideline for Air Quality Units in South Africa to increase their output efficiency and ultimately improve air quality (Govender and Kruger 2009:60).

2.5.3 National Prosecution Authority

According to Koen, Hollowayy, Elphinstoney & Stylianidesz. (2012:85) the development of a planning tool that the NPA could use to plan their future resource requirements over the short to medium term required extensive modelling, and its final form included features which, to the best knowledge of the development team, make it unique both locally and internationally. Model design was largely influenced by the challenges emanating from the special requirements and context of the problem. Resources were not forecasted directly, but were derived with the help of simulation models that traced docket flows through various resource-driven processes. Docket flows were derived as a proportion of reported crimes, and these were forecasted using a multivariate statistical model which could take into account explanatory variables as well as the correlations between the patterns observed within different crime categories.

The various components of the planning tool, including inputs and outputs of the simulation models and the linkages between the forecasts and the simulation models, were implemented in a set of spreadsheets. By using spreadsheets as a common user interface, the planning tool could be used by prosecutors and managers who may not have extensive mathematical or modelling experience (Koen et al. 2012:85). Koen et al. (2012:96) continue to state that they are confident that this final planning tool, which provides a direct link between estimated future workload and required resources, will be a useful enhancement to the resource planning of the NPA. In addition, the flexibility provided by the workload forecasts and simulation models will enable the NPA to do a more comprehensive testing of future scenarios and of the sensitivity of resource requirements to changes in the criminal justice environment.

2.6   Application of OR in other industries

OR's role in both, the public and the private sectors is increasing rapidly. In general, OR addresses a wide variety of issues in transportation, inventory planning, production planning, communication operations, computer operations, financial assets, risk management, revenue management, and many other fields where improving business productivity is paramount (Heger, 2006). According to Ittman *et al.* (2007:7) the mining industry in South Africa has also always been a fertile area for OR applications. OR can be applied at the non-manager levels as well, as engineers or consumers alike can benefit from the improved and streamlined decision-making process.

Weintraub and Horner (2003:47) suggest that Xiang-Sun Zhang of China says that OR theory and techniques have been widely applied in industry, agriculture and military as well as in government. Ittman *et al.* (2007:2) continues to articulate that OR applications happen in a number of areas. These include:

- o   planning
- o   trade and industry
- o   agriculture, forestry and associated areas
- o   local government, hospitals, postal services, transport, and defence

Heger (2006) suggest that the myriad applications of OR include scheduling, routing, workflow improvements, elimination of bottlenecks, inventory control, business process re-engineering, site selection, or facility and general operational planning. The WSD could benefit from most of these applications as it has major backlogs from previous financial years, a huge amount of inventory is being handled and because it is a massive organisation it has a lot of processes involved in pursuit of delivering a service to its clients.

2.6.1   South African retail banking industry

According to Scholtz, Bekkery & Du Toit (2012:117), the South African retail banking industry used OR techniques to improve cash management in the industry, for which a decision support system (DSS) was developed. The DSS was applied to an ATM network in the Eastern Cape, South Africa, to investigate 90 different scenarios. Results showed that the application of a formal vehicle routing method consistently yielded higher service levels at lower cost when compared to two other routing approaches, in conjunction with selected ATM reorder levels and a knapsack-based notes dispensing algorithm. It was then concluded that the use of vehicle routing

methods is especially beneficial when the bank has substantial control over transportation cost.

2.6.2 South African winery

Recent technological advances have had a major impact on the management of traditional wineries, giving rise to the prospect of computerised decision support with respect to a range of complex harvesting and wine making decisions which have to be taken routinely (Van der Merwe, Van Dyk & Van Vuuren, 2011:83). Van de Merwe *et al.* continue to suggest that two nested scheduling problems were considered, the active cellar scheduling problem, and the harvest scheduling problem at a winery in the South African Western Cape. A nested tabu search approach was presented to solve these two scheduling problems simultaneously. This solution approach has been implemented as a computerised decision support tool, called VinDSS.

2.6.3 Fishing industry

According to Hasan (2012:37) A commercial fishery faces uncertainty mainly from variation in catch rate, which may be due to weather, and other environmental factors. The firm attempted to manage this uncertainty through planning co-ordination of fishing trawler scheduling, catch quota, processing and labour allocation, and inventory control. Schedules must necessarily be determined over some finite planning time horizon, and the trawler schedule itself introduces man-made variability, which in turn induces inventory in the processing plant. Hasan continues and argues that the variability of catch rate had virtually no effects on the profitability. Numerical results for several planning time horizon models were presented, based on data for a major New Zealand fishery. It was concluded from the experiments that more complicated stochastic integer program seems to be unnecessary, since the variability in catch rate of fish has a minor impact on profitability of the fishery. Using the average expected catch rate in a deterministic model appears to be effective (Hasan 2012:57).

2.6.4 Companies that use OR techniques in SA

Weintraub and Horner (2003:48) state that, according to Ittmann, currently, Sasol, which is one of the large petroleum and chemical companies in South Africa, is a big user of simulation (the arena simulation package), as well as optimization (pims, the LP package that has been developed specifically for the chemical industry). Caps logistics has been used successfully within three larger South African organizations, namely Spoornet (railway company), Abi (cold drink company) and Afrox (gas company).

Ittmann *et al.* (2007:2) claim that projects that the CSIR was involved over the years include:

- transportation model and a sales forecasting model to assist in the location of new petrol stations for Engen;
- various distribution models for different private sector companies;
- an integrated operations control system for SAA with industry partners;
- a simulation model for the exporting of coal as part of a feasibility study;
- a trackless mining simulation model;
- numerous simulation models in the rail environment;
- vehicle routing for beer distribution; and
- election forecasting.

OR was also applied at the Internal Audit department of a South African gold mining company. A goal programming model was developed to establish optimal allocation of internal audit time, based on the AHP risk evaluations and other quantitative considerations (Kr¨uger & Hattingh, 2006:59). Maize Board to distribute maize in the country, which was a transportation problem in linear programming

2.6.5 Transportation model on warehousing at San Miguel Corporation

A case study was done at the San Miguel Corporation based in the Philippines, which faced unique distribution challenges (Heger, 2006:394). With more than 300 products, including beer, alcoholic drinks, juices, bottled water, feeds, poultry and meats that are distributed to every corner of the Philippines archipelago, shipping and warehousing costs make up a large part of their total product costs. To address these challenges a transportation model was chosen as a solution. According to Heger (2006), transportation models deal with the distribution of goods from several points of supply to a number of points of demand.

The City of Cape Town with its scattered service points could be faced with similar challenges to San Miguel Corporation. According to the City of Cape Town (2010),

the city is South Africa's third-largest city; Cape Town has a large concentration of people, resources, services and infrastructure, while it is faced with a number of physical constraints in terms of its spatial development. Home to 66% of the Western Cape's population, Cape Town generates 76% of the region's gross domestic product (GDP), and contributes 11% to national GDP, making the city an important driver of regional, provincial and national development. The City of Cape Town (2010) continues to suggest that Cape Town is the Western Cape region's major service centre for health care, education and shopping, and provides employment for people from across the province and beyond. The city is becoming increasingly linked to surrounding towns, resulting in higher levels of interdependence, but also placing greater pressure on the resources and infrastructure of those towns.

It is the writer's opinion that this interlink and interdepency also creates a challenge as it requires transportation of goods and services between suppliers and its stores (the chain known as Supply Chain Management), and between departments to deliver its service mandate to the public. A transportation model would, therefore, be relevant if used to address and optimise the transportation problems associated with the supply chain management process.

According to Ittmann (2009), the Council for Supply Chain Management Professionals asserts that supply chain management integrates supply and demand management within and across companies. According to the CoCT (2011), demand management provides for an effective system to ensure that resources that are required to support the strategic operational commitments of the City are delivered at the correct time, at the right price and at the right location, and that the quantity and quality satisfy the needs of the City. A transportation model would address the issue of price and location as Heger (2006) describes the model as a model used for the distribution of goods from several points of supply to a number of points of demand optimally.

Like San Miguel Co., though a different organization, the CoCT engages in procurement of goods to deliver its mandate of service delivery to its clients, namely the public. Ittman (2009) mentions that SCM also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries (in the CoCT's case, it is different directorates within the organization), third party service providers (departments and branches within the directorates), and customers (in the case of CoCT internal clients, which are sections within branches of the organization). Figure 2.6.5 below shows the main elements of a supply chain that, in many

applications, form the basic elements of a quantitative model of a supply chain, which means that from these elements a problem would be identified in pursuit to optimize the SCM processes to suite the CoCT' s demand, as specified by the organization's SCM policy. That problem could be solved using the transportation model.
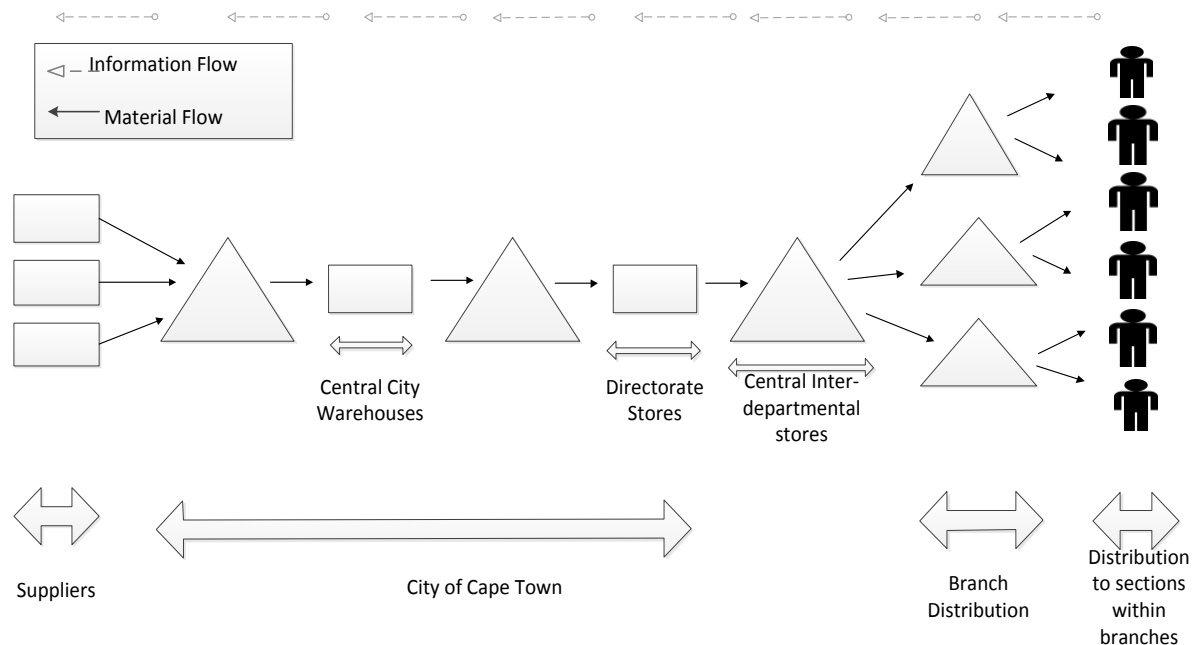
Figure 2.6.5: Main elements of a typical supply chain
(Adapted from Ittman, 2009)

Heger (2006) states that at San Miguel Co., the company grappled with the following questions:

- Which products should be produced in each plant and in which warehouse should they be stored?
- Which warehouses should be maintained and where should new ones be located?
- When should warehouses be closed or opened?
- Which demand centres should each warehouse serve?

The transportation model of LP was able to answer the questions; the firm saved $7.5 million annually with optimal beer warehouse configurations over the existing national configurations (Heger, 2006:394). In addition, the frozen products warehouse indicated that a saving of $2.17 million saving was made in the optimal configuration.

2.7   OR and decision making

According to Heger (2006) the driving idea behind OR is to collaborate with clients to design and improve operations, make better decisions, solve problems, and advance managerial functions including policy formulation, planning, forecasting, and performance measurement. In essence, OR is all about making better and more informed decisions. Over the entire history of OR, researchers have endeavoured to assist decision-makers through the use of quantitative methods, tools and problem structuring methods to improve their ability to make more informed decisions, (Ittman 2009, p. 91).

Peterson (2009, p. 22) concurs and says OR is used as an aid in decision-making and is most often used to analyse complex real-world systems, with the goal of improving performance. OR may assist decision-makers in almost any management function. To illustrate, OR supports the key decision making process, allows to solve urgent problems, can be utilized to design improved multistep operations (processes), setup policies, supports the planning and forecasting steps, and measures actual results.

OR is concerned with decision making in business and industry, in government and society. The decisions may be about large-scale undertakings such as the building of a new gold mine, or about small ones such as the re-routing of a local bus service. They may be concerned with long-term plans for the redevelopment of a whole inner-city area, or with the immediate problems of selecting a port to handle exports of cars, or how to balance predator and prey populations in the management of a National Park. In any of these situations, OR can help to get a better decision (ORSSA 2010). OR is intended to improve decision and values indicating what one wants to achieve, are essential for guiding decision making (Keeney 1994). Heger (2006) continues to articulate that as OR has made (over the years) significant contributions in virtually all industries, in almost all managerial and decision-making functions, and at most organizational levels, the list of OR applications are prodigious.

2.8   Leadership and decision making

2.8.1   Decision making

According to Campbell, Whitehead & Finkelstein (2009) decision making lies at the heart of our personal and professional lives. Some are small, domestic, and innocuous. Others are more important, affecting people's lives, livelihoods, and well-being. Inevitably, we make mistakes along the way. Campbell *et al.* continue to insinuate that the daunting reality is that enormously important decisions made by

intelligent, responsible people with the best information and intentions, are sometimes hopelessly flawed. This implies that even the most intelligent people can make bad decisions, even with the best information availed to them, hence it is important to take the risk out of decision making by ensuring that the decisions that are made are the most optimal decisions, especially for the WSD, as the decisions made in this department can impact on the quality and delivery of water in the municipality, either positively or negatively. If negatively, the greater risk is a loss of peoples' lives.

