UNIVERSITY OF KWAZULU NATAL

NON-REVENUE WATER REDUCTION PROGRAMMES FUNDED BY THE PRIVATE SECTOR TO SOLVE UNDER STAFFING AT KWA-ZULU NATAL'S MUNICIPALITIES

By

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A dissertation submitted in partial fulfilment of the requirements for the degree of Master of Business Administration

Graduate School of Business & Leadership

College of Law and Management Studies

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2018

College of Law and Management Studies

Supervisors Permission to Submit Thesis/Dissertation for Examination

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Title: Non-Revenue Water Reduction Programmes Funded by the Private Sector to Solve Under Staffing at Kwa-Zulu Natal's Municipalities		
Qualification: MBA	**School:** Graduate School of Business and Leadership	
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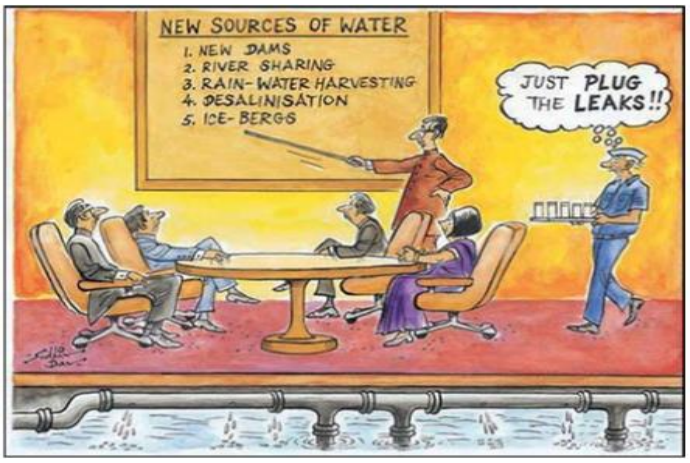
Acknowledgements

I wish to express my sincere appreciation and gratitude to the following individuals, without who assistance, this study would not have been possible:

- To my parents, Mr A.J. Poona and Mrs P.H. Poona to whom have guided me in my younger years and gave me the tools to tackle most hurdles that life has thrown at me;
- To my parents-in-law, Mr L. Gordhan and Mrs V. Gordhan who have assisted my wife and I through this journey by always being around to help out with their grandchildren;
- To Kieron Moodley and Perusha Govender, my two newest friends who have for the last two years of course work and this thesis made life much easier through their support and assistance;
- To the gatekeepers and respondents who took the time and effort to make this dissertation possible;
- To John Jameson, who was there on nights when pressure and stress was taking its toll on me;
- To my dearest wife and love of my life, Trisha Poona to whom this degree would not have been possible. Thank you for your sacrifice, effort and support in carrying all the family responsibilities so I could effortlessly continue with my studies; and
- Lastly, to my children, Ruan and Ziva I dedicate this degree to you both and thank you for not making me feel guilty for not being around as often as I wanted to. I did this degree to encourage and demonstrate to you both that if you work twice as hard as everyone else and never give up that you will always prosper in anything you put your mind to…



Source: Water and Sanitation Programme of the World Bank (2007)

Abstract

Over the last two decades and more recently in the Western, Eastern and Northern Cape provinces have seen droughts that destabilised these cities socially, economically and financially. The solution was to responsibly and frugally use the available potable water and the reduction of Non-Revenue Water has to become a priority. Kwa-Zulu Natal province in SA had the worst reported, vacancy rates for water units and the highest NRW percentages. The main purpose of this study was to present the true vacancy rates actually were for all the NRW units within the District Municipalities in KZN, assess the current heads of these units on their knowledge of NRW principles and to understand the reasons for the vacancy rates. Lastly, the study attempted to present how these public officials inclinations were if they employed Shared Water Saving Contracts to reduce NRW rates, reduce their vacancy and increase their knowledge and skills on NRW if these contracts were funded by the private sector. The full population of the heads of NRW units for the thirteen DMs in the province took part in the questionnaire survey for this quantitative study. The salient findings were that the last published vacancy rates were 17.8% for KZN but the true vacancy rates within NRW units was found to be 57.9% which included unbudgeted posts as well. Over 60% of the reasons for this situation was that there was insufficient budget and their superiors not understanding the importance of NRW reduction. Just under half the participants were considered to have a poor knowledge on NRW fundamental concepts. However, these officials do believe that SWSCs could be used as an alternate funding model to help reduce the vacancy rates, increase NRW knowledge of these officials and have the private sector fund these projects. It is recommended that more training and seminars need to be held within SA to capacitate Municipal officials on NRW. It is also recommended that all DMs run pilot SWSC projects as fast tracking this process to get the private sector funding as soon as possible and arrest the high NRW figures being reported which will have a knock-on effect of delaying possible drought and water scarcity issues going forward.

Keywords: alternative funding model, drought mitigation, non-revenue water, shared water savings contracts, vacancy rates

Table of Contents

List of Figures

List of Tables

List of Acronyms and Abbreviations

BABE	Burst and Background Estimate
DBSA	Development Bank of South Africa
DMA	District Metered Area
DMs	District Municipalities
DWAF	Department of Water and Forestry
DWS	Department of Water and Sanitation
FAVAD	Fixed and Variable Area Discharge
HR	Human Resources
KZN	KwaZulu-Natal
IWA	International Water Association
MFMA	Municipal Finance Management Act
MWIG	Municipal Water Infrastructure Grant
NDPW	National Department of Public Works
NGOs	Non-Government Organisations
NRW	Non-Revenue Water
PPP	Private Public Partnerships
SA	South Africa
Stats SA	Statistics South Africa
SWSCs	Shared Water Savings Contracts
WLTF	Water Loss Task Force
WSA	Water Services Authourity

CHAPTER ONE

Introduction

"Drought Crisis: 3 Provinces Declared National Disasters" was the article's heading on a News24 website on 13 February 2018 (Tandwa, 2018). Over the last two decades and more recently towns and cities in the Northern, Western and Eastern Cape provinces have seen droughts that destabilised these cities socially, economically and financially. These provinces have been declared disasters, however other provinces could follow suit (Tandwa, 2018). In order to stave off these potential droughts one of the solutions is to use the current water resources frugally and make water networks operationally efficient i.e. reducing the current rate of leakage in pipelines feeding consumers their potable water. The technical engineering term for this is the reduction of Non-Revenue Water (NRW) which has to become a priority for drought mitigation (Hedden and Cilliers (2014), Santos, Pagsuyoin, Herrera, Tan and Krista (2014) and Low, Grant, Hamilton, Gan, Saphores, Arora and Feldman (2015)). Indeed, it was one of the strategies employed by the City of Cape Town that helped it avoid Day Zero (Dolley, 2017).

According to the most recent national study conducted in South Africa by McKenzie, Siqalaba and Wegelin (2012) confirmed that the Province of KwaZulu-Natal (KZN) was the worst-performing province with respect to NRW and even though these programmes have been implemented over the last two decades the country, and KZN especially, did not seem to be making headway in reducing NRW.

There are various beliefs as to why NRW reduction programmes were not successful and had tried to mitigate these issues but still the trend continued (McKenzie et al., 2012). Due to these circumstances this study investigated three aspects that were not looked at in detail previously. It also provided solutions that would overcome all three problems. Lastly, it would assist Municipalities financially to become self-sufficient, operationally more efficient and fill all their vacant, unfunded and frozen posts within NRW units in the Municipalities.

1.1 Motivation for the Study

The National Department of Water and Sanitation (DWS) stated in its National Water and Sanitation Master Plan the following statistics (DWS, 2018):

- "Only 27% of all potable water produced in SA is utilised by Municipalities for domestic and non-domestic usage";

- "of this 41% of Municipal water does not generate revenue and 35% is lost through leakage";

- "Municipalities are losing about 1,660 million cubic metres (or m^3) per year through non-revenue water. At a unit cost of R6/m^3 this amounts to R9.9 billion each year"; and

- "R33 billion more is needed each year for the next 10 years to achieve water security".

The implementation of NRW reduction programmes have been on-going in the country since its first pilot project in 1997 at Msunduzi Municipality but this issue of high NRW never seemed to be getting better (Wegelin, 2015). Internationally, seminal authors like Lambert (1994, 1999 and 2002), Mckenzie (2002 and 2012) and Thornton (2006) have written many books and published papers which proved that NRW reduction programmes have helped both to reduce water wastage and increase revenue for Municipalities. Locally the experts in the field including Shepherd (2014), and Wegelin (2012, 2013 and 2015) who have also proven, published and presented at numerous South African (SA) conferences, stating that lowering NRW is possible and could be done in a sustainable way.

The question then is why have so many NRW reduction programmes, in this country, once implemented by the private sector, failed once their contract ends? Wegelin and Jacobs (2013) tried to address the phenomenon and came up with some answers which included but were not limited to the lack of funding, lack of knowledge, ageing infrastructure, change management issues, no coordination between stakeholders etc. The current study believed

that the gap that existed in these studies was related to getting access to private sector funding. A further gap also included the lack of knowledge on this niche specialty (as it was, and still is, not part of any tertiary institution's curriculum) as well competency rates of Municipal officials tasked with reducing NRW. Lastly the low vacancy rates within NRW units in Municipalities also needed further investigation. Wegelin (2015) mentioned the low vacancy rates but did not conclusively interrogate the vacancy figures quoted as they were much higher than what was, and is, actually occurring in reality. To this end this study attempted to understand what the situation was within the 13 District Municipalities (DMs) within KZN on the three knowledge gaps identified and also advocated for a single solution to the three problems. High levels of NRW was and remains a real problem that faces South Africans as "Water is Life" and it is more relevant now than ever before.

1.2 Problem Statement

As mentioned in the previous section that the reduction of NRW or implementation of successful Water Conservation/Water Demand Management (WC/WDM) programmes within Municipalities would help the water entities to become operationally more efficient and financially more self-sufficient (Frauendorfer and Liemberger, 2010). However, in reality, most of these programmes used National Government grant funding and very little to none of their own financial resources to implement such programmes, often with insufficient staff resourcing from the Municipal side, as well as lack of knowledge in how to implement these complex programmes (Wegelin, 2015).

Carden and Armitage (2013), Ruiters (2013), Brettenny and Sharp (2016) and DWS (2018) demonstrated that SA literature pointed to the lack of required government funding, knowledge and pointless, extensive regulatory reporting, but did not examine the issues of staff vacancy rates, proper training and expertise required as well as alternative funding options that places the onus of finding solutions on the private sector. Only Wegelin (2015) mentioned staff vacancy rates as a problem but the researcher believed that the figures quoted are actually understated. The problem statement can therefore be stated as NRW reduction and WC/WDM programmes never seem to yield the results that should be realised. The main reasons for this occurring is that most Municipalities are understaffed, do not have sufficient knowledge on these types of programmes and have not developed a funding solution where the private sector can play a role in providing solutions to these issues. In

view of that this study's purpose, as well as how it aims to fulfil the objectives, are contained within the subsequent sections.

1.3 Purpose of the Study

The purpose of this study was to determine what the true, current rate of vacancies were for KZN's DMs as well as what the extent of the knowledge was on NRW reduction programmes. Additionally, the purpose was also to find out if a relatively new funding model in the water industry could be utilised by the private sector to solve both the human resources dilemma and perceived lack of knowledge by Municipal officials.

1.4 Objectives of the Study

The objectives of the study for KZN's DMs were:

- To identify the true vacancy rates for NRW units within Municipalities;
- To understand the reasons for the low vacancy rates when it comes to NRW units within Municipalities;
- To evaluate the Municipal officials' NRW knowledge and expertise that currently filled these NRW Municipal units; and
- To ascertain if Municipal officials preferred a funding model where the private sector funds NRW reduction programmes to solve the vacancy rates and to facilitate the increase knowledge and experience of these officials.

1.5 Research Questions

The research questions to be answered by this study include:

- What were the true vacancy rates of NRW units within KZN's DMs?

- What were the reasons, according to Municipal officials, that their NRW units were not at full occupancy?

- To what extent were the Municipal officials that occupied the NRW units knowledgeable about NRW reduction principles and programmes?

- Could a shared savings contract or performance-based contract with the private sector be used to solve vacancy rates and perceived lack of knowledge within Municipal NRW units?

1.6 Expected Outcomes

The expected outcomes included were but not limited to:

- Providing the public and private sector within KZN's DMs on the "true" vacancy rates of NRW units;

- Stakeholders would understand from the Municipal officials' opinions the reasons they believed that the vacancy rates were at their current level;

- The study attempted to gauge if the current Municipal officials' knowledge and experience in NRW principles were what was required to run such programmes; and

- That the private sector would find it financially rewarding to fully fund NRW reduction programmes using a shared savings model.

1.7 Delimitations/Scope of Study

The study did not include all the Municipalities in SA but only focused on the KZN province due to (McKenzie et al., 2012) indicating that most Municipalities could not even provide reporting on their NRW status. The KZN province was chosen as they have the worst reported vacancy rates within the country and this study would provide insight as to how to possibly rectify the situation. Additionally, the officials that had answered surveys were only

from NRW units within the 13 DMs of KZN, or officials that were responsible for those units who were heads of those units. Other Municipal officials were not chosen as they did not have expertise in this niche specialty of civil engineering and thus could not give technical reasons for the problems being faced by their respective Municipalities. A survey method was used as it gave all Municipal officials anonymity to answer questions truthfully about the current human resourcing quandary and if the reasons were broadly financial, political or a combination of both aspects. In summary the target population were all officials who were heads of NRW units that were employed within all of the province's Municipal NRW units.

1.8 Expected Limitations of the Study

Some of the officials that were within the KZN NRW units were in acting capacities and were at a lower management level which could skew the insight the survey wished to extract. This could have adversely affected the second objective of the study. Some Municipalities did not even have a NRW unit and trying to get their opinion/s proved difficult however was mitigated by personally visiting those Municipalities. Legislative requirements for NRW reporting then fell into the ambit of the Municipality's Water Service Authority (WSA) Manager. Once again, if this was the case, then their insight into the problems were limited but still had to be taken into account.

1.9 Assumptions

The assumptions that were made included:

- All respondents to the survey were at a suitable management level and had adequate experience in their posts;

- That all respondents had some experience in implementing NRW reduction programmes;

- Municipal officials would answer truthfully as to the reasons why they believed their Municipality did not fill all funded, unfunded and frozen posts;

- The NRW Municipal officials wanted to fund programmes via private funding as opposed to grant funding sourced from the National Government budget;

- The private sector would want to invest in Municipalities when it will be financially viable to do so; and

- Lastly, that a NRW reduction programme always yielded financial gains and operational efficiency for the Municipality once implemented.

1.10 Structure of the Dissertation

This dissertation was divided into five chapters as briefly outlined.

Chapter One: Introduction

This chapter provides an introduction to the study. It explores the background for NRW and the challenges currently being experienced in the country, reasons for choosing the area of study and in addition, outlines the objectives, research questions and a summary of the methodology.

Chapter Two: Evaluation of Academic Debates

This chapter establishes the theoretical and conceptual framework upon which NRW reduction is based. It reviews the literature on what constitutes vacancy rates and the reasons thereof, the knowledge levels of Municipal staff and a possible funding model to assist in reducing NRW and vacancy rates.

Chapter Three: Research Design and Methodology

This chapter explores the research design, defines the study area and establishes the population and sample size. It then defines the sampling and data analysis methods, while also accessing the reliability and validity of the data. It concludes by looking at the bias of the data and the ethical considerations.

Chapter Four: Research Results and Interpretation

This chapter presents the analysis of the study and interprets the relationships between variables. The main purpose of this chapter is to analyse the data collected in order to come up with real facts to answer the research questions as outlined in chapter one.

Chapter Five: Discussions, Conclusions and Recommendations

In this chapter, the findings of the analysis are tested against the objectives of the study, as well as against the review of the literature. This chapter provides the general conclusions of the study by deducing on the discussion presented in chapter four. It also gives recommendations for future studies, moving forward.

1.11 Summary

The aim of this study has been outlined; the current situation in which DMs, and in particularly KZN's DMs, are not effectively managing the country's precious resource of potable water was, and still is, a major concern for all stakeholders in the country. The understaffing of NRW units in KZN's DMs as well as the reasons for this situation are of great importance in attempting to understand if it contributes to the high NRW. Additionally, the current DMs leaderships' understanding of NRW concepts and principles needed to be interrogated as this could exacerbate the current situation. Lastly, finding solutions to all these problems could be accomplished with shared savings or public/private, partnership type contracts where the private sector could inject their own funds into Municipalities but buy-in has to come from the Municipal officials.

In the following chapter, more in-depth information is given on what NRW actually is through-out the world, but more importantly in South Africa, and how it's various initiatives helps to lower water leakage and increase revenue for Municipalities. It further critically assesses various literature sources on vacancy rates of Municipalities, NRW status in South Africa and pros and cons of shared savings type contracts.

CHAPTER TWO
Evaluation of Academic Debates

2.1 Introduction

This chapter reviews literature and helps establish the theoretical framework and contractual and financial model that have either never been used or partially adopted in SA. As these assist to reduce Non-Revenue Water as well as creating funding and training for vacant, unfunded and frozen posts at Municipalities' NRW units. This chapter reviews literature, both internationally and locally, on what NRW reduction is and how its interventions, when utilised, could benefit Municipalities by making them more operationally efficient and financially self-sustainable. It further illustrates that water is a necessity of life and how this is even more of an issue in the SA perspective as it is a constitutional right that all citizens have to have access to. Statistics from other publications are then presented as to the current situation of NRW within all Municipalities in SA, and more especially the DMs in KZN. Lastly, the vacancy rates of water operators are reviewed within water units in the Municipalities. A proposed funding model is researched that could help the private sector assist the Municipalities by funding the entire programme without using internal or grant funds while also funding the filling and training of staff that will fill all vacant, frozen and unfunded posts.

2.2 Burst and Background Estimate (BABE) Framework

There is one theoretical framework that will underpin this research and two concepts that were derived from it thereafter. The theoretical framework is called the Burst and Background Estimate (BABE) which was the first accurate attempt to quantify how much of potable water in a water network was being lost through leakage in pipelines underground and was published in 1994 (Lambert, 1994). This is important as, once one can measure and verify what is being lost through visible and non-visible leakage, one requires a framework which will enable one to reduce those losses. From this the concept of the "Four Basic Methods of Managing Real Losses" was published in 2002 which helped practitioners regarding how to actually reduce these water losses once they could measure them. A Municipality is required to, not only reduce losses, but the custodians of the water network

are also required to increase revenue, thereby making the system even more efficient. The next concept that enabled this to be possible was called the "Four Pillars of Apparent Losses" which was also published in 2002. This framework and the two subsequent concepts are discussed in more detail further on to emphasise their importance for this study.

Lambert (1994) stated that though, "some published technical relationships exist, there has been no overall methodology which attempts to provide a component-based estimate of annual losses in different parts of the distribution system for any particular combination of local circumstances i.e. pressure, burst frequency, burst flow rate, number of properties, length of mains, method of leakage control, standards of service and waste notice service/enforcement policy." This seminal paper started the revolution of attempting to accurately measure potable water volumes in a water network system in order to assess how much of water that is treated and fed into a water pipeline system is actually lost through leakage in underground pipelines (Force and Thornton, 2003). Utilising the BABE concept a water utility/Municipality can approximate with a high degree of certainty how much of water is being wasted through leakage (Force and Thornton, 2003). Using all the components described above the BABE concept could be "customised" to any system around the world by using local conditions of pressure, burst frequencies, number of connections etc. to enter these variables into software which calculated the volumes for background leakage and bursts (Thornton and Lambert, 2006).

Background leakage can be defined as being undetectable leakage that exist in every water pipeline network and these leaks are often, either detected by chance, or until they gradually worsen to a point where they can be detected (Gupta and Kulat, 2018). Schwaller and van Zyl (2014) reiterates that background leakage by definition cannot be found, that these loss rates are very low and could occur at any point in a network and that it is not economically viable to attempt to locate and repair them. However, Berardi and Giustolisi (2016) defined burst leakage as excess leakage from pipelines that are caused by cracks, breakages and ruptures of pipelines.

2.2.1 The Real Loss Reduction Concept

As the above-mentioned framework of measurement of the water system was accepted throughout the world the next evolution that included a methodology/concept to help reduce

the physical leakage was presented by Lambert (2002). The basis of this proven technique was that there are only four approaches to reduce water leakage viz. pressure management, active leak detection, pipeline replacement and speed and quality of the repairs of leakage as shown in Figure 2.1 (Lambert, 2002). It should be noted that three of the arrows point inwards and hence that carrying out those activities will always reduce leakage (Gupta and Kulat, 2018). However, the top arrow in Figure 2.1 could either decrease or increase water losses in a network and was dependent on whether pressure management was used to increase or decrease pressure in a pipeline system (Gupta and Kulat, 2018).

The concept included three squares in the centre which represent, from outside to inside, the current water losses in a network, the economic level of losses where economically speaking it would cost a Municipality more money to reduce losses than to simply let it continue leaking, whilst the last internal square is the leakage that is unavoidable and will always be prevalent in a water network (even a brand new system that is laid and commissioned is allowed to leak) (Lambert, 2002). This concept was, and is, helpful in that it enabled the custodians of a water network system in strategising and prioritising their implementation plans using their available budget (Gupta and Kulat, 2018).

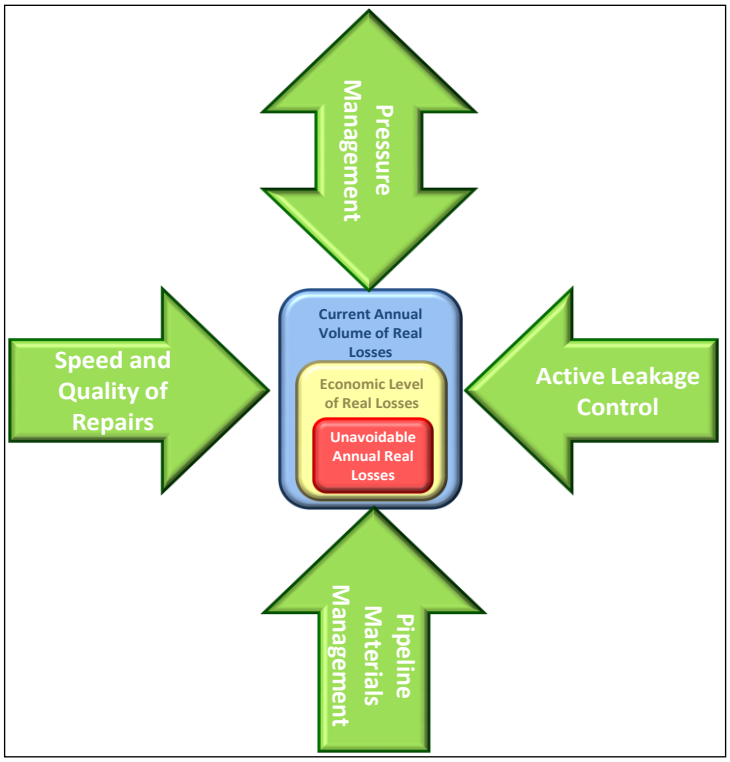


Figure 2.1: Four Basic Methods of Managing Real Losses (adapted)

Source: Lambert (2002)

2.2.1.1 Pressure Management

The major innovation of efficient water loss control was, and still is, pressure management. (McKenzie et al., 2012) It was the common engineering design of water supply systems that required adequate pressure to be provided to ensure that a specified minimal level of service is met (Wegelin, 2015).

However, it was now understood that certain types of leaks are very sensitive to pressure (McKenzie et al., 2012). Excess pressure, which was not always carefully assessed by water system operators, has a cost in terms of higher leakage and unnecessary energy usage (Wegelin, 2015). McKenzie et al. (2012) stated that the better understanding of both high and low pressure variations gave water network operators more control in preventing surging ruptures and backflow conditions, thereby extending the life of infrastructure and safeguarding distribution system water quality.

Pressure control has proven to be effective in reducing leakage from "background" leaks, or those leaks that are so small that they are not easily located or repaired through conventional means (Lambert, Fantozzi and Thornton, 2013). Wegelin (2015) suggested that the installation of Pressure Reducing Valves (PRV's) and the use of selective pressure reduction during minimum usage night-time hours was a technique that was effective in economically reducing background leakage. This technique has greatly challenged the traditional concepts of what is regarded as "unavoidable" leakage reduction (Wegelin, 2015).

Lambert et al. (2013) stated that specifying appropriate pressure control has been found to be one of the most successful and cost-effective means of controlling both background and excessive or real loss leakage. Pressure management consisted of the following activities:

- Pressure modelling via innovative methods such as the Fixed and Variable Area Discharge (FAVAD) paths model;

- Controlling pressures close to, but greater than, the minimum standard of service;

- Operation of discrete pressure zones which is configured based upon topography or service supply standards;

- Limiting maximal pressure levels or surges in pressure; and

- Off-peak pressure reduction

These methods were all feasible to help reduce losses from small "background" leaks.

2.2.1.2 Active Leakage Control

Aamo (2016) defined active leak detection or control as using various methods to find visible and non-visible (or underground) leakage in pipeline networks. These methods included, but are not limited to, using visual cues, correlating noise logging, acoustic wave technology and smart wireless sensor networks. However, Vermersch, Carteado, Rizzo, Johnson, Arregui and Lambert (2016) suggested that the more sophisticated the method being used to find leaks, the more expensive the exercise will become and hence an assessment on the return on investment for the exercise should be carried out prior to implementation. The effect of burst and leak run time has been exposed and incorporated as an active leakage control strategy (Vermersch et al., 2016). Leaks left to run for long periods of time created large annual loss volumes (Wegelin, 2015).

Lambert et al. (2013) stated that in any distribution system, the greatest annual volume of losses occur from long-running, small-to-medium sized leaks on customer service connections, except at very low densities of service connections. To achieve successful leakage control, water utilities must be effective and efficient in providing routine surveillance to identify leaks as well as in executing timely, lasting repairs (Wegelin, 2015). According to Aamo (2016) active leakage control consists of the following activities:

- Regular inspection and sounding of all water main fittings and connections: leakage surveys;

- Leakage modelling via innovative methods such as minimum night flow analysis;

- Metering of individual pressure zones;
- District Metered Area (DMA) metering: measuring total inflow per day, week or month;
- Continuous or intermittent night flow measurements;
- Short-period measurements at any time of day (spot flow and pressure measurements); and
- Temporary placing of leak noise detectors and loggers.

2.2.1.3 Speed and Quality of Repairs

Throughout the world, and mainly in the Metros of SA, most utilities have a good reputation at ensuring that all reported and visible leaks are repaired timeously (Lambert et al., 2013). Gupta and Kulat (2018) stated that this generally accounts for only 15% of leakage in pipeline networks. It is the unreported or non-visible leaks that need to be found and repaired quickly (Gupta and Kulat, 2018). Gomes, Sousa and Marques (2013) suggests that the speed and quality of repairs require water operators to locate it as fast as possible and carry out quality and lasting repairs using the appropriate materials in order that the leak does not reoccur. The length of time a leak runs for increases the total leakage for a system and hence once a leak is detected it should be repaired. Charalambous, Foufeas and Petroulias (2014) stated, "Key issues to be considered by water utilities when formulating a repair policy include:

- Efficient organisation and procedures from the initial alert through to the repair itself;
- Availability of equipment and materials;
- Sufficient funding;

- Appropriate standards for materials and workmanship; and

- Committed management and staff."

2.2.1.4 Pipeline Materials Management

This last and fourth pillar is generally coined under asset management (Gomes et al., 2013). All water infrastructure including pipelines has a useful lifespan and, as such, would need to be replaced (Gomes et al., 2013). According to Charalambous et al. (2014) pipe replacement is the most expensive method of the four pillars and hence must always be a last resort once all other interventions have been thoroughly completed. In order to decide which pipelines to replace the water operators need to have an understanding of the pipelines' conditions as well as deterioration rates which is difficult to determine as all the infrastructure is underground (Gomes et al., 2013). Li, Huang, Xin and Tao (2015) stated that currently the only reliable method to utilise is burst frequency modelling which entails utilising burst record data in low pressure zones for the prioritisation of pipeline replacement. Charalambous et al. (2014) stated, "The critical factors of asset management are:

- Understanding how assets are currently performing;

- Collecting data and turning it into useful information for planning; and

- Good information systems."

2.2.2 The Apparent Loss Reduction Concept

The second concept is similar to the reduction of real losses as it deals with increasing the revenue (or decreasing the apparent losses) for a Municipality and also has only four approaches that can be utilised (Thornton and Rizzo, 2002). These include accounting controls which examine a consumer meter's volume trend over a few months to ensure that there are no anomalies (Thornton and Rizzo, 2002). Data handling controls deal with errors that might occur from when a meter reader goes out to site to take a meter reading, to them

noting the volume that passed, to possible errors in the input of that volume on a billing system that will generate the invoice for consumers (Vermersch et al., 2016). Policy and enforcement include having a purpose-written policy that discourages illegal connections by consumers of a Municipality (Vanalle, Lucato and Sato, 2017). However enforcement of these policies generally are difficult due to political motivations in developing countries (Vanalle et al., 2017).

The last approach also has an arrow that can increase or decrease apparent losses, and deals with choosing the correct meter to measure Municipalities consumers' consumption (Vermersch et al., 2016). If the correct meter is not chosen for a particular consumer then either it is oversized and cannot pick up low flows (e.g. from a toilet leaking continuously at night inside a consumer's property), or, if the meter is undersized, it will miss large volumes and cannot measure large flowrates (e.g. if a hotel is exceptionally busy during a peak period) (Vanalle et al., 2017). Similarly, the boxes within the arrows have the same conceptual style as previously discussed and could either decrease, or increase and decrease as explained in relation to the preceding Figure 2.1 (Gupta and Kulat, 2018).

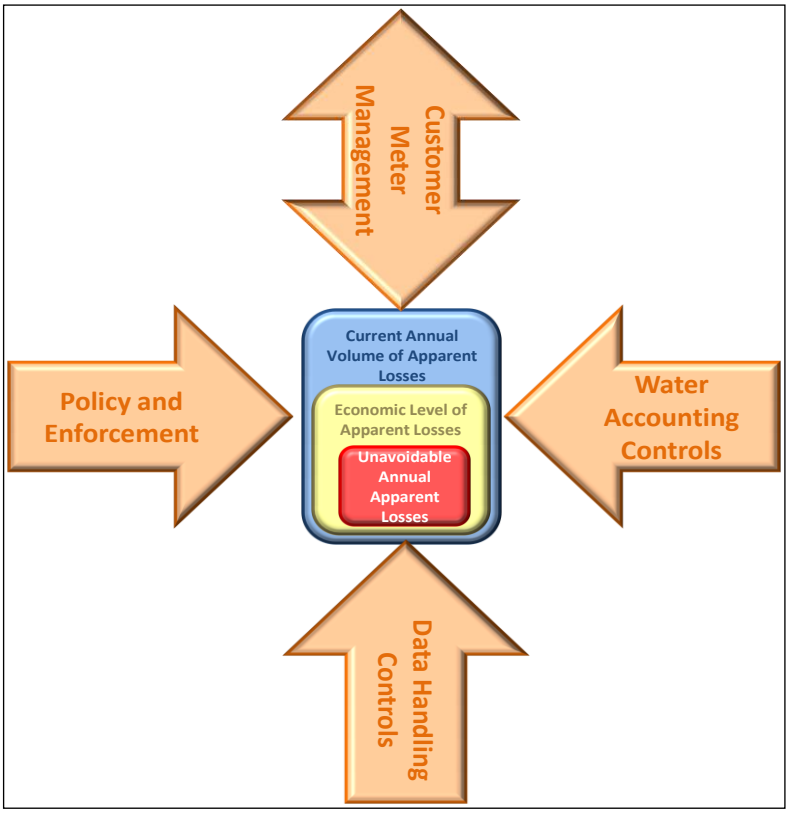


Figure 2.2: Four Pillars of Apparent Losses (adapted)

Source: Thornton and Rizzo (2002)

2.2.2.1 Customer Meter Management

This component deals with metering errors in terms of sizing the meters depending on the water usage profile of the consumer (Fontanazza, Notaro, Puleo and Freni, 2015). According to Couvelis and Van Zyl (2015) it should be noted that certain consumers have varying consumption patterns and as such the correct type and size of meter is required. Hence the Municipality should always log their meter and have constant interactions with commercial consumers (Couvelis and Van Zyl, 2015). Industrial, commercial and institutional consumers account for the majority of consumption when it comes to a utility, and as such they are the cash cows (Fontanazza et al., 2015). Therefore making more of an effort to understand their water usage patterns can help to determine if the meter type and size are actually under-registering their water usage or not (Venkatesh, Chan and Brattebø, 2014). Hence, it is critical that meter management forms an integral part of revenue generation or apparent loss reduction (Venkatesh and Brattebø, 2012).

2.2.2.2 Water Accounting Controls

In most Municipalities bills to consumers are created by a meter reading done by a human meter reader (Fontanazza et al., 2015). The human element in this process adds an element of fallibility as the person who takes down the reading, hands it over to a data-capturer at the office before the billing system will finally produce a bill for the consumer (Fontanazza et al., 2015). However, there should be certain parameters or validation checks programmed into the billing system in order to help identify anomalies (Fontanazza et al., 2015).

Couvelis and Van Zyl (2015) used an example of a meter reader that recorded a decimal place in the incorrect position for the meter reading as meters read in both kilolitres and litres on their dials, and by having the decimal place in the incorrect position a consumer could be charged 1 or 100 kilolitres for a month's usage instead of the correct 10 kilolitres. Hence, simply-stated water accounting controls refer to the fact that a Municipality's billing system should have a pre-programmed algorithm or script that will interrogate the previous three to six months' consumption and ensure that there is no large variation, and if there were then the billing staff would be required to validate and recheck the meter reading so errors in billing are reduced (Couvelis and Van Zyl, 2015).

2.2.2.3 Data Handling and Controls

As previously mentioned in the earlier section various errors could occur from the start of a meter reading process to the point that the consumer receives their bill in the letterbox at home (Couvelis and Van Zyl, 2015). Additionally, there are other errors that could take place due to aging meters, negligence or even corruption between meter readers and consumers (Beal and Flynn, 2015). Beal and Flynn (2015) suggest that proper and repeated training of meter readers is non-negotiable as this will help reduce negligence and, possibly, complacency, whereas rotating the meter readers to various suburbs will help eliminate corruption between consumers and meter readers. Furthermore, the meter readers are at the coal face when it comes to interactions with consumers, hence they must be well-versed when it comes to information regarding meters in the event that consumers should question them (Couvelis and Van Zyl, 2015). Using these mitigating controls as well as the ones mentioned in the preceding section will help reduce apparent losses for a Municipality.

2.2.2.4 Policy and Enforcement

This component deals specifically with illegal connections or "unauthorised consumption" made by consumers and the policies that each of the Municipalities have in place, but more importantly the enforcement thereof should a consumer be found guilty of stealing water (Meier, Kayser, Kestenbaum, Amjad, Dalcanale and Bartram, 2014). Meier et al. (2014) confirmed that although South Africa is one of the unique countries in the world that has low water tariff rates and, in fact has a free basic water usage as a constitutional right for each household, that illegal connections are still rife amongst the poverty to low income class of the economy. Additionally, the country's ruling party acknowledged the historical past that has set up the current economic climate whereby most of the illegal connections occurred within their constituencies and hence there is little political will to enforce the legislated By-Laws for most Municipalities (Fabricius, Koch, Turner and Magome, 2013).

But according to van den Berg (2015) international best practise suggests that even the lower income spectrum of the consumers needed to abide by the principle of paying for water that is in excess of what has been stipulated by the free basic water allocation or else Municipalities/utilities will not be financially viable in the medium to long term. Unfortunately, in South Africa policies are in place but enforcement does not take place, and

illegal connections are rife due to the socio-economic issues facing the country (Meier et al., 2014).

2.2.3 Non-Revenue Water Reduction

With the increasing international trend towards sustainability, economic efficiency and protection of the environment, the problem of losses from water supply systems has been of major interest worldwide since the late 1970's (Alperovits and Shamir, 1977) but took more prominence since the mid-1990's (Lambert, Brown, Takizawa and Weimer, 1999). Both the technical and financial aspects are receiving increasing attention, especially during water shortages or periods of rapid development during that era (Kim and Mays, 1994, Lambert, 1994, Herz, 1998, Kleiner, Adams and Rogers, 1998).

In 1996, the Operations and Maintenance Committee of the International Water Association's (IWA) Distribution Division set up a Task Force to review existing methodologies for international comparisons of water losses from water supply systems. The resulting seminal publication by Lambert et al. (1999) summarised the conclusions of the Water Losses Task Force (WLTF), with particular reference to the preferred Performance Indicators for assessing operational performance in the controlling of real losses in supply systems. This publication gave an international standard for both existing and new definitions as well as recommendations on how to implement Non-Revenue Water (NRW) reduction strategies. One of the new definitions was for NRW as stated by Lambert et al. (1999), "Non-Revenue Water is the difference between System Input Volume and Billed Authorised Consumption."

From this point onwards the world's practitioners and leading researchers for water losses began to adopt, follow and implement WLTF recommendations (Farley and Liemberger, 2005). This occurred throughout the world including SA (Farley and Trow, 2003, Farley and Liemberger, 2005, Pearson, 2009, González-Gómez, García-Rubio and Guardiola, 2011, McKenzie et al., 2012, Kanakoudis and Muhammetoglu, 2014, van den Berg, 2015, Adedeji, Hamam, Abe and Abu-Mahfouz, 2018). Surprisingly, when researching the NRW reduction concept as a theoretical framework there were no opposing views locally or abroad, hence this accepted theoretical framework would be the central element for this dissertation.

As an explanation the WLTF created the IWA Water Balance as per Figure 2.3 and it postulated that any water that entered a water distribution system should be measured and termed System Input Volume (Lambert et al., 1999). Thereafter, the volume of water that is billed to their various consumers was termed Billed Authorised Consumption (or simply Revenue Water) (Lambert et al., 1999). Whilst the term NRW is used in reference to all water that was not paid for by way of unbilled consumption, apparent losses and real losses (Lambert et al., 1999). It should be noted that South Africa is one of a very small proportion of the world's countries that gave, and still continues to give, their domestic consumers free basic water (Kiefer, van de Lande, Adler-Michaelson, Neumeyer, Khalfan, Roaf, Morley, O'Connell, Johnson and Montgomery, 2012). As such a modified water balance has been created for this country to ensure that it is considered as part of the approach to reduce NRW (Seago and McKenzie, 2007).

<table>
<tr><td rowspan="8">System Input volume m^3/year
(± x%)</td><td rowspan="4">Authorised Consumption m^3/year
(±x%)</td><td rowspan="2">Billed Authorised Consumption m^3/year
(±x%)</td><td>Billed Metered Consumption</td><td rowspan="2">Potential Revenue water m^3/year
(±x%)</td><td>Free Basic</td></tr>
<tr><td>Billed Unmetered Consumption</td><td rowspan="2">Revenue</td></tr>
<tr><td rowspan="2">Unbilled Authorised consumption m^3/year
(±x %)</td><td>Unbilled, Metered Consumption</td><td rowspan="5" colspan="2">Non-Revenue Water m^3/year
(±x%)</td></tr>
<tr><td>Unbilled Unmetered Consumption</td></tr>
<tr><td rowspan="4">Water Losses m^3/year
(±x%)</td><td rowspan="2">Apparent Losses m^3/year
(±x %)</td><td>Illegal Connections</td></tr>
<tr><td>Metering Inaccuracies</td></tr>
<tr><td rowspan="3">Real Losses m^3/year
(±x %)</td><td>Mains Leaks</td></tr>
<tr><td>Reservoir Overflows</td></tr>
<tr><td>Service Connection Leaks</td></tr>
</table>

Figure 2.3: The South African Modified IWA Water Balance (adapted)

Source: Mckenzie and Wegelin (2009)

In short, the theory that was used for the reduction of NRW was developed by the WLTF from 1996 and published by Lambert et al. (1999) and further improved on by Lambert (2002). This theory was used to study NRW reduction techniques and interventions for real losses which refers to the reduction of physical water leakage in a water system. This indicated that any water utility's primary function was to both increase revenue water, and decrease NRW thereby making a system more efficient over time. As applied to this dissertation, this theory held that, should a water utility manage to increase their revenue water one would subsequently expect them to have extra budget/funding available to ring-

fence a portion of those funds and fill all of their unfunded/frozen posts with the Municipalities NRW units.

2.2.4 Theoretical Framework and Concepts Summary

The theoretical framework that underpinned the reduction of NRW was BABE which enabled practitioners from around the world to all standardise their method and calculate the volume of water leakage from underground water pipelines that can be customised to the local conditions by using a software programme. This gave rise to building of a component-based water balance which can be calculated using the IWA's recommended and adopted definitions for each of the components.

Finally, two concepts for the reduction of real (or leakage) losses and apparent (or accounting) losses was also widely accepted and followed throughout the world. It is the intention of this study to underpin the research objectives by utilising these proven and internationally accepted frameworks and concepts.

2.3 Literature Review on Research Constructs

2.3.1 Prioritisation of Access to Water versus Municipal Efficiency

Following SA's political transition in 1994 the policy makers at the time followed best practise in the allocation of budgets to National, Provincial and Municipal entities (Klug, 2010). Bearing the past in mind the Constitution of the Republic of SA committed the various arms of Government to bring about change in an equitable manner to the socio-economic rights of all its citizens within the constraints of available resources (Klug, 2010).

As this was one of the main agendas it was only natural that most policies from that point on was pro-poor and ensured all South Africans had access to all resources in the country (Fabricius et al., 2013). However, Khemani (2015) argued that due to the non-effective plans during the implementation of these policies most of the poor citizenry were in fact still being denied their basic rights of which access to water was one of them.

Currently 75% of countries throughout the world have recognised the human right to water (Organization, 2014). However, SA is only one of only seven countries in the world that had this right enshrined in its Constitution (Meier et al., 2014). Due to this there are powerful monitoring frameworks that were put in place to track progress versus targets, and as such most Municipalities always place a priority on achieving those targets resulting in approximately 3.5 million people having been given access to free water by 2012, which they previously did not enjoy (Supply and Programme, 2014). It seemed that the difficulty most Municipalities in SA faced came to being able to balance accomplishing the task of catching up to the backlog and giving their citizens access to water versus still efficiently and responsibly running their Municipalities (Brettenny and Sharp, 2016). Monkam (2014) concurred with this view that the smaller or non-Metro Municipalities spent most of their budgets/grant funding on projects that were monitored whilst neglecting other mandatory requirements (such as the reduction of NRW) that were not strongly monitored and emphasised.