2.8.2 Leadership

According to Jing & Avery (2008), Cannella suggests that during the past four decades, the impact of leadership styles on organizational performance has been a topic of interest among academics and practitioners who work in the area of leadership. Rowe, Cannella Jr., Rankin & Gorman (2005) also argue that perhaps the one reason could be that leaders are decision makers or maybe the most prominent reason for this interest is the widespread belief that leadership can affect the performance of organizations. Jing and Avery (2008), under the transactional leadership paradigm suggest that leaders adopt a consultative style for making decisions. They engage in different degrees of consultation with individual followers, but the leaders remain the final decision-makers. Leaders do not often empower followers, and followers have little power in the organization, apart from being able to withdraw from or contribute more of their labour.

2.9   Decision making in Local Government

The whole of South Africa is divided into local municipalities. Each municipality has a council where decisions are made, and municipal officials and staff who implement the work of the municipality.

According to Education and Training Unit (ETU) (2011) council comprises elected members who approve policies and by-laws for their area. The council has to pass a budget for its municipality each year. They must also decide on development plans and service delivery for their municipal area.   The work of the council is co-ordinated by a mayor who is elected by council. The unit continues to suggest that the mayor is assisted by an executive or mayoral committee, which is made up of councillors. The mayor, together with the executive, also oversees the work of the municipal manager and departmental heads.   The work of the municipality is done by the municipal administration that is headed by the municipal manager and other officials. S/he is

responsible for employing staff and co-ordinating them to implement all programmes, which are approved by council (ETU, 2011).

The CoCT, being at the heart of government, is guided by political leaders who can influence decision making at a higher level of governance. If leaders are decision makers and the final decision sometimes lies with them, it simply means that decisions will be made according to their different leadership styles and their political agendas. Turpin and Marais (2004) state that the political view sees decision making as a personalised bargaining process, driven by the agendas of the participants rather than rational processes. They further suggest that the decision making process remains a continuous battle between different coalitions, influence and power is wielded in a deliberate manner and to further self-interest. The goals of the coalition are defined by self-interest rather than what is good for the organisation as whole (Turnip and Marais, 2004). The OR tools, if applied, can, therefore, help to eliminate the element of inferiority in the decisions.

Jing and Avery (2008) distinguish leadership characteristics, under organic leadership and suggest that an organisation should adopt a mutual agreement style to make decisions. Decisions need not be unanimous but can be based on consensus. The members have a high degree of power as a result of this shared leadership. Accountability and responsibility are shared as well. One way of having harmony in how decisions are made in an organisation would be to have a system that does not include individuals' perspectives and judgements, as the system would provide credible scientific information to support decisions made by individuals.

ETU (2011) states that there is a cycle of decision-making that is followed in most councils, and this is presented below.

> 1. Agendas have to be prepared before meetings and any committee reports, petitions or motions have to appear on an agenda before they can be discussed.
>
> 2. When an issue comes up for discussion at a council meeting, it is often referred to a committee or to the exco for further discussion and a deadline is given for when a report should be made available.
>
> 3. If the matter is referred to a committee, the committee will report to exco. Exco will consider the issue and either support their recommendations or put opposing recommendations forward to the council meeting.
>
> 4. The council will then vote on the matter.

The author's deduction is that managers in the WSD take into account the decisions that are made at the above mentioned forums, and use those decisions as a baseline when making their own decisions.

According to the City of Cape Town's IDP (2004-2005:46), the City is governed by 200 councillors. A total of 100 of them represent wards, while the other 100 are elected through a system of proportional representation. The council is the highest decision making body, which delegates certain functions to the Executive Mayor, her Mayoral committee, and Section 79 committees.
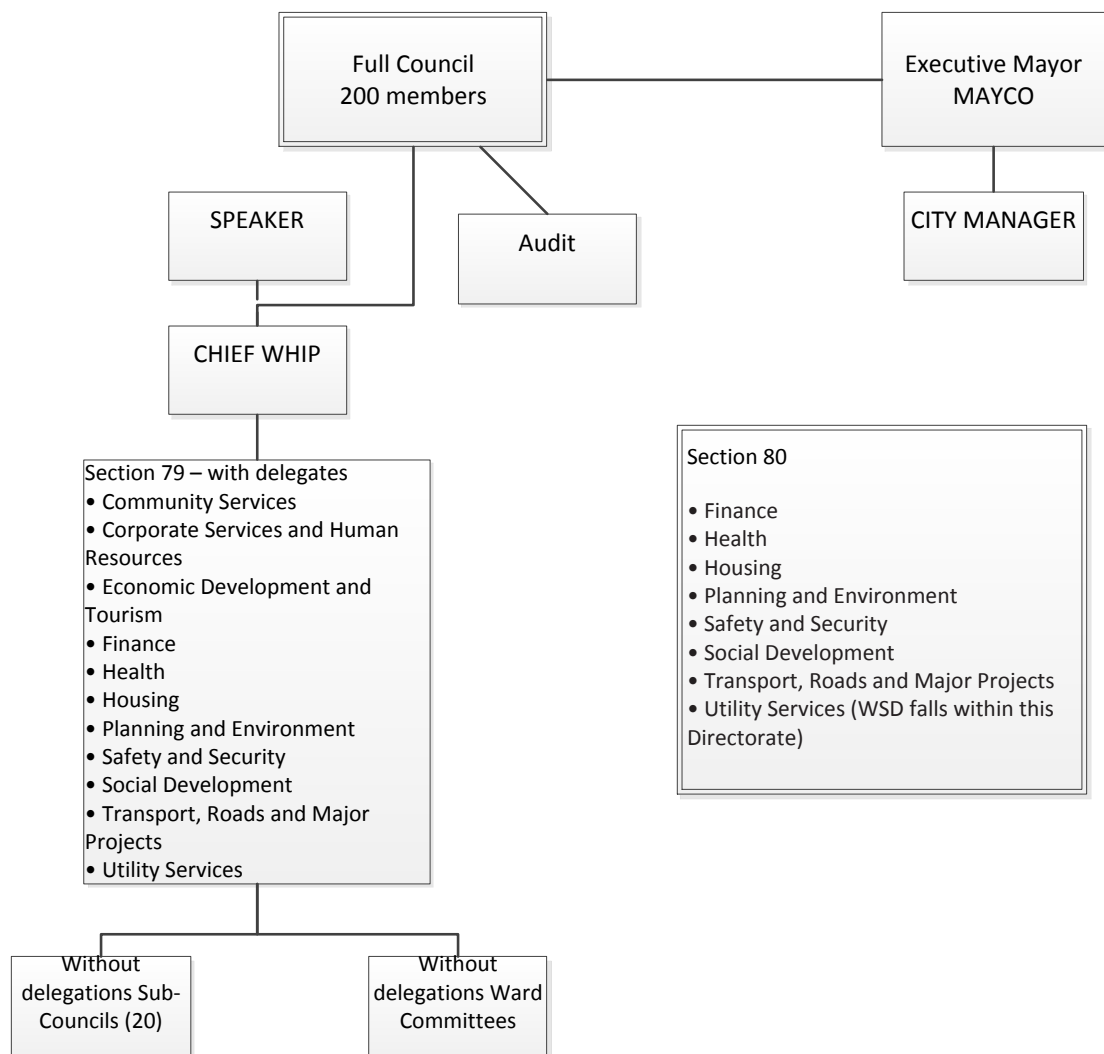

Figure 2.9a: Structure of Council
(Adapted from City of Cape Town's IDP 2004-2005:46)
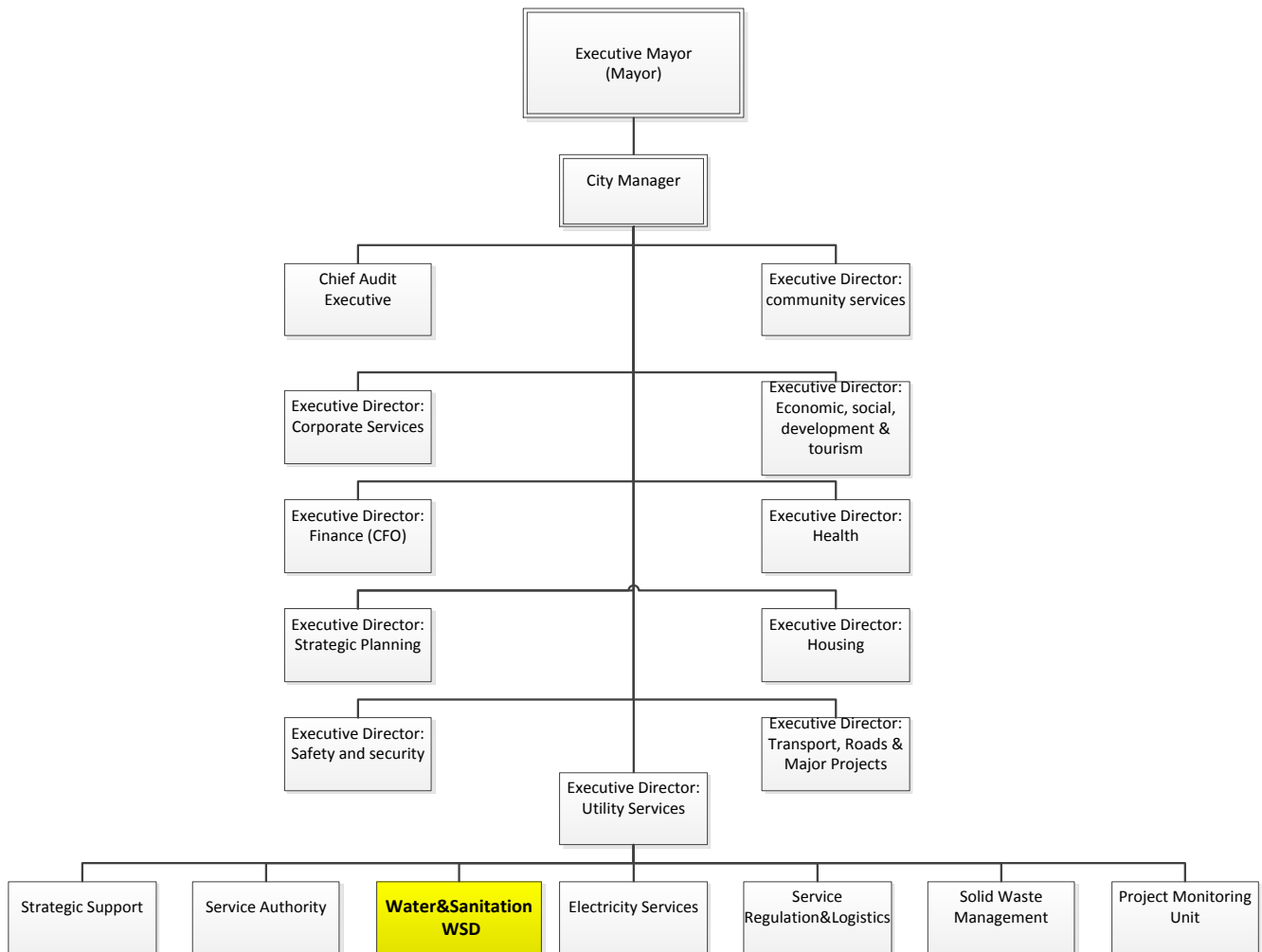
Figure 2.9b: Structure of council administration
(Adapted from City of Cape Town IDP 2004-2005:47 & 14 City of Cape Town Overview 2011)

Figures 2.9a & 2.9b above illustrate the decision making hierarchy in the CoCT. All the delegates mentioned are actively involved in decision making, mostly at a strategic level and sometimes at an operational level, as prescribed in the MSA.

The idealised model of representative democracy in local government suggests that, through regular, free and competitive elections, citizens make known their needs and priorities. The councillors that they elect then formulate strategies, make key decisions and prioritise expenditure choices through formal policy and budgetary processes, with officials (who are politically neutral) who advise them and implement the decisions (Devas, 2002).

Memela *et al.* (2008:6) suggest that most municipal councils have not communicated effectively to their citizens their development vision and plan, as reflected in the

Integrated Development Plans (IDP), and IDPs are hardly used to guide actual decision-making. As a result, in most municipalities there is no, or only a weak, relationship between the IDP and the annual budget/expenditure as reflected in the Service Delivery and Budget Implementation Plans. And within most municipal councils there is no consensus on its service delivery priorities, resulting in inefficient use of limited resources. Councillors (and often administrators as well) are generally unclear about their role and, as a result, are not properly equipped to fulfil their role effectively, often resulting in interference in administrative matters. In most municipalities, there are no mechanisms in place to measure customer satisfaction or to deal with customer complaints systematically. The failure of these councillors has a direct impact on all municipal departments, branches, sections and sub-sections, especially the Water and Sanitation Department.

The Department of Provincial and Local Government (2001:7) states that the Municipal Systems Act places responsibility on council to adopt the performance management system, while holding the executive committee or executive mayor responsible for the development of the system. The executive committee or executive mayor may assign responsibilities to the municipal manager in this regard, but remains accountable for the development of the performance management system. The municipal manager may further delegate the responsibility to another senior manager. Decision making is delegated in a similar manner from executives via senior and middle management straight down to junior management.

2.9.1 Tools used for planning and decision making at CoCT

(a) GIS

Geographic Information Science (GIS) is a powerful tool in local authority planning and is used at the strategic development information (SDI) and GIS Department of the CoCT, as most information has a 'spatial' or geographic component. The SDI & GIS Department delivers effective decision-making and improved service delivery through information and knowledge management. The department's mission is to be the key supplier of information and sharer of knowledge in order to aid strategic planning and decision making in the City. This mission is based on the belief that validated information and knowledge are key elements in an effective decision-making process. The City of Cape Town should address a wide range of development needs with limited resources. To ensure that these resources are used efficiently, proper development planning and decision-making, based on the right

information and knowledge, is required (City of Cape Town, 2010). This branch delivers an integrated GIS service to the City.