2.3.2 Current State of NRW in SA

"We are not a water rich country. Yet we still lose a lot of water through leaking pipes and inadequate infrastructure. We will be putting in place measures to reduce our water loss by half by 2014" said former President Zuma (2010) during his State of the Nation Address. The goal was set but unfortunately at a Municipal level the success of interventions was not adequate (McKenzie et al., 2012). Wegelin and Jacobs (2013) confirmed that there have been various books, publications, manuals and conferences, both locally and abroad, (for e.g. Hunt, McDevitt and Hunt (1998), Lambert (2002), Force and Thornton (2003), Thornton and Lambert (2006), Green (2011) etc.) that could have been utilised over the years to help guide and even to help draft effective NRW strategies, but in studies on the situation it was shown that Municipalities did not have NRW strategies in place or if they existed were not successfully implemented.

Many Municipalities and water entities cannot grasp the benefits, as well as the necessity, of dealing with NRW reduction in water networks (Farley and Trow, 2003). Since then, there have been lots of effort to ensure Municipalities reduce their NRW (Wegelin and Jacobs, 2013). These included performance management incentives as well as the introduction of compulsory, regulatory reporting via the Green and Blue Drop initiatives

from the DWS (Wegelin and Jacobs, 2013). More recently, the Auditor General has also begun to look at Municipalities that have losses greater than 30% (Wegelin, 2015). With all these regulatory commitments it would seem likely that NRW reduction had been prioritised and that programmes had been funded and run (McKenzie et al., 2012). However, this was not the case as McKenzie et al. (2012) noted in a report that included 132 of the 237 (or 56%) Municipalities. The report documented that the current NRW for this subset was an average of 36.8% or rather R5.4 billion/annum (McKenzie et al., 2012).

From the same report it emerged that when it comes to the KZN province, which comprised of 13 DMs, the average NRW was 43.5% or R678 million/annum (McKenzie et al., 2012). In a subsequent report on KZN, Donnenfeld, Hedden and Crookes (2018) stated that the province could reduce their NRW to 34.3% or R535 million/annum but this assertion was subject to NRW interventions that would take place over a period of five years and would depend on adequate funding. The problem it would seem was that all these reports' recommendations were primarily based on inadequate funding, copious reporting and regulatory requirements for reporting, however none questioned or considered if the Municipalities had adequate human resources and/or the requisite knowledge of those resources in undertaking NRW projects. It is the opinion of the researcher that this was the gap in research that needs to be addressed in this study.

2.3.3 NRW Unfunded/Frozen Posts

There were numerous reports of vacancy rates within Municipalities throughout SA. However, these reported vacancies were exclusively related to officially approved organograms. A report published by Treasury (2008) indicated vacant local government positions for KZN in 2005 and 2006 as sitting at 37% and 39% respectively as per Figure 2.4.

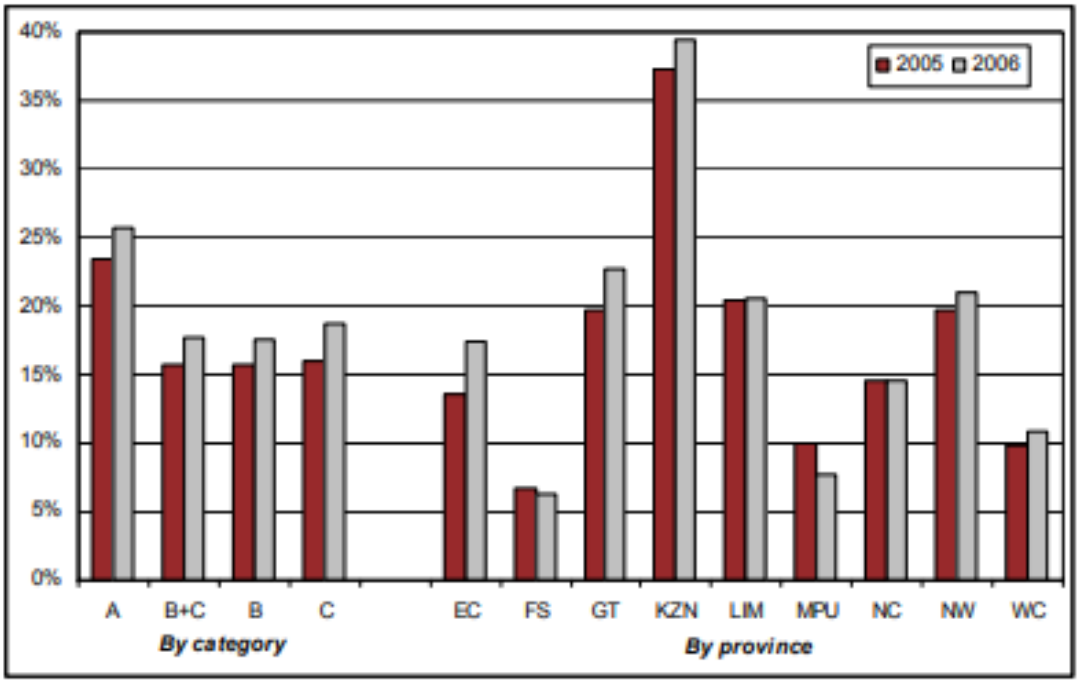


Figure 2.4: Vacancy Rates by Municipal Category and Province within Government's Water Sector

Source: StatsSA (2017), Non-financial census of Municipalities for the year ended 30 June 2006

The good news was that those vacancies had reduced from more than a decade ago (StatsSA, 2017). In a press statement by StatsSA (2017) they had concluded that, as of 2016 funded, vacant posts in KZN had reduced to 17.8% which was still higher than the National average of 14.4%. However, of particular concern to this study was the staff vacancy rates within the water sector. From the same publication Figure 2.5 showed that within the water sector there was a 13.6% vacancy rate (StatsSA, 2017).

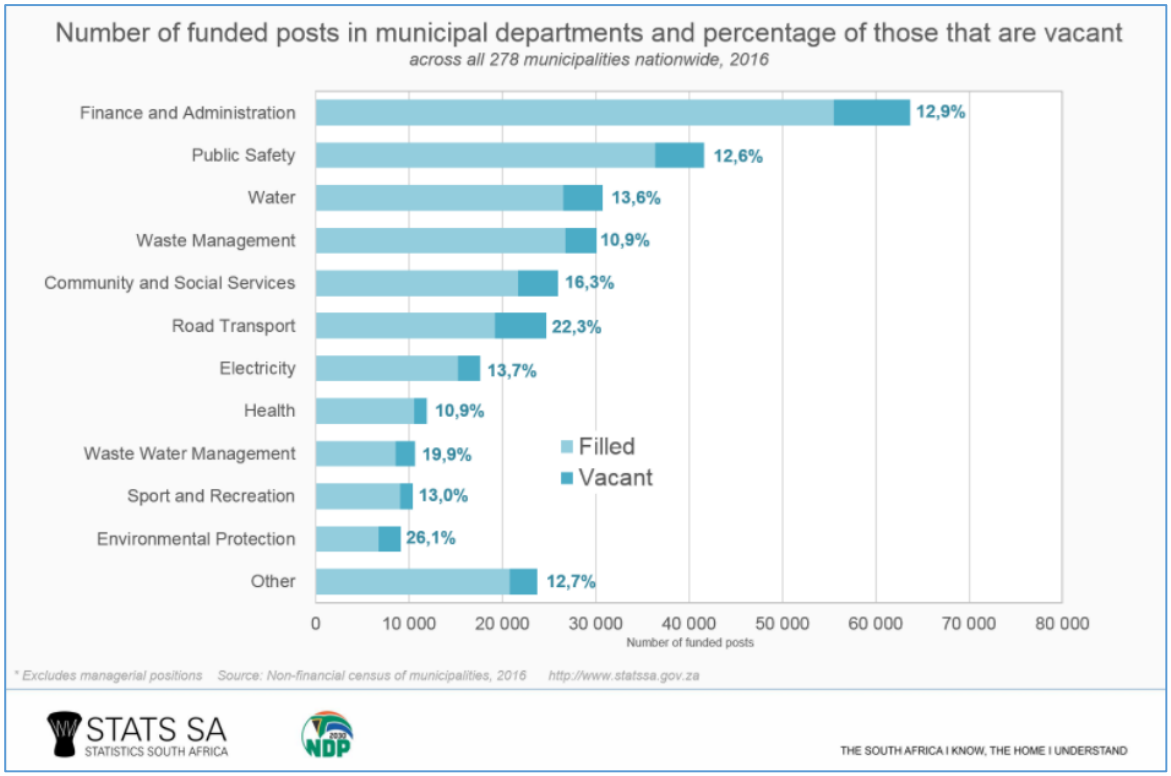


Figure 2.5: Vacancy Rates for various Government Sectors

Source: Non-Financial census of Municipalities, 2017

As previously mentioned due to the precarious financial positions that most Municipalities faced they had an approved organogram which was accepted by a Municipality's Executive Committee, thereby there were funds that were allocated for all the posts approved. However, most researchers did not delve into the problem of the frozen/unfunded posts within these organograms. The frozen/unfunded posts were what the Water Technical units within Municipalities required to actually fulfil their mandate.

Figure 2.6 was an example of a typical full organogram for the City of uMhlathuze's NRW unit. What was startling to note was that there were only five funded posts. Although not shown, as the names of the individuals have been removed to ensure research anonymity, the Senior Engineer also fulfilled this role and was also "Acting" for the position of Manager: Infrastructure Planning and NRW Reduction. Using the same methodology to calculate the statistics provided by Stats SA and the way they have been reported would mean that the City of uMhlathuze's vacancy rate would be 40%. However, in reality, when considering the vacant funded posts as well as the frozen/unfunded posts, the vacancy rate

was actually 85%. The researcher believed that this was one of the real causes of NRW being at such a high level within SA which was corroborated by Wegelin (2015).

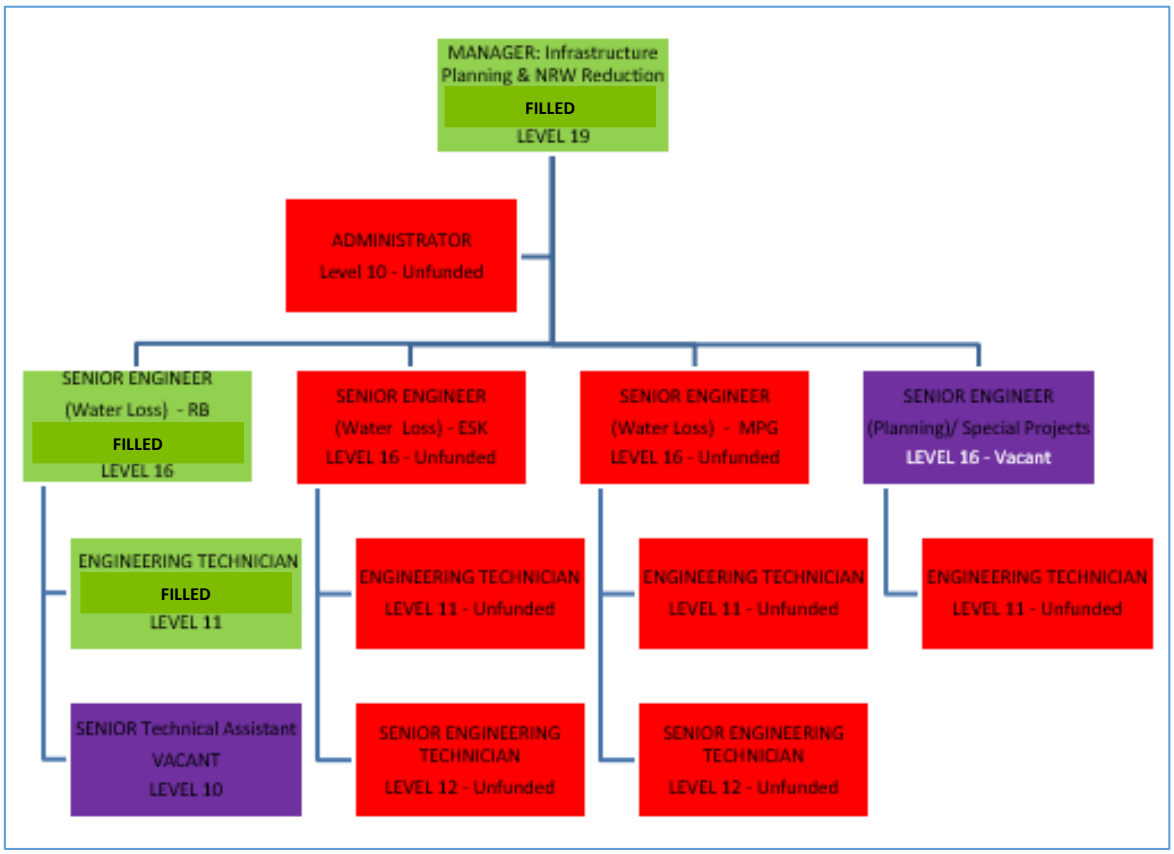


Figure 2.6: City of uMhlathuze's Organogram for the NRW unit

Source: City of uMhlathuze

2.3.4 Lack of Capacity and Experience

Since the start of the century researchers lamented the fact that the NRW reduction projects that were run by the public sector were generally bound to fail or that they were not sustainable (Lambert et al., 2013). This outlook can be attributed to the fact that these projects were considered as once-off projects, as well as to staff members' lack of experience and understanding when it comes to NRW principles (Wegelin, 2015). Kingdom, Liemberger and Marin (2006) stated that, in order for NRW reduction interventions to be successful it required a wide range of managers, skilled staff as well as professional engineers on one side of the equation while skilled system operators, technicians and plumbers were required on the other end. Kingdom et al. (2006) further argued that, "NRW reduction, in its broadest sense, is not taught at universities or technical colleges nor in many

of the water industry training institutions around the world. As a consequence, staff with necessary skills are not widely available. Addressing this issue will require both an acceptance of the widespread challenges and consequences associated with NRW and then the development of appropriate training materials, methods, and institutions." Baietti, Kingdom and van Ginneken (2006) echoed similar sentiments encouraging public utilities/Municipalities to set aside a budget for their staff to attend training on NRW as this specialty field is not taught by most tertiary institutions. It therefore stands to reason that private training sessions are the only means to educate their workforce on NRW principles and practises (Frauendorfer and Liemberger, 2010). To successfully and sustainably reduce NRW Utility owners or Municipalities need to motivate their staff members, management and all stakeholders and provide them with adequate funding, training and the necessary technology (Frauendorfer and Liemberger, 2010).

The lack of capacity and requisite experience within the South African context when it comes to Municipal officials regarding NRW issues was previously mentioned in the "State of Non-Revenue Water in South Africa" in 2012 and stated that it was one of the major reasons for the reported high NRW figures for most Municipalities (McKenzie et al., 2012). Wegelin (2015) also agreed with this conclusion and further stated that the institutional capacity constraints of Municipalities as a whole contributed to high NRW.

Moreover, internationally there are movements in the sector to try and close this gap when it comes to educating the public and private sector on NRW (Lascano, Nuñez, Esparragoza, Schmidt and Nagel, 2014). Lascano et al. (2014) and his team, from South America, have attempted to create a model where they tried to disseminate engineering knowledge via three outlets viz. publishing case studies online and as text, workshops to train tertiary education educators in target regions in addition to workshops to target the private and public sector's water operators. Although there are many facets to their workshops NRW does feature as one of their modules. In Germany, Bahadir and Dichtl (2015) have created a world-wide network of 35 partner universities in 18 countries throughout the world from four continents, with the exception of South Africa as seen in Figure 2.7, and their excellence centre focuses on capacity building in developing countries through training and networking. Bahadir and Dichtl (2015) stated that, in order to achieve these goals, "the existing study programmes at partner universities related to sustainable water management are [to be] analysed and

upgraded; new courses are [to be] initiated for further education of scientific and technical staff at universities, enterprises, and public authorities."

Figure 2.7: Partnerships Created with various universities on four Continents

Source: Bahadir and Dichtl (2015)

2.3.5 Models Used for Funding

Sutherland, Hordijk, Lewis, Meyer and Buthelezi (2014) stated that the responsibility for the provision of water (and revenue gain for Municipalities) has changed hands between National and Local Government over the last twenty-five years. For the first five years post-democracy, the Department of Water Affairs and Forestry (DWAF) implemented and drove the water supply programmes (Sutherland et al., 2014). After the turn of the century there were new Local Government institutions established due to the National Municipal Demarcation process whereby water service functions were delegated to the Municipal level (Sutherland et al., 2014). Thereafter as per the Municipal Financial Management Act No 56 of 2003 (MFMA) Municipalities could only derive their income to run their institutions primarily through revenue derived from the sales of water, electricity and rates (Treasury, 2012). All Municipalities then use the revenue generated from these three streams and cross-

subsidise all other functions that have been mandated to them like the upkeep of parks, roads, libraries etc. (Treasury, 2012)

Sutherland et al. (2014) noted that the problem with this situation was that most Municipalities still were not financially self-sufficient to address their backlogs and could not self-fund their activities (including NRW reduction projects). In response to this National Government introduced grants that all Municipalities could apply for (Gounden, Pfaff, Macleod and Buckley, 2006). NRW reduction programmes fell within the Municipal Water Infrastructure Grant (MWIG) fund (Ruiters, 2013). This fund was unfortunately continually being depleted as the need was so large that not enough of the National Budget could accommodate the applications received (Gounden et al., 2006). This was further corroborated more recently by the then Finance Minister Pravin Gordhan (2013) during the National Budget speech to Parliament.

With the funding needs requiring an increase each year while budget allocation from the various government grants were constantly being reduced there was thus a need to look at alternative funding models (Ruiters, 2013, du Plessis, 2017). These alternative funds were necessary to help Municipalities in reducing NRW while at the same time increasing their efficiencies (Wegelin, 2015). The traditional method of borrowing from institutions like the Development Bank of SA (DBSA) and other commercial banks was not financially feasible as the interest that was charged continued to compound and, in order to show any real impact these projects have to have minimum lifespans of between five to ten years on average (Wegelin, 2015).

Moreover, noted that there are many foreign Government and local and international Non-Government Organisations (NGOs) that were willing to fund NRW reduction programmes as it made business sense according to many (Ruiters, 2013). However, the local market (Municipalities by large) were, and still are, hesitant or unwilling to change the way they procure the services of professional service providers as well as funding (Ruiters, 2013). This same sentiment has been agreed upon by Wegelin (2015) who stated that the following constraints existed when it comes to applying NRW reduction programmes within SA Municipalities:

- Large scale NRW programmes are expected to require large budgets which cannot be funded from internal sources and very few Municipalities are able to access external funding of any nature;

- Approximately 45% of Municipalities cannot even calculate their water balances and hence, even when grant funding is allocated, the interventions are done in a haphazard or ad hoc manner resulting in targets and goals never being realised;

- The Non-Financial Census of Municipalities indicated a staff vacancy rate of approximately 25% in Municipal water departments which in turn suggested that the implementation of interventions from a unit with staff shortages would never be accomplished; and

- With various training workshops held with more than 500 Municipal water professionals in 2011 the issue of the lack of funding for NRW reduction programmes was always raised throughout the country. However, in contrast to this the National Treasury Local Government Revenue and Expenditure Report (2013) highlighted that on average 23.3% of capital budgets for water projects was not spent.

Ruiters (2013) studied all the various models that Municipalities could utilise to access private funding and it became clear that the most robust method would be through Private Public Partnerships (PPP), but once again very few Municipalities have taken this up. From the other angle the private sector was also not willing to fund entities that they believed did not have the manpower or knowledge to actually achieve targets (Ruiters, 2013).

Another model called the Shared Water Savings Contract (SWSC), or as it is internationally referred to, Performance Based Contracting, has also being researched. Internationally this concept has been used successfully between private and public entities albeit mostly for electrical efficiencies (Selviaridis and Wynstra, 2015). However, more recently the National Department of Public Works (NDPW) have started engaging with the private sector to try and unlock the billions of Rands available (Selviaridis and Wynstra, 2015). The simple premise was that the private sector would bring in all the funding and technical know-how,

then implement the NRW reduction interventions and that the savings gained from reduced water losses would be shared 50% by the private and public entity (Ruiters, 2013). In this manner the onus is totally on the private sector to ensure that results are delivered otherwise they would lose their initial funding (Ruiters, 2013).

2.4 Summary of Literature Review and Research Gaps

This chapter established the theoretical framework upon which the researcher believed that Municipalities could be used to garner interest in private funding such that most, if not all vacant, unfunded and frozen posts within NRW units could be filled with individuals that have the required knowledge and experience. It has also shown that most decision makers within Municipalities are focussing on reducing the backlogs for individuals without basic services rather than addressing both this need as well as the need to reduce NRW thereby assisting the Municipality financially. The state of NRW within SA is cause for concern and this concern is even more relevant in the KZN province.

In terms of vacancy rates when it comes to water-related positions within Municipalities the researcher believes that these figures were extremely understated and further believes that a gap in knowledge exists as, thus far, no entity or literature reported on unfunded and frozen posts within SA. The chapter also highlighted a funding model of shared savings, used mainly in the electricity industry, which could be the solution that helps solve the issue related to the funding of these NRW projects, while helping to fill all the posts required in a fully-funded, unfrozen Municipal organogram. Lastly, there have been no Municipalities that have tried this funding and contractual model as yet with only the NDPW having awarded seven contracts over the last decade that dealt with individual buildings, but once again no reports on the successes or failures of the programme have been published as yet.

CHAPTER THREE
Research Design and Methods

3.1 Introduction

This study has employed a quantitative research method. The chapter describes the methods used to gather the research data and the analysis methods employed. Preliminary desktop research enabled the development of the research questions. In this regard, the chapter explains the research methodology and the rationale behind it. The research design, which includes research strategy, study area, target population, sample space and data collection tools, are explained. Lastly, the validity of the data, limitations and ethical considerations, are also taken into account.

3.2 Research Design and Rationale

A survey instrument has been utilised for this deductive study that was quantitative in nature. Creswell and Creswell (2017) suggested that the purpose of using a survey research method was to be able to generalise from a sample of the population so that inferences could be made about the attitude of Municipal officials with respect to the proposed new funding approach, as well as regarding the general understanding of the reasons why so many of the NRW posts are vacant. The collection of data was cross-sectional in nature as the study wanted to understand what the current issues are with respect to the objectives and propose possible solutions and recommendations that could assist SA Municipalities.

Yeboah and Kayaga (2008), Husseina, Yonedaa, Nor'Azizi Othmana, Zakib and Yusofc (2017) and Malithi (2017) utilised the same research design and rationale that was deployed for this study, and which was used to gauge the competence of water operators in the public sector. Additionally, using a survey assisted the researcher in getting feedback from respondents with a rapid turnaround period as it was done in the respondent's own free time versus requiring individual interviews to be set up with Municipal officials throughout the province.

3.3 Study Area

The study area encompassed all thirteen DMs within the Kwa-Zulu Natal province. The province has the highest number of vacancies within water units when compared to the rest of the country. Furthermore McKenzie et al. (2012) also stated that this province also had the highest NRW in terms of financial losses per annum, hence a solution was required. Additionally, Donnenfeld et al. (2018) believed that with the appropriate and correct implementation of NRW interventions the province could reduce the NRW within KwaZulu-Natal to R535million per annum.

3.4 Target Population and Sample Size

Robinson (2014) stated that the delineation of the sample universe entails the inclusion or exclusion of a set of criteria, or a combination of both. Robinson (2014) further stated that the inclusion criteria specifies an attribute that must be possessed for cases to qualify for the study. In this study the target population were all the officials that were within the water units in the DMs within KZN. However, in terms of trying to narrow the scope of the study, as previously mentioned, only Municipal officials that were currently within the NRW units of the water divisions were considered. If there were no NRW units then the official that was tasked with reporting NRW figures monthly to the DWS was asked to complete the survey.

As mentioned above there are thirteen DMs in the province and the methodology in determining the sample size for a finite population that is advised by Krejcie and Morgan (1970) is presented in Table 3.1 using a 5% interval and 95% confidence level parameter.

Table 3.1: Table for Determining a Sample Size from a Finite Population

N	S	N	S	N	S	N	S	N	S
10	10	100	80	280	162	800	260	2800	338
15	14	110	86	290	165	850	265	3000	341
20	19	120	92	300	169	900	269	3500	346
25	24	130	97	320	175	950	274	4000	351
30	28	140	103	340	181	1000	278	4500	354
35	32	150	108	360	186	1100	285	5000	357
40	36	160	113	380	191	1200	291	6000	361
45	40	170	118	400	196	1300	297	7000	364
50	44	180	123	420	201	1400	302	8000	367
55	48	190	127	440	205	1500	306	9000	368
60	52	200	132	460	210	1600	310	10000	370
65	56	210	136	480	214	1700	313	15000	375
70	59	220	140	500	217	1800	317	20000	377
75	63	230	144	550	226	1900	320	30000	379
80	66	240	148	600	234	2000	322	40000	380
85	70	250	152	650	242	2200	327	50000	381
90	73	260	155	700	248	2400	331	75000	382
95	76	270	159	750	254	2600	335	1000000	384

*Note N is the Population Size and S is the Sample Size

Source: Adapted from Krejcie and Morgan (1970)

Taking the thirteen DMs into consideration as the population size the table indicated that the sample size used for this study had encompass a minimum of twelve DMs as respondents, but in this case all thirteen responded which ensured a 95% confidence level.

3.5 Sampling Techniques and Size

Sampling refers to the process of selecting the sufficient number of correct elements from a population in order to be able to generalise properties attained from the study of the sample to the entire population (Sekaran and Bougie, 2016). This is a multi-stepped approach which includes:

- defining the population;
- determination of the sampling frame;

- determination of the sample design;

- determination of the appropriate sample size; and

- execution of the sample process.

The population for this study were all the DMs in the KZN province. However, as stated previously, the study required a minimum of one respondent from each of the minimum twelve DMs. To ensure richness as well as data collection of the correct data it was imperative to collect the questionnaire data from the most senior role players within these DMs that deal with NRW. This is because these officials would be able to offer more information and knowledge on the subject matter, versus obtaining information on the state of vacancy rates in an entire unit from less senior employees such as plumbers within the NRW. With this in mind at the very minimum the study required information from either the Manager of NRW, or alternatively the Water Services Authority (WSA) Manager to whom all senior staff of the Municipality's NRW units ultimately report to within the Municipal environment.

The sampling technique that was used is referred to as probability stratified sampling. Creswell and Creswell (2017) stated that stratified sampling is used when a researcher needs to divide the population into characteristics of importance for the research. This was utilised, as explained above, as the study required participation from the senior role-players within these DMs that were specifically involved in NRW activities and who understood the constraints that their Municipalities have to endure. Taking into consideration was the ease of getting access to all these senior role players. This did not prove difficult as the KZN DWA unit holds a quarterly forum where all thirteen DMs' NRW Managers have to be present. If they were unable to attend they were obliged to send through their WSA Managers. If for whatever reason either did not attend the forum then the questionnaire was emailed to them, while the last alternative was for the researcher to send a third party to those individuals personally.

3.6 Research Instruments

The research instrument that was utilised was a hard copy questionnaire, or alternatively when the researcher could not physically meet Municipal officials then an online questionnaire was emailed to them to complete. The four main categories of variables were identified as being current vacancy rates, the qualification and experience of current officials, the officials' understanding of basic NRW principles and their understanding of financial models other than National Government grant funding.

The instrument was designed by the researcher to include factual questions (to gather vacancy rates as well as each official's experience/knowledge gaps) and attitudinal questions (to gather opinions on the reasons for the vacancy rates and also alternative funding models). Yeboah and Kayaga (2008) and Al-Washali (2011) used this type of questionnaire survey as their research instrument on similar NRW studies, whilst Kamau (2013) and Monney, Oduro-Kwarteng and Odai (2014) utilised the same in attempting to ascertain the reasons behind low vacancy rates in the water and sanitation sector in Kenya and Ghana respectively.

3.7 Pre-Testing

The methods for pre-testing that was used for the questionnaire included sharing it with six peers from the private sector who are working within this niche industry as well as four Municipal officials in DMs from the Western Cape province. This ensured that the researcher was able to gauge the validity, appropriateness, reliability and necessity of the questions. Additionally, any ambiguous questions, grammar and English errors were minimised. The researcher currently works with five other NRW units' DMs outside of KZN and the same research was conducted on them as they are in the public sector and would have similar responses as the target population. Thereafter, a debriefing of all respondents was conducted to clarify the survey's direction, ease of understanding of the questions, relevance of questions, wording of questions, and the correct format as well as ascertaining if the scale for answers was appropriate. Thereafter, revisions of the questionnaire were conducted before it being rolled out to the target population.

3.8 Validity and Reliability

Validity refers to how well a developed instrument measures the concept it is intended to measure (Mertens, 2014). According to Mertens (2014) a test is valid as an attribute measuring tool if (a) the attribute exists and (b) variations in the attribute casually produce variations in the outcomes. The factual factors produce variations on the attitudinal outcomes.

Reliability refers to the extent to which a test is without bias, ensuring consistent measurements across both time and items within the instrument (Nardi, 2018). A test can be considered reliable if, under stable conditions, it can be used by a number of researchers with consistent and unvarying results. It reflects on the consistency with which reliable outcomes are achieved over time. It is a measure of the degree to which the measured parameters are free of errors. The research will have a high degree of reliability because of two major factors, namely:

- The researcher had no part in the handing out or emailing of the questionnaire as this was conducted by a third party, therefore no bias influence on the respondent could be exerted; and

- The respondents were required to complete the questionnaire within their own time and space with there being only minimal pressure to complete it within a week of receiving it.

Lastly, to ensure that the data and results were acceptably valid and reliable Cronbach's Alpha, or the coefficient alpha which is universally accepted in life sciences research, has been used in this study. Vaske, Beaman and Sponarski (2017) stated that Cronbach's Alpha is commonly used to examine the internal consistency or reliability of summated rating scales.

3.9 Data Collection Techniques

As previously mentioned, all champions of NRW units for all DMs in the province meet every quarter, and this meeting is chaired by the Deputy Director: Water Regulation. This DWS official ensures that all Municipalities within the province report their water balances to him on a monthly basis and was the third party that administered the questionnaire to all the Municipal officials. This was done at the forth quarterly meeting held in Pietermaritzburg in October 2018. The respondents completed the questionnaire at the meeting and they were granted an additional week when they required information not at their disposal at the time with respect to vacancy rates in their respective NRW departments.

In the case where some respondents did not attend the meeting the Deputy Director emailed them explaining the need for the questionnaire to be completed. Unfortunately, this Deputy Director is one of nine in all the provinces in SA and is one of the most pro-active, hence if another researcher wanted to replicate this study it could prove to be difficult as the other provinces do not have similar quarterly meetings as in KZN.

3.10 Data Analysis

The raw data was captured on an Excel spreadsheet and analysed once all of the respondents' data was collected. The final analysis was done through a freeware program called SPSS version 25 with the help of a statistician.

3.11 Ethical Considerations

There were various ethical considerations that were taken into consideration and included:

- The gatekeeper for this study was the Deputy Director: Water Regulation from the DWS as this individual is the province's custodian of all NRW reduction programme grant funding. DWS are currently financially stressed and are looking at ways to get private sector funding involved in Municipal NRW reduction programmes to lighten the load on an ever-decreasing budget from National Government;

- All respondents' consent was sought first and foremost explaining the following issues transparently:

    - The nature and purpose of the study;
    - The expected benefits of the study;
    - Possible harm that may come from the study;
    - Information about confidentiality and anonymity; and
    - The option for potential participants to choose to take part, or not, in the study.

- Factual accuracy from the participants' responses would not be altered and the findings gathered from the questionnaires would be presented as they have been answered. To ensure the integrity of the study no fabrication, falsification or misrepresentation of data due to the researcher's preconceptions would affect the final results.

3.12 Conclusion

The research design and methods have been discussed. The target population and sample size have also been explained, but due to all respondents answering the questionnaires the sampling techniques and size did not have any impact in this study. This quantitative, deductive study attempted to understand and establish the various factors related to, and the correlation between, high NRW experienced in KZN in relation to factors like vacancy rates, the knowledge and experience of Municipal officials as well as their possible inclinations towards shared savings contracts.

CHAPTER FOUR
Research Results and Interpretation

4.1 Introduction

The aim of this chapter is to deal with the analysis of the data collected in order to try and answer the research questions alluded to in Chapter 1. The population for this study encompassed of 13 DMs within KZN which represented the entire population and a questionnaire was used as the survey instrument. A nominal scale was utilised for the descriptive portion of the questionnaire which was used to categorise or classify individuals while an ordinal scale was used for Section B of the questionnaire. In the last section of the questionnaire a Likert scale was utilised in this quantitative, deductive study. The results of the survey were then analysed and interpreted.

4.2 Treatment of Data

The data that was obtained from all the participants was screened to ensure that there were no irrational answers that could influence the outcome or introduce errors when it comes to the data analysis process. The following were the findings with regard to possible errors that were made by the participants and the changes that were made to the data to ensure they were statistically relevant:

- Question 2 – Respondents 4, 10 and 11 all answered that they had a Bachelor's degree but their positions which they stipulated in question 3 indicated that that their designation within their Municipalities were technician, candidate technician and technician respectively. A person that holds a bachelor's degree cannot be employed as a technician and vice versa a person that holds a National Diploma cannot be employed as an Engineer. Hence, these three respondents' educational level was changed to National Diploma;

- Question 5b – Respondents 1, 3, 6 and 13 all indicated that they did not have a NRW unit within their organisations however these participants then indicated that there were positions that were filled, vacant and/or frozen in the subsequent follow-up

questions. Therefore these respondents' answer were changed to indicate that they in fact do have NRW units;

- Question 5c – Respondent 2 indicated that the total number of positions in the NRW unit was 26. However, when adding their filled positions, vacant positions and unbudgeted positions the sum was 33. Hence the total number for respondent 2's organogram was changed to 33; and

- Question 13 – Respondents 11 and 13 did not indicate any answer for the Likert scale question and left them blank. To correct this anomaly their opinion was taken as neutral.

These minor changes had to be undertaken otherwise the data analysis would not be accurate or statistically reliable meaning that it would be impossible to draw effective conclusions and recommendations. Additionally, as the population and sample numbers are relatively small these errors would have undoubtedly changed the outcomes of the study.

4.3 Reliability of the Questionnaire

Half of Section A of the questionnaire consisted of the respondents' demographic information whilst the second half deals with the current vacancy rates and possible reasons for these rates. Section B tried to ascertain the participants' knowledge and experience with regards to NRW principles and concepts. Section C was utilised to understand the perceptions and attitudes towards shared savings contracts. Each of the sections and questions were included such that the four key constructs could be tapped. To test the reliability of research objectives 2, 3 and 4, the Cronbach alpha was calculated. The Cronbach alpha is the measure of internal item consistency.

Lee Cronbach developed the Cronbach alpha in 1951, this functioned as a measure of internal consistency/reliability and is expressed as a value between 0 and 1, with 0 meaning absolutely no reliability whilst 1 represents flawless reliability (Diedenhofen and Musch, 2016). Arguably, a Cronbach alpha of 0.7 as a minimum is considered acceptable and values higher than 0.9 indicate redundancy and further suggests that opportunities exist for the

questionnaire to be optimised (Bonett and Wright, 2015). Bindak (2013) stated that the formula used to calculate Cronbach alpha is:

$$\propto = \left[\frac{K}{K-1}\right]\left[1 - \frac{\sum Vi}{Vt}\right]$$

Where K - The number of items in the objective

$\sum Vi$ - Addition of variance for each item

Vt - Variation of the total scores of the objective

Each construct's means, standard deviations and variances were calculated for research objectives 2, 3 and 4 initially, before the computation of Cronbach alpha took place. The results of these reliability tests are contained in Table 4.1, 4.2 and 4.3.

4.3.1 Reasons for Vacancy Rates

This section of the questionnaire only relied on one question to answer this construct. The mean, standard deviation, variance and Cronbach alpha results are contained in Table 4.1.

Table 4.1: Cronbach alpha for the Reasons Related to Vacancy Rates

Objective	Mean	Standard Deviation	Variance	Cronbach alpha α
Vacancy Rates	3.00	1.000	1.000	0.813

0.813 is the measured Cronbach alpha for the reasons of vacancy rates. Hence, due to this measure of the Cronbach alpha as a reliability criterion for the second half of Section A of the questionnaire it is considered reliable.

4.3.2 NRW Knowledge and Expertise

This section of the questionnaire was composed of five questions to answer this construct. The mean, standard deviation, variance and Cronbach alpha results are contained in Table 4.2.

Table 4.2: Cronbach alpha for NRW Knowledge and Expertise of Respondents

Objective	Mean	Standard Deviation	Variance	Cronbach alpha α
NRW Knowledge	2.77	1.423	2.026	0.723

0.723 is the measured Cronbach alpha for the respondents' NRW knowledge and expertise. Hence, it is considered reliable due to this measure of the Cronbach alpha as a reliability criterion for Section B of the questionnaire.

4.3.3 Shared Savings Contracts

This section of the questionnaire had six questions to answer this construct. The mean, standard deviation, variance and Cronbach alpha results are contained in Table 4.3.

Table 4.3: Cronbach alpha for Shared Savings Contracts

Objective	Mean	Standard Deviation	Variance	Cronbach alpha α
Shared Savings Contracts	15.54	2.436	5.936	0.906

0.906 is the measured Cronbach alpha for the participants' attitude towards shared savings contracts. Hence, due to this measure of the Cronbach alpha as a reliability criterion for Section C of the questionnaire it is considered reliable, but as it is higher than 0.9 it indicated redundancy in the questionnaire when it comes to this section.

4.4 Descriptive Statistics

4.4.1 Demographics

The demographic analysis which has been presented below represents the respondents' ages, highest educational levels, current position held in their respective Municipalities and salary grading.

Figure 4.1 shows the age distribution of all thirteen respondents that formed the population of the study. The graph indicates that the majority of the respondents are above the age of 26 and fall between the age group of 26 to 35 years old followed thereafter by the age group of 36 to 45 years old.

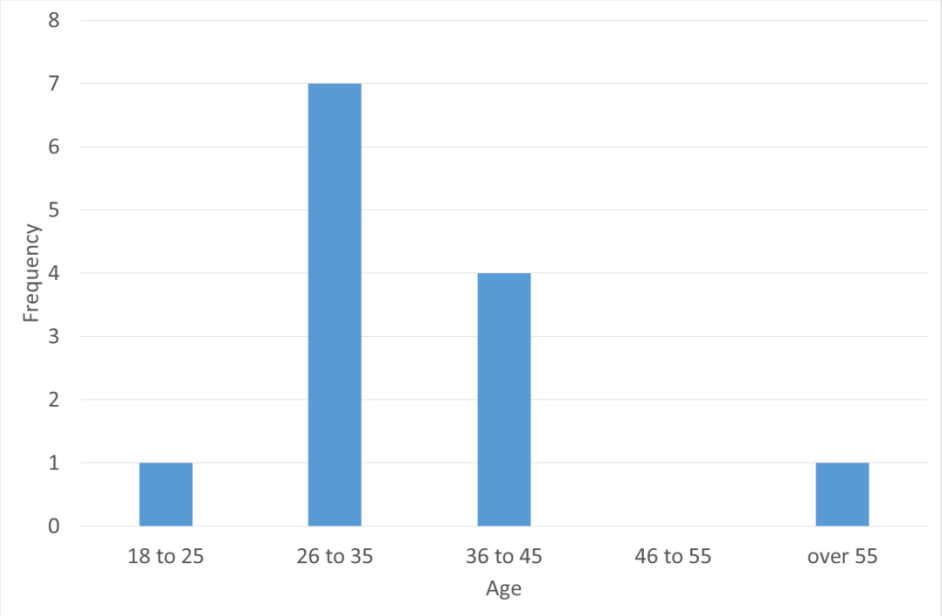


Figure 4.1: Age Groups

Figure 4.2 depicts the highest level of education that the respondents have attained. Predominantly a Bachelor of Science accounted for 38% followed by a National Diploma at 31%. The highest attained qualification was a Master of Science (15%) followed by the minority of a Bachelor of Technology and a senior certificate with 8% each.

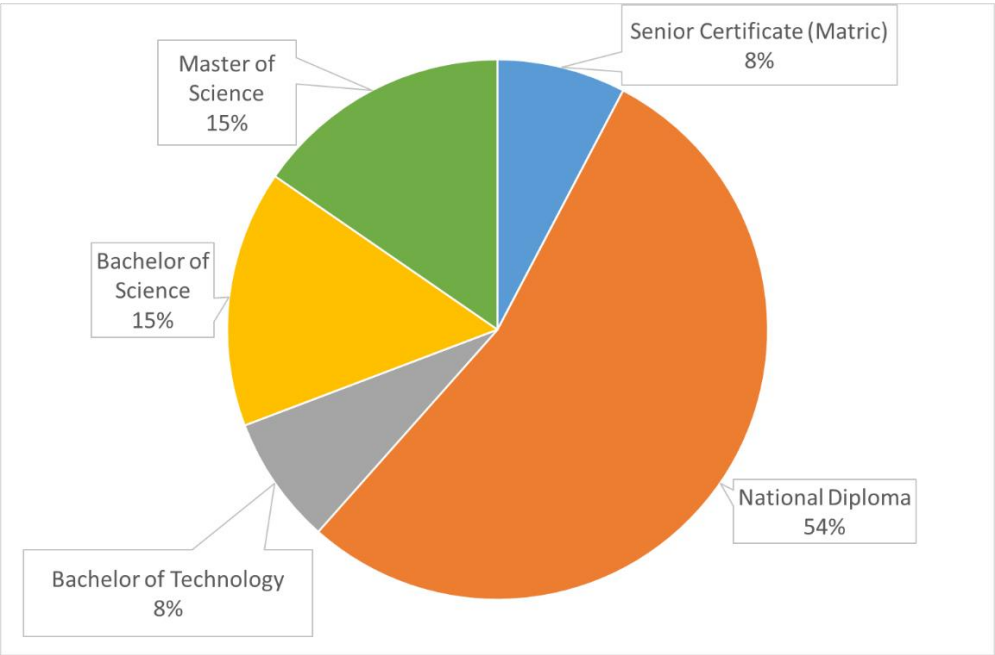


Figure 4.2: Highest Qualification Attained

With respect to the participants' job titles Figure 4.3 indicates that the majority of these officials are Technicians/Technologists (54%), followed by Managers, a single Project Engineer and Superintendent. These trends are worrying cause for concern as the heads of NRW units have Technicians and Technologists and none of these individuals are professionally registered with the Engineering Council of South Africa (ECSA). The most worrying issue is that one of the DM's has a superintendent who is charged with NRW initiatives while the superintendent's highest qualification is a National Senior Certificate pass.