The model below shows how information that is stored and generated on the GIS system is used for planning and decision making.
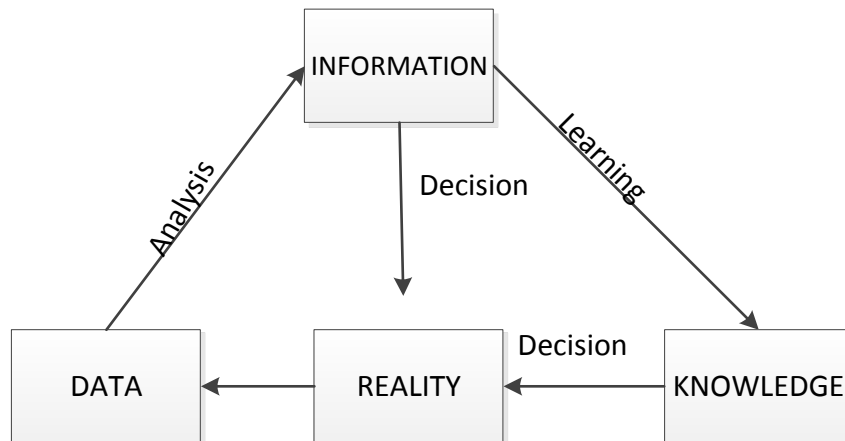

Figure 2.9.1a: Link between information and decision making
(Adapted from City of Cape Town, 2010)

The same model can be used to support the application of other decision making tools, should they be introduced in the WSD, as illustrated below.
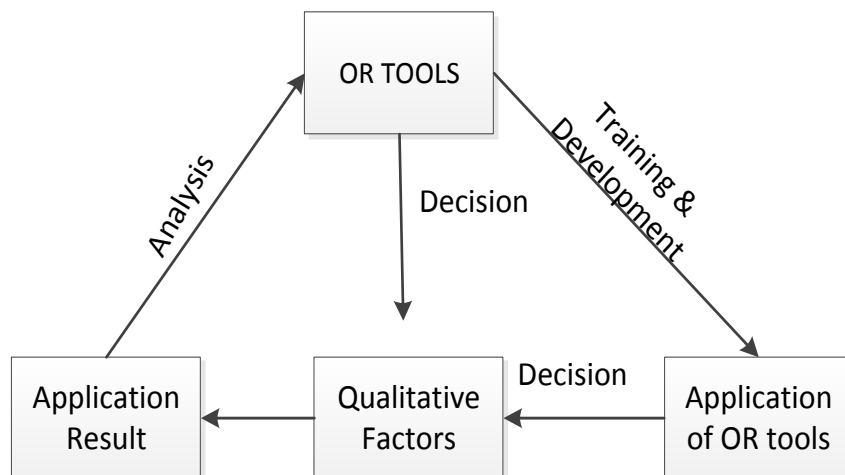

Figure 2.9.1b: Link between OR tools and decision making

(b) SAP

SAP is an enterprise resource planning software, which stands for Systems, Applications, and Products in Data Processing. According to Chien and Tsaur (2007), SAP, since the early 1970s, has evolved into a major information system software product line, which has revolutionized how large organizations approach business computing. At present, SAP is the pioneer and largest firm among ERP vendors. Singla (2008) describes Enterprise Resource Planning (ERP) as a software system that encompasses a wide range of software products, which support day-to-day business operations and decision-making. Singla suggests that ERP serves many industries and numerous functional areas in an integrated fashion, attempting to automate operations from supply chain management, inventory control, manufacturing scheduling and production, sales support, customer relationship management, financial and cost accounting, human resources and almost any other data oriented management process. Singla continues to suggest that ERP systems are designed to enhance an organization's competitiveness by upgrading an organization's ability to generate timely and accurate information throughout the enterprise and its supply chain.

SAP solutions have been successfully implemented and used in a wide range of local governments and government entities (such as power generators, distributors and retailers) throughout the world. Specifically in the South African Government arena, SAP applications have been implemented at, to name a few, the City of Cape Town and other metro municipalities; Denel; Department of Water Affairs and Forestry; Eskom; Gauteng Legislature; South African Revenue Services (SARS); Telkom; City of Johannesburg and Transnet.

The CoCT's SAP software environment has made the day-to-day management of Cape Town more transparent. With SAP's Enterprise Resource Planning, as the backbone as well as the industry-specific set of solutions contained in SAP for Public Sector and SAP for Utilities, city officials laid out specific improvement goals for the new IT platform, including materials management accounting, procurement, materials management, human resources, and pay roll management (Lenovo, Kaupthing Bank, P&G and City of Cape Town, 2007). SAP is not purely a technological solution like most applications. It is a strategic business transformation solution, which is used as a catalyst to achieve technology driven business process re-engineering and transformation (Strachan, 2005:18). They also set clear benchmarks to measure the projects' success, with the firm expectation that the project pays for itself within four

years. But with the improvements achieved through billing alone, the city saw a return on their investment in just over two years (Lenovo *et al.*, 2007).

According to Strachan (2005:1), many of the problems that are currently being experienced in local governments in South Africa can be attributed to:

- The lack of integrated applications;
- Disparate legacy applications;
- Applications that are no longer supported;
- Multiple databases;
- No single view of data / citizens / households;
- Lack of standard financial practises;
- Non-standard payrolls and HR applications; and
- Inconsistent and inaccurate utility billing.

Most of the problems listed above, if presented, can lead to improper decision making at management level.

Strachan (2005:1) mentions that SAP, as an integrated business suite, is able to address these (and many more) known problems, and can deliver all of these core requirements as the one, which has been successfully implemented at the CoCT through the SAP business suite concept. SAP is a tried and tested solution. It has been implemented with my SAP Business Suite and SAP for Utilities at over 200 municipality sites – including the CoCT and Tshwane Metropolitan Council (Strachan, 2005:18).

Both Sap and the GIS are used as decision making tools at the CoCT.

2.10 Challenges faced by the WSD

According to the City of Cape Town's IDP (2004-2005:77), Water Services in the City faces critical challenges. These challenges include removal of the backlog of basic services, achieving customer and stakeholder satisfaction, achieving the target of water demand in 2010 that is 20% below the unconstrained projected demand, meeting the standards for wastewater effluent and ensuring that bulk infrastructure is extended to meet the growth demands of the city. Sustainability of the service is another key challenge – ensuring full cost recovery, maintaining and replacing existing assets and financing capital.

The IDP continues to stipulate that with the integrated water resource planning approach, the key challenge is forecasting the water resource augmentation and bulk infrastructure needs, which are relative to the effectiveness of water demand management initiatives. In order to optimally achieve this, effective institutional arrangements should be established, while the organization's structure should be finalized, staff should be placed in the new structure, and business process re-engineering continues. A part of the business process re-engineering could be the introduction of the extensive use of OR tools and techniques to aid decision making in the organisation.

National/provincial/legislative requirements that affect decision making in the City of Cape Town's Water and Sanitation Department are:

- National Water Act, 36 of 1998;
- Water Services Act, 108 of 1997;
- Strategic Framework for Water Services, September 2003;
- Municipal Legislation such as the Systems Act, Structures Act, Finance Bill, and Budgets
- Other related acts such as the Health Act, 63 of 1977.

2.11 Municipality service delivery challenges

According to Goldberg (2009:48), Cape Town is home to approximately 3.3 million people or 884,000 households. Current population growth is estimated to be 1.65 percent per annum, which includes an annual influx of approximately 48,000 people, many arriving from the Eastern Cape. On average, the city has a relatively low density when compared with cities worldwide, (approximately 1,154 people per km2). Low densities generally result in less efficient service delivery, as there is a larger reticulation system that should be serviced and maintained. With aging infrastructure and asset stripping already an issue within Cape Town, low densities place additional pressure on the City in terms of servicing the area. Management at the CoCT's WSD should take decisions concerning when this infrastructure is due for replacement, and a lot of quantitative data is required to support those decisions. Conversely, some areas in Cape Town, especially informal settlements, have extremely high densities, which pose another set of infrastructural and social problems (Goldberg, 2009:47). It is, therefore, crucial for a municipality such as the CoCT to do proper forecasting and from this make informed decisions on whether to increase capacity to accommodate the increased numbers or not. This decision cannot be based solely on qualitative factors.

According to Memela *et al.* (2008:1), South African citizens are increasingly dissatisfied with the quality and quantity of services that are provided by local government. This is in spite of the fact that local government in South Africa has improved its service delivery substantively over the past ten years at a pace and extent that is rarely seen anywhere in the world. Nevertheless, citizens in South Africa generally feel further removed from (local) government and from "development", and demand more and better services on the one hand, while being less willing to contribute to local development through their own actions and initiatives on the other hand. To counteract this trend, local government institutions should pay more attention to "good governance". Memela *et al.* (2008) continues to suggest that Governance is the formation and stewardship of the rules that regulate the public realm; it is, therefore, the space where state, as well as economic and societal actors interact to make decisions. If and when decision making improves, then automatically there will be better governance in the organisation and improved service delivery.

What this suggests is that each and every decision that is made, therefore, is crucial towards achieving good governance. Therefore, governance is not merely about how a government and social organisations interact, and how they relate to citizens, but it also concerns the state's ability to serve citizens and other actors, as well as the manner in which public functions are carried out, public resources are managed and public regulatory powers are exercised. The quality of governance, therefore, is measured in terms of how well various actors handle the rules that make up the basic dimensions of the political regime (Memela *et al.*, 2008:2). The above-mentioned factors are called qualitative factors, which should be considered collectively with quantitative analysis in decision making.

Dayananda *et al.* (2002:7) concur and articulate that qualitative factors are those, which will have an effect on a project or in the decision making, but will eventually be impossible to evaluate accurately in monetary terms. The public's service delivery satisfaction is not measurable and not quantifiable; hence, it is a qualitative factor. Service delivery issues, even though they have to be considered, can, therefore, not be made the only bases of decisions that are made in any organisation. Quantitative factors should be considered in conjunction with the qualitative factors for improved and more informed decision making. The weather, state and federal legislation, new technological breakthroughs, the outcome of an election, and so on, may all be factors that are difficult to quantify (Render *et al.*, 2006). Politics, however, is one of the major influences that determine how decisions are made in municipalities. Political organisations carry different mandates, therefore, an outcome of an election

can sometimes translate to a change in strategic intents (IDP) for a municipality, and this, therefore, can affect the way that decisions are made.

Render *et al.* (2006) imply that because of the importance of qualitative factors, the role of quantitative analysis in the decision-making process can vary. The results of quantitative analysis will be combined with other (qualitative) information in making decisions.

2.12   Results of lack of service delivery in municipality

The worst scenario would be the public service delivery protests, which could turn ugly such as the recent service delivery protests. According to Brooks (2009), protests over poor public service soared in 2010, as analysed by Municipal IQ, which monitors municipal services. Poor South Africans staged twenty four major protests in 2010, compared with twenty seven during 2009, the group said in a statement. "We've got high levels of unemployment, the whole world is suffering from an economic downturn and that's not making it any easier," said Adrian Hadland, a director at the Human Sciences Research Council, a think-tank that advises on public policy. "Part of the frustration is that local government is very uneven, and that is often the level of government where things are most keenly felt and expressed". Grobler (2009) concurs and says that according to the United Association of South Africa's (Uasa) CEO, Koos Bezuidenhout, "dissatisfaction with poor service delivery, or the complete lack thereof, at municipal level is now spreading like a veld fire throughout South Africa."

Failure to deliver services to the people by the WSD could lead to dissatisfaction and public service protests. It is, therefore, crucial to ensure that decisions that are taken in this department are scientifically supported and proven to be optimal, informed and reliable.

2.13   The OR Approach

According to Render *et al.* (2006:3), the following steps should be followed when taking the OR approach, as one step does not have to be finished completely before the next is started. In most cases, some steps will be modified to some extent before the final results are implemented. In some instances, testing the solution might reveal that the model or the input data are not correct. The steps that would follow defining the problem should, therefore, be modified. The steps are as follows:
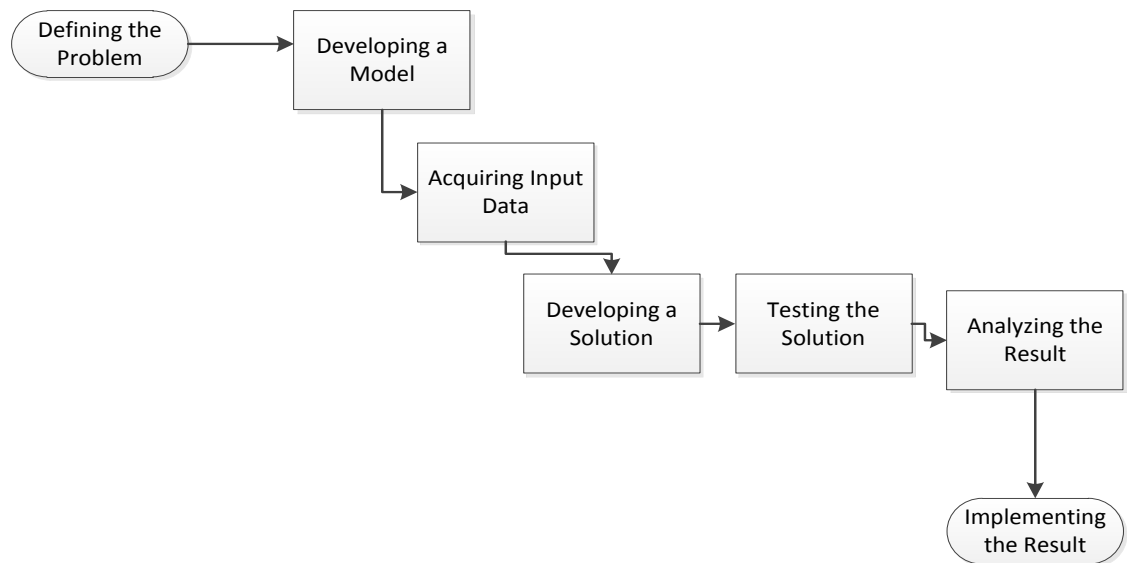
Figure 2.13: OR approach steps
(Adapted from Render *et al.*, 2006:3)

2.14 Summary

This chapter presented the background of the organisation and the department that is the subject of the research, its position in government as a whole, and its mandate. Operational research was described and previously used applications of OR in other companies and government entities were tabled. The bases of decision making and the tools, which the organisation uses and which are linked to the strategic plan also formed part of the discussions of this chapter. Literature was presented on the challenges that the department faces, service delivery and the impact of decision making on the delivery of services to the public. The highlight of this chapter involved discussions around the link between OR techniques and decision making tools at the WSD of CoCT.