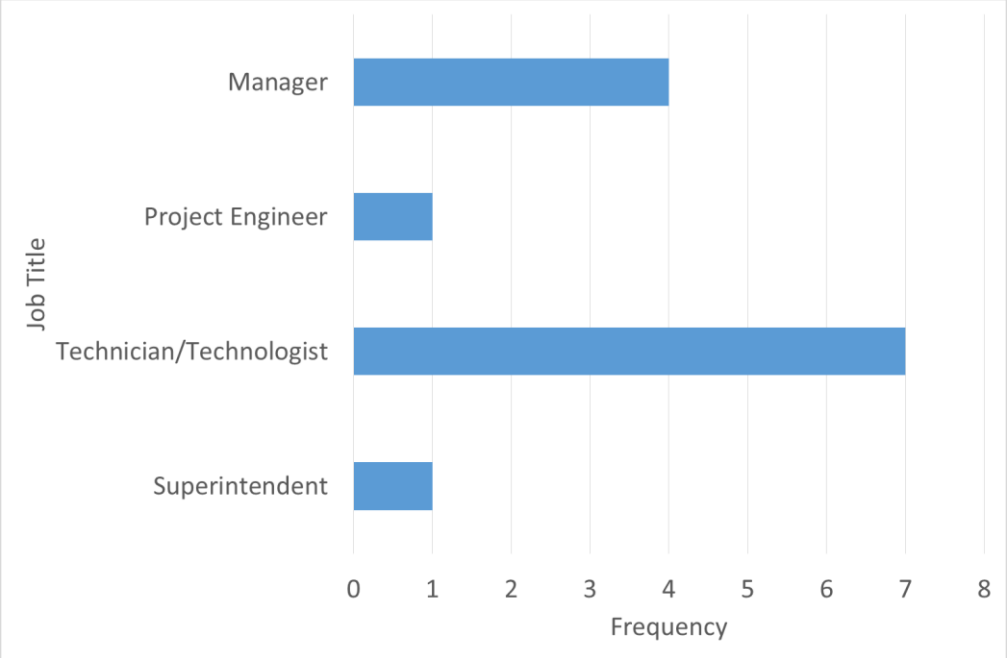


Figure 4.3: Current Positions of Employment held by Participants

The last question in the questionnaire on demographics attempted to separate the Metro Municipality from the smaller DMs. Ajam (2014) stated that there are significant differences in terms of the funding received by Metros in SA when compared to the neighbouring DMs. In SA there are three categories of Municipalities viz. A represents Metros, B represents DMs and C represents Local Municipalities (LMs). In a majority of cases all LMs will fall under the custodianship of their respective DM. Figure 4.4 indicates that of the 13 participants, there is only one Metro and 12 DMs and no LMs that completed the questionnaires. This will have an impact on the inferential statistics contained further on in this chapter.

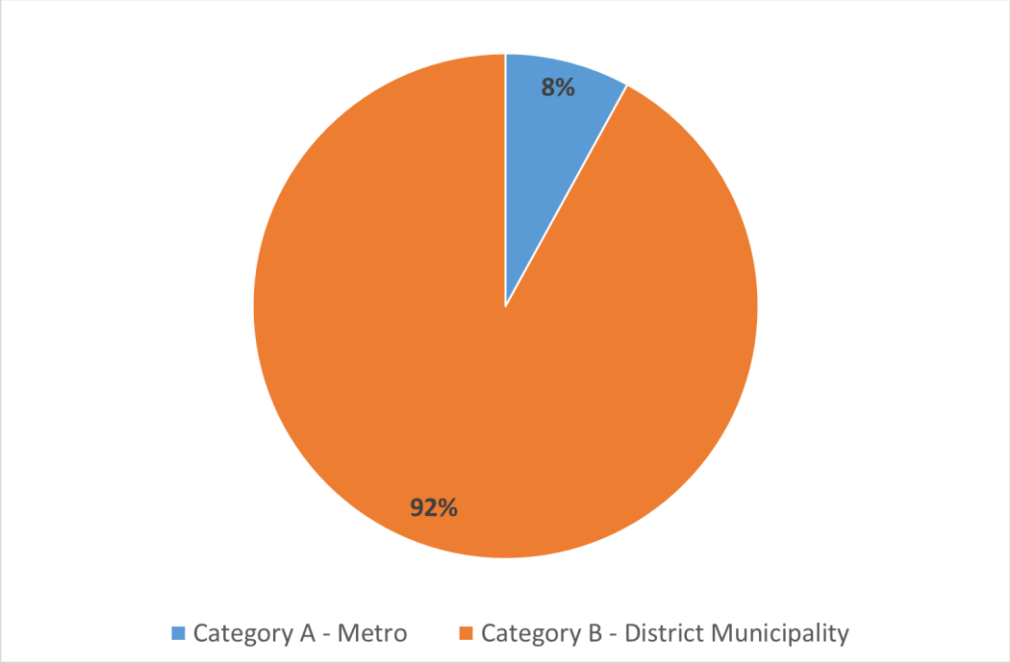


Figure 4.4: Various Categories of Municipalities within KZN

4.4.2 Research Construct 1 – True Vacancy Rates

Five questions were put to all the participants regarding the true vacancy rates for NRW units within all DMs. The first of these questions was to ascertain if participating Municipalities had a NRW unit. Figure 4.5 indicates that only 39% of Municipalities in the Province have a NRW unit.

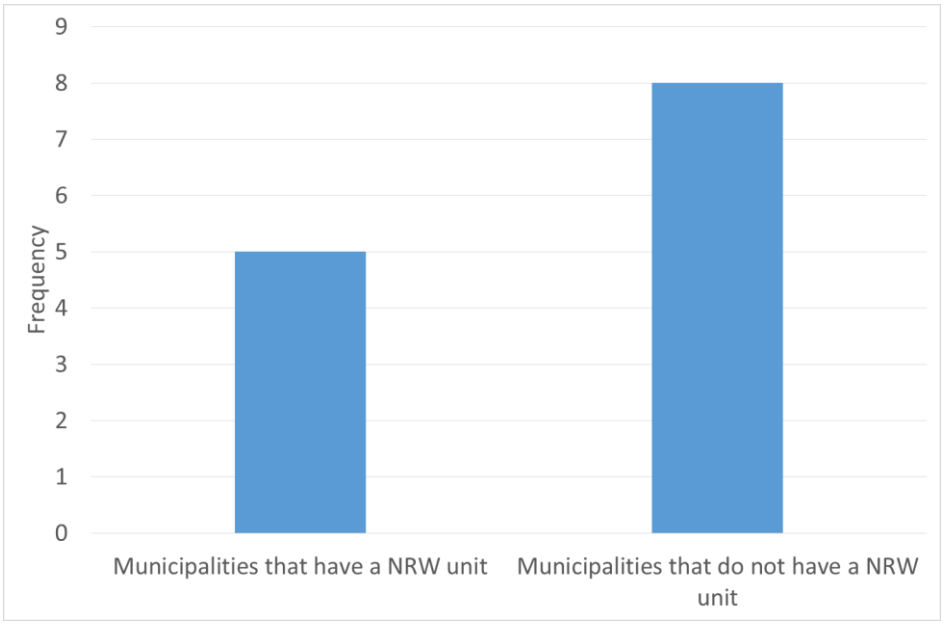


Figure 4.5: Municipalities that do or do not have NRW units

In analysing the data further, it seems that some of the respondents did not answer this question correctly. Four of the DMs indicated that they did not have NRW units, but for the following four questions these same respondents indicated how many employees fulfilled positions within a NRW unit. The researcher's only alternative was to correct these four anomalies and change Figure 4.5 results to correspond with the correct situation. In doing so Figure 4.6 indicates the correct data and indicates that 69% of Municipalities have a NRW unit and 31% do not.

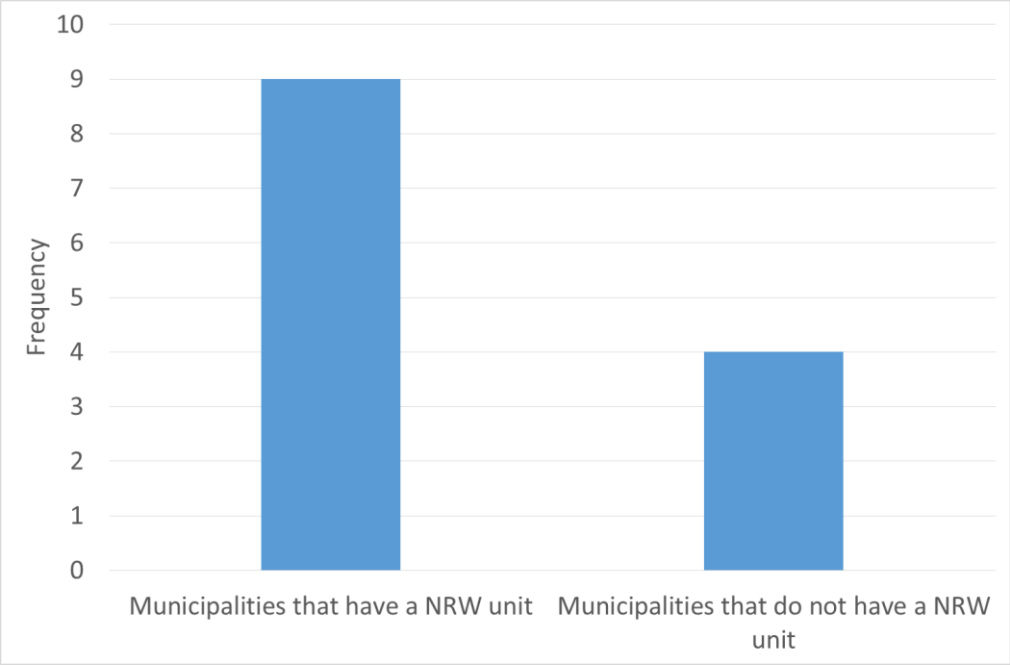


Figure 4.6: Corrected data on Municipalities with and without a NRW Unit

Table 4.4 summarises all the data collected from all the Municipalities in terms of how many positions are available on their organograms, as well as the number of filled positions, vacant but funded positions and, lastly, unbudgeted positions. As can be observed there are a total of 114 posts for NRW units in KZN but a mere 42% of these are currently filled. A further 23% have not being filled but funding is available and lastly 35% of posts have been frozen meaning that no-one can be employed to fill those particular posts as there is no funding available for these posts in various Municipalities.

Table 4.4: True Vacancy Rates for KZN Municipalities

Municipality	NRW Unit Present	Total Positions	Filled Positions	Vacant Positions	Unbudgeted Positions
DM 1	Yes*	12	0	6	6
DM 2	Yes	33*	19	7	7
DM 3	Yes*	4	1	0	3
DM 4	No	0	0	0	0
M 1	Yes	30	20	5	5
DM 5	Yes*	2	2	0	0
DM 6	Yes	blank	blank	blank	blank
DM 7	No	blank	blank	blank	blank
DM 8	No	0	0	0	0
DM 9	No	0	0	0	0
DM 10	Yes	13	3	2	8
DM 11	Yes	17	2	5	10
DM 12	Yes*	3	1	1	1
Totals		**114**	**48**	**26**	**40**

*Responses that have been corrected

4.4.3 Research Construct 2 – Reasons for Vacancy Rates

To determine the possible reasons for the high proportion of vacancy rates all the participants had to choose as many, or as few, reasons they believed to be the root cause/s behind these rates. The questionnaire offered respondents five predetermined reasons to select from, while space was provided where they could add any other significant reasons they were aware of. The five predetermined reasons provided were:

- Reason 1 - Skills shortage in the industry with regard to this specialty to fill these positions
- Reason 2 - Municipality does not understand the importance of this unit's function
- Reason 3 - Municipality does not have sufficient budget to fill this unit's vacant posts
- Reason 4 - Municipality has other budget priorities to deal with like backlogs etc.

- Reason 5 - Not sure

No participant chose to give any other reasons for the vacancy rates which indicated they felt that the reasons above were the only causes for the vacancy rates. The approach that was used in Table 4.5 was that a total of 26 choices were made and a weighted average showed that the majority (or 34.6%) of the participants felt that their Municipality did not have sufficient budget to fill vacant posts. Just over quarter, or 26.9%, believed that their Municipality's senior management does not understand the importance of NRW whilst 23.1% felt that their Municipalities had other priorities to deal with. Only 11.5% thought there was a skills shortage in the industry whilst 3.8% was not sure for the reason.

Table 4.5: Participants' Reasons for Vacancy Rates

Municipality	Reason 1	Reason 2	Reason 3	Reason 4	Reason 5
DM 1			✓		
DM 2			✓		
DM 3	✓		✓	✓	
DM 4		✓	✓		
M 1			✓	✓	
DM 5		✓			
DM 6					✓
DM 7		✓		✓	
DM 8		✓	✓	✓	
DM 9	✓	✓		✓	
DM 10		✓	✓		
DM 11			✓		
DM 12	✓	✓	✓	✓	
Totals	3	7	9	6	1

4.4.4 Research Construct 3 – Municipal Officials' Knowledge and Experience

For this section of the survey five questions about NRW general knowledge was included and for each of the questions only a single answer from five multiple choice questions was correct. The percentage of correct answers on the five topics can be found in Figure 4.7. In relation to the questions pertaining to pressure management, apparent losses and NRW the correct responses were 69%, 31% and 62% respectively. Whilst the final two questions on real losses and water balances respectively saw 46% and 92% of correct answers. When all

correct answers were examined collectively the percentage was 55% which is a concern as this is not an impressive percentage.

Only the fifth question regarding the water balance had an overwhelming majority of correct answers followed by the first question of pressure management. In the other three questions the percentage of correct answers amongst all the participants sat at less than 50%.

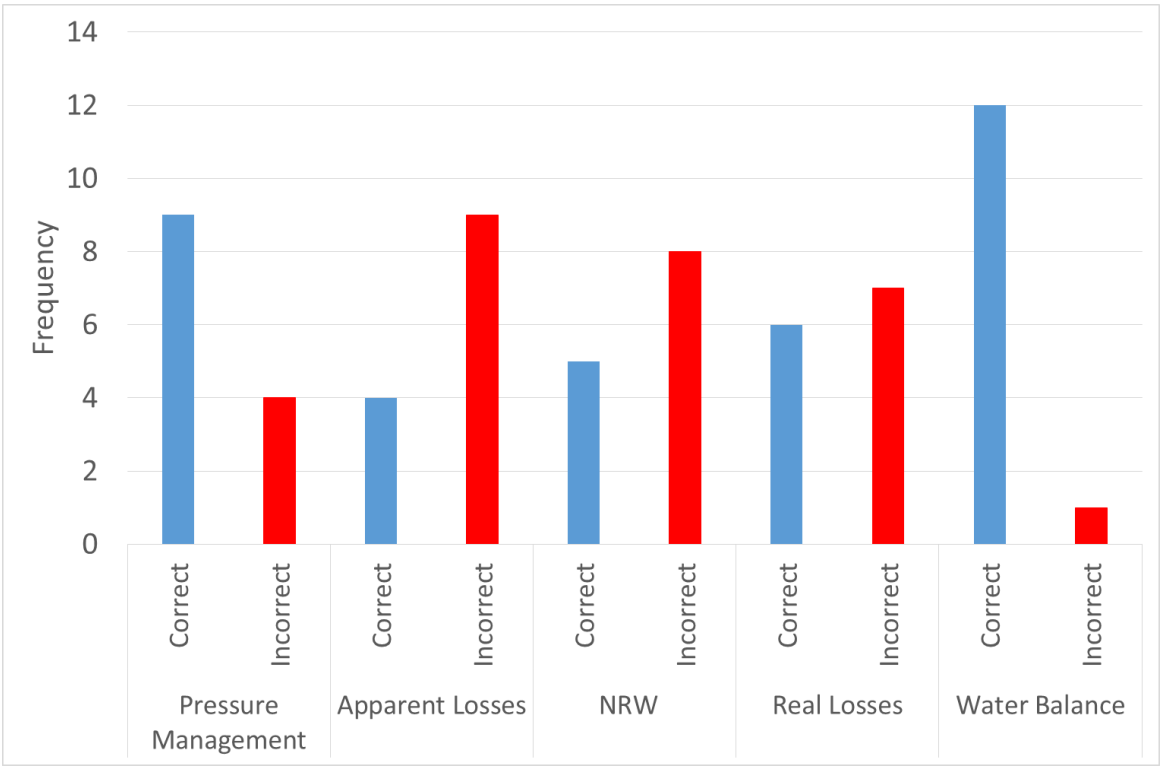


Figure 4.7: Results of Municipal Officials' Knowledge of NRW

Table 4.6 represents the frequency distribution with regard to the NRW knowledge of the Municipal officials. Just under 70% of the respondents scored 60% or less when their understanding of NRW concepts and initiatives was measured. The minority of four of the 13 participants scored 80% or more in correct answers.

Table 4.6: Frequency Distribution on NRW Knowledge

Overall Score	Frequency	Percent	Cumulative Percent
0%	0	0,0%	0,0%
20%	3	23,1%	23,1%
40%	3	23,1%	46,2%
60%	3	23,1%	69,2%
80%	2	15,4%	84,6%
100%	2	15,4%	100,0%
Total	**13**	**100%**	

4.4.5 Research Construct 4 – Shared Savings Contracts

For this particular section of the survey a Likert scale was utilised in trying to assess/measure the Municipal officials' degree of intensity when it comes to beliefs, perceptions or attitudes towards shared savings contracts. Figure 4.8 indicated the following findings:

- Overwhelmingly 85% of the participants agreed or strongly agreed that shared savings contracts in fact could help reduce NRW for Municipalities as well as help reduce the number of unfunded vacant posts in their respective organograms and are of the opinion that the private sector can help with this dilemma whilst the rest were neutral on this issue;

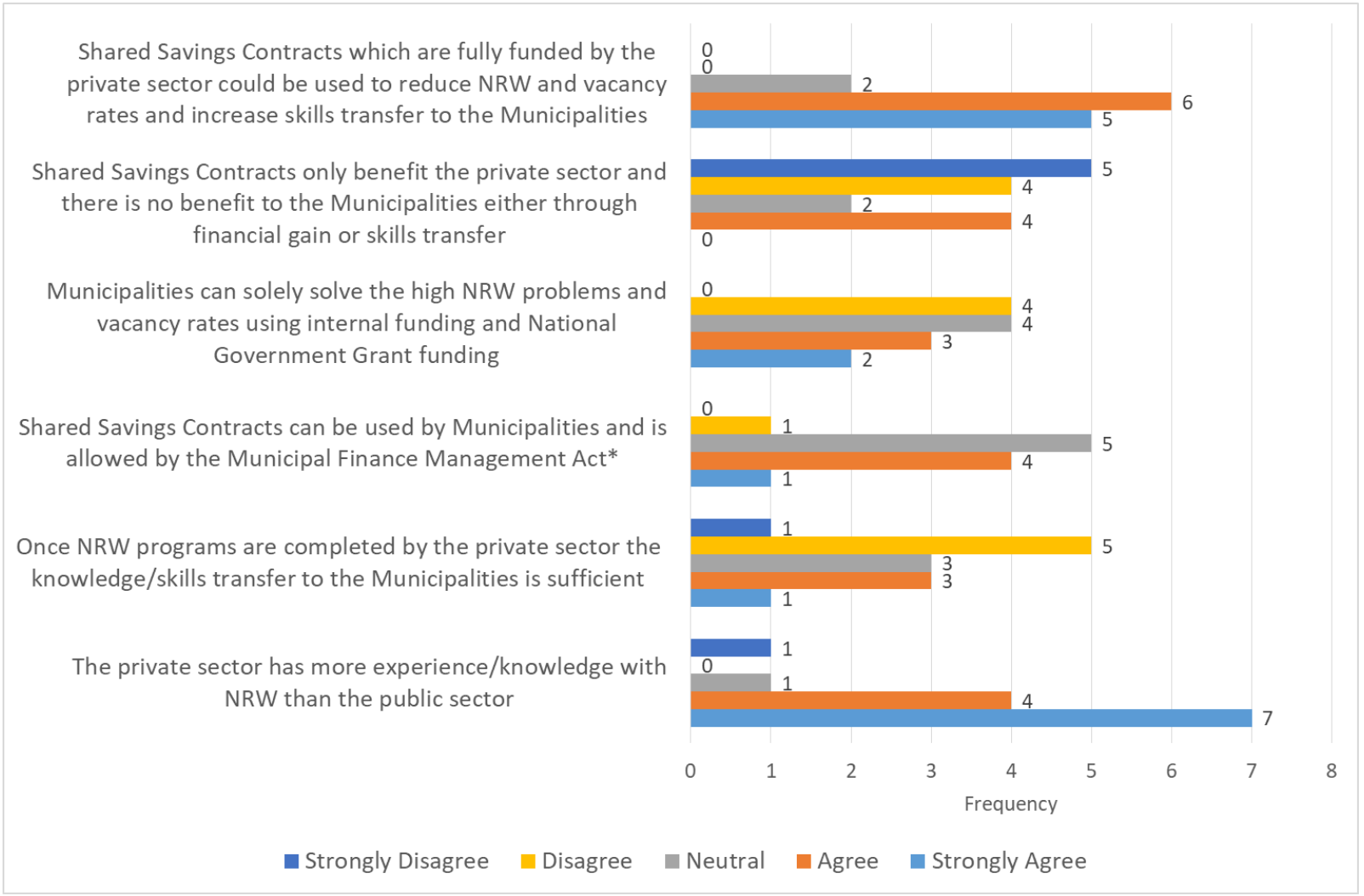
- Contrary to the above bullet point 46% of respondents believed that shared savings contracts does not have a positive impact in terms of financial gain or skills transfer to Municipalities. However, 23% were neutral on this issue and just under one third agreed that shared savings contracts do have a positive effect on a Municipality's financial gain and skills transfer;

- In terms of whether the Municipalities can solve their NRW and vacancy rate problems by only using internally-generated funding or National Government grant funding it was found that 38% agreed that they could, whilst 31% were neutral and the final 31% disagreed which indicated a fairly evenly distributed opinion. This would be contrary to their opinions in Table 4.2 where 69% believed that vacancy rates were high due to insufficient budgets;

- Two of the thirteen participants left their selection blank for this particular question, thereby not sharing their opinions on the matter. Excluding the two blanks into consideration the remaining 46% agreed that the Municipal Finance Management Act allowed for shared savings contracts, 46% were neutral on this issue whilst 9% disagreed. At this stage it was decided that the two blanks would be converted into a neutral stance as not answering the question in essence would logically translate into a neutral stance. Taking this into consideration then would indicate that only 38% agreed, 54% were neutral and 8% disagreed;

- The majority (or 46%) do not believe that skills transfer from private sector to their public sector colleagues is sufficient, 23% are neutral on this issue whilst 31% believe that it is sufficient. Comparing this with the knowledge assessment of these officials a worrying trend emerges in that 31% of respondents believe that knowledge transfer is sufficient, however the average correct answers came in at 55%; and

- The majority feel that the private sector has more knowledge/experience than the public sector whilst 8% were neutral and 8% strongly disagreed with this sentiment.