This chapter further discussed the history of OR in South Africa, its use in government, and how it was introduced and applied in industries other than government. Companies that use OR tools in SA were mentioned to support the use of OR in companies today. To expand on this, the previous example of applications of OR in companies and organisations were considered to demonstrate how OR was previously used to achieve certain goals within companies. OR was then discussed as a decision making tool before the chapter introduced the element of leadership and how it links to decision making. Local government has its own factors and planning tools that support its current decision making, and these were outlined for the purpose of the findings of the study and the recommendations that will be derived from the analysis of results.

CHAPTER THREE

CHAPTER 3:   RESEARCH METHODOLOGY

3.   Introduction

This chapter presents the research methods that were used for this study. The target population, which was the population for the research study was chosen to investigate and find answers to the research questions so that the research objectives are met. The sampling techniques and the methods of data collection are also discussed in detail.

3.1   Target population

The population was the CoCT staff members, where there is a wide variety of decision makers with different capacities within the organisation. The CoCT has a variety of employees who hold different positions in different departments, and who hold different qualifications. The population comprised of decision makers in middle and senior management, with or without a tertiary qualification, and who work at the Water and Sanitation Department. The population comprised of professionals from engineering, supply chain and human resources management. The population size of interest from which the sample was drawn comprises a total of 197 employees. Most of the decision making is done by these professionals in the Water and Sanitation Department, which impacts other departments, as well as the expected output, which is service delivery.

3.2   Sample selection and method sampling

The stratified random sampling technique was used for engineering, SCM and HRM professionals. According to Wamocha, Muliro, Nasongo and Injendi (2012:105), the stratified random sampling technique involves dividing the population into homogeneous subgroups and then taking a simple random sample in each group. The sample was selected in such a way to ensure that all different levels of management groups in the population were represented in the sample in proportion to the number in the population, while the subgroups had an equal chance of being included. This type of sampling is necessary when the population that is sampled is not homogeneous in terms of certain required characteristics. Rather than selecting randomly from the entire population, the researcher divided the population into two or

more subpopulations (strata). The population size for this study consisted of 197 management personnel from WSD, amongst whom 97 hold junior positions, 50 hold middle positions and 48 in senior positions. A sample size of 130 personnel at different levels of management was considered as sufficient, as this calculated by using the hypergeometric methodology (refer to the equation below).

Calculating minimum sample size

Hypergeometric (for small population – less than 200)

$$n = \frac{NZ^2pq}{E^2(N-1) + Z^2pq} \quad (Morris, E.\ 2012)$$

$$= \frac{(197)(1.96^2)(0.5\text{x}0.5)}{0.05^2(197-1) + 1.96^2(0.5x0.5)}$$

$$= \frac{(197)(3.8416)(0.25)}{0.0025(196) + 3.8416(0.25)}$$

$$= \frac{189.1988}{0.49 + 0.9604}$$

$$\textbf{Sample size} = \textbf{130}.\textbf{44}$$

$$n = 66.21\% \ of \ the \ total \ population$$

Equation 3.3.1: Calculation of minimum sample size

(Adapted from Evan Morris, 2012)

Where

n is the required sample size

N is the population size

p and q are the population proportions. (If these are not known, they are each set to 0.5).

z is the value that specifies the level of confidence wanted for the confidence interval when data is analysed. Typical levels of confidence for surveys are 95%, in which case z is set to 1.96.

E sets the accuracy for the sample proportions. With the accuracy of plus or minus 5%, E is then set to 0.05.

According to Wamocha, Muliro, Nasongo and Injendi (2012:105), stratified random sampling technique was chosen because it divides the population into distinct, independent strata, which can enable researchers to draw inferences about specific subgroups that may be lost in a more generalized random sample. Secondly, utilizing a stratified sampling method can lead to more efficient statistical estimates (provided that strata are selected based on relevance to the criterion in question, instead of availability of the samples).

The stratified random technique helped the researcher to stratify between the differences in perceptions among respondents who are in different levels management. The researcher wanted to ascertain possible trends in perceptions and opinions among the different status groups. These trends were discovered by using the cross tabulation reports. To satisfy this sampling technique, the respondents were asked to specify their designation and level of management, and 50 people out of the 73 respondents specified their designation and of the 50, 2% were at a director departmental level, and 22% were section heads, which are more strategic levels, while 36% were line managers.

3.3   Method of data collection

To collect responses for the survey a questionnaire was used administered on Survey Monkey, which is a web-based method of data collection. The questionnaire was sent electronically via e-mail to obtain the data. This method was chosen as it is more confidential and allows the participants to be honest without worrying about confidentiality. The questionnaire was divided into the following sections: education, position level, knowledge of OR, organisational decision making techniques, and decision making versus service delivery.

3.4   Data validity and reliability

Golafshani (2003:598) mentions that reliability is described as the extent to which results are consistent over time, while an accurate representation of the total population under study is referred to as reliability, and if the results of a study can be reproduced under a similar methodology, then the research instrument is considered as being reliable. Golafshani (2003:599) also states that validity determines whether the research truly measures that, which it was intended to measure or how truthful the research results are. In other words, does the research instrument allow you to achieve the best results possible of your research object? Researchers generally determine validity by asking a series of questions, and will often look for the answers in the research of others.

According to Cooper and Schindler (2006:318-320), three major forms of validity can be identified, namely 'content validity', which was mostly used in this research, 'criterion-related validity' and 'construct validity'.

3.5 Ethical considerations

In the context of research, according to Saunders, Lewis and Thornhill, (2001:130), "… ethics refers to the appropriateness of your behaviour in relation to the rights of those who become the subject of your work, or are affected by it". The following ethics were observed in the research study:

o Informed consent: Participants should be given the choice to participate or not to participate, and furthermore be informed in advance about the nature of the study.
o Right to privacy: The nature and quality of participants' performance must be kept strictly confidential.
o Honesty with professional colleagues: Findings must be reported in a complete and honest fashion, without misrepresenting what has been done or intentionally misleading others as to the nature of it. Data may not be fabricated to support a particular conclusion.
o Confidentiality/Anonymity: It is good research practice to offer confidentiality or anonymity, as this will lead to participants giving more open and honest responses Saunders *et al.* (2001).

In conjunction with the above, a permission letter was sought from the CoCT to undertake the research. Respondents were informed of the objectives of the research and their consent to participate in this research was sought. In addition, anonymity and confidentiality was guaranteed to all respondents.

3.6 Research assumptions

The following research assumptions pertain to the research study:
o The use of operational research tools at the WSD of the CoCT can improve management's poor decision making.
o Improved decision making within the department will improve levels of service delivery.
o There are no operational research tools or techniques that are used at the CoCT apart from SAP (ERP) system.

3.7 Research constraints

The following constraints applied to the research:

o The research was limited to the WSD and no other departments, which limited the response rate and eliminated the opinions and views of employees from those departments.

o The availability of Senior Managers and Middle Management staff members posed a constraint to the research. This also contributed to the poor response rate.

o The poor overall response from respondents, only the deductions from those that responded to the survey could be discussed and analysed.

o Lack of representation from the SCM and HR respondents, which was owing to the nature of business at the WSD.

3.8 Summary

The research strategy described in this chapter such as the method of data collection; sample selection; method sampling; and data validity were used to gain input into the questionnaire, and to specify what the outcomes of the next chapter would be measured against.

CHAPTER FOUR

CHAPTER 4: DATA ANALYSIS

4.   Introduction

This chapter presents results from the questionnaire, which was conducted within the Water and Sanitation Department of the City of Cape Town. The aim of this study, as mentioned in Chapter 1, was to analyse the efficiency of decision making techniques at the City Of Cape Town's Water and Sanitation Department and to investigate and assess the possible impact of the use of OR techniques at the WSD.

The questionnaire, a copy is attached in the Appendix, was administered by means of a web-based survey, namely Survey Monkey.

4.1   Discussion

An invitation was sent via electronic mail to 145 CoCT WSD employees and as discussed in Chapter 3, the total population was 197 and the sample size was calculated to be 66.21% of the total population, which adds up to 130 employees (refer to equation 1 on page 43). However, only 73 employees responded to the survey, which is 52.2% of 130, which is the sample size required. Nulty (2008) suggests that with a confidence level (z) of 95% (refer to equation 3.3.1) and a sample size of between 100-150 the response rate was 82%. Nulty continues to argue that a 60% to 70% response rate can be accepted as adequate because in spite one's best efforts, it will be difficult and/or expensive to obtain a response rate of above 70%. A response rate of 52.2 % is, therefore, considered as slightly inadequate as it falls below the 60 % - 70% benchmark. Taking into account Nulty's argument, the results can, therefore, not be seen as a true representation of all the management of the WSD owing to the inadequate response rate.

The questionnaire consisted of 10 questions, which comprised open-ended and closed-ended questions (see Appendix A). There were 3 sections in the questionnaire, namely:
- **Section A:** Education & Position Level (Questions1-3);
- **Section B:** Knowledge of OR/Quantitative Analysis , which evaluates if the participants have any knowledge of OR, and how familiar they are with OR techniques (Questions 4 & 5); and
- **Section C:** Organisational (CoCT) Decision Making Techniques, and decision making vs. service delivery, where the researcher tries to discover if there is a

link between decision making and service delivery, and how OR affects this (Questions 6-10).

4.2   The results

The results that were obtained from the completed questionnaire were analysed by means of SPSS Software. Statistical Package for the Social Sciences is a Windows-based program that can be used to perform data entries and analysis to create tables and graphs. SPSS is capable of handling large amounts of data and can perform all analyses covered in the text and much more (Howell, 2011). The summary of the results of the analyses are presented in sections 4.3 to 4.12. The charts are presented in the form of the number of the respondents and in percentages.

Section A: Education and position level

4.3   Question 1: Which field or section are you in?

With this closed-ended multiple choice research question the researcher sought to discover, which field of expertise uses OR techniques. The answering choices were as follows:

1. Corporate HR   2. Corporate SCM   3. Engineering   4. Other

In total, 52 (which makes up 71.23% of the population) of the respondents were in engineering, and 21 (28.77%) were from other fields (please refer to chart 4.1 below).

The researcher then asked respondents to specify their designations in an attempt to discover if they are in positions that require decision making, and to what extent; a detailed discussion follows in the next chapter.

A summary of the results follows.

Which field or section are you in?
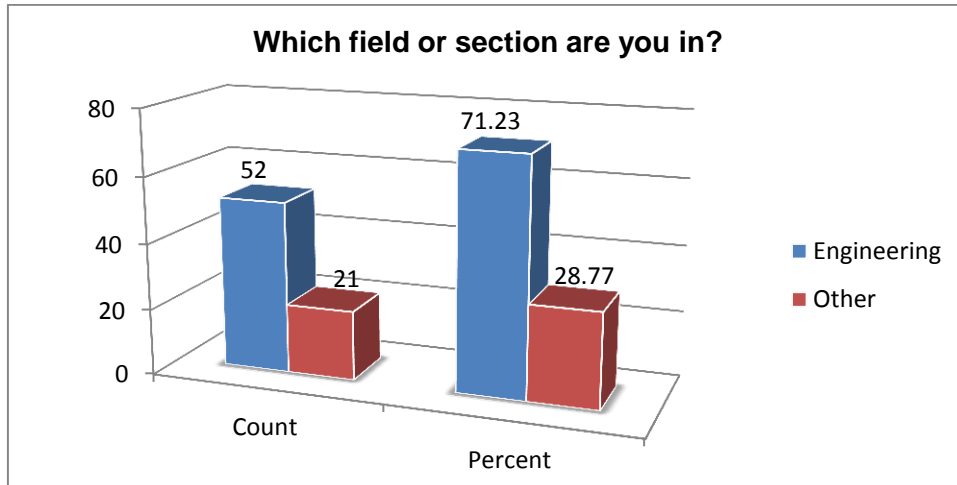
Chart 4.3: Frequency distribution 1

4.4   Question 2: Do you have a tertiary qualification?

This closed-ended categorical research question sought to discover the relationship between application and knowledge of OR tools and a formal qualification.   The answering choices were Yes or No, followed by an extension request for respondents to specify their highest tertiary qualification (refer to chart 4.4.2).   Of the 73 respondents, 66 (90.41%) have a tertiary qualification, while 6 (9.59%) do not have any formal qualification.

Summary of results:

Tertiary Qualification
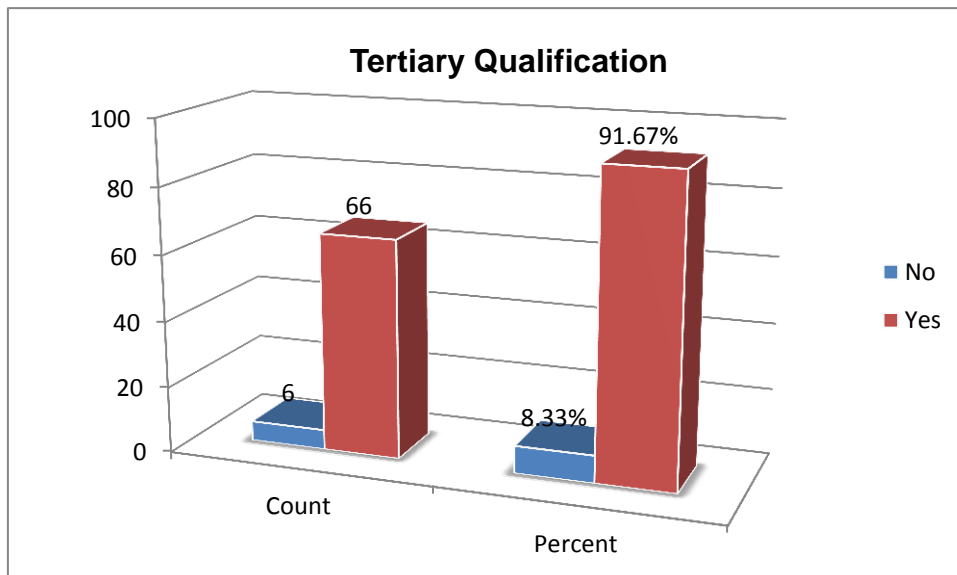
**Chart 4.4.1: Frequency distribution 2**
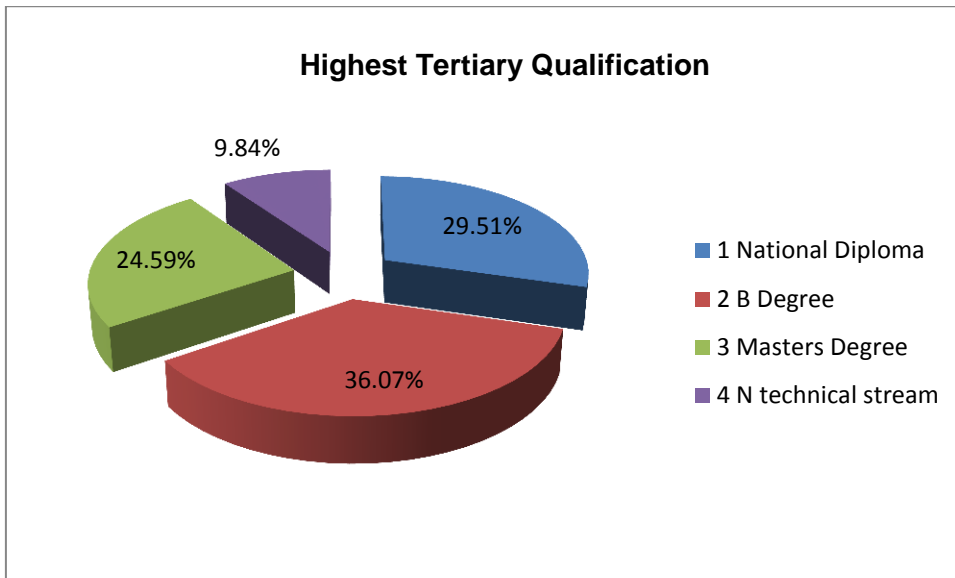
Chart 4.4.2: Frequency distribution open ended 2

4.5 Question 3: What level of management do you occupy?

Respondents' level of management determines how much decision making is required by that job and how complex those decisions are. The answers ranged between different levels of management from junior level 1 to level 5. A total of 2.74% of the respondents are level 2 managers; 5.48% are level 3; level 4 - 31.51%; the most are level 5 managers comprising 43.84% of the population; and 16.44 are managers who are more junior than level 5, which is the most junior of the levels listed in chart 4.5.

Respondents were also asked to optionally specify their number of years in service.

Summary of results:
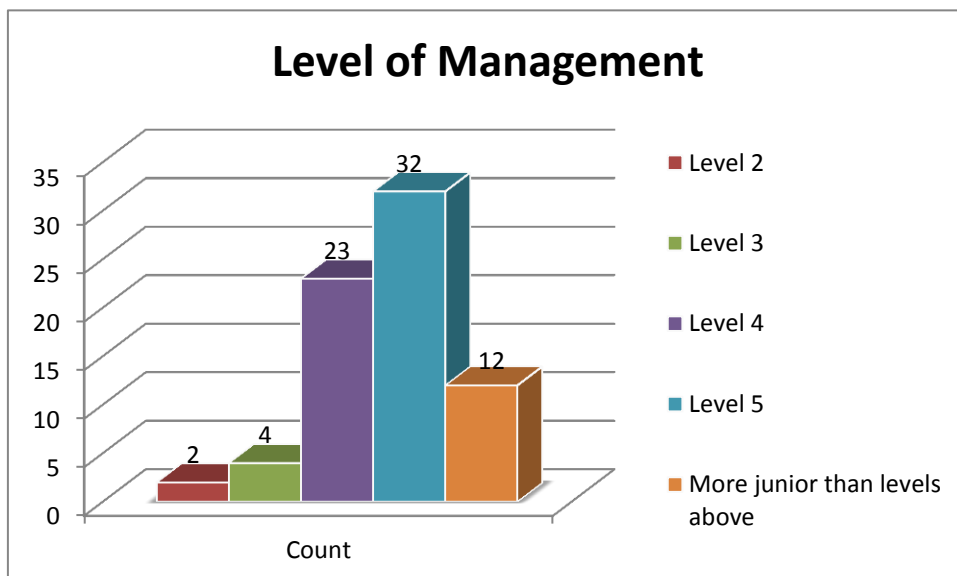
Chart 4.5: Frequency distribution 3

4.6   Question 4: Do you have any knowledge of Operational Research or Quantitative Analysis?

The question sought to discover if the respondents have any knowledge of OR, and if they do, the question branched out for respondents to detail which aspects of OR (discussed in the next chapter) they have knowledge of and how they think their knowledge of OR might impact on their decision making. A total of 67% of the respondents answered no, while 32% of the respondents answered yes.

Summary of results:
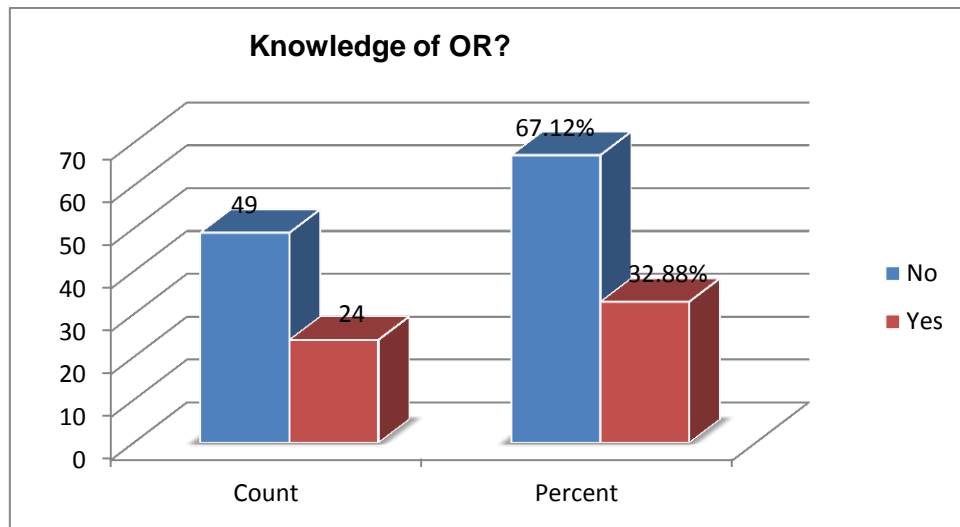
Chart 4.6: Frequency distribution 4

4.7   Question 5: How did you get to know about OR/Quantitative Analysis?

The question was a multiple choice closed-ended question, which was meant to discover the respondents' knowledge of OR and if it was as a result of formal education, application at work, subject reading or other (with a condition to specify if chosen). As presented in Chart 4.5, 39.39% of the respondents know of OR through formal education; 30.3% through subject reading; and 12.12% through application at work. A total of 18.18% of the respondents had a combination of all of the above options.

This question was not relevant to respondents that answered No to Question 4.

Summary of results:

How did you get to know to about OR?

	1. Formal education	2. Subject reading	3. Application at work	4. Formal education & subject reading	5. Formal education, subject read, application at work	6. Formal education & application at work	7. Subject read & application at work
Count	13	10	4	2	1	1	2
Percent	39.39	30.3	12.12	6.06	3.03	3.03	6.06
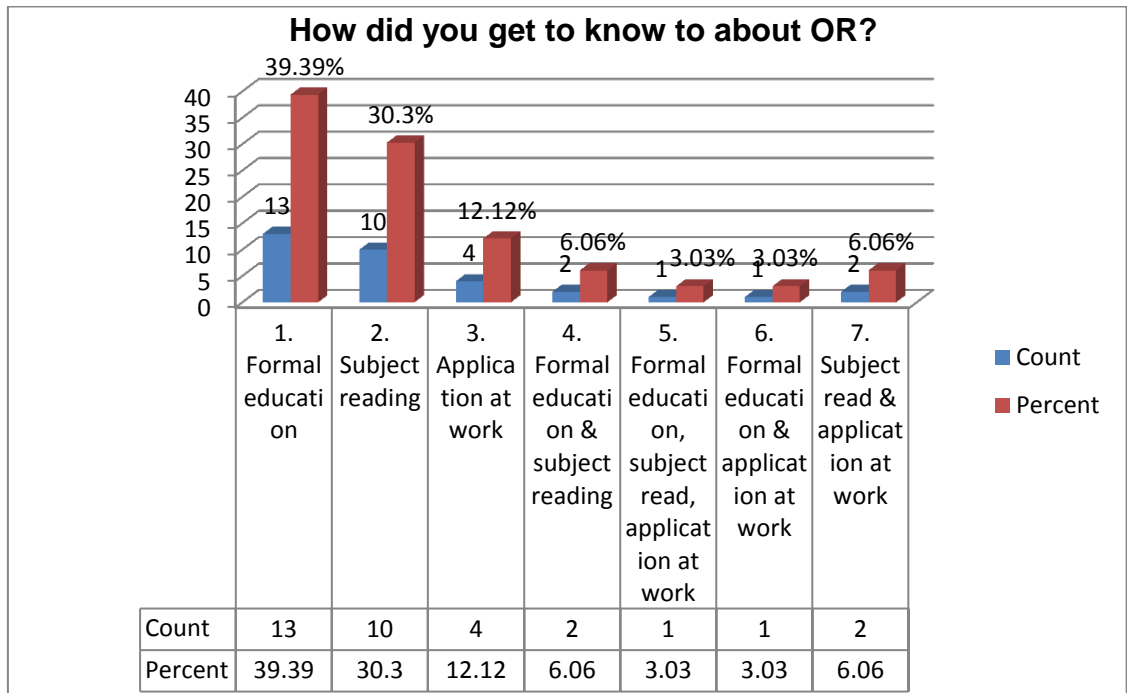
Chart 4.7: Frequency distribution 5

4.8   Question 6: What decision making tools or techniques does the City Of Cape Town use?

In this open ended question the researcher sought to test if there are any decision making tools that are used at the CoCT and if the respondents are aware of them. This is an open-ended question, therefore, the results that were received were too fragmented and difficult to analyse. The values were combined in similarity and coded with numbers before being grouped according to code numbers, for example all the respondents that answered Not known, Not Any or Not sure were coded as response 1 and grouped as respondents with the same or similar responses.

The results show that 50% of the respondents were either not sure, not aware of any or no tools are used at the CoCT' s WSD. While 27.42% of the respondents answered SAP, 3.23% of respondents answered IDP, with 1.61% saying that the decision making is policy driven, 3.2% says that it is based on gut feel, 6.45% respondents see cost benefits with risk and needs analysis as a decision tool, which is used at the WSD. A total of 3.23% of responded that meetings inform decision making, while 4.83% chose multiple answers such as number 1 and 4, 2 and 3 or 2, 3 and 6.

Summary of results:
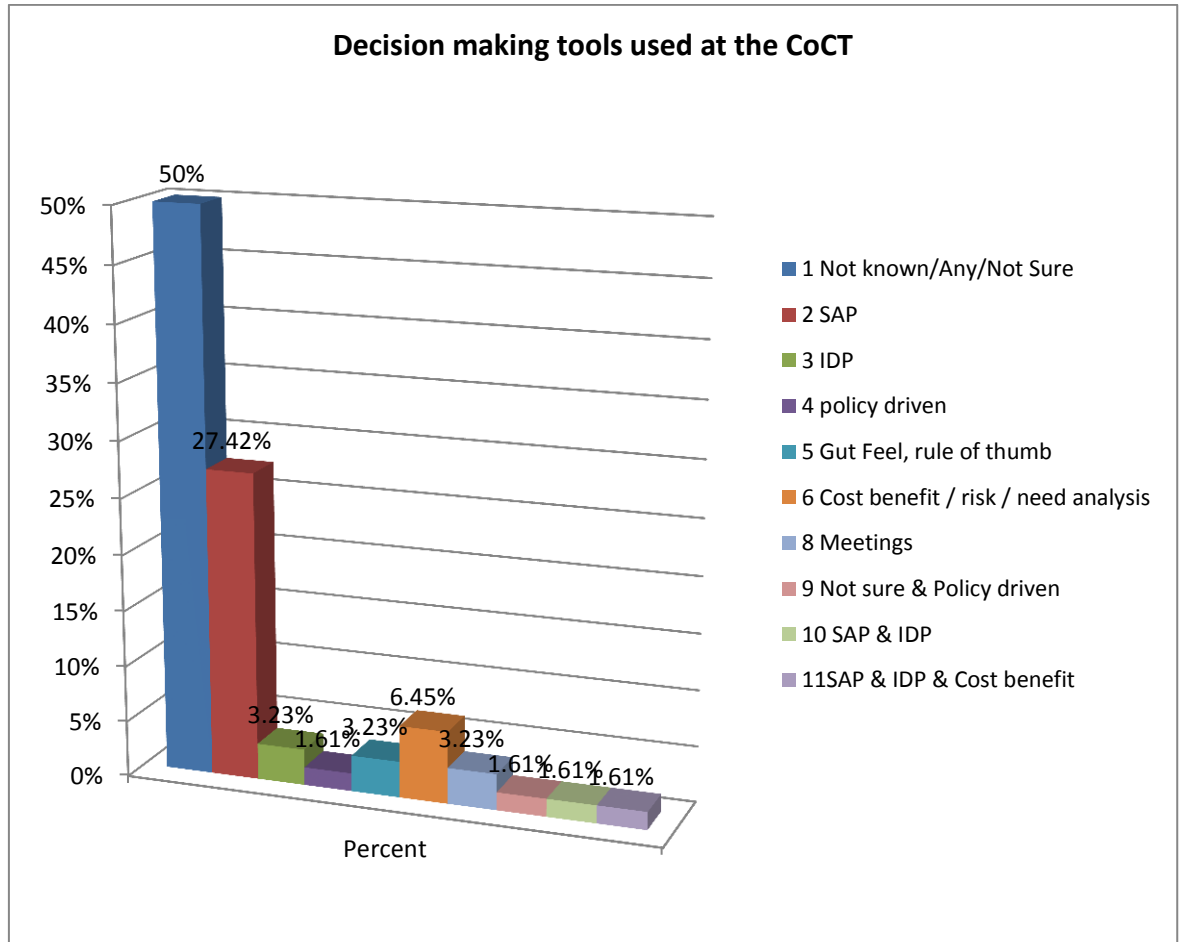
Chart 4.8: Frequency distribution 6

4.9   Question 7: Do you think that the current decision making tools or techniques can be improved upon or changed?

In this closed-ended question the researcher wanted to determine whether the respondents think that the current decision making tools at the CoCT's WSD are efficient, or if they need to be improved. The response choices were **Yes / No**. Chart 4.5 shows that 86.96% of the respondents think that the current decision making tools can be changed or improved upon, while 13.04% answered did not think so.