*Two participants left their selections blank and it was assumed their stance was neutral

Figure 4.8: Participants' Perceptions towards Shared Savings Contracts

Table 4.7 below indicates the frequency distribution for Construct 4: Shared Saving contracts. The cut off value of 17 and below being returned by the respondents as a valid percentage courtesy of approximately 77% agreeing that shared water savings contracts could be utilised in reducing NRW for Municipalities. There were six in this construct where 1 and 2 on the Likert scale represented "strongly agree" and "agree". Thus an overall score of 17 and below indicated that respondents were positive about the use of shared saving contracts as an alternate supply chain management route.

Table 4.7: Frequency Distribution for Shared Saving Contracts

Overall Score	Frequency	Percentage	Cumulative Percentage
11	1	7,7%	7,7%
13	1	7,7%	15,4%
14	4	30,8%	46,2%
16	2	15,4%	61,5%
17	2	15,4%	76,9%
18	1	7,7%	84,6%
19	2	15,4%	100,0%
Total	**13**	**100%**	

4.5 Inferential Statistics

Gravetter and Wallnau (2016) stated that with inferential statistics one would be testing a hypothesis and then one would draw conclusions about a population which is based on a sample.

4.5.1 Chi-Squared Test

The chi-square test are some of the most basic inferential statistics tests and are used to determine if two categorical variables are related or not (Ferguson, 2017). McHugh (2013) stated that the calculations required to compute the Chi-square provides enough data about how each of the groups executed in the study. Employing the chi-square test allows the researcher a richness of detail in trying to understand the results and inadvertently assists the study to assimilate more information from this statistic than from other tests (Ferguson, 2017).

Because of how it is calculated precaution must also be taken as the chi-square value is very sensitive to the sample size being either too small or to large (Sharpe, 2015). A *p*-value which is 0.05 or less indicates that a researcher can be 95% confident that there is a relationship between two variables that have been tested (McHugh, 2013).

4.5.2 Research Construct 2 – Reasons for Vacancy Rates

A cross tabulation was conducted to determine if there was a relationship between the respondents' positions in the Municipalities and the reason/s they gave (if any) for the vacancy rates at their NRW units. Table 4.8 illustrates the respondents' views on the reasons for vacancy.

Table 4.8: Cross tabulation between positions held and their views on vacancy

	Superintendent	**Candidate Technician**	**Technician**	**Technologist**	**Project Engineer**	**Manager**	**Total**
Skills shortage in the industry	0.0%	3.9%	3.9%	0.0%	0.0%	3.9%	**11.5%**
Importance of NRW to superiors	3.9%	3.9%	15.4%	0.0%	0.0%	3.9%	**26.9%**
Insufficient budget	0.0%	0.0%	15.4%	3.9%	3.9%	11.5%	**34.6%**
Other budget priorities	3.9%	3.9%	3.9%	0.0%	3.9%	7.7%	**23.1%**
Not sure	0.0%	0.0%	0.0%	0.0%	0.0%	3.9%	**3.9%**
Total	**7.7%**	**11.5%**	**38.5%**	**3.9%**	**7.7%**	**30.8%**	**100%**
	n = 26		**Chi-Square = 24.950**			***p* = 0.465**	

In Table 4.8, the *p* value is 0.465 which indicates that the findings are not significant and are due to chance. Since the probability is more than 0.05, we cannot be certain that there is a significant relationship between the respondents' views on the reasons for vacancy in their organisations and their positions held within the Municipality. Even though statistically these two variables are not related some analysis of the results can still be made. Logically, one would assume that the higher position one held the more experienced and knowledgeable the person would be and thus the more insightful their take on the reason/s for vacancies would be, however one of the Managers indicated that they were not sure.

The majority of the respondents (38.5%) are in a Technician post which is a middle management post, and they felt equally that both insufficient budget as well as a lack of understanding when it comes to the importance of the NRW programmes on the part of their superiors were the main reasons behind vacancy rates. However, the Managers (which would be considered a top management position) felt strongly that insufficient budget and other budget priorities were the leading causes of vacancy rates. Besides the one Manager not being sure of the reasons a smaller minority felt that skills shortage was a relatively insignificant reason for vacancy rates. These findings reveal that insufficient budget, superiors not understanding the importance of NRW programmes and other budget priorities accounted for 84.6% of the reasons given for vacancy rates.

4.5.3 Research Construct 3 – Municipal Officials' Knowledge and Experience

A cross tabulation was conducted to determine if there was a relationship between the respondents' positions in the Municipalities and their knowledge of NRW principles. Table 4.9 illustrates the respondents' knowledge on NRW principles. A pass mark of 50% was allocated as the threshold and for any mark higher than 50% the respondent was considered to have a good knowledge of NRW principles versus a scores of less than 50% where they were considered to have a poor knowledge.

Table 4.9: Cross tabulation between positions held and their knowledge on NRW principles

	Poor Knowledge	**Good Knowledge**	**Total**
Superintendent	0,0%	7,7%	**7,7%**
Candidate Technician	7,7%	0,0%	**7,7%**
Technician	15,4%	23,1%	**38,5%**
Technologist	7,7%	0,0%	**7,7%**
Project Engineer	0,0%	7,7%	**7,7%**
Manager	15,4%	15,4%	**30,8%**
Total	**46,2%**	**53,9%**	**100,1%**
	n = 13	**Chi-Square = 4,148**	***p* = 0,528**

In Table 4.9, the *p* value is 0.528 which indicates that the findings are not significant and are due to chance. Since the probability is more than 0.05, we are certain that there is no significant relationship between the respondents' knowledge on NRW principles and their

positions held within the Municipality. Even though statistically these two variables are not related some analysis of the results can still be made.

Due to the relative small number of population and sample size the results came in at just over half of respondents having a good knowledge on NRW principles. The job designations are quite wide in terms of distribution and one would have assumed that Technologists, Project Engineers and Managers with adequate experience would have a good knowledge however this is also evenly spread with a poor knowledge. Surprisingly, the Superintendent achieved a mark of 100% on the five questions which was the main cause of the two variables not having a significant relationship. The findings in this construct ask more questions about the skills levels of the personnel occupying the heads of the NRW units in KZN as the same respondents only rated a skills shortage in the industry of just above 11% in the previous construct.

4.5.4 Research Construct 4 – Shared Savings Contracts

A cross tabulation was conducted to determine if there was a relationship between the respondents' level in the organisation and their degree of beliefs that SWSCs could help remedy the issue of vacancy rates, insufficient funding and knowledge as well as skills transfer of NRW principles and practises. The respondents strongly perceived that SWSCs would be a viable solution and this cross tabulation will identify which respondents occupying various positions felt this way. The results are illustrated in Table 4.10.

Table 4.10: Cross tabulation between positions held and their degree of beliefs on SWSCs

	Agree	Neutral	Disagree	Total
Superintendent	0,0%	7,7%	0,0%	**7,7%**
Candidate Technician	7,7%	0,0%	0,0%	**7,7%**
Technician	30,8%	0,0%	7,7%	**38,5%**
Technologist	7,7%	0,0%	0,0%	**7,7%**
Project Engineer	0,0%	0,0%	7,7%	**7,7%**
Manager	30,8%	0,0%	0,0%	**30,8%**
Total	**77,0%**	**7,7%**	**15,4%**	**100,1%**
	n = 13	**Chi-Square = 19,760**		***p* = 0,032**

In Table 4.10, the *p* value is 0.03 which indicates that the findings are significant and are not due to chance. Since the probability is less than 0.05, one can be 95% certain that there is a significant relationship between the respondents' level in the organisation and whether they believe that SWSCs could help remedy the issue of vacancy rates, insufficient funding and knowledge as well as skills transfer of NRW principles and practises. Almost all levels of position felt that SWSCs could be the answer to the three problems previously identified. The exceptions were the respondents that held Technician and Project Engineer posts and the accounted for 15.4% whilst the Superintendent who accounted for 7.7% was neutral in his stance. This finding reveals that respondents in the majority (77%) agree that SWSCs can solve these three issues mentioned previously and that they are at various levels in terms of positions within their respective Municipalities.

4.6 Summary

In the research results and findings, some relationships were made between the results and relevant existing literature whilst others did not indicate any relationship. The study also portrayed two significant findings and gave some insight into what influenced these findings.

It was revealed that 58% of all posts available in NRW units in KZN are either not filled or unbudgeted which is much higher than what is reported in the literature. Overwhelmingly, just under 85% believed that the three main causes for these high vacancy rates are due to insufficient budgets, superiors not understanding the importance of NRW programmes and other budget priorities that take precedence over allocating budgets for the NRW posts. Just below half of the respondents have a poor knowledge of NRW principles and practises which has been corroborated through previous research. Finally just more than three quarters of respondents do believe that SWSCs could solve all three of these issues.

The discussions, conclusions and recommendations of this study are presented in Chapter 5. The implications of the research findings will also be presented. Lastly, Chapter 5 will indicate the limitations encountered in this study and suggest recommendations for further research.

CHAPTER FIVE

Discussions, Conclusions and Recommendations

5.1 Introduction

To reiterate the issue, high NRW within KZN Municipalities exists and it is the worst in the country. The three main reasons for this situation, that this study has postulated, are due to high vacancy rates within NRW units, inadequate budgets and a lack of knowledge and experience with respect to NRW principles on the part of the Municipal officials. Furthermore, a solution was sought to remedy this situation in the form of shared savings contracts where funding from the private sector would be able to possibly solve these three problems simultaneously. Data from all the senior stakeholders from the 13 DMs in KZN was collected, presented and analysed in the preceding chapter. In certain instances it needed to be corrected which was also stipulated in the chapter. This final chapter will round of this study by discussing the analysed data, concluding on aspects of the study and putting forward meaningful recommendations to the relevant stakeholders to help solve the research problems. Lastly, the implications and limitations of this study as well as recommendations for future studies will also be presented.

5.1.1 Demographic Data

Only four categories of demographics were considered in relation to the respondents of the study viz. age, educational level, current position within the Municipality and salary grading. The other demographics that are usually included in these studies such as sex and race were excluded. These exclusions were done after the pre-testing phase as the participants during that phase of the study felt it would have no bearing on the research objectives should these two categories be included and hence they were left out.

In terms of age the highest ranking NRW stakeholders for NRW within the 13 DMs were between 26 and 35 years old or represented 54% of the population which indicated that the majority are considered young for positions of this nature. 8% was below 25 years old which is strange as this position generally would be earmarked for older candidates due to them requiring the requisite experience. A further 8% was above 55 years in age. The remaining

31% were between 36 and 45 years old. In relation to the educational levels of the participants the majority (or 54%) had a National Diploma whilst two participants (or 15%) had bachelor's degrees and another two (or 15%) had their master's degrees. 8% had a Bachelor of Technology degree and the last participant (or 8%) only had a senior certificate. This last participant's lack of tertiary education is worrisome as positions of this nature require tertiary education as grounding as staff members are required to deal with civil engineering principles in order to effectively run a NRW unit.

With respect to positions held within their respective DMs the majority (or 54%) held Technician posts followed by 31% that held Management positions. The last two participants were a Project Engineer and a Superintendent. In summary, the majority of the stakeholders that ran NRW units were between 26 and 35 years old, held National Diplomas from tertiary institutions and held Technician posts.

The last demographic category was salary grading. This was left out of the analysis of the data as the salary grading of the various DMs were significantly different in that certain DMs had a Grade Level from 1 to 25 whilst others had various other alpha numeric scales that did not allow the data to be comparable and as such were excluded from the study. This problem did not feature at pre-testing as the four DMs in the Western Cape province that were tested had a uniform salary scaling which was not the case in KZN.

5.2 Research Constructs

Before discussing the four constructs the following situation needs to be reiterated to ensure this study's context is relevant and that what is being researched and the recommendations put forward are relevant and required. Farley and Trow (2003) stated that many water utilities (Municipalities in the South African context) cannot grasp the benefits as well as necessity of dealing with NRW reduction in water networks. This statement can be justified in the South African context as NRW in SA on average was 36.8% or R5.4billion/annum as attested to by McKenzie et al. (2012). In a more recent report by DWS in 2018 NRW ballooned to 41% or R9.9billion/annum that is being lost in the country's water networks.

Further to this it was estimated that the National Fiscus would require R330billion over the next decade to arrest the current status quo (DWS, 2018). This situation is untenable and is

especially true in the KZN province as it is the worst performing with an average NRW of 43.5% (DWS, 2018). The findings from Chapter 2 indicate that vacancy rates (StatsSA, 2017) and lack of knowledge in relation to NRW principles from the public sector as attested to by McKenzie et al. (2012), Wegelin and Jacobs (2013) and Wegelin (2015) were the main reasons for this situation. Lastly, to possibly combat this situation SWSC were mentioned as a solution to NRW. Shared savings contracts have proven to be successful in the field of losses which was experienced in the electrical field of supply when there is a lack of funding from grant funding (Selviaridis and Wynstra, 2015).

5.2.1 Objective 1

To identify the true vacancy rates for NRW units within Municipalities.

5.2.1.1 Discussion of Objective 1

The main aim for this objective was to evaluate what the true vacancy rates were at all of KZN's DMs. The National Treasury in 2008 published a report stating that vacant local government positions in KZN during 2006 was sitting at 39%. This needs to be placed into context as this would include all local government departments and not exclusively the water sector. In 2017, a press statement was released by Statistics SA which reported on findings from 2016 and stated that vacant posts which were funded in KZN was at 17.8% which was still higher than the National average of 14.4%. However, with respect to the water sector of KZN there was a 13.6% vacancy rate for funded positions.

At this juncture it should be noted that all the statistics that have been published and presented above are related to vacancy rates for positions that are funded and do not include positions that exist in Municipalities' organograms which are either unfunded or frozen due to a lack of budget. The clear difference between the vacant posts that are funded or unfunded/frozen was discussed using the example of the City of uMhlathuze's organogram where, using the premise used by National Treasury and Statistics SA, their vacancy rate would be reported as 40% (only measuring vacant, funded positions) but when actually taking into account unfunded/frozen positions the true vacancy rate was actually 85%.

The data collected from the respondents and subsequently analysed indicated that of the 13 DMs there were only five NRW units in existence and nine did not have a NRW unit. However, it was revealed in the subsequent questions that four of those DMs that indicated they did not have a NRW unit had an organogram with filled and vacant positions which was contrary to their submissions. This indicated that there were actually nine DMs that had NRW units and four that did not which meant that these four DMs have a vacancy rate of 100%.

From the nine DMs there were 48 filled positions, 26 vacant positions and 40 unfunded/frozen positions. If one reported as per National Treasury and Statistics SA then accordingly the vacancy rate would be 35.1% (26 divided by 74). However, if one attempted to calculate the true vacancy rate this would be 57.9% (66 divided by 114). Both these vacancy rates are significantly higher and in contrast to what has been detailed in the various published reports mentioned previously. However, when comparing the data analysed (which was exclusive to NRW units) versus the published reports it cannot be correlated as the published data presented are for entire water units within DMs and not just applicable to a sub-unit of the water unit. Nevertheless, it still does give insight and confirmation that vacancy rates and/or true vacancy rates are much higher for NRW units within the nine DMs.

5.2.1.2 Conclusions related to Objective 1

The findings show that there is a marked difference when it comes to how the public sector reports on vacancy rates versus the data analysed which shows much higher levels of vacant positions within NRW units. On the other hand, this needs to be interrogated further as it seems a true account of the vacancy rates should have been sought through the DM's Human Resources (HR) unit rather than from the Technical officials. Inferences can still be made and having such high vacancy levels in any unit will no doubt lead to poor performance in attempting to reduce the current levels of NRW as well as resulting in poor staff morale due to them being overworked. It is the author's opinion that the true vacancy rate should always be reported rather than what has been published as this will give all stakeholders a realistic account of what is actually transpiring and the challenges that are experienced by these Municipal officials.

5.2.1.3 Recommendations related to Objective 1

Based on the discussion and conclusions the following recommendations on the true vacancy rates of NRW units can be made:

- Get the official organograms from the DM's Human Resources unit versus from the Technical officials as this would reduce possible errors that were experienced in the data collection of this study;

- Definitions for total positions, filled positions, funded and vacant positions as well as unfunded and vacant/frozen positions must all be available to respondents; and

- Confirmation needs to be sought with regard to filled positions as some Municipalities have a post that is filled by a certain individual while that same person is "acting" in another position which could lead to statistical errors.

5.2.2 Objective 2

To understand the reasons for the low vacancy rates with regard to NRW units within Municipalities.

5.2.2.1 Discussion of Objective 2

From the findings of Objective 1 it is clear that the vacancy rates and the true vacancy rates for the 13 DMs are significantly higher than what has previously been published, hence the purpose of Objective 2 which was to try and understand the reasons for these unusually high rates. Additionally, it was also found in the previous construct that four of the 13 DMs did not have NRW units hence this research objective will hopefully shed some light on the reasons for this situation.

Kingdom et al. (2006) stated that NRW reduction is not taught at tertiary institutions of any kind throughout the world including SA and as a result staff with the requisite skills and experience are not available. According to Wegelin (2015) the staff vacancy rate was

approximately 25% and he also attributed that partly to the lack of skilled candidates available to occupy posts within NRW units.

The question that was put to all the respondents had five pre-determined answers as well as an option for any other reasons to be filled in. With respect to the five pre-determined reasons for the high vacancy rates the respondents could choose as few or as many of the options as they wanted. Not one of the respondents filled in any other reasons to explain the vacancy rate which indicated that they believed only the five pre-determined reasons to be the cause/s for this situation. The 13 participants selected 26 options and accordingly the weighting of the reasons are as follows:

- 11.5% felt that skills shortage in the industry was the cause;
- 26.4% felt that their respective Municipality did not understand the importance of the NRW unit's function;
- 34.6% felt that the Municipality did not have sufficient budget to fill this unit's vacant posts;
- 23.1% felt that the Municipality had other budget priorities to deal with like backlogs etc.; and
- 3.8% were not sure of the reason/s.

The majority felt that the lack of budget and funding was the main reason for the high vacancy rates. This would support the reason for the final construct of this study being included as it postulates that, due to the lack of budget and funding from National Government, the private sector can assist with employing SWSCs to remedy this constraint. This possible solution will be discussed further under Objective 4. The second reason was that their senior management did not understand the importance of reducing NRW. This reason was never illustrated in the literature review nor mentioned previously in any of the studies that have been researched and should be included in further studies. This reason could possibly have been so prevalent be due to demographic data which showed that the

majority of the respondents were young and at a Technician level and have not reached a point in their professional career where they have the ability to change their superiors' opinions.