The question extends to a branching question, which requested the respondents to specify why, if answered **Yes (discussed in the next chapter)**.

Summary of results:

Do you think the current decision making tools or techniques can be improved or changed?
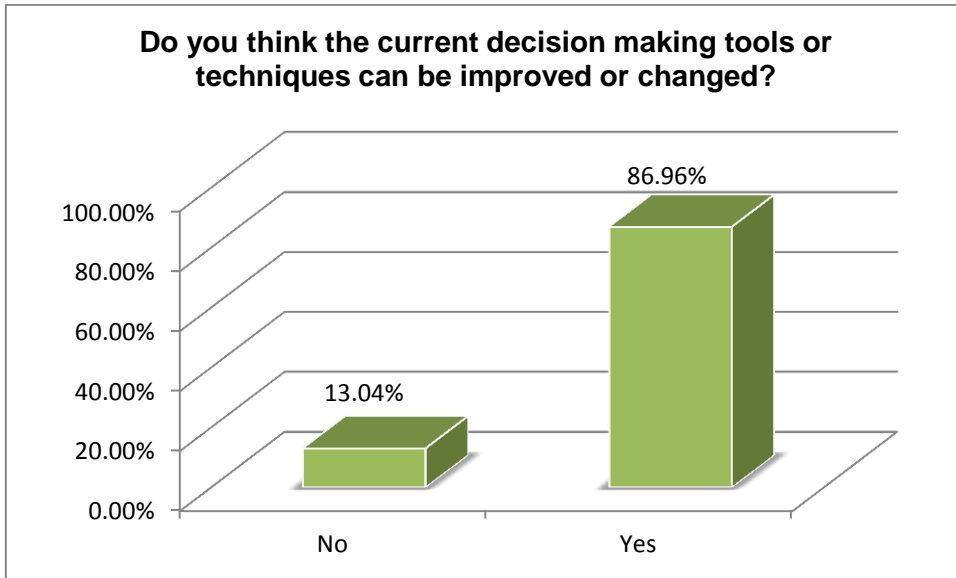
Chart 4.9: Frequency distribution 7

4.10 Question 8: Do you think that if properly researched, and if scientific researched techniques were used in the CoCT that the quality of decision making would improve?

This question sought to determine whether the inefficient decision making tools discovered in Question 6 by respondents who answered yes, could possibly be rectified by application of OR tools at the CoCT. A total of 63 respondents answered yes, while 7 answered no.

Summary of results

If OR was used would decision making improve at the CoCT?
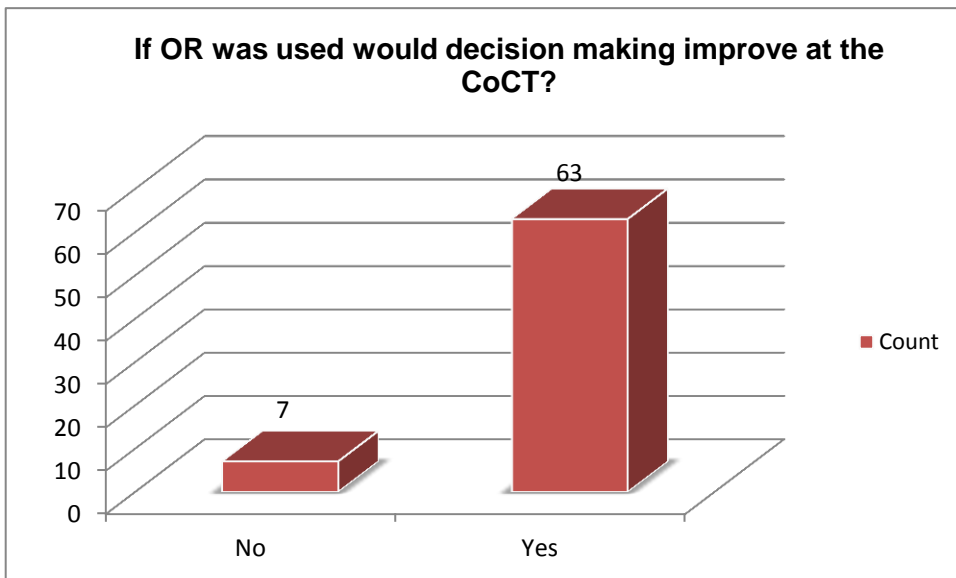
Chart 4.10: Frequency distribution 8

4.11   Question 9: How does politics affect management's decision making?

The CoCT, is an organisation that is affected by politics, especially when it comes to policy and decision making, hence this question sought to determine how much decision making is affected. The four answer choices were between 0 to 100%. A majority of the respondents (74.65%) believe that politics have a 50-100% effect on management's decision making; 18.31% think that it has 25-50%; 4.23% say that it is 0-10%; and 2.82% of the respondents answered that it has about 10-25% effect.

Summary of results:
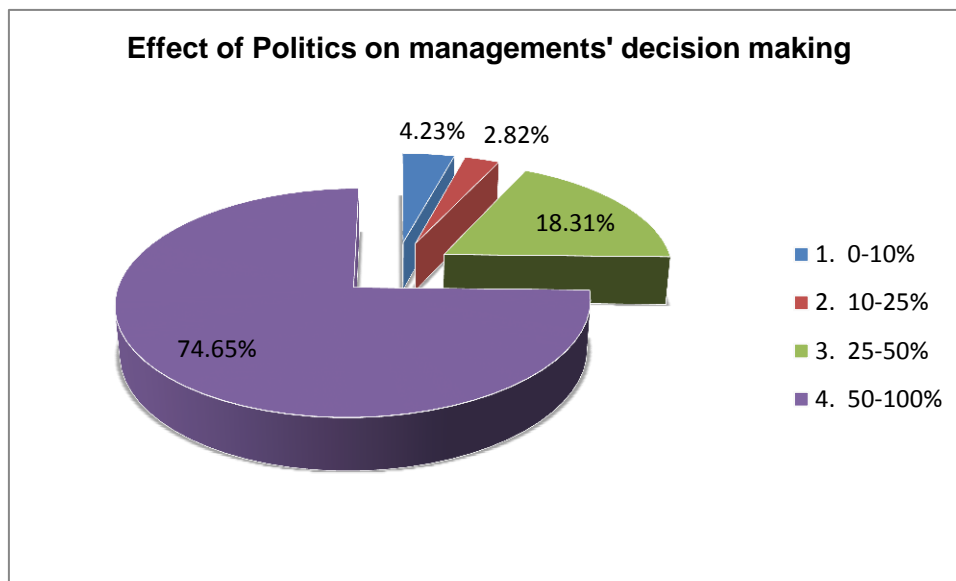
Chart 4.11: Frequency distribution 9

4.12   Question 10: Do you think that poor service delivery is a result of bad decision making amongst CCT's management?

As mentioned in Chapter 3, this question attempted to determine the relationship between decision making at the CoCT and service delivery, if there is one at all. The question was followed by a request for respondents to elaborate on why they answered Yes or No. One respondent was excluded from the analysis owing to multiple selections of yes and no instead of choosing one of the two. A total of 60.56% of respondents believe that poor service delivery is a result of management's bad decision making, while 38.03% disagreed.

Summary of results:

Poor service delivery a result of bad decision making
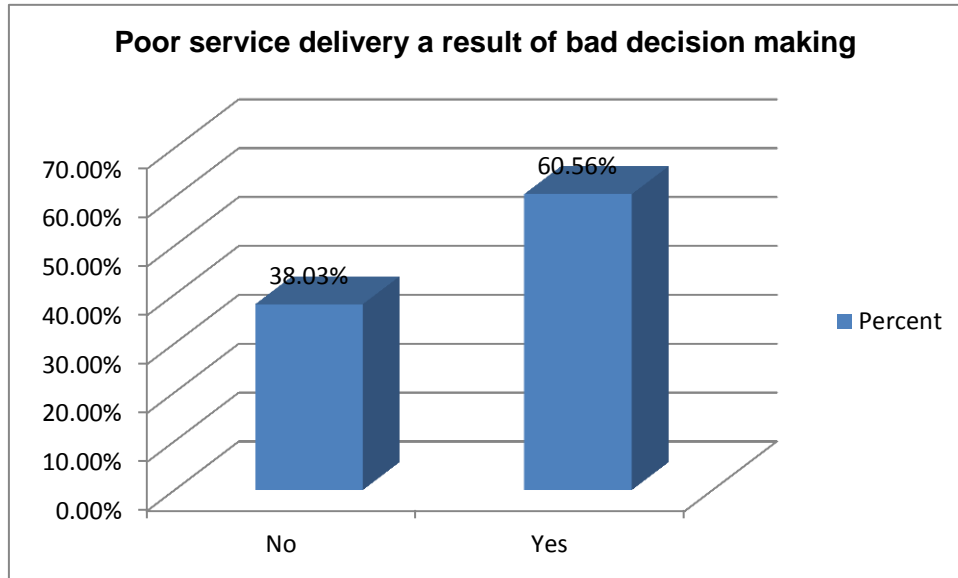
Chart 4.12: Frequency distribution 10

4.13   Summary of Chapter

The results that were presented in this chapter are limited to the data presented and do not include the open ended questions (the please explain / specify questions), which were meant to highlight certain emphasis on respondents' views and opinions. These secondary questions, including a discussion of the results, are detailed in the next chapter.   The results further present statistics that were used to answer the research questions as set out in Chapter 1, section 1.5. The responses to the open ended questions were used as input for discussion in chapter 5.

CHAPTER FIVE

CHAPTER 5:   DISCUSSION OF RESULTS

5.   Introduction

The purpose of this research was to investigate whether OR tools and techniques are being used and its possible impact on decision making amongst management at the CoCT's WSD and its impact on service delivery. The discussions in this chapter are based on the analysis of results from the previous chapter, which fulfilled the investigation in relation to the primary and secondary objectives of this research, and led the researcher to conclusions and recommendations. The limitations of the research are also discussed.

It is assumed that the attributes of the respondents influence their behaviour and answers for the survey questions. The achievement of the goals and objectives of the study, were to discover whether the CoCT's current decision making tools are efficient enough with or without the use of OR techniques, and therefore determine what changes should be made. This will be done by being able to answer the research questions by analysing the results and aligning them to the research objectives.

5.1   Discussions

5.1.1   Field of work in the WSD

Even though the survey was mailed to 145 participants who are employees at the WSD in all levels of management and in all fields, only 73 people responded to the survey even after several reminders. Of those 73 people 52 are from the engineering field and 21 are from other fields. None of the respondents were from HR or SCM, which could be as a result of the limitation (discussed in 5.4). Here the researcher sought to highlight for which applications in the WSD the OR techniques would be needed, and are currently used. In Chapter 2 (2.6) Heger (2006) suggests that the myriad applications of OR include scheduling, routing, workflow improvements, elimination of bottlenecks, inventory control, business process re-engineering, site selection, or facility and general operational planning. According to Heger (2006), revenue and supply chain management reflect two growing applications that are distinguished by their use of several OR methods to cover several functions. The researcher sought by inviting the SCM and HR participants to the survey to test Heger's statement above that the application is growing in these two fields. It was

also to eliminate or preserve the assumption that because operational research is described as an interdisciplinary sub-discipline of applied mathematics that uses various methods to derive optimal or optimised solutions to complex problems (Peterson, 2009:22), that it is mostly used by people who have a mathematical background. The results though failed to satisfy this test because of the limitation previously mentioned above which leaves a gap for future studies.

5.1.2 Tertiary qualification vs. knowledge of OR

Of the surveyed employees, 72 responded to the tertiary education question, and of the 72, 66 respondents have a tertiary qualification with only 6 being without. The theory was that the employees who have a tertiary qualification, especially those with a post graduate degree, will have some knowledge of OR and might even apply OR tools in their jobs. As stipulated in Chart 4.2.2 in the previous chapter, the extension of Question 2 was meant to discover if there is any relationship between level of qualification and not having or having knowledge of OR. The extension Question 2.2 was answered by 61 respondents and 24.59% of these respondents have a post graduate degree (as per chart 2.2). According to Table 5.1.2b below, the results show that of the 15 respondents that possess a post graduate degree, only 8 have knowledge of OR. A cross tabulation report of Questions 2 and 4 (Table 5.1.2a) also shows that of the 66, only 22 (33.33%) respondents who have a tertiary qualification have knowledge of OR with 44 with none. An interesting result though is that of the 6 respondents who have no tertiary qualification, 2 respondents answered yes to having knowledge of OR. This eliminates the assumption that employees who have a tertiary qualification will have knowledge of OR, as there is no result that supports this assumption. The results clearly indicate that even though the WSD has a high percentage of qualified employees, a majority of them have no knowledge of OR.

Counts section	Q4: Do you have any knowledge of Operational Research or Quantitative Analysis?		
Q2			
Do you have a tertiary qualification?	N	Y	Total
N	4	2	6
Y	44	22	66
Total	48	24	72

Table 5.1.2a: Cross tabulation of Questions 2 and 4

Counts Section	Q4: Do you have any knowledge of Operational Research or Quantitative Analysis?		
OEQ2			
If yes, please specify highest tertiary qualification and field for example, NDip Mechanical Engineering	N	Y	Total
1 National Diploma	13	5	18
2 B. Degree	14	8	22
3 Master's Degree	7	8	15
4 N technical stream	4	2	6
Total	38	23	61

Table 5.1.2b: Cross tabulation of question OEQ2 and Q4

It was shown in the literature review that White *et al*. (2011) suggest that the main aim of OR and developing countries' initiatives appears to be to promote an increase in the use of OR as a practical tool for problems within developing countries. However, the challenge is with the lack of OR practice in developing countries, while the lack of knowledge amongst the surveyed employees at the WSD proves that there is indeed a lack of OR practice in South Africa as a developing country. Chart 4.5 in the previous chapter also emphasizes that of the 33 that responded to Question 5, 17 respondents got to know about OR through formal education, however, only about 8 of the respondents who have knowledge of OR use it as an application at work, which again shows the lack of application of OR techniques in the organisation. Some of the respondents have knowledge of optimisation, assignments, decision making trees, simulation, Linear Programming and the statistical aspects of OR. These respondents articulated that when applied, OR techniques eliminate the error of judgement in decision making and provide guidance based on historical data for recommendation, while others differed in response and suggested that it had minimal to no effect on their decision making. This is, however, not conclusive, as they are not knowledgeable on OR, hence this can be deducted as merely the respondents' perception.

5.1.3 Level of management vs. decision making

a)   The decision making hierarchy at the CoCT is illustrated in Figure 2.9b. Level 2 in the hierarchy is highlighted in yellow in the figure, which is a position of director WSD. The hierarchy then filters down as per mentioned levels in Chart 4, section 4.3. All the delegates mentioned are actively involved in decision making mostly at a strategic level and sometimes at an operational level, as prescribed in the MSA. Chart 4.3 shows that a majority (43.84%) of the respondents were level 5, which is more

operational or functional (middle) managers, and 31.51% were section heads, which refers to a link between operational and strategic functions in the WSD. There was no proper balance in response between middle and senior managers (level 3 to 2 with 2 being the highest level) owing to the fact that in the WSD there is only a few senior managers, with the rest residing in other departments. Only about 8% of level 3 and 2 managers were surveyed. Level 2 managers report to the executive director who reports to the City Manager, a post which is very close to politics (refer to 2.9a). De Visser (2010) suggests that municipal councils are democratically elected according to an electoral system that combines constituency (ward) representation with proportional representation. He continues to explain that the council elects an executive mayor who exercises all executive authority. The executive mayor appoints a mayoral committee to assist him or her, and that the council delegates parts of its executive authority to its executive mayor or executive committee. As the delegating authority, the council, therefore, remains ultimately responsible for the exercise of executive authority and has concomitant controlling powers over the executive. The 8% of senior managers who were surveyed are close to these political appointees, however, this is subject to further analysis or research.

The cross tabulation below shows the decision making tools or techniques that are used by the CoCT, as mentioned by the different levels of management. According to Table 5.1.3a below, only 62 responded to Question 3, while 50% of the respondents (almost half of them being level 5 managers) either do not know or are not sure of any decision making tools or techniques that are used by the organisation in spite of the fact that literature in Chapter 2 suggests SAP and the IDP as some of the decision making tools in the CoCT. However, this can be read in more than one manner, as respondents could be using the tools (such as, SAP as it is compulsory for use by all employees) and not be aware that the tool is a decision making tool, or it could be that the respondents frankly do not know of any tools, which could be a concern for the Department.

In Table 5.1.3a below 19 (about 30%) of the respondents identified SAP as a decision making tool in the organisation. In Chapter 2 SAP is described as an enterprise resource planning tool. Singla (2008) describes ERP as a software system that encompasses a wide range of software products, which supports day-to-day business operations and decision-making. Singla suggests that SAP solutions have been successfully implemented and used in a wide range of local governments and government entities (such as power generators, distributors and retailers) throughout the world. Specifically in the South African Government arena, SAP applications

have been implemented at, to name a few; the City of Cape Town and other metro municipalities. Results in the table below concur with Singla in that SAP is an enterprise resource tool and is used to influence decision making at the CoCT.

Only 4 respondents identified the IDP as a decision making tool in the organisation. In Chapter 2, a statement by Memela *et al.* (2008:6) suggests that most municipal councils have not communicated effectively to their citizens their development vision and plan, as reflected in the Integrated Development Plans (IDP), and IDPs are hardly used to guide actual decision-making. One could conclude that this is also the case at the CoCT as well. As described by the CoCT' s Finance Directorate in Chapter 2, the IDP is the strategic plan of the City seeking to achieve the above and link, integrate and coordinate plans, taking into account proposals for the development of the municipality. The IDP also aligns the resources and capacity of the municipality with the implementation of the plan, while it also forms the policy framework and general basis on which the annual budgets are based, and it is compatible with provincial and national development plans. The IDP is, therefore, used at more strategic levels, which are senior levels 2 and 3, however, none of the senior managers identified the IDP as a decision making tool. It was only identified by middle managers in levels 4 and 5 (refer to Table 5.1.3a below and for further analysis to Appendix C), which proves Memela *et al.* (2008:6) suggestion that IDPs are hardly used to guide actual decision-making.

	Q3: What level of management do you occupy?					
Q6				**Levels**		
What decision making tools or techniques does the City Of Cape Town use?	**2**	**3**	**4**	**5**	**6**	**Total**
1 Not known/Any/Not Sure	1	1	7	15	7	31
2 SAP	1	0	8	5	3	17
3 IDP	0	0	1	1	0	2
4 policy driven	0	0	1	0	0	1
5 Gut Feel, rule of thumb	0	0	1	0	1	2
6 Cost benefit / risk / need analysis	0	2	0	1	1	4
8 Meetings	0	0	1	1	0	2
1 & 4	0	0	0	1	0	1
2 & 3	0	0	0	1	0	1
2 & 3 & 6	0	0	0	1	0	1
Total	2	3	19	26	12	62

Table 5.1.3a: Cross tabulation of Questions 6 and 3.

b)   Sixty (60) respondents believe that the current decision making techniques can be improved if proper scientific researched techniques were used, however, 9 are satisfied with the current techniques. This concurs with what Heger (2006) suggests

in the literature review that the driving idea behind OR is to collaborate with clients to design and improve operations, make better decisions, solve problems, and advance managerial functions, including policy formulation, planning, forecasting, and performance measurement. In essence, OR is all about making better and more informed decisions. Petersen (2009:22) concurs and suggests that OR may assist decision-makers in almost any management function.

Of the 17 respondents that identified SAP as a decision making tool, 16 believe that current decision making techniques can be improved (refer to Appendix B cross tabulation of Q6 and Q7), and because they identified SAP as a decision making tool earlier, it is expected that they believe that SAP should be improved. Some respondents suggested that the IDP and SAP cannot be the only tools and that more scientific tools are required, as decisions are based on emotions, while most of the respondents said that there is no substance in current tools, others say there is no data, which supports decision making tools, hence programs do not function correctly. This then emphasizes the need for an introduction of OR techniques in the Department.

5.1.4 Politics and decision making vs. service delivery

74.65% of the respondents stated that politics has a 50-100% effect on management decisions, while about 18% suggested that it has a 25-50% effect. This supports the Education and Training Unit's (2011) articulation that each municipality has a council where decisions are made and municipal officials and staff who implement the work of the municipality. The council comprises of elected members who approve policies and by-laws for their area. The council passes a budget for its municipality each year. They must also decide on development plans and service delivery for their municipal area. The work of the council is co-ordinated by a mayor who is elected by council. The management of the WSD has no control over who is elected or who sits in the council, nor do they have any control of decisions that are made by the council or the Mayor (refer to Figures 2.9a and b). This could create a lot of red tape in the organisation, as politicians are not involved in the operations of the organisation.

A majority of the respondents asserted that politicians in national government influence all decisions in local government; they do not put business needs first, but rather political agendas. Some expressed that the interference of councillors is a huge problem, especially close to election time, while others said that local governments are judged and elected based on their service delivery credentials, hence politics does play a part in decision making and political appointments instead of academic credentials, which was also highlighted as a problem. The respondents

mentioned that managers use policies that are drafted by politicians and budgets are also approved by politicians, which concurs with Education and Training Unit's statement above, and that politicians do not have technical expertise, and are less informed about business needs, and do not make good technical decisions. De Visser (2010) concurs and says that, currently, the council as an assembly can be the locus of the type of executive and administrative decision making that deals with the hard and immediate allocation of resources, jobs and power, rather than being limited to policy making, appropriation and oversight which is less attractive to the proverbial political fraudster. De Visser continues to suggest that there are reports of instances where regional party structures seek to operate municipalities by remote control.

For a municipality the size of the CoCT, it is vital that business needs and service delivery are placed before politics to avoid protests. In general, OR addresses a wide variety of issues in transportation, inventory planning, production planning, communication operations, computer operations, financial assets, risk management, revenue management, and many other fields, where improving business productivity is paramount (Heger, 2006). OR would, therefore, eliminate the problem of less informed decision making, which could result in unhappy rate payers.

A total of 60.56% of the respondents stated that poor service delivery is a result of bad decision making at the CoCT with 38.03% disagreeing. The respondents explained that no thought is put into decisions that are made, which affects the end-product, service delivery, and that bad decisions cost money, which could have been used in service delivery. There is no doubt that councillors, members of municipal executives and officials are struggling to define clear roles amongst themselves. This is aggravated by undue political interference by political parties (De Visser, 2010). The strain of limited resources leads to bad service delivery, and it is viewed that there is a lack or no strategy communication to subordinates, which is misleading. Others believe that service delivery is dependent on decisions that are made by managers, influenced by politicians, while others suggest that it is a lack of resources, inferior quality, poor standards, ageing infrastructure, and budget deficit that leads to poor service delivery. Some respondents suggest that it is politicians who create high expectations and false promises which cannot be met and the politics between the Democratic Alliance (DA), which is destabalizing the ruling party in the WC. The continued spate of community protests, which are directed at councillors and municipal officials is evidence of a serious breakdown of relationships between communities and councillors (De Visser, 2010).

5.2   Conclusion

5.2.1   Decision making at the WSD

This survey shows that there is a lack of use of OR techniques as decision making tools in the WSD of the CoCT, but the extent of how minimal the use is, is up for debate. The importance of OR in today's world cannot be over emphasized, as it provides rational bases for decision making by seeking to understand and structure complex situations, and to utilize this understanding to predict system behaviour like machinery behaviour and trends and improve system performance. Respondents believed that IDP and SAP cannot be the only tools used for decision making, there is no substance in decision making associated with these tools. They also believe that there is no data, which supports current decision making tools and that the current programs such as SAP do not function correctly, and that SAP cannot point out errors as it is a push tool. The general belief was that there is room for improvement to avoid reactive decision making.

Since the CoCT is a complex organization, even though the OR approach steps (Figure 2.13) are there to guide the process, questions still persist not only about how operational research techniques should be introduced at the WSD, but also about current decision making tools as well, with consensus that the existing decision making tools can be improved by introducing OR techniques. Models such as the link between information and decision making Figure 2.9.1b can be used for guidance in the improvement process. Again, the exact nature of this improvement remains unclear and can be clarified with further studies. Literature suggests that the operation of OR techniques in organisations that are similar to the CoCT has been a success in the past. However, the fact that only a small percentage of the respondents knows of or even applies OR techniques in the organization remains a concern. According to previous research, it would seem that the application of OR in the industry as a whole has enhanced decision making and, in turn, productivity. A majority of the respondents believe that poor service delivery is a result of management's bad decision making. Respondents suggested that management's poor decisions affected end product, which is service delivery and that bad decisions cost money, which could have been used in service delivery, hence there is a strain on the limited resources. The respondents continued to state that causes of poor service delivery are also lack of resources, inferior quality, poor work standards, ageing infrastructure and budget deficit, most of which can be addressed with OR techniques.

5.2.2 Issues affecting decision making at the WSD

Another factor, which should be observed, is that more than two thirds of the respondents believe and are frustrated by the fact that politics has too much effect on managers' decision making. A belief amongst a majority of the respondents was that politicians in national government influence all decisions in local government, and that they do not place business needs first, but rather political agendas, while managers are, therefore, forced to make decisions to align to political demands. Judging by the responses, the belief is that politicians do not have the technical expertise; are less informed about business needs, and do not make good technical decisions.   In conjunction with the introduction of OR techniques at the organisation, the possibility of restructuring the structure of council administration in the structure of council administration Figure 2.9b of Chapter two by appointing people who have the skills, expertise and an understanding of the business at the top of the structure (where strategic decision making takes place) instead of making political appointees. This does, however, leave a gap for future studies.

Earlier on in Chapter 2, the research suggested that during the apartheid era OR was mostly used in the SA government and since 1994, but was however discontinued in most government departments. However, it is now almost 20 years into the post-apartheid era and the new officials are not so new anymore; hence the understanding is that the environment is assumed to have improved with a majority of the respondents having years of service with the organisation ranging from between 11 and 38 years. This is, therefore, recommended to be the best time to introduce OR techniques as an official tool in the WSD, and later in the CoCT, as whole. The survey showed that only four respondents apply OR techniques out of the 73 that were surveyed. This reveals that their use of OR is because of their personal initiatives, and that there is no official OR tool, which is available for decision makers in the organisation to use.

5.2.3 The research and population surveyed

Future research should not overlook the fact that the CoCT' s WSD consists of mostly technical employees owing to the nature of their business, and that HR and SCM within the department serve as support services and are, therefore, seconded from corporate (a department on its own) to the WSD. The number of employees in the HR and SCM category is quite small compared to engineering, which this could be

linked to the poor response in the two fields. It would also have been good to have more responses from the non-engineering side of the department, and to make comparisons between the views of the technical and non-technical respondents. Certain question types also had their own inherent limitations; for example, some questions should have been made compulsory such as the open-ended questions such as please explain / elaborate questions do not offer a true reflection of views and responses from all the respondents, nonetheless they are still useful to allow the researcher to understand the participants better, and to gather suggestions and recommendations.

The findings from this survey will be used to stimulate a gap for the next research project, which can be used as input for improvement at the organisation, which is the subject of this research study.

5.3   Recommendations

The researcher recommends the following:

1. There is a clear gap in terms of the existence of OR, therefore, the employer should offer OR training to overcome the identified gaps. The results shown that 67% of the respondents had no knowledge of OR. A prior follow-up investigation by the CoCT would be required though to ensure that all management members of the WSD are well represented, which was not fulfilled by this study. If the follow-up investigation still maintains the results of this study, then training will be required.   For implementation, the CoCT can use Figure 2.13 for OR approach steps. Organisations such as the ORSSA and the CSIR can also be approached by the CoCT for guidance and input regarding implementation.