Followed closely behind was the third reason which was that Municipalities had other budget priorities. This is counter intuitive as the purpose of NRW reduction programmes is to increase revenue and decrease water losses for a Municipality. This enables the Municipality to become more financially and operationally efficient and thus to have more budget available to actually deal with their "other" budget priorities. It would seem likely that more education and training on the pros of NRW reduction needs to take place at senior levels within Municipalities. Surprisingly, approximately 13% believed that skills shortage of adequate NRW practitioners was not a major issue. This is contrary to what had been published internationally by Kingdom et al. (2006) as well as locally by Wegelin (2015). This could possibly mean that these respondents from NRW units are not familiar with the industry requirements for NRW reduction as mentioned by Kingdom et al. (2006). This anomaly from the respondents' data and published research should be a future research topic to help understand this phenomenon. Additionally, a possible solution would be to rather employ a Likert scale to report on the five reasons, or even asking future respondents to rank those four options in terms of importance which would possibly be helpful in aligning what is felt and experienced in the industry versus published papers.

5.2.2.2 Conclusions Related to Objective 2

The findings show that the respondents believe that the major reason for the current vacancy rates are due to lack of funding and/or budget provided. The lack of funding will be addressed using the SWSCs that will be discussed under the last objective of this study which will help solve the vacancy rate. The next reason was that they believed their superiors did not understand the advantages of running NRW reduction programmes. The only way to combat this would be for the DWS to run training and education programmes to all WSAs throughout SA and reiterate that NRW reduction strategies and programmes have been proven to be one of the best solutions to creating operational and financial efficiencies within water utilities. Lastly, very few believed that skills shortage or a lack of knowledge in the industry played a significant part in vacancy rates. This will require further investigation in

future studies to try and understand this as it is contrary to reports that have been published internationally and locally.

5.2.2.3 Recommendations Related to Objective 2

Based on the discussion and conclusions the following recommendations can be made in relation to the reasons for the true vacancy rates of NRW units:

- A need to investigate the reasons behind the four DMs that have no NRW unit indicating a 100% vacancy rate;

- Change management will be required to be done internally by the respondents to try and convince their superiors that NRW reduction should be a priority; and

- Communication, education and training is desperately required to convince Municipal officials of the positive consequences reducing NRW will bring about in terms of increasing revenue and decreasing water losses, thereby freeing up more of the budget to carry out other budget priorities.

5.2.3 Objective 3

To evaluate the NRW knowledge and expertise of the Municipal officials that currently fill the positions in the KZN NRW Municipal units.

5.2.3.1 Discussion of Objective 3

To ensure that the five questions chosen were fair to all respondents only definitions for NRW principles were chosen. Furthermore this methodology was accepted subsequent to pre-testing respondents who also felt it was the fairest way to evaluate NRW knowledge from their public sector counterparts during their debriefing. These definitions have been universally accepted and used since the mid-nineties and are contained in seminal publications by Lambert (1994), Lambert et al. (1999) and Lambert (2002) and are the foundations for NRW principles. However, Wegelin and Jacobs (2013) noted that there are

various avenues of education from various organisations including books, publications, manuals, conferences etc. that have been made available both for free and at a cost enabling all NRW practitioners to learn more about their field in order for them to understand and implement NRW strategies successfully. Yet SA as a whole, and KZN specifically, have not been successful despite this. (Wegelin, 2015) further stated in a subsequent publication that approximately 45% of all Municipalities could not even calculate their own water balances which is the first step to any NRW reduction strategy which requires Municipalities to measure and understand where the problems are and then to address them systematically.

These published findings come as no surprise in that just under 70% of the respondents scored 60% or less, and just over 46% of these had scores between 20% and 40%. Hence, the previous research on the knowledge of NRW principles concur with the population sample that were tested in this study. There was also no significant relationship statistically between the respondents' positions within their Municipalities and their knowledge base on NRW principles. However, it did illustrate that just under half of the respondents were considered to have a poor working knowledge about NRW and that this was evenly distributed between lower, middle and upper management levels.

5.2.3.2 Conclusions Related to Objective 3

The findings demonstrate that whilst NRW reduction programmes have been run globally as well as locally for the last two decades, that Municipal officials still lack the requisite knowledge as just under half of them have a poor knowledge of the five fundamental principles of NRW. One of the major reasons contributing to this situation could be the lack of skills transfer from the private sector to the public sector, or even the global sector to the SA sector as most conferences for NRW take place overseas and DMs are already constrained with budget issues and therefore cannot send their officials overseas for training. More than a decade ago Kingdom et al. (2006) also stated that NRW was not taught at any tertiary institutions worldwide and it is the same here in SA. The research suggests that this trend is continuing as all graduates still leave tertiary institutions without any knowledge at all about NRW which could be the main reason for the knowledge deficit that currently exists in KZN Municipalities.

5.2.3.3 Recommendations Related to Objective 3

Based on the discussion and conclusions the following recommendations can be made based on the evaluation of the NRW knowledge and expertise of the KZN officials that currently head the KZN NRW Municipal units:

- An investigation into why knowledge and skills transfer is not taking place between the private and public sectors;

- More training and seminars need to be held within SA to capacitate Municipal officials on NRW principles, strategies and implementation; and

- A study will need to be conducted to assess the existing disconnect between the industry and tertiary institutions and confirm the reasons for NRW not being taught as a specialty as part of civil engineering programmes as it has been around for more than two decades.

5.2.4 Objective 4

To ascertain if Municipal officials preferred a funding model where the private sector funds NRW reduction programmes to solve the vacancy rates as well as increase the knowledge and experience of these officials.

5.2.4.1 Discussion of Objective 4

Municipalities' requirements for funding increases year on year and the budget allocation from various grant funds from National Government are decreasing, therefore there is a need to look at alternate funding options (du Plessis, 2017). The need has become so dire that DWS (2018) stated, "R33 billion more is needed each year for the next 10 years to achieve water security". Moreover, du Plessis (2017) further stated that foreign Governments as well as foreign and local NGOs were willing to fund SWSCs in SA but the DMs within SA were still hesitant or unwilling to change their procurement strategy to include SWSCs. To this end there have been no DMs in SA that have published SWSCs to date and the only sector

of Government that has implemented this type of contract has been various National Ministries such as NDPW.

The findings of this study illustrate that just under 85% of the respondents believed that SWSCs can help reduce NRW, reduce the high vacancy rates and also increase skills and knowledge transfer to the public sector. SWSCs are geared up to ensure that the Municipality and private sector enjoy the benefits of the commercial agreement equally but all the risk and funding injection is taken on by the private sector. Taking this into consideration just under half the respondents did not believe that this was the case whilst only under a third of the respondents believed this to be true and the remaining respondents were neutral on this issue which would indicate that the respondents obviously do not fully understand the concepts related to SWSCs which is possibly the reason du Plessis (2017) stated that Municipalities were reluctant to implement these types of contracts.

With respect to Municipalities solving the vacancy problems on their own with no private sector funding the respondents were almost evenly split in terms of agreement and disagreement with this statement whilst just under a third remained neutral. This is surprising as the research from Chapter 2 indicates that the vacancy rates are increasing over time and that the true vacancy rates, which are not being reported, are much higher than the vacancy rates that are reported. Just under 40% of the participants did not have any opinion if SWSC are allowed by the MFMA which indicates once again the lack of knowledge on this contractual and legislative situation. Just under half of the respondents felt that the skills transfer from the private sector to the public sector is insufficient and, contrary to this, just under a third of the respondents felt that it was sufficient. Overwhelmingly, 85% of this study's participants felt that the private sector has more knowledge and experience when it comes to NRW programmes. Lastly, it was found that there is a significant relationship between the respondent's level in the organisation and whether they believe that SWSCs could help remedy the issue of vacancy rates, insufficient funding as well as the knowledge and skills transfer of NRW principles and practises.

All these findings, except one, support the previous research conducted that shows SWSCs could help resolve the high vacancy rates, skills and knowledge transfer and the reduction of NRW to ensure SA and KZN do not have future water scarcity issues. The one finding from the respondents that did not agree with the past research was that the public sector still

believes that they can solve these NRW issues by themselves without the help of the private sector. This definitely seems to be an anomaly in the results and further research would possibly be required to dive deeper into this issue and attempt to understand this anomaly.

5.2.4.2 Conclusions Related to Objective 4

It can be concluded that Municipal officials do believe the SWSCs could be used as an alternate funding model to help reduce the vacancy rates, increase the NRW knowledge and experience of these officials and to have the private sector fund these projects thereby taking the pressure off the national budget. However, to achieve this more education and training on SWSCs still needs to take place in the public sector as the study demonstrates that they are willing to get involved and that they see the positives of this type of alternative funding and contractual model, but to date not a single Municipality in KZN has attempted to pilot it. Their willingness in their responses to implement SWSCs is only countered by the fact that none of the DMs have implemented them. Future research needs to be undertaken as to the reasons why they have not been piloted and then fully implemented to break the impasse of wanting to implement SWSC, but either not being allowed or able to do it.

5.2.4.3 Recommendations Related to Objective 4

Based on the discussion and conclusions the following recommendations on SWSCs being used as an alternate funding model to help reduce high vacancy rates, skills and knowledge transfer and the reduction of NRW in KZN are:

- Each DM running pilot projects on small systems, and not the entire DM, should be carried out by all of the DMs in KZN to help the Municipal officials learn about and, subsequently, start enjoying the benefits of SWSCs;

- For all the DMs' heads of NRW units to meet together, discuss and understand the reasons why they want to use SWSCs but have not done so thus far; and

- Fast tracking the above processes to obtain the private sector funding as soon as possible and arrest the high NRW figures being reported which will have the knock-on effect of delaying possible drought and water scarcity issues going forward.

5.3 Implications of the Study

The identified gap in the literature was that the information that has been presented in relation to vacancy rates is a watered-down percentage and not the true situation that is plaguing DMs, which could possibly be one of the reasons that NRW within DMs are at the high levels that they are. Additionally, the knowledge and skills levels with respect to NRW knowledge needs to be addressed as only approximately 50% of the respondents have a good knowledge on five of the most basic principles of NRW and this cannot be acceptable in any professional environment. Lastly, this study demonstrates that although SWSCs are a possible solution to arrest the current problems discussed and that, although the DMs want to implement them, they are reluctant but the reasons for this reluctance would require further investigation.

These implications will assist the gatekeepers (i.e. UW and DWS) in carrying out education and training programmes to equip the heads of NRW units at DMs as well as pushing them forward to help combat NRW reduction as UW are the majority bulk water supplier of potable water in the KZN province while DWS are the legislative regulator of that water. The more effort that is made in this respect will only assist the province in delaying water scarcity issues and possible future drought scenarios.

5.4 Limitations of the Study

There have been numerous limitations that occurred during the study that restricted various parts of the study and hence influenced the results of the finding and conclusions. The limitations of this research include:

- Ideally, it would have been more beneficial to have the sampling population include all the Municipal officials in KZN that are in those 114 filled NRW positions. Had they all completed the survey this would have helped in that the data could have

given higher correlated, statistical results. Due to the time constraints this was not possible and only heads of the respective NRW units were targeted as respondents;

- The second construct in determining the reasons for the rates of vacancy should have either asked the participants to rank each of the provided reasons, or given them a Likert scale to assess the reasons for the vacancy rates as the respondents were unable to choose their priority reasons for the vacancy rate (as per a ranking scale) or clarify their level of agreement of disagreement to the questionnaire statements. This could have affected the accuracy in arriving at the conclusions; and

- The scope of the study encompassed the KZN province only, but to draw a reasonable conclusion that can be expanded to the rest of country the study required the inclusion of other DMs in the other eight provinces. However, due to time constraints this was not possible hence the conclusions and recommendations made in the study can only hold true for the KZN province.

5.5 Recommendations for Further Research

From the findings and analysis of the data in this study a number of gaps in information and/or data emerged as well as avenues of further research that should be carried out. The specific courses of action for further research is strongly recommended as follows:

- Examining the reasons as to why no tertiary institutions have included NRW into their syllabuses globally, but more specifically in SA, as this country is a water scarce country and over the last decade or so has been prone to droughts. This would capacitate all professional officials as they would have had sound theoretical grounding on NRW principles as they enter the working world;

- There have been no studies done on the reasons as to why knowledge transfer does not take place between the private and public sector with respect to NRW as all books, seminars and conferences on this subject are authored or run by the private sector;

- With the majority of the participants agreeing that SWSC should be the contractual model going forward the causes of them not implementing these contracts need further investigation;

- An understanding of the factors that hamper and/or inhibit the private sector from investing more in South African Municipalities in terms of projects and funding models such as SWSCs; and

- Lastly, the true vacancy rates should be assessed in consultation with the Municipalities' HR units and should not have required the technical officials' input as their responses may bring about errors in the vacancy data.

5.6 Summary of Chapter

This study's research questions and objectives have been adequately addressed. Although there were limitations with regard to the study these limitations did not severely impact the conclusions and recommendations that were made herein. All the recommendations provided are relevant, realistic and practical to achieve. However, various stakeholders all need to be involved in these recommendations if the province and country want to reduce NRW successfully and sustainably. The study presented published data on staff vacancy rates which was much lower than what is actually the situation and this needs to be addressed as the NRW problems cannot be addressed without adequate staffing of competent officials with the requisite qualifications, knowledge and experience. The study also indicated that the main reason for vacancy rates was due to budget constraints which could be overcome if SWSCs are utilised in a sustainable manner. It is evident that using SWSCs as a model for funding from the private sector can lead to the reduction of NRW whilst simultaneously overcoming budget deficits for filling posts within the DMs as well as facilitating the knowledge and skills transfer from the private sector to the public sector officials in KZN DMs.

References

AAMO, O. M. 2016. Leak detection, size estimation and localization in pipe flows. *IEEE Transactions on Automatic Control,* 61**,** 246-251.

ADEDEJI, K. B., HAMAM, Y., ABE, B. T. & ABU-MAHFOUZ, A. M. 2018. Pressure management strategies for water loss reduction in large-scale water piping networks: A review. *Advances in Hydroinformatics.* Springer.

AJAM, T. 2014. Intergovernmental fiscal relations in South Africa. *The Oxford Companion to the Economics of South Africa*.

AL-WASHALI, T. 2011. Non-revenue water management in Sana'a water distribution system. *Institute for Technology and Resources Management in the Tropics and Subtropics (ITT), University of Jordan*.

ALPEROVITS, E. & SHAMIR, U. 1977. Design of optimal water distribution systems. *Water resources research,* 13**,** 885-900.

BAHADIR, A. M. & DICHTL, N. 2015. EXCEED–Excellence Centre for Development Cooperation Sustainable Water Management in Developing Countries. *Journal of Water Resource and Hydraulic Engineering Jan,* 4**,** 1-8.

BAIETTI, A., KINGDOM, W. & VAN GINNEKEN, M. 2006. *Characteristics of well-performing public water utilities*, Water Supply and Sanitation Board.

BEAL, C. D. & FLYNN, J. 2015. Toward the digital water age: Survey and case studies of Australian water utility smart-metering programs. *Utilities Policy,* 32**,** 29-37.

BERARDI, L. & GIUSTOLISI, O. 2016. Special issue on the battle of background leakage assessment for water networks. American Society of Civil Engineers.

BINDAK, R. 2013. Relationship between randomness and coefficient alpha: a Monte Carlo simulation study. *Journal of Data Analysis and Information Processing,* 1**,** 13.

BONETT, D. G. & WRIGHT, T. A. 2015. Cronbach's alpha reliability: Interval estimation, hypothesis testing, and sample size planning. *Journal of Organizational Behavior,* 36**,** 3-15.

BRETTENNY, W. & SHARP, G. 2016. Efficiency evaluation of urban and rural municipal water service authorities in South Africa: A data envelopment analysis approach. *Water SA,* 42**,** 11-19.

CARDEN, K. & ARMITAGE, N. 2013. Assessing urban water sustainability in South Africa-not just performance measurement. *Water SA,* 39**,** 00-00.

CHARALAMBOUS, B., FOUFEAS, D. & PETROULIAS, N. 2014. Leak detection and water loss management. *Water Utility Journal,* 8**,** 25-30.

COUVELIS, F. & VAN ZYL, J. 2015. Apparent losses due to domestic water meter under-registration in South Africa. *Water SA,* 41**,** 698-704.

CRESWELL, J. W. & CRESWELL, J. D. 2017. *Research design: Qualitative, quantitative, and mixed methods approaches*, Sage publications.

DIEDENHOFEN, B. & MUSCH, J. 2016. cocron: A Web Interface and R Package for the Statistical Comparison of Cronbach's Alpha Coefficients. *International Journal of Internet Science,* 11.

DOLLEY, C. 2017. 'Pessimism', harsh realisations and a cash crunch: Unpacking the City of Cape Town's drought crisis plan. *News 24*.

DONNENFELD, Z., HEDDEN, S. & CROOKES, C. 2018. A Delicate Balance: Water Scarcity in South Africa.

DU PLESSIS, A. 2017. South Africa's Water Availability and Use. *Freshwater Challenges of South Africa and its Upper Vaal River.* Springer.

DWS 2018. National Water and Sanitation Master Plan: Volume 1 Call for Action. *In:* SANITATION, D. O. W. A. (ed.).

FABRICIUS, C., KOCH, E., TURNER, S. & MAGOME, H. 2013. *Rights resources and rural development: Community-based natural resource management in Southern Africa*, Routledge.

FARLEY, M. & LIEMBERGER, R. 2005. Developing a non-revenue water reduction strategy: planning and implementing the strategy. *Water Science and Technology: Water Supply,* 5**,** 41-50.

FARLEY, M. & TROW, S. 2003. *Losses in water distribution networks*, IWA publishing.

FERGUSON, T. S. 2017. *A course in large sample theory*, Routledge.

FONTANAZZA, C. M., NOTARO, V., PULEO, V. & FRENI, G. 2015. The apparent losses due to metering errors: a proactive approach to predict losses and schedule maintenance. *Urban Water Journal,* 12**,** 229-239.

FORCE, I. W. L. T. & THORNTON, J. 2003. Managing leakage by managing pressure: a practical approach. *Water 21*.

FRAUENDORFER, R. & LIEMBERGER, R. 2010. *The issues and challenges of reducing non-revenue water*, Asian Development Bank.

GOMES, R., SOUSA, J. & MARQUES, A. 2013. The influence of pressure/leakage relationships from existing leaks in the benefits yielded by pressure management. *Water Utility Journal,* 5**,** 25-32.

GONZÁLEZ-GÓMEZ, F., GARCÍA-RUBIO, M. A. & GUARDIOLA, J. 2011. Why is non-revenue water so high in so many cities? *Water Resources Development,* 27**,** 345-360.

GORDHAN, P. 2013. Budget speech. *Republic of South Africa, Pretoria: Government Printers*.

GOUNDEN, T., PFAFF, B., MACLEOD, N. & BUCKLEY, C. Provision of free sustainable basic sanitation: the Durban experience. 32nd WEDC International Conference, Sustainable Development of Water Resources, Water Supply and Environmental Sanitation, Colombo, 2006.

GRAVETTER, F. J. & WALLNAU, L. B. 2016. *Statistics for the behavioral sciences*, Cengage Learning.

GREEN, D. 2011. *Water conservation for small and medium-sized utilities*, American Water Works Association.

GUPTA, A. & KULAT, K. 2018. A Selective Literature Review on Leak Management Techniques for Water Distribution System. *Water Resources Management***,** 1-23.

HEDDEN, S. & CILLIERS, J. 2014. Parched prospects-the emerging water crisis in South Africa. *Institute for Security Studies Papers,* 2014**,** 16.

HERZ, R. K. 1998. Exploring rehabilitation needs and strategies for water distribution networks. *Journal of Water Supply: Research and Technology-Aqua,* 47**,** 275-283.

HUNT, J., MCDEVITT, W. & HUNT, G. 1998. Water efficiency manual for commercial, industrial and institutional facilities. *A joint publication of the Division of Pollution Prevention and Environmental Assistance and Division of Water Resources of the North Carolina Department of Environment and Natural Resources, and the Land-of-Sky Regional Council-WRATT Program*.

HUSSEINA, M., YONEDAA, K., NOR'AZIZI OTHMANA, Z., ZAKIB, M. & YUSOFC, M. H. M. 2017. EFFECTS OF NUMBER OF CONNECTIONS AND PIPE LENGTH TO THE WATER LOSSES IN MELAKA. *JURNAL TEKNOLOGI,* 79**,** 45-59.

KAMAU, H. N. 2013. *Fringe benefits effects on employee productivity in the public sector (a case of state department of water, Nairobi County, Kenya).*

KANAKOUDIS, V. & MUHAMMETOGLU, H. 2014. Urban Water Pipe Networks Management Towards Non-Revenue Water Reduction: Two Case Studies from Greece and Turkey. *CLEAN–Soil, Air, Water,* 42**,** 880-892.

KHEMANI, S. 2015. Buying votes versus supplying public services: Political incentives to under-invest in pro-poor policies. *Journal of Development Economics,* 117**,** 84-93.

KIEFER, L., VAN DE LANDE, H., ADLER-MICHAELSON, H., NEUMEYER, H., KHALFAN, A., ROAF, V., MORLEY, D., O'CONNELL, M., JOHNSON, C. & MONTGOMERY, I. 2012. The Human Right to Safe Drinking Water and Sanitation in Law and Policy–A Sourcebook. *WASH United, Berlin, Germany*.