2. The CoCT should have a structured decision making matrix, which identifies their tools to support decision making in the organisation.   This matrix should be communicated through the organisation and especially to the management.   The results also revealed that 50% of the management representatives who were surveyed were either not sure or did not know what decision making tools are currently used at the WSD. Only 50% of the respondents identified either SAP and/or the IDP as a decision making tool, which is alarming and should be addressed by a proper decision making matrix.

3. The employer can also create a culture of OR awareness to overcome ignorance. This would also support the decision making matrix and its implementation. The responses that were received indicated that 95% of the managers who were surveyed thought that politics affect the decision making of management at the WSD by 50-100%. When the respondents were asked by the extension of the question in the questionnaire to elaborate, some expressed that politicians influence all decisions in local government. They (politicians) do not place business needs first, but rather their political agendas, which often leads to managers being forced to make decisions to align to political demands. One respondent expressed that the interference of senior councillors in administration is a huge problem and will compromise service delivery in future. The separation of decision making powers is a non-negotiable requirement.

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APPENDICES

APPENDIX A: The Questionnaire

QUESTIONNAIRE on the use of Operational Research (OR) techniques at CoCT's Water & Sanitation Department

This questionnaire is strictly confidential and your responses will be treated with total anonymity. Participants may withdraw from the research at any time for any reason, and can omit any questions that they do not want to answer. No names are required.
...
Please answer the following questions by indicating with a tick ✓ that, which best describes

you.

Section A: Education and position level

1. What field or section are you in?

☐ Corporate HR   ☐ Corporate SCM   ☐ Engineering   ☐ Other

Please specify your designation [   ]

2. Do you have a tertiary qualification?

☐ Yes

☐ No

If yes, (please specify highest tertiary qualification and field, for example ND Mech Eng)

[   ]

3. What level of Management do you occupy?

☐ Level 1

☐ Level 2

☐ Level 3

☐ Level 4

☐ Level 5

☐ More junior than levels above

Please specify number of years in service with the CoCT

[   ]

....

Section B: Knowledge of OR/Quantitative Analysis

This section is to evaluate participants' knowledge of OR and how farmiliar they are with OR techniques.

4. Do you have any knowledge of Operational Research or Quantitative Analysis?

☐ Yes

☐ No

If yes, which aspects of OR and how do you think your knowledge of OR impacts on decision making?

```
[text area]
```


5. How did you get to know about OR/Quantitative Analysis?

☐ Formal education

☐ Application at work

☐ Subject reading

Other (please specify)

```
[text area]
```

....

Section C: Organisational (CoCT) Decision Making Techniques, and decision making vs. service delivery

In this section the researcher is trying to discover if there is a link between decision making and service delivery and how OR affects this.

6. What decision making tools or techniques does the City Of Cape Town use?

   Please list them below:

```
[                    ▲]
[                     ]
[◄                   ►]
```

7. Do you think that the current decision making tools or techniques can be improved upon or changed?

☐ Yes

☐ No

Please state why or why not.

```
[                    ▲]
[                     ]
[                     ]
[◄                   ►]
```

8. Do you think that if properly researched, and if scientific research techniques were used in the CoCT, the quality of decision making would improve?

☐ Yes

☐ No

9. How much does politics affect the decision making of management at the CoCT?

☐ 0-10%

☐ 10-25%

☐ 25-50%

☐ 50-100%

Please elaborate.

```
[                    ▲]
[                     ]
[                     ]
[◄                   ►]
```

10. Do you think that poor service delivery is a result of bad decision making on the part of the COCT's management?

☐ Yes

☐ No

What do you think the link is between poor service delivery and decision making in your organisation? Please elaborate.

APPENDIX B: Cross Tabulation Report

Question 3 vs. Question 6

Q6 What decision making tools or techniques does the City Of Cape Town use?	OEQ3				
	1	**2**	**3**	**4**	
	0-5 yrs	**6-10 yrs**	**11-20 yrs**	**21-38 yrs**	**Total**
1 Not known/Any/Not sure	4	0	6	15	25
2 SAP	5	0	6	3	14
3 IDP	1	1	0	0	2
4 Policy driven	1	0	0	0	1
5 Gut Feel, rule of thumb	1	0	0	1	2
6 Cost benefit / risk / needs analysis	0	0	0	3	3
8 Meetings	1	0	1	0	2
1 & 4	1	0	0	0	1
2 & 3	0	0	0	1	1
2 & 3 & 6	0	0	0	1	1
Total	14	1	13	24	52

The number of rows with at least one missing value is 21

Row Percentages Section

Q6 What decision making tools or techniques does the City Of Cape Town use?	OEQ3				
	1	**2**	**3**	**4**	
	0-5 yrs	**6-10 yrs**	**11-20 yrs**	**21-38 yrs**	**Total**
1 Not known/Any/Not sure	16	0	24	60	100
2 SAP	35.7	0	42.9	21.4	100
3 IDP	50	50	0	0	100
4 policy driven	100	0	0	0	100
5 Gut Feel, rule of thumb	50	0	0	50	100
6 Cost benefit / risk / needs analysis	0	0	0	100	100
8 Meetings	50	0	50	0	100
1 & 4	100	0	0	0	100
2 & 3	0	0	0	100	100
2 & 3 & 6	0	0	0	100	100
Total	26.9	1.9	25	46.2	100

The number of rows with at least one missing value is 21

Column Percentages Section

Q6 What decision making tools or techniques does the City Of Cape Town use?	OEQ3				
	1	**2**	**3**	**4**	
	0-5 yrs	**6-10 yrs**	**11-20 yrs**	**21-38 yrs**	**Total**
1 Not known/Any/Not sure	28.6	0	46.2	62.5	48.1
2 SAP	35.7	0	46.2	12.5	26.9
3 IDP	7.1	100	0	0	3.8
4 policy driven	7.1	0	0	0	1.9
5 Gut Feel, rule of thumb	7.1	0	0	4.2	3.8
6 Cost benefit / risk / needs analysis	0	0	0	12.5	5.8
8 Meetings	7.1	0	7.7	0	3.8
1 & 4	7.1	0	0	0	1.9
2 & 3	0	0	0	4.2	1.9
2 & 3 & 6	0	0	0	4.2	1.9
Total	100	100	100	100	100

The number of rows with at least one missing value is 21

Question 4 vs. 2

Counts Section

		Q4: Do you have any knowledge of Operational Research or Quantitative Analysis?						
Q2								
Do you have a tertiary qualification?	**N**	**Y**	**Total**					
N	4	2	6					
Y	44	22	66					
Total	48	24	72					
The number of rows with at least one missing value is 1								

Row Percentages Section

		Q4: Do you have any knowledge of Operational Research or Quantitative Analysis?						
Q2								
Do you have a tertiary qual	**N**	**Y**	**Total**					
N	66.7	33.3	100					
Y	66.7	33.3	100					
Total	66.7	33.3	100					
The number of rows with at least one missing value is 1								

Column Percentages Section

		Q4: Do you have any knowledge of Operational Research or Quantitative Analysis?						
Q2								
Do you have a tertiary qualification?	**N**	**Y**	**Total**					
N	8.3	8.3	8.3					
Y	91.7	91.7	91.7					
Total	100	100	100					
The number of rows with at least one missing value is 1								

Question 4 vs. OEQ2

Counts Section

	Q4: Do you have any knowledge of Operational Research or Quantitative Analysis?		
OEQ2			
	N	Y	Total
1 National Diploma	13	5	18
2 B Degree	14	8	22
3 Master's Degree	7	8	15
4 N technical stream	4	2	6
Total	38	23	61

The number of rows with at least one missing value is 12

Row Percentages Section

	Q4: Do you have any knowledge of Operational Research or Quantitative Analysis?		
OEQ2			
	N	Y	Total
1 National Diploma	72.2	27.8	100
2 B Degree	63.6	36.4	100
3 Master's Degree	46.7	53.3	100
4 N technical stream	66.7	33.3	100
Total	62.3	37.7	100

The number of rows with at least one missing value is 12

Column Percentages Section

	Q4: Do you have any knowledge of Operational Research or Quantitative Analysis?		
OEQ2			
	N	Y	Total
1 National Diploma	34.2	21.7	29.5
2 B Degree	36.8	34.8	36.1
3 Master's Degree	18.4	34.8	24.6
4 N technical stream	10.5	8.7	9.8
Total	100	100	100

The number of rows with at least one missing value is 12

Question 7 vs. Question 6

Counts Section

Q6 What decision making tools or techniques does the City Of Cape Town use?	Q7: Do you think that the current decision making tools or techniques can be improved upon or changed?		
	N	Y	Total
1 Not known/Any/Not sure	8	21	29
2 SAP	1	16	17
3 IDP	0	2	2
4 Policy driven	0	1	1
5 Gut Feel, rule of thumb	0	2	2
6 Cost benefit / risk / needs analysis	0	4	4
8 Meetings	0	2	2
1 & 4	0	1	1
2 & 3	0	1	1
2 & 3 & 6	0	1	1
Total	9	51	60

The number of rows with at least one missing value is 13

Row Percentages Section

Q6 What decision making tools or techniques does the City Of Cape Town use?	Q7: Do you think that the current decision making tools or techniques can be improved upon or changed?		
	N	Y	Total
1 Not known/Any/Not Sure	27.6	72.4	100
2 SAP	5.9	94.1	100
3 IDP	0	100	100
4 policy driven	0	100	100
5 Gut Feel, rule of thumb	0	100	100
6 Cost benefit / risk / needs analysis	0	100	100
8 Meetings	0	100	100
1 & 4	0	100	100
2 & 3	0	100	100
2 & 3 & 6	0	100	100
Total	15	85	100

The number of rows with at least one missing value is 13

Column Percentages Section

Q6 What decision making tools or techniques does the City Of Cape Town use?	Q7: Do you think that the current decision making tools or techniques can be improved upon or changed?		
	N	Y	Total
1 Not known/Any/Not sure	88.9	41.2	48.3
2 SAP	11.1	31.4	28.3
3 IDP	0	3.9	3.3
4 Policy driven	0	2	1.7
5 Gut Feel, rule of thumb	0	3.9	3.3
6 Cost benefit / risk / needs analysis	0	7.8	6.7
8 Meetings	0	3.9	3.3
1 & 4	0	2	1.7
2 & 3	0	2	1.7
2 & 3 & 6	0	2	1.7
Total	100	100	100

The number of rows with at least one missing value is 13

OEQ3 vs. Question 6

Counts Section						
	OEQ3					
Q6	1	2	3	4		
What decision making tools or techniques does the City Of Cape Town use?	0-5 yrs	6-10 yrs	11-20 yrs	21-38 yrs	Total	
1 Not known/Any/Not sure	4	0	6	15	25	
2 SAP	5	0	6	3	14	
3 IDP	1	1	0	0	2	
4 Policy driven	1	0	0	0	1	
5 Gut Feel, rule of thumb	1	0	0	1	2	
6 Cost benefit / risk / needs analysis	0	0	0	3	3	
8 Meetings	1	0	1	0	2	
1 & 4	1	0	0	0	1	
2 & 3	0	0	0	1	1	
2 & 3 & 6	0	0	0	1	1	
Total	14	1	13	24	52	

The number of rows with at least one missing value is 21

Row Percentages Section						
	OEQ3					
Q6	1	2	3	4		
What decision making tools or techniques does the City Of Cape Town use?	0-5 yrs	6-10 yrs	11-20 yrs	21-38 yrs	Total	
1 Not known/Any/Not sure	16	0	24	60	100	
2 SAP	35.7	0	42.9	21.4	100	
3 IDP	50	50	0	0	100	
4 policy driven	100	0	0	0	100	
5 Gut Feel, rule of thumb	50	0	0	50	100	
6 Cost benefit / risk / needs analysis	0	0	0	100	100	
8 Meetings	50	0	50	0	100	
1 & 4	100	0	0	0	100	
2 & 3	0	0	0	100	100	
2 & 3 & 6	0	0	0	100	100	
Total	26.9	1.9	25	46.2	100	

The number of rows with at least one missing value is 21

Column Percentages Section						
	OEQ3					
Q6	1	2	3	4		
What decision making tools or techniques does the City Of Cape Town use?	0-5 yrs	6-10 yrs	11-20 yrs	21-38 yrs	Total	
1 Not known/Any/Not sure	28.6	0	46.2	62.5	48.1	
2 SAP	35.7	0	46.2	12.5	26.9	
3 IDP	7.1	100	0	0	3.8	
4 policy driven	7.1	0	0	0	1.9	
5 Gut Feel, rule of thumb	7.1	0	0	4.2	3.8	
6 Cost benefit / risk / needs analysis	0	0	0	12.5	5.8	
8 Meetings	7.1	0	7.7	0	3.8	
1 & 4	7.1	0	0	0	1.9	
2 & 3	0	0	0	4.2	1.9	
2 & 3 & 6	0	0	0	4.2	1.9	
Total	100	100	100	100	100	

The number of rows with at least one missing value is 21

Question 9 vs. Question 10

Counts Section

		Q9: How much effect does politics affect management's decision making?				
Q10						
Do you think that poor service delivery is a result of bad decision making on the part of the COCT's management?		**1**	**2**	**3**	**4**	**Total**
N		2	1	6	18	27
Y		1	1	7	34	43
Y & N		0	0	0	1	1
Total		3	2	13	53	71

The number of rows with at least one missing value is 2

Row Percentages Section

		Q9: How much effect does politics affect management's decision making?				
Q10						
Do you think that poor service delivery is a result of bad decision making on the part of the COCT's management?		**1**	**2**	**3**	**4**	**Total**
N		7.4	3.7	22.2	66.7	100
Y		2.3	2.3	16.3	79.1	100
Y & N		0	0	0	100	100
Total		4.2	2.8	18.3	74.6	100

The number of rows with at least one missing value is 2

Column Percentages Section

		Q9: How much effect does politics affect management's decision making?				
Q10						
Do you think that poor service delivery is a result of bad decision making on the part of the COCT's management?		**1**	**2**	**3**	**4**	**Total**
N		66.7	50	46.2	34	38
Y		33.3	50	53.8	64.2	60.6
Y & N		0	0	0	1.9	1.4
Total		100	100	100	100	100

The number of rows with at least one missing value is 2