KIM, J. H. & MAYS, L. W. 1994. Optimal rehabilitation model for water-distribution systems. *Journal of Water Resources Planning and Management,* 120**,** 674-692.

KINGDOM, B., LIEMBERGER, R. & MARIN, P. 2006. *The challenge of reducing non-revenue water (NRW) in developing countries. How the private sector can help: A look at performance-based service contracting*, World Bank Group.

KLEINER, Y., ADAMS, B. J. & ROGERS, J. S. 1998. Long-term planning methodology for water distribution system rehabilitation. *Water resources research,* 34**,** 2039-2051.

KLUG, H. 2010. *The constitution of South Africa: a contextual analysis*, Bloomsbury Publishing.

KREJCIE, R. V. & MORGAN, D. W. 1970. Determining sample size for research activities. *Educational and psychological measurement,* 30**,** 607-610.

LAMBERT, A. 1994. Accounting for losses: The bursts and background concept. *Water and Environment Journal,* 8**,** 205-214.

LAMBERT, A. 2002. International report: water losses management and techniques. *Water Science and Technology: Water Supply,* 2**,** 1-20.

LAMBERT, A., BROWN, T. G., TAKIZAWA, M. & WEIMER, D. 1999. A review of performance indicators for real losses from water supply systems. *Journal of Water Supply: Research and Technology-AQUA,* 48**,** 227-237.

LAMBERT, A., FANTOZZI, M. & THORNTON, J. Practical approaches to modeling leakage and pressure management in distribution systems–progress since 2005. Proceedings of the 12th Int. Conf. on Computing and Control for the Water Industry-CCWI2013, 2013.

LASCANO, S. K., NUÑEZ, J., ESPARRAGOZA, I. E., SCHMIDT, L. & NAGEL, R. Teaching students to appreciate the global challenges of sustainability. Twelfth LACCEI Latin American and Caribbean Conference for Engineering and Technology, Guayaquil, Ecuador, 2014.

LI, R., HUANG, H., XIN, K. & TAO, T. 2015. A review of methods for burst/leakage detection and location in water distribution systems. *Water Science and Technology: Water Supply,* 15**,** 429-441.

LOW, K. G., GRANT, S. B., HAMILTON, A. J., GAN, K., SAPHORES, J. D., ARORA, M. & FELDMAN, D. L. 2015. Fighting drought with innovation: Melbourne's response to the Millennium Drought in Southeast Australia. *Wiley Interdisciplinary Reviews: Water,* 2**,** 315-328.

MALITHI, W. 2017. Impacts of non revenue water on the national water supply and drainage board and methods to minimize it.

MCHUGH, M. L. 2013. The chi-square test of independence. *Biochemia medica: Biochemia medica,* 23**,** 143-149.

MCKENZIE, R. & WEGELIN, W. 2009. Challenges facing the implementation of water demand management initiatives in Gauteng Province. *Water SA,* 35**,** 168-174.

MCKENZIE, R. S., SIQALABA, Z. & WEGELIN, W. 2012. *The State of Non-Revenue Water in South Africa (2012)*, Water Research Commission.

MEIER, B. M., KAYSER, G. L., KESTENBAUM, J. G., AMJAD, U. Q., DALCANALE, F. & BARTRAM, J. 2014. Translating the human right to water and sanitation into public policy reform. *Science and engineering ethics,* 20**,** 833-848.

MERTENS, D. M. 2014. *Research and evaluation in education and psychology: Integrating diversity with quantitative, qualitative, and mixed methods*, Sage publications.

MONKAM, N. F. 2014. Local municipality productive efficiency and its determinants in South Africa. *Development Southern Africa,* 31**,** 275-298.

MONNEY, I., ODURO-KWARTENG, S. & ODAI, S. N. 2014. Assessing human resource capacity needs to meet the MDG targets on water and sanitation in Ghana. *Developing Country Studies,* 4**,** 17-27.

NARDI, P. M. 2018. *Doing survey research: A guide to quantitative methods*, Routledge.

ORGANIZATION, W. H. 2014. Investing in water and sanitation: increasing access, reducing inequalities, special report for the Sanitation and Water for All (SWA), high level meeting (HLM) 2014.

PEARSON, D. Developing a non-revenue water reduction strategy with inadequate data. IWA International Conference 'WaterLoss, 2009. 6-12.

ROBINSON, O. C. 2014. Sampling in interview-based qualitative research: A theoretical and practical guide. *Qualitative Research in Psychology,* 11**,** 25-41.

RUITERS, C. 2013. Funding models for financing water infrastructure in South Africa: Framework and critical analysis of alternatives. *Water SA,* 39**,** 313-326.

SANTOS, J. R., PAGSUYOIN, S. T., HERRERA, L. C., TAN, R. R. & KRISTA, D. Y. 2014. Analysis of drought risk management strategies using dynamic inoperability input–output modeling and event tree analysis. *Environment Systems and Decisions,* 34**,** 492-506.

SCHWALLER, J. & VAN ZYL, J. 2014. Modeling the pressure-leakage response of water distribution systems based on individual leak behavior. *Journal of Hydraulic Engineering,* 141**,** 04014089.

SEAGO, C. & MCKENZIE, R. S. 2007. *An assessment of non-revenue water in South Africa*, Water Research Commission Pretoria.

SEKARAN, U. & BOUGIE, R. 2016. *Research methods for business: A skill building approach*, John Wiley & Sons.

SELVIARIDIS, K. & WYNSTRA, F. 2015. Performance-based contracting: a literature review and future research directions. *International Journal of Production Research,* 53**,** 3505-3540.

SHARPE, D. 2015. Your chi-square test is statistically significant: Now what? *Practical Assessment, Research & Evaluation,* 20.

STATSSA 2017. Municipalities: Where are the staff vacancies? *In:* STATSSA (ed.).

SUPPLY, W. U. J. W. & PROGRAMME, S. M. 2014. *Progress on drinking water and sanitation: 2014 Update*, World Health Organization.

SUTHERLAND, C., HORDIJK, M., LEWIS, B., MEYER, C. & BUTHELEZI, S. 2014. Water and sanitation provision in eThekwini Municipality: a spatially differentiated approach. *Environment and Urbanization,* 26**,** 469-488.

TANDWA, L. 2018. Drought Crisis: 3 Provinces Declared National Disasters. Available: https://www.news24.com/SouthAfrica/News/drought-crisis-3-provinces-declared-national-disasters-20180213 [Accessed 20 March 2018].

THORNTON, J. & LAMBERT, A. 2006. Managing pressures to reduce new breaks. *Water,* 21**,** 24-26.

THORNTON, J. & RIZZO, A. Apparent losses, how low can you go. Proceedings of the leakage management conference, 2002. 20-22.

TREASURY, L. P. 2012. Municipal Finance Management Act.

TREASURY, N. 2008. 2008 Local Government Budgets and Expenditure Review.

VAN DEN BERG, C. 2015. Drivers of non-revenue water: A cross-national analysis. *Utilities Policy,* 36**,** 71-78.

VANALLE, R. M., LUCATO, W. C. & SATO, I. D. 2017. Business innovation in credit and collection: a case study in a Brazilian water supplying company. *International Journal of Business Innovation and Research,* 14**,** 382-396.

VASKE, J. J., BEAMAN, J. & SPONARSKI, C. C. 2017. Rethinking internal consistency in Cronbach's Alpha. *Leisure Sciences,* 39**,** 163-173.

VENKATESH, G. & BRATTEBØ, H. 2012. Assessment of environmental impacts of an aging and stagnating water supply pipeline network. *Journal of Industrial Ecology,* 16**,** 722-734.

VENKATESH, G., CHAN, A. & BRATTEBØ, H. 2014. Understanding the water-energy-carbon nexus in urban water utilities: Comparison of four city case studies and the relevant influencing factors. *Energy,* 75**,** 153-166.

VERMERSCH, M., CARTEADO, F., RIZZO, A., JOHNSON, E., ARREGUI, F. & LAMBERT, A. 2016. Guidance Notes on Apparent Losses and Water Loss Reduction Planning. *UK. Free download available at http://www. leakssuite. com/guidance-notes-app-loss*.

WEGELIN, W. & JACOBS, H. 2013. The development of a municipal water conservation and demand management strategy and business plan as required by the Water Services Act, South Africa. *Water SA,* 39**,** 415-422.

WEGELIN, W. A. 2015. *Guideline for a robust assessment of the potential savings from water conservation and water demand management.* Stellenbosch: Stellenbosch University.

YEBOAH, P. & KAYAGA, M. 2008. Management of non-revenue water: A case study of the water supply in Accra, Ghana. *Water, Engineering and Development Centre, Department of Civil Engineering, Loughborough University*.

ZUMA, J. 2010. *State of the Nation Address by His Excellency, JG Zuma, President of the Republic of South Africa, at the Joint Sitting of Parliament, Cape Town*, The Presidency.

Appendix 1: Informed Consent Letter and Questionnaire

UNIVERSITY OF KWAZULU-NATAL
GRADUATE SCHOOL OF BUSINESS AND LEADERSHIP

Dear Respondent,

MBA Research Project
Researcher: Mr Vishal Poona 031-7001177
Supervisor: Dr Vuyokazi Mtembu 031-2608192
Research Office: Ms P Ximba 031-2603587

I, Vishal Asvant Poona an MBA student, at the Graduate School of Business and Leadership, of the University of KwaZulu Natal. You are invited to participate in a research project entitled "Non-Revenue Water Reduction Programs Funded by the Private Sector to solve Under Staffing at Kwa-Zulu Natal's Municipalities". The aim of this study is to determine what the true, current rate of vacancies are for KZN's DMs as well as the extent of the knowledge is for NRW reduction programs and if a relatively new funding model in the water industry can be utilised by the private sector to solve both the human resources dilemma and perceived lack of knowledge by Municipal officials.

Through your participation I hope to understand the current situation of why there is such a high vacancy rate within Municipalities as well as their knowledge of NRW principles. The results of the focus group are intended to contribute to providing these Municipalities with a finance model that will assist them in getting private sector funding to help fill the vacant posts as well as skills transfer and training to increase NRW knowledge of all officials.

Your participation in this project is voluntary. You may refuse to participate or withdraw from the project at any time with no negative consequence. There will be no monetary gain from participating in this survey/focus group. Confidentiality and anonymity of records identifying you as a participant will be maintained by the Graduate School of Business and Leadership, UKZN.

If you have any questions or concerns about completing the questionnaire or about participating in this study, you may contact me or my supervisor at the numbers listed above.

The survey should take you about 12 minutes to complete. I hope you will take the time to complete this survey and I thank you for taking part in the research should you wish to do so.

Sincerely

Investigator's signature_____ Date_____

This page is to be retained by participant

UNIVERSITY OF KWAZULU-NATAL
GRADUATE SCHOOL OF BUSINESS AND LEADERSHIP

MBA Research Project
Researcher: Mr Vishal Poona 031-7001177
Supervisor: Dr Vuyokazi Mtembu 031-2608192
Research Office: Ms P Ximba 031-2603587

CONSENT

I…… (full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project. I understand that I am at liberty to withdraw from the project at any time, should I so desire.

SIGNATURE OF PARTICIPANT

……

This page is to be retained by researcher

Section A: Respondent Data and Vacancy Rates

(Please place a cross on the appropriate box and fill in information where required)

1. Age

☐ 18 – 25 ☐ 26 – 35 ☐ 36 – 45 ☐ 46 – 55 ☐ over 55

2. Highest Education Level

☐ National Certificate ☐ National Diploma ☐ Honour's Degree/BTech
☐ Bachelor's Degree ☐ Master's Degree ☐ PhD
☐ None ☐ Other (please specify) ……

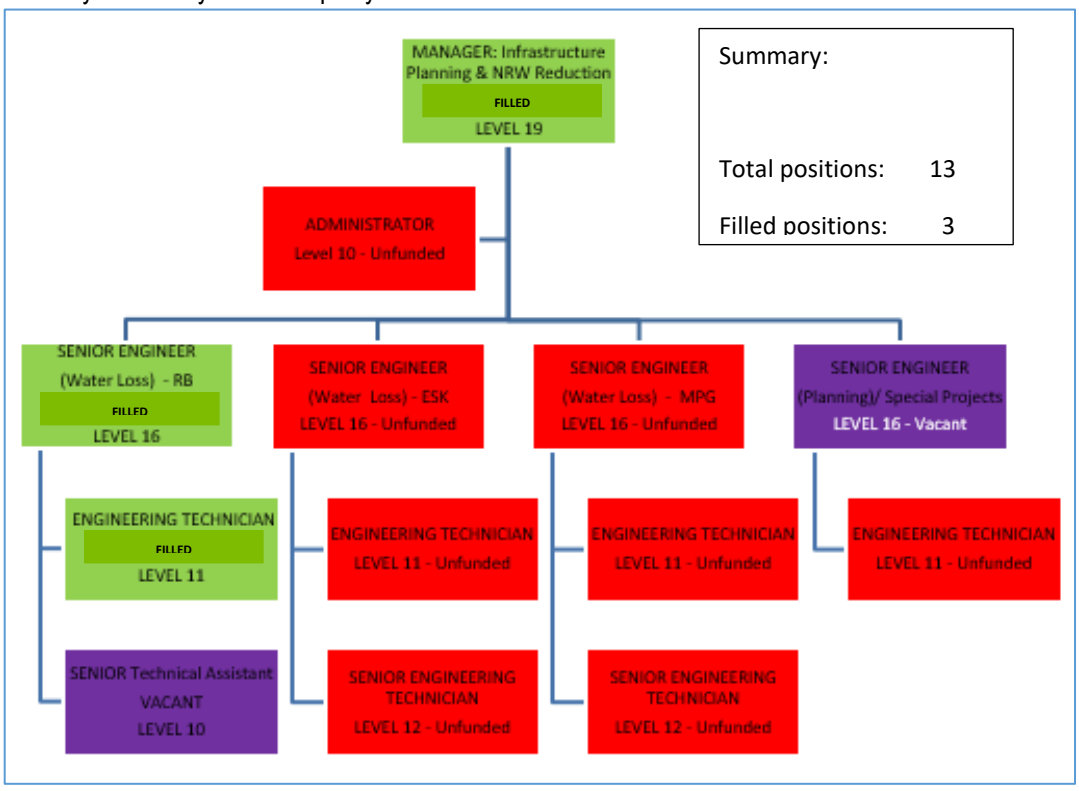
3. Current designation in the Municipality

☐ Candidate Technician ☐ Candidate Engineer ☐ Technician
☐ Engineer ☐ Project Technician ☐ Project Engineer
☐ Manager ☐ Head of Department ☐ Director
☐ Executive ☐ Other (please specify) ……

4. Current Task/Salary Grading in the Municipality

Grade level (please specify between Grade levels 1 to 25): ……

5. Vacancy Rates at your Municipality



Using a typical organogram example shown in the previous page, please answer the following questions with respect to your OWN Municipality:

5a) What category is your Municipality?

☐ A ☐ B1 ☐ B2 ☐ B3 ☐ B4 ☐ not sure

5b) Does your Municipality have a Non-Revenue Water or Water Conservation/Water Demand Management Unit?

☐ Yes ☐ No

5c) How many positions (including filled, vacant, unfunded) in total are there in your Municipality's Non-Revenue Water or Water Conservation/Water Demand Management Unit according to approved organogram?

Please specify: ……

5d) How many positions in this unit are filled?

Please specify: ……

5e) How many positions in this unit are vacant?

Please specify: ……

5f) How many positions in this unit are unfilled/unbudgeted/frozen?

Please specify: ……

5g) Why do you believe that there is the current vacancy rate in the NRW unit at your Municipality?

☐ Skills shortage in the industry with regard to this specialty to fill these positions
☐ Municipality does not understand the importance of this Unit's function
☐ Municipality does not have sufficient budget to fill this Unit's vacant posts
☐ Municipality has other budget priorities to deal with like backlogs etc.
☐ Not sure.
☐ Other reason/s, please specify: ……..

……

……

Section B: Respondents knowledge of NRW Principles and Concepts

(Please place only one cross on the appropriate box for each question)

6. What are the outcomes of pressure management?

☐ A reduced minimum night flow
☐ A decrease in burst frequency in the network under pressure management
☐ A reduction in average zone pressure
☐ All of the above
☐ Not sure.

7. Apparent Losses include the following components:

☐ Illegal connections, meter under reading and reservoir overflows
☐ Meter under/over registration and unauthourised consumption
☐ Illegal connections, meter over reading and reservoir overflows
☐ All of the above
☐ Not sure.

8. Non-Revenue Water can be defined as

☐ Water produced by treatment plants which is billed to consumers
☐ Difference between the water supplied and sold to consumers
☐ Water that has been produced and is lost before it reaches the consumer
☐ All of the above
☐ Not sure.

9. Which real loss intervention should be carried out last taking into account the cost of the intervention:

☐ Pressure management
☐ Active leak detection
☐ Pipeline/mains replacement
☐ Speed and quality of leakage repair
☐ Not sure.

10. In the South African Modified Water Balance the component of Billed Authourised Consumption consists of:

☐ Billed Metered Consumption
☐ Billled Unmetered Consumption
☐ Revenue Water
☐ Free Basic Water
☐ All of the above.

Section C: Shared Saving Contracts and their Application for NRW Reduction Contracts

(To what extent do you agree with the following statements? Using a scale of 1 to 5, please circle the numeric value corresponding to your opinion for each statement)

No	Statement	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
11	The private sector has more experience/knowledge with NRW than the public sector	1	2	3	4	5
12	Once NRW programs are completed by the private sector the knowledge/skills transfer to the Municipalities is sufficient	1	2	3	4	5
13	Shared Savings Contracts can be used by Municipalities and is allowed by the Municipal Finance Management Act	1	2	3	4	5
14	Municipalities can solely solve the high NRW problems and vacancy rates using internal funding and National Government's Grant funding	1	2	3	4	5
15	Shared Savings Contracts only benefit the private sector and there is no benefit to the Municipalities either through financial gain or skills transfer	1	2	3	4	5
16	Shared Savings Contracts which are fully funded by the private sector could be used to reduce NRW and vacancy rates and increase skills transfer to the Municipalities	1	2	3	4	5

Appendix 2: Ethical Clearance

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

16 October 2018

Mr Vishal Asvant Poona 981192763
Graduate School of Business and Leadership
Westville Campus

Dear Mr Poona

Protocol Reference Number : HSS/1313/018M
Project title: Non-revenue Water Reduction Programs Funded by the private sector to solve Under staffing at Kwa-Zulu-Natals municipalities

Full Approval – Expedited Application

In response to your application received 21 August 2018, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol has been granted **FULL APPROVAL.**

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment /modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

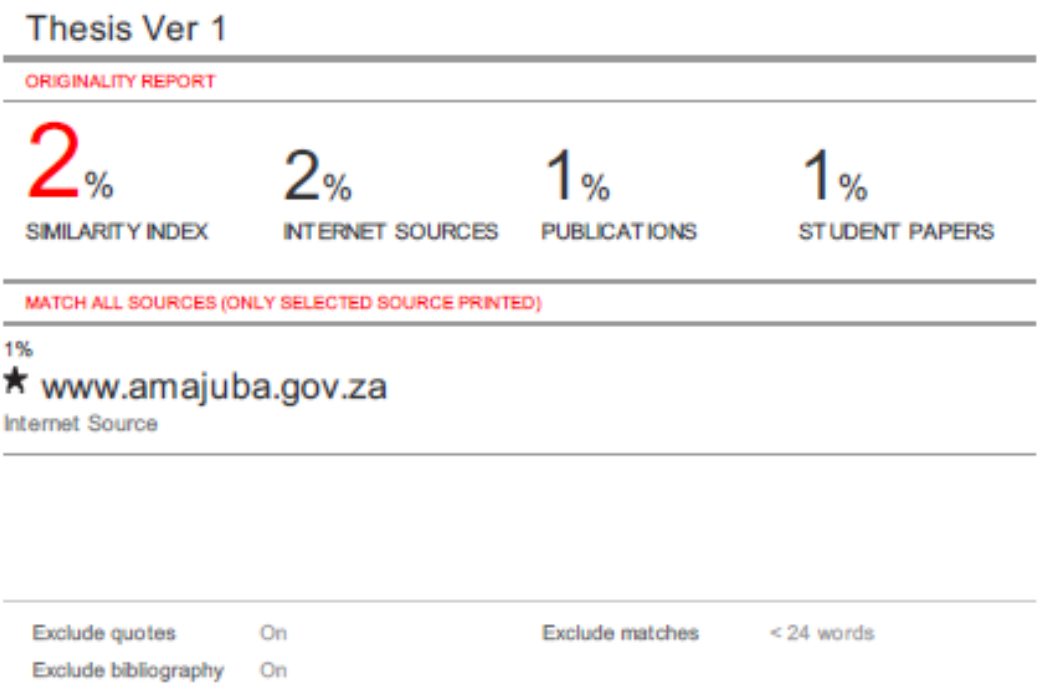
[redacted]

Dr Rosemary Sibanda (Deputy Chair)
Humanmities & Social Sciences Research Ethics Committee

/pm

Cc Supervisor: Dr Vuyokazi Mthembu
cc Academic Leader Research: Professor M Hoque
cc School Administrator: Ms Zarina Bullyraj

Appendix 3: Turnitin Report



